Uniform Federal Policy-
Quality Assurance Project Plan

Hazardous Toxic and Radioactive Waste Project
Remedial Investigation

Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Contract No. 912DR-15-D-0014
Delivery Order No. W912DR18F0587

Prepared for

United States Army Corps of Engineers
Baltimore District

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
°F	Degrees Fahrenheit
%	Percent
%D	Percent difference
%R	Percent recovery
ADR	Automated Data Review
AES	Atomic emission spectroscopy
Alion	Alion Science and Technology Corporation
AOC	Area of concern
AM	Amino
APP	Accident Prevention Plan
ARAR	Applicable or relevant and appropriate requirements
ASR	Archives Search Report
AST	Aboveground storage tank
ASTM	American Society for Testing and Materials
B.A.	Bachelor of Arts
BERA	Baseline ecological risk assessment
BFB	4-bromofluoro-benzene
B.S.	Bachelor of Science
bgs	Below ground surface
Bluestone	Bluestone Environmental Group, Inc.
BRAC	Base Realignment and Closure
BTEX	Benzene, toluene, ethylbenzene, and xylene
CAS	Chemical Abstracts Service
CCB	Continuing calibration blank
CCV	Continuing calibration verification
CCVA	Cold vapor atomic absorption
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIH	Certified Industrial Hygienist
CLLE	Continuous liquid/liquid extraction
COC	Contaminant of concern
COD	Chemical oxygen demand
CON	Containerized
COPC	Contaminant of potential concern
COR	Contracting Officer Representative
CPR	Cardiopulmonary resuscitation
CSM	Conceptual site model

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

CSP	Certified Safety Professional
CVAA	Cold vapor atomic absorption
D	Difference
DCE	1,2-dichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DER	Division of Environmental Remediation
DERP	Defense Environmental Restoration Program
DFW	Definable feature of work
DFTPP	Decafluorotriphenylphosphine
DoD	Department of Defense
DGM	Digital geophysical mapping
DNT	Dinitrotolune
DO	Dissolved oxygen
DQO	Data quality objective
DU	Decision unit
EA	EA Engineering, P.C. and Its Affiliate EA Science and Technology
ECD	Electron capture detector
EICP	Extracted ion current profile
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer manual
EMI	Electromagnetic
EOD	Explosive ordnance disposal
EPA	United States Environmental Protection Agency
ERA	Ecological risk assessment
FS	Feasibility study
FSP	Field sampling plan
ft	Foot (feet)
FUDS	Formerly Used Defense Site
FUDSChem	Formerly Used Defense Site Online Chemical Database
GC	Gas chromatograph
GIS	Geographic information system
GPR	Ground penetrating radar
Greeley-Polhemus	Greeley-Polhemus Group, Inc.
GSA	General Services Administration
GSE	Green Seal Environmental, Inc.
H_a	Alternative hypothesis

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

H_0	Null hypothesis
HASP	Health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCI	Hydrochloric acid
HDPE	High density polyethylene
HHRA	Human health risk assessment
HI	Heat index
HNO3	Nitric acid
HPA	Historic Photographic Analysis
HPLC	High performance liquid chromatography
HTRW	Hazardous toxic and radioactive waste
ICAL	Initial calibration
ICP	Inductively coupled plasma
ICP-AES	Inductively coupled plasma-atomic emission spectroscopy
ICS	Interfering element check standards
ICS-A	Interference check solution A
ICS AB	Interference check solution AB
ISTD	Internal standard
ICV	Internal calibration verification
ID	Identification
IDW	Investigation-derived waste
IRP	Installation restoration program
ISM	Incremental sampling methodology
in.	Inch(es)
IS	Internal standard
ITRC	Interstate Technology Regulatory Council
KO	Contracting Officer
LCS	Laboratory control sample
LCMSMS	Liquid Chromatography with tandem mass spectrometry
LDR	Linear dynamic range
LEP	Licensed Engineering Professional
LLCCV	Low-level calibration check standard
LOD	Limit of detection
LOQ	Limit of quantitation
LUC	Land use control
MC	Munition constituents
MCL	Maximum contaminant level
MD	Munitions debris

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

MDL	Method detection limit
MEC	Munitions and explosives of concern
mg/kg	Milligram(s) per kilogram
mg/kg	Milligram(s) per kilogram
mL	Milliliter(s)
MMRP	Military Munitions Response Program
MPPEH	Material potentially presenting an explosive hazard
MRS	Munitions Response Services
MS	Matrix spike
MS	Mass spectrometry
M.S.	Master of Science
MSA	Measurement systems analysis
MSD	Matrix spike duplicate
NA	Not applicable
NAVSCOLEOD	Naval School, Explosive Ordnance Disposal
NCP	National Contingency Plan
ND	Non-detect
NFA	No further action
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NS	No standard
NV	Not validated
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OEW	Ordnance and Explosive Waste
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste Emergency Response
oz	Ounce(s)
PA	Preliminary assessment
PAH	Polycyclic aromatic hydrocarbon
PAL	Project action limit
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethylene
PDF	Portable document format
PDS	Post digestion spike
P.E.	Professional Engineer
PFTBA	PerFluoroTriButylAmine

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

P.G.	Professional Geologist
Ph.D.	Doctor of Philosophy
PIPC	Palisades Interstate Park Commission
PM	Project Manager
PMP	Project management plan
POC	Point-of-contact
POL	Petroleum, oil, and lubricants
PPE	Personal protective equipment
PUL	Precision utility location
QA	Quality assurance
QAPP	Quality assurance project plan
QASP	Quality assurance surveillance plan
QC	Quality control
QCP	Quality control plan
QCS	Quality control supervisor
QL	Quantitation limit
QSM	Quality Systems Manual
RSCO	Recommended soil cleanup objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
RPD	Relative percent difference
RRT	Relative tension time
RSD	Relative standard deviation
RSL	Regional screening level
RT	Retention time
SA	Spike added to spiking matrix
SARA	Superfund Amendments and Reauthorization Act
SEDD	Staged electronic data deliverables
SI	Site investigation
SIM	Selected ion monitoring
SLERA	Screening-level ecological risk assessment
SME	Sporadic marginal exceedance
SOP	Standard operating procedure
SR	Sample result
SSHO	Site Safety and Health Officer
SSL	Soil screening level
SSR	Spike sample result
STR	Senior technical reviewer

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

SU	Sampling unit
SUXOS	Senior Unexploded Ordnance Supervisor
SVOC	Semi-volatile organic compound
TAL	Target analyte list
TBD	To be determined
TCE	Trichloroethylene
TCL	Target compound list
TNT	Trinitrotoluene
µg/L	Microgram(s) per liter
USACE	U.S. Army Corps of Engineers
USAEC	United States Army Environmental Command
USFWS	U.S. Fish and Wildlife Service
USAGC	United States Army Geospatial Center
UST	Underground storage tank
UXO	Unexploded ordnance
UXOQCS	UXO Quality Control Specialist
UXOSO	UXO Safety Officer
VE	Validation electronic
VEM	Validation electronic and manual
VOA	Volatile organic analyte
VOC	Volatile organic compound

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INTRODUCTION

EA Engineering, P.C. and Its Affiliate EA Science and Technology (EA)[1] has prepared this Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) in support of the Hazardous Toxic and Radioactive Waste (HTRW) Remedial Investigation (RI) being conducted at the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS), located in Stony Point, Rockland County, New York (NY) (FUDS Project Number [No.] C02NY074403) (Figure 1). The work is being performed under W912DR-15-D-0014 Delivery Order Number (No.) W912DR18F0587, under the oversight of the U.S. Army Corps of Engineers (USACE) Baltimore and New England Districts.

This UFP-QAPP functions as the work plan for EA to implement the HRTW RI which includes the investigation of 19 HTRW Areas of Concern (AOCs) and munitions constituents (MC) associated with the operational history of the site. This UFP-QAPP documents the project organization, roles, and responsibilities; specific investigative procedures, data collection activities; laboratory analytical and reporting procedures; quality assurance (QA), and quality control (QC); and the assessment of oversight planning that will help ensure the quality of the investigation. The purpose of this UFP-QAPP is to provide instruction and guidance associated with the collection, analysis, and reporting of data to ensure collected data are scientifically valid, meet the established QC objectives, are legally defensible, and support project objectives.

The Iona Island Naval Ammunition Depot FUDS consists of approximately 124 acres of land and inland water. The Navy used the site as an Ammunition Depot from 1900 to 1947. Activities included preparing, assembling, maintaining, inspecting, testing, and issuing ammunition; however, there was no manufacturing conducted on site. Iona Island Naval Ammunition Depot was deactivated in 1947. The former depot was excessed by the Navy in 1957 and transferred to the General Services Administration (GSA). GSA conveyed the FUDS property to Palisades Interstate Park Commission (PIPC) in 1965. PIPC currently utilizes a portion of Iona Island as a storage facility; however, the property is closed to the public and use is restricted to park purposes only. The FUDS property is part of the much larger Hudson River National Estuarine Research Reserve, a Significant Coastal Fish and Wildlife Habitat Area and National Natural Landmark.

Historical Department of Defense (DoD) activities at the Iona Island Naval Ammunition Depot FUDS may have resulted in the release of contaminants to environmental media (surface soil, subsurface soil, sediment, surface water, and groundwater) at concentrations that may pose a risk to human health and ecological receptors. In addition, historical records for the Iona Island Naval Ammunition Depot FUDS include several reports of ordnance items found within the FUDS and the potential for munitions of explosive concern (MEC) to be found within the FUDS. An explosion in 1903, originating from the approximate center of the depot, is thought to have thrown stored ammunition shells as far as 1,250 feet (ft) from the blast. Anecdotal evidence identifies the potential for MEC around the former loading docks, where munitions may have been intentionally

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[1] EA Engineering, P.C. is affiliated with EA Engineering, Science, and Technology, Inc., PBC who does business as EA Science and Technology in State of New York.

dumped or accidentally dropped into the Hudson River during the loading and unloading of supply vessels. Additionally, several potential MEC items have been reportedly sighted in low-tide conditions in an area between Iona Island and Round Island referred to as a “dump site” (Alion 2008).

The USACE is conducting work at the site under the Defense Environmental Restoration Program (DERP) for FUDS (DERP-FUDS) and in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendment and Reauthorization Act, and the National Oil and Hazardous Substances Contingency Plan (National Contingency Plan [NCP]. The FUDS program cleans up only DoD-generated eligible contamination, which occurred before the transfer of the property to private owners or federal, state, or local governments.

There are three projects at the Iona Island Naval Ammunition Depot FUDS:

- C02NY074401 Containerized (CON) HTRW project, which include response actions at an area of an eligible FUDS property to address:

    — Underground storage tanks (USTs), aboveground storage tanks (ASTs), transformers, hydraulic systems, investigative-derived waste (IDW), abandoned inactive monitoring wells, etc. Response actions for drums containing hazardous substances, pollutants, and contaminants are performed under the HTRW project category.

    — Incidental removal of contaminated soil resulting from a leaking UST or other container.

    — Long-term corrective actions required by Resource Conservation and Recovery Act (RCRA) Subtitle I, involving significant soil and groundwater response actions following UST closure/removal actions.

- C02NY074402 HTRW project, which includes environmental response actions at an area of an eligible FUDS property as the result of DoD activities related to hazardous substances, pollutants, and contaminants as defined in CERCLA; petroleum, oil, or lubricants (POL); DoD-unique materials; hazardous wastes or hazardous waste constituents; low-level radioactive materials or low-level radioactive wastes and explosive compounds released to soil, surface water, sediments, or groundwater as a result of DoD activities.

- C02NY074403 Military Munitions Response Program (MMRP) project, which include response actions at an area of an eligible FUDS property related to military MEC and their MC as the result of DoD activities at FUDS.

This UFP-QAPP was prepared for the HTRW RI. The FUDS CON/HTRW project was closed out in 2012. The MEC investigation portion of the MMRP project is being addressed under a separate MMRP RI with a separate UFP-QAPP. Table 1 provide at the end of the Introduction provides a linkage between MMRP and HTRW UFP-QAPPs.

The HTRW RI is being conducted to characterize the nature and extent of hazardous substances in environmental media attributable to past DoD activities, and evaluate potential risk to human health and ecological receptors. Previous investigations have identified 19 areas of concern (AOCs) included in the HTRW project. The FUDS-eligible AOCs are the locations/footprints of former buildings/structures where various contaminants of potential concern (COPCs) resulting from historical site activities have been detected or may be present (Figure 2). The following buildings/structures were demolished/removed by PIPC between 1965 and 1972 (U.S. Army Geospatial Center [USAGC] 2018):

- ***AOC #1: Former Building 103*** – Paint and Oil Storage
- ***AOC #2: Former Building 121*** – Incinerator
- ***AOC #3: Former Building 123*** – Garage Building
- ***AOC #4: Former Buildings 124 to 128*** – Sewage Disposal Plant (and Suspected Outfall)
- ***AOC #5: Former Building 207*** – Marine Garage Building
- ***AOC #6: Former Building 213*** – Paint Locker for Building 202
- ***AOC #7: Former Building 215*** – Garage Building
- ***AOC #8: Former Building 219*** – Garage Building
- ***AOC #9: Former Building 220*** – Garage Building
- ***AOC #10: Former Building 406*** – Tin, Electrical, and Annealing Shop Building
- ***AOC #11: Former Building 407*** – Paint Shop and Pipe Shop
- ***AOC #12: Former Building 410*** – Power House
- ***AOC #13: Area A*** – One Former Fuel Oil AST (2,500 gallons); located near Former Building 233
- ***AOC #14: Area B*** – One Former Fuel Oil AST (size unknown); located near Dock 131

- ***AOC #15: Area C –*** Two Former Fuel Oil ASTs (size unknown); located near Former Building 417
- ***AOC #16: Area D –*** Dumping Area

- ***AOC #17: Area E –*** Former Coal Trestle and Storage Area; located near Former Building 410

- ***AOC #18: Area F –*** Former Coal Storage Area; located near Former Building 215

- ***AOC #19: Three Former Transformers –*** T1 northwest of Building 406, T2 near Area D, and T3 northeast of Building 220.

A review of additional former buildings was conducted during preparation of this UFP-QAPP at the request of the USACE to identify locations where filling or possible spilling of explosive-containing materials could have occurred. Seven former explosive storage and filling operations buildings were identified as having significant potential for explosive hazard based on limited information available in previous reports and input from USACE. These former buildings have not been previously investigated, and the presence of explosives in environmental media related to these buildings is unknown. Although these buildings are not currently included in the HTRW project at the Iona Island Naval Ammunition Depot FUDS and were not scoped in the existing contract, they are being considered for evaluation during this HTRW RI pending direction of contracting officer.

- Building 609 – Mine Loading Plant
- Building 506 – Filling House #3 (Bombproof)
- Building 503 – Filling House #6
- Building 404 – Filling House #1
- Building 307 – Filling House #5
- Building 306 – Filling House #2
- Building 202 – Shell House #5 & D Plant

This HTRW RI will be the first comprehensive investigation of the Iona Island Naval Ammunition Depot FUDS. A two-phased approach will be employed during this RI to facilitate data collection, evaluation, and discussion. Phase I will include sampling of environmental media within the FUDS boundary (surface soil from 0-6 in. bgs and shallow subsurface soil from 6-36 in. bgs or refusal) and an evaluation of potential risk to human and ecological receptors. A shoreline reconnaissance survey and sediment sampling for total organic carbon and grain size will be conducted to evaluate the potential transport of COPCs from the FUDS to the shoreline and the subsequent risk to human and ecological receptors. The results of the Phase I investigation will be used to evaluate the need for further investigation during Phase II.

While the HTRW and MMRP RIs are being conducted as separate investigations with separate UFP-QAPPs, the investigations will be implemented concurrently and results from each investigation will be used to supplement the findings of each RI. For example, while the MMRP RI includes the investigation of munitions and explosives of concern (MEC) and munitions constituents (MC) (explosives only) if a breached munitions item is encountered during the MMRP RI, soil sampling for MC including metals associated with the former operational use across the site, AOC #16 - Area D Dumping Area), is being investigated as a part of this HTRW investigation. The risk associated from potential munitions constituents will being evaluated as a part of the HTRW risk assessments. In addition, the MMRP RI includes geophysical surveys and intrusive investigations within the accessible land portions of the MRS-01 1903 Explosion Area boundary and four areas within the Iona Island Naval Ammunitions Depot FUDS boundary where dumping and/or dropping of munitions is suspected. If buried drums are identified during the geophysical and/or intrusive investigation (particularly in AOC #16 - Area D Dumping Area), then appropriate sampling of drums contents and surrounding soils be conducted under the HTRW RI during subsequent phases of investigation (i.e. Phase II or additional phases, if needed).

This UFP-QAPP functions as the work plan to implement the HTRW RI and, and as such, it documents the project organization, specific procedures for execution of the technical field sampling, laboratory analytical procedures, quality assurance (QA), quality control (QC), and the assessment of oversight planning that will help ensure the quality of the investigation. This document meets the requirements and elements set forth in the Intergovernmental Data Quality Task Force UFP for QAPPs (United States Environmental Protection Agency [EPA] 2005). The UFP-QAPP Manual integrates the EPA 7-step Data Quality Objective (DQO) process (EPA 2006), and the terminology in this UFP-QAPP is consistent with the UFP-QAPP Manual (EPA 2005). The worksheets in this document follow the Optimized UFP-QAPP format of Revision 1 of the UFP-QAPP Workbook (EPA 2012) as outlined in Table 2.

The purpose of this UFP-QAPP is to provide instruction and guidance associated with the collection, analysis, and reporting of data to ensure collected data are scientifically valid, meet the established QC objectives, are legally defensible, and support project objectives. This UFP-QAPP will be used in conjunction with the Accident Prevention Plan (APP) (EA 2018) and the Environmental Protection Plan (EPP) to address elements of the work to be performed (Appendix A and B).

The crosswalk identifying the Optimized UFP-QAPP worksheets compared with earlier EPA QAPP guidance (EPA 2001a, 2002a) is provided in Table 2. References used in preparation of the UFP-QAPP worksheets are presented in Worksheet #13 and at the end of this UFP-QAPP. Appendixes attached to this UFP-QAPP include the following:

- Appendix A: Accident Prevention Plan
- Appendix B: Environmental Protection Plan
- Appendix C: Technical Project Planning Meeting #1
- Appendix D: Human Health Risk Assessment Work Plan
- Appendix E: Ecological Risk Assessment Work Plan
- Appendix F: Laboratory Certifications
- Appendix G: Laboratory SOPs

- Appendix H: Field SOPs
- Appendix I: Field Forms

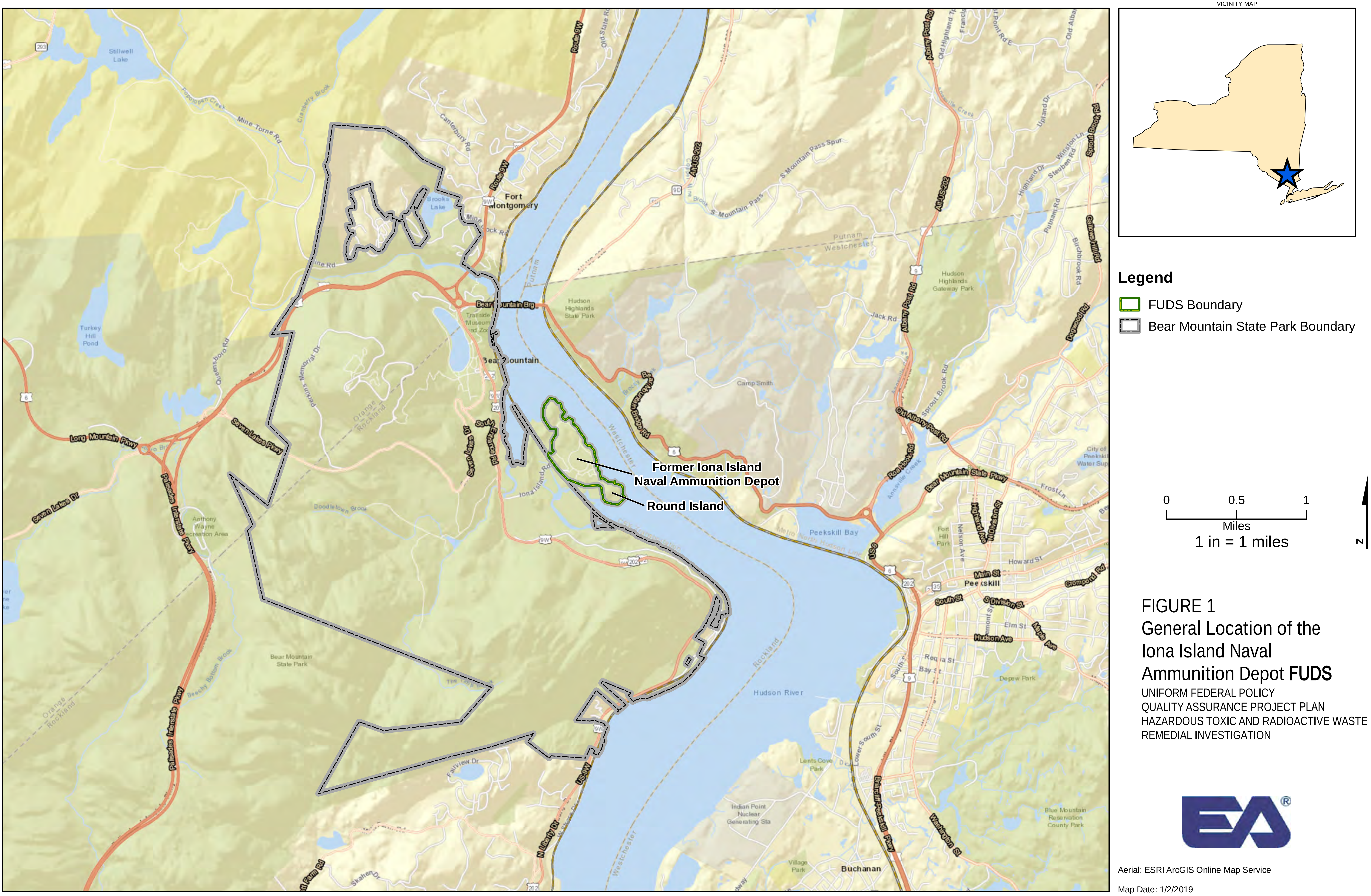

FIGURE 1
General Location of the Iona Island Naval Ammunition Depot **FUDS**
UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 1/2/2019

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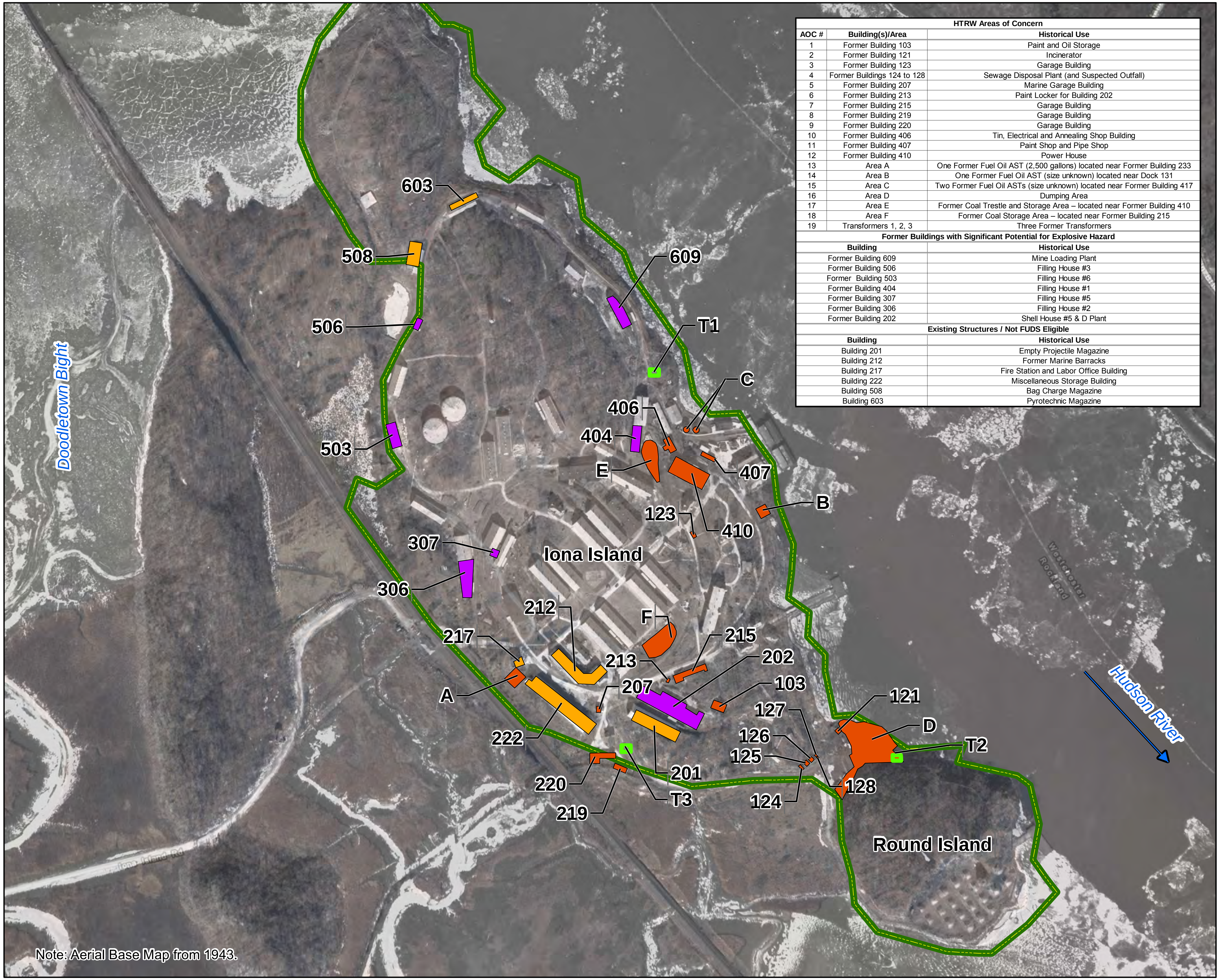


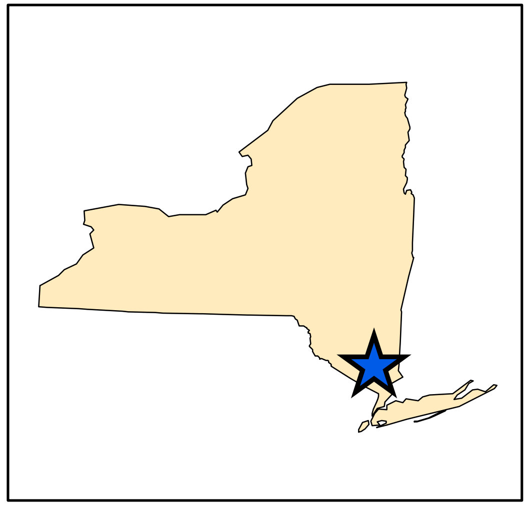
HTRW Areas of Concern		
AOC #	**Building(s)/Area**	**Historical Use**
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Former Buildings with Significant Potential for Explosive Hazard	
Building	**Historical Use**
Former Building 609	Mine Loading Plant
Former Building 506	Filling House #3
Former Building 503	Filling House #6
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

Existing Structures / Not FUDS Eligible	
Building	**Historical Use**
Building 201	Empty Projectile Magazine
Building 212	Former Marine Barracks
Building 217	Fire Station and Labor Office Building
Building 222	Miscellaneous Storage Building
Building 508	Bag Charge Magazine
Building 603	Pyrotechnic Magazine

Note: Aerial Base Map from 1943.

VICINITY MAP



Legend

- 🟩 FUDS Boundary
- 🟥 HTRW Project Areas of Concern
- 🟩 FormerTransformers
- 🟪 Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
- 🟧 Remaining Structure (Not FUDS Eligible)

0 400 800
Feet
1 in = 400 ft

N

FIGURE 2
HTRW Project RI Areas of Concern

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 4/16/2019

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Table 1 – Linkage Between HTRW and MMRP QAPPs

Activity	Task	Applicable QAPP	Connection	Anticipated Schedule
Meetings	Technical Project Planning (TPP)	HTRW-QAPP MMRP-QAPP	Systematic planning process for MMRP and HTRW	• Meeting #1-Held November 7, 2018 • Meeting #2-Present MMRP DGM and HTRW Field Effort #1 results • Meeting #3-Present MMRP AGC and HTRW Field Effort #2 results • Meeting #4-Present MMRP intrusive investigation and follow-on HTRW results
MMRP Investigation	Digital geophysical mapping (DGM) survey of accessible and near-shore areas	MMRP-QAPP	Work will be performed in conjunction with HTRW field activities	• MMRP Field Effort #1 – Spring 2020 • Activities performed in conjunction with the HTRW Field Effort #1 (soil sampling) • Avoid least bittern nesting season in the marsh in mid-April to mid-July
	Advance Geophysical Classification (AGC)			• MMRP Field Effort #2 – Spring 2020 • Work will be performed in conjunction with HTRW Field Effort #2 (sediment sampling) • Avoid least bittern nesting season in the marsh in mid-April to mid-July
	Intrusive investigations of dig list Mag and Dig of area not suitable for DGM Underwater operations at former docks, MC sampling as necessary at breached MEC items			• MMRP Field Effort #3 – Late Summer 2020 • Avoid least bittern nesting season in the marsh in mid-April to mid-July
	Incremental sampling (IS) soil at breached MEC locations (if necessary, for MC (explosives) including evaluation of data to determine extent			• MMRP Field Efforts #1, #2, or #3, as necessary if a breached MEC is identified.

Activity	Task	Applicable QAPP	Connection	Anticipated Schedule
	MEC Risk Assessment performed in accordance with the guidance document "Trial Period for Risk Management Methodology at FUDS MMRP Projects"		Work will be conducted during the RI Reporting	• After completion of data collection.
HTRW Investigation	IS for site-related constituents including MC metals and explosives in soil; shoreline reconnaissance survey; risk assessments	HTRW-QAPP	Work will be performed in conjunction with MMRP field activities	• HTRW Phase I investigation– Spring 2020 • Work will be performed in conjunction with MMRP Field Effort #1 (DGM survey) • Risk assessments performed per the Human Health and Ecological Risk Assessment Work Plans located in Appendices D and E, respectively.
	Groundwater and/or sediment sampling for constituents of potential concern			• HTRW Phase II investigation – Summer 2020 • Work will be performed in conjunction with MMRP Field Effort #3 (Intrusive Investigation of Selected AGC Anomalies)

Table 2 Crosswalk: UFP-QAPP Workbook to 2016-G-05 QAPP

Optimized UFP-QAPP Worksheets		2106-G-05 QAPP Guidance Section	
1 and 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 and 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7, and 8	Personnel Qualifications and Sign-Off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
10	Conceptual Site Model	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations	Chapter 3	QAPP Elements for Evaluating Existing Data
14 and 16	Project Tasks and Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits and Laboratory Specific Detection/Quantitation Limits	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 and 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field Quality Control	2.3.5	Quality Control Requirements
21	Field Standard Operating Procedures	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical Standard Operating Procedures	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 and 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32, and 33	Assessments and Corrective Action	2.4	Assessments and Data Review (Check)
		2.5.5	Reports to Management

Optimized UFP-QAPP Worksheets		2106-G-05 QAPP Guidance Section	
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

QAPP Worksheets #1 and #2 – Title and Approval Page

Site Location	Iona Island Naval Ammunition Depot FUDS, Stony Point, Rockland County, New York	
Contract/Work Assignment	W912DR-15-D-0014, Delivery Order #W912DR18F0587	
Contract Title	Iona Island FUDS MMRP and IRP*– Remedial Investigation through Decision Document	
Document Title	UFP-QAPP HTRW Remedial Investigation, Iona Island Naval Ammunition Depot FUDS, Stony Point, Rockland County, New York	
Lead Organization Project Manager (PM)	Erin Kirby, P.G., LEP USACE–New England District	
Signature:	*Field Copy to be Signed*	**Date:**
Technical Manager (TM)	Todd Beckwith USACE–Baltimore District	
Signature:	*Field Copy to be Signed*	**Date:**
Investigative Organization PM	Timothy Reese, P.E. EA Engineering, P.C. and Its Affiliate – EA Science, and Technology	
Signature:	*Field Copy to be Signed*	**Date:**
Regulatory Agency Regional PM Printed Name/Title Signature/Date	Steven Scharf New York State Department of Environmental Conservation (NYSDEC)	
Signature:	*Field Copy to be Signed*	**Date:**
Stakeholder PM Printed Name/Title Signature/Date	Edwin McGowan, Ph.D. Palisades Interstate Park Commission (PIPC)	
Signature:	*Field Copy to be Signed*	**Date:**

*Installation Restoration Program (IRP) has been changed to HTRW throughout the document per the Project Delivery Team (PDR) request.

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QAPP Worksheets #3 and #5 – Project Organization and Quality Assurance Plan Distribution List

This worksheet identifies key project personnel, as well as lines-of-authority and lines-of-communication among the lead organization, prime contractor, subcontractors, and regulatory agencies. This draft UFP-QAPP, final UFP-QAPP, and any changes/revisions will be provided to UFP-QAPP recipients shown on the project organizational chart below. Contractors and subcontractors shown on this chart are responsible for document control within their organizations.

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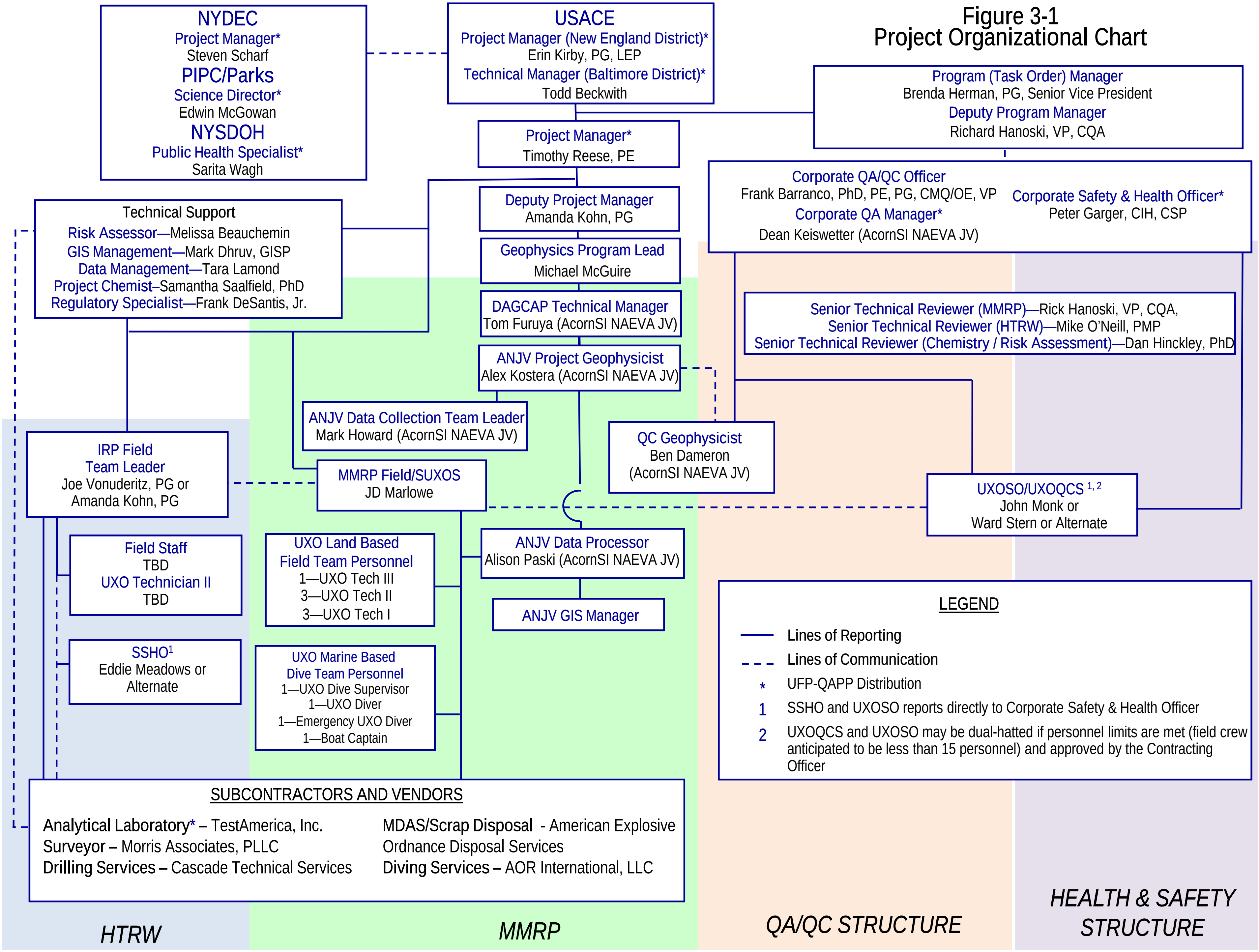
Table 3-1 Responsible UFP-QAPP Recipients

Name	Title	Organization	Telephone Number	Email Address
Erin Kirby	Project Manager	USACE – New England District	978-318-8147	erin.kirby@usace.army.mil
Todd Beckwith	Technical Manager	USACE – Baltimore District	410-962-6784	todd.t.beckwith@usace.army.mil
Steven Scharf	Project Manager	NYSDEC	518-402-9620	steven.scharf@dec.ny.gov
Edwin McGowan	Science Director	PIPC/Parks	845-786-2701	edwin.mcgowan@parks.ny.gov
Timothy Reese	Project Manager	EA	410-329-5198	treese@eaest.com
Peter Garger	Corporate S&H Manager	EA	410-527-2425	pgarger@eaest.com

Figure 3-1
Project Organizational Chart



NYDEC
Project Manager*
Steven Scharf

PIPC/Parks
Science Director*
Edwin McGowan

NYSDOH
Public Health Specialist*
Sarita Wagh

USACE
Project Manager (New England District)*
Erin Kirby, PG, LEP
Technical Manager (Baltimore District)*
Todd Beckwith

Program (Task Order) Manager
Brenda Herman, PG, Senior Vice President
Deputy Program Manager
Richard Hanoski, VP, CQA

Project Manager*
Timothy Reese, PE

Technical Support
Risk Assessor—Melissa Beauchemin
GIS Management—Mark Dhruv, GISP
Data Management—Tara Lamond
Project Chemist–Samantha Saalfield, PhD
Regulatory Specialist—Frank DeSantis, Jr.

Deputy Project Manager
Amanda Kohn, PG

Geophysics Program Lead
Michael McGuire

DAGCAP Technical Manager
Tom Furuya (AcornSI NAEVA JV)

ANJV Project Geophysicist
Alex Kostera (AcornSI NAEVA JV)

Corporate QA/QC Officer
Frank Barranco, PhD, PE, PG, CMQ/OE, VP
Corporate QA Manager*
Dean Keiswetter (AcornSI NAEVA JV)

Corporate Safety & Health Officer*
Peter Garger, CIH, CSP

Senior Technical Reviewer (MMRP)—Rick Hanoski, VP, CQA,
Senior Technical Reviewer (HTRW)—Mike O'Neill, PMP
Senior Technical Reviewer (Chemistry / Risk Assessment)—Dan Hinckley, PhD

ANJV Data Collection Team Leader
Mark Howard (AcornSI NAEVA JV)

QC Geophysicist
Ben Dameron
(AcornSI NAEVA JV)

IRP Field
Team Leader
Joe Vonuderitz, PG or
Amanda Kohn, PG

MMRP Field/SUXOS
JD Marlowe

UXOSO/UXOQCS $^{1, 2}$
John Monk or
Ward Stern or Alternate

Field Staff
TBD
UXO Technician II
TBD

UXO Land Based
Field Team Personnel
1—UXO Tech III
3—UXO Tech II
3—UXO Tech I

ANJV Data Processor
Alison Paski (AcornSI NAEVA JV)

ANJV GIS Manager

SSHO^{1}
Eddie Meadows or
Alternate

UXO Marine Based
Dive Team Personnel
1—UXO Dive Supervisor
1—UXO Diver
1—Emergency UXO Diver
1—Boat Captain

LEGEND

- —— Lines of Reporting
- - - - Lines of Communication
- * UFP-QAPP Distribution
- 1 SSHO and UXOSO reports directly to Corporate Safety & Health Officer
- 2 UXOQCS and UXOSO may be dual-hatted if personnel limits are met (field crew anticipated to be less than 15 personnel) and approved by the Contracting Officer

SUBCONTRACTORS AND VENDORS

Analytical Laboratory* – TestAmerica, Inc.
Surveyor – Morris Associates, PLLC
Drilling Services – Cascade Technical Services
MDAS/Scrap Disposal - American Explosive Ordnance Disposal Services
Diving Services – AOR International, LLC

HTRW

MMRP

QA/QC STRUCTURE

HEALTH & SAFETY STRUCTURE

QAPP Worksheets #4, #7, and #8 – Personnel Responsibilities, Qualifications, and Sign-off Sheet

This worksheet identifies key project personnel for each organization performing tasks defined in this UFP-QAPP and summarizes their title or role, qualifications (e.g., training and experience), any specialized training, licenses, certifications, or clearances required by the project. The qualifications of USACE personnel are under the purview of the DoD and will not be outlined in this UFP-QAPP. In addition, federal and state stakeholders' qualifications are under the purview of their respective agencies and will not be presented in this UFP-QAPP. The table in this worksheet summarizes the responsibilities and provides a space for the signatures of key personnel to the site covered in this UFP-QAPP. Signatures on the sign-off sheet indicate personnel have read, and agree to implement this UFP-QAPP, as written. Certification and training records for identified personnel are maintained by the organization's human resources department and are available on request.

Organization: Contractor - EA

Name	Project Title/Role	Education/Experience	Specialized Training	Licenses/ Certifications	Signature/Date
Brenda Herman, Professional Geologist (P.G.)	Program Manager	**Undergraduate Course Work** • Bachelor of Science (B.S.); Biology; University of Delaware; 1984 **Graduate Course Work** • Master of Science (M.S.); Geology; University of Delaware; 1989 Ms. Herman is a P.G. with 29 years of experience managing and conducting environmental projects for the DoD. Ms. Herman has been the Program Manager for several Indefinite Delivery/Indefinite Quantity contracts with USACE–Baltimore, Norfolk, and Omaha districts, as well as Aberdeen Proving Ground and Fort Belvoir. These contracts have covered hazardous, toxic, and radiological waste and MMRP investigation and removals; natural resources; compliance; and technology services.	• Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Responses (HAZWOPER) • USACE Construction Quality Management for Contractors • EA PM Training • Wharton Class, Essentials of Management	• P.G.—Tennessee (No. 4671)	*Field Copy to be Signed*
Richard Hanoski	Deputy Program Manager	**Undergraduate Course Work** • B.S.; Psychology; University of La Vern; 1986 **Graduate Degree** • Master of Public Administration/Management Information Systems/1994 (Troy State University) Mr. Hanoski is a Certified Quality Auditor and Master Explosives Ordnance Disposal (EOD) Technician D with 40 years of experience and is responsible for managing the national Munitions Response Services. He reviews and provides the technical direction for all MRS, including performance and technical oversight of all MRS operations and associated activities (digital geophysics, GIS, logistics, explosives management. He is responsible for all aspects of the MRS and Environmental Remediation divisions nationally and internationally. Performs MRS administrative and operational functions of EA.	• OSHA 40-Hour Training • OSHA 8-Hour Hazardous Waste Operations Supervisor Training • OSHA 8-Hour HAZWOPER Refresher • EA Project Management Training • USACE/Naval Facilities Engineering Command QC Certification	• Certified Quality Auditor, American Society for Quality • Master EOD Technician	*Field Copy to be Signed*
Timothy Reese, Professional Engineer (P.E.)	Project Manager (PM)	**Undergraduate Course Work** • B.S; Civil Engineering; Syracuse University; 1989 Mr. Reese has 24 years of PM experience, including 20 years as PM at munitions sites and has managed MMRP and HTRW projects at 100+ DoD facilities nationwide for the U.S. Army, Air Force, and U.S. Environmental Protection Agency (EPA). He has performed and managed complex environmental, construction and MEC projects. He has successfully completed environmental and munitions projects under various federal regulations including: MMRP, CERCLA, SARA, NCP, and Toxic Substances Control (TSCA), as well as guidance provided by the DoD, U.S. Army, USACE, Navy, Air Force, EPA, and state regulators (including the NYSDEC). Over the past 10 years, he has managed 25 MEC task orders at the field operation level at 80+ current and former installations and FUDS under MMRP. Base Realignment and Closure, and Installation Restoration Program (IRP) including five RI/FS involving DGM mapping, MC sampling, surface/subsurface MEC investigations, MEC and munitions debris (MD) clearance, and removal actions.	• OSHA 40-Hour HAZWOPER Training; 1989 • OSHA 8-Hour HAZWOPER Refresher; annually • OSHA 8-Hour Hazardous Waste Operations Supervisor Training; 1990 • Construction Quality Management for Contractors, USACE; 2016 • Geosynthetic Research Institute – Designing with Geosynthetics for Landfill Design, Drexel University • Hazardous Waste/Material Operations Training Course • U.S. Department of Transportation Regulation Training • IATA Training in the Shipment of Dangerous Goods • Visual Sample Plan Training • Cardiopulmonary resuscitation (CPR) and First Aid Training; Biannually	• P.E.—New Jersey (No. 39951)	*Field Copy to be Signed*

Name	Project Title/Role	Education/Experience	Specialized Training	Licenses/ Certifications	Signature/Date
Amanda Kohn, P.G.	Deputy PM	**Undergraduate Course Work** • B.S., State University of New York at Cortland; Geology; 2004 Ms. Kohn is a P.G. with 11 years of experience in EA's Site Characterization and Remediation Group. She is experienced in the CERCLA process from the Preliminary Assessment (PA)/Site Investigation (SI) through Remedial Action stage. She is currently serving as the PM for three EPA Superfund Sites and one NYSDEC Superfund Site. In addition, she has served as the Deputy PM, Task Manager, and Field Team Lead for multiple projects under DoD, EPA, and NYSDEC contracts. Her responsibilities have included tracking and managing budgets and schedules, serving as a point-of-contact with clients, preparing planning documents, coordinating field investigations, overseeing project execution, completing data analysis, and developing and reviewing technical reports.	• OSHA 40-Hour HAZWOPER Training; 2007 • OSHA 8-Hour HAZWOPER Refresher; Annually • OSHA 8-Hour Health and Safety Supervisor Training; Current • CPR and First Aid Training; Biannually • Project Management Training; 2017	• P.G.–Pennsylvania (No. 005105) • P.G.–New York (No. 000115)	*Field Copy to be Signed*
Michael McGuire	Geophysics Program Lead	**Undergraduate Course Work** • B.S.; Geophysical Engineering; Colorado School of Mines; 1981 Mr. McGuire serves as a Senior Geophysicist in the Munitions Response Group and provides technical support on MMRP projects. He has more than 31 years of experience as a geophysicist including project management, data collection, processing, interpretation, and mapping of seismic reflection and refraction data, time and frequency domain electromagnetic (EM) data, magnetic data, ground penetrating radar data, resistivity data, and borehole geophysics. He has extensive experience related to the detection and mapping of UXO.	• OSHA 40-Hour HAZWOPER Training; 1989 • OSHA 8-Hour HAZWOPER Refresher; Annually • OSHA 8-Hour Health and Safety Supervisor Training; Current • Amoco 720-Hour Geologic and Geophysical Training; 1987 • Project Management, Supervision, Public Speaking, Department of Transportation; Tetra Tech, Inc. • ESTCP/NAOC UX-Analyze Advanced Classification Course • U.S. Army Engineering Support Center Huntsville Oasis Montaj UX-Analyze • Pacific Northwest National Laboratories Visual Sample Plan for MEC Investigations Course • CPR and First Aid Training; Biannually		*Field Copy to be Signed*
Dan Hinckley, Doctor of Philosophy (Ph.D.)	Senior Technical Reviewer	**Undergraduate Course Work** • B.S.; Chemistry; Wright State University, Dayton, OH; 1983 **Graduate Course Work** • M.S.; Environmental Chemistry, Physical Chemistry; Wright State University, Dayton, OH; 1985 • Ph.D.; Marine Chemistry, Chemical Oceanography; University of South Carolina, Columbia, SC; 1989 Dr. Hinckley has 36 years of multi-disciplinary experience in environmental chemistry, marine chemistry, analytical chemistry, physical chemistry, human health and ecological risk assessment, environmental assessment, and project management. He specializes in human health and ecological risk assessments, environmental fate and transport assessment, environmental characterization, sample design, evaluations of soil, water, and sediment quality and QA/QC issues. He has participated in more than 300 human health and ecological risk assessments performed for sites from Egypt to Guam and has worked with risk assessors in more than a dozen states and most EPA regions. He has performed Senior Technical Reviews and external reviews for many risk assessments, including those associated with EPA Regions 3 and 6, and the State of Delaware.	• DoD Environmental Monitoring and Data Quality Workshop; 2009–2010 • EA Project Management Training; 1993, 2005 • Expert Witness Workshop; 1994		*Field Copy to be Signed*
Cynthia Cheatwood	Risk Assessor	**Undergraduate Course Work** • B.S.; Civil Engineering; University of Maryland, 1993 **Graduate Course Work** • M.S.P.H.; Environmental Health; Johns Hopkins Bloomberg School of Public Health; 2016 Ms. Cheatwood is an environmental engineer with 26 years of experience who specializes in human health risk assessment and environmental site assessments. As the primary risk assessor for numerous projects, Ms. Cheatwood is familiar with standard human health risk assessment practice and has successfully completed over 200 risk assessments under various regulatory frameworks, including federal, state, and local agencies. She has performed and overseen all aspects of a risk assessment, from determining appropriate sample plans, maintaining databases of chemical data, to using exposure models.	• OSHA, 40-hour HAZWOPER Training, 1993 • OSHA, 8-hour HAZWOPER Supervisor Training, 1996		*Field Copy to be Signed*

Name	Project Title/Role	Education/Experience	Specialized Training	Licenses/ Certifications	Signature/Date
Melissa Beauchemin	Risk Assessor	**Undergraduate Degree** - B.S.; Biology; Stonehill College, Easton, MA; 1998 **Graduate Degree** - M.S.; Environmental Science; University of Massachusetts; 2002 Ms. Beauchemin has over 18 years of experience as an environmental scientist, specializing in risk assessments, sediment quality evaluations, remedial investigations, and site-closure documents. She prepares technical documents according to state and federal guidance for complex sites, ranging in size from small local upland habitats to broad-scale offshore assessments, and from the local to national scale. Ms. Beauchemin evaluates potential risks to aquatic and terrestrial organisms from exposure to industrial chemicals in environmental media. She has evaluated risks from persistent environmental chemicals such as polychlorinated biphenyls, dioxins/furans, polycyclic aromatic hydrocarbons (PAHs), pesticides, explosives, and metals (e.g., arsenic, mercury, and lead).	- OSHA, 40-hour HAZWOPER Training, 2005 - OSHA, 8-hour HAZWOPER Refresher, Annually		*Field Copy to be Signed*
Samantha Saalfield, Ph.D.	Project Chemist	**Undergraduate Course Work** - Bachelor of Arts (B.A.); Geology/Chemistry; Whitman College; 2004 **Graduate Course Work** - Ph.D.; Earth Sciences; Dartmouth College; 2009 Dr. Saalfield has more than 13 years of experience in site characterization and remediation, including inorganic geochemistry, contaminant fate and transport, groundwater modeling, geochemical analysis, and data quality planning and analysis. She specializes in the behavior of inorganic contaminants in surface and groundwater. She also has experience with data quality planning and analysis, assessments of remedial alternatives, and geochemical and hydrogeological modeling.	- OSHA 40-Hour HAZWOPER Training; 2009 - OSHA 8-Hour HAZWOPER Refresher; Annually - Confined Space Training; 2014 - INNOV-X Systems Radiation Safety and Operations Training for Field X-ray fluorescence analyzers - Interstate Technology and Regulatory Council's Incremental Sampling Methodology Training - DoD Quality Systems Manual v.5 Training - EA PM Training, 2q - CPR and First Aid Training; Biannually		*Field Copy to be Signed*
Frank DeSantis, Jr.	Regulatory Specialist	**Undergraduate Course Work** - B.S.; Environmental and Forest Biology; State University of New York College of Environmental Science and Forestry; 2000 Mr. DeSantis has over 14 years of experience in the biological and environmental fields, including Phase I and Phase II assessments in support of the Army Operational Range Assessment Program, remedial action–operation and long-term management activities in support of the U.S. Air Force and Army Environmental Command environmental programs; site characterizations and pre-design investigations in support of U.S. Air Force performance-based remediation programs; and RIs and FSs and remedial design for the NYSDEC. He has provided project management for preliminary site assessments, site characterizations, RI/FS, and remedial design/remedial actions. He served as the investigation manager for an RI/FS of a metals-impacted tidal marsh at Camp Smith, New York. He understands the New York guidance (e.g., Division of Environmental Remediation [DER]-10: Technical Guidance for SI and Remediation) and promulgated remedial regulations (e.g., Title 6, New York Codes Rules and Regulations, Part 375, Soil Clean-up Objectives) at sites with metal contaminants showing migration via surface water and sediment deposition.	- OSHA 40-Hour HAZWOPER Training - OSHA 8-Hour HAZWOPER Refresher; Annually - OSHA 8-Hour Hazardous Waste Operations Supervisor Training - 30-hour Construction Safety and Health - Permit Required Confined Space Training - Safe-Capture: Chemical Immobilization of Wildlife - CPR and First Aid Training; Biannually		*Field Copy to be Signed*
Michael O'Neill, PMP	Senior Technical Reviewer	**Undergraduate Course Work** - B.S.; Engineering Science; Loyola College; 1990 Mr. O'Neill is a PM with 27 years of experience in every facet of the CERCLA process. He has 23 years of experience successfully completing environmental projects under Federal regulations (CERCLA, Resource Conservation and Recovery Act (RCRA), SARA, TSCA, and MMRP) as well as DoD and U.S. Army guidance. He has been involved in many phases of site assessments (Phase I and Phase II site assessments, environmental baseline surveys and engineering FSs), and RIs beginning with development of the scope of work and preparation of the field sampling plan, preparation of health and safety plans, site and subcontractor management, site research, sampling and sample custody, as well as report preparation, remedial design, project costing and oversight during remedial action. He has experience managing various size tasks and projects.	- OSHA 40-Hour HAZWOPER Training - OSHA 8-Hour Hazardous Waste Operations Supervisor Training - Asbestos Inspector - Lead Inspector (EPA Agency Model Curriculum) - MARSSIM Radiological Survey Design Course - Introductory Health Risk Communications Workshop - Construction Quality Management for Contractors - EA Project Management Training - UXO Safety Training Program - Anti-Terrorism Level I Training - CPR and First Aid Training; Biannually	- Project Management Institute (No. 1273776)	*Field Copy to be Signed*

Name	Project Title/Role	Education/Experience	Specialized Training	Licenses/ Certifications	Signature/Date
Frank Barranco, Ph.D., P.G., P.E.	Corporate QC Manager	**Undergraduate Course Work** • B.A., Geology; Duke University; 1984 **Graduate Course Work** • M.S.; Geology; University of Texas Arlington; 1988 • Ph.D., Environmental Science and Engineering; Colorado School of Mines; 1998 Dr. Barranco has more than 25 years of experience in the development and implementation of QA/QC systems. As the Director of QC for EA's Quality Management Program, Dr. Barranco authors, and implements company-wide QA and QC policies, guidance documents, and SOPs. In this role, Dr. Barranco is heavily involved in the quality monitoring associated with QC systems across EA, including the Senior Technical Review Program, Project and Program Reviews, and oversight of the Technical Chiefs. In addition to this company-wide role, Dr. Barranco serves as QA Officer on individual programs and large Indefinite Delivery/Indefinite Quantity contracts across EA.	• OSHA 40-Hour HAZWOPER Training • OSHA 8-Hour Hazardous Waste Operations Supervisor Training • CPR and First Aid Training; Biannually	• P.G.–Tennessee (No. 005603) • P.E. –Maryland (No. 43120) • Certified Manager of Quality/ Operational Excellence (No. 53424)	*Field Copy to be Signed*
Peter Garger, Certified Industrial Hygienist (CIH), Certified Safety Professional (CSP)	CIH	**Undergraduate Course Work** • B.A. Chemistry, Hofstra University; 1978 **Graduate Course Work** • M.S. Environmental Health Science, Sc. M. Hygiene and Public Health, Johns Hopkins University; 1981 Mr. Garger is a CIH and CSP with over 38 years of experience. He oversees health and safety activities for EA, including all health and safety activities in support of multiple Army, United States Air Force, Navy, and EPA contracts. Maintains EA's Corporate Health and Safety Program Manual, coordinates safety-training activities, and develops and maintains medical surveillance programs. He has 30+ years of experience managing, and conducting industrial hygiene services, including oversight of environmental remediation projects. Manages OSHA reporting requirements.	• OSHA Construction Outreach Trainer for 10- and 30-hour Construction Safety Training • OSHA 10-Hour Supervisor Training; 1989-Present • Department of Transportation Hazardous Materials Training; 1994 • USACE – Unexploded Ordnance Training; 1994 • HAZWOPER 40-hour Training, 8-hour Supervisor Training, and 8-hour refresher • CPR and First Aid Certified • Investigating and Mitigating Microbial Contamination in Buildings; 1995 • National Institute for Occupational Safety and Health 582 Microscopic Evaluation of Fibers; 1993 • Asbestos Building Inspector/Management Planner; 1993 • X-Ray Fluorescence Testing Operator – Lead Paint Analysis; 1992 • Drug and Alcohol Awareness for Supervisors Training; All One Health; 2017	• CSP– (No. 20560) • CIH–American Board of Industrial Hygiene (No. 3118)	*Field Copy to be Signed*
John "JD" Marlowe	Senior Unexploded Ordnance Supervisor (SUXOS)	**Education** • Graduate of Naval EOD School; Indian Head, Maryland; 1995 Mr. Marlowe has 39 years of experience in all phases of munitions response actions and applicable safety standards, including supporting DoD installation operations and IRP remedial investigations. He has extensive EOD/ UXO experience in all phases of munitions response actions, including SUXOS experience on MMRP action projects for the DoD. He is experienced in performing and supervising MEC projects and has extensive "hands-on" training to include all aspects of safety; extensive project and technical management, field operations and crew leadership; and expertise in MEC/UXO identification and recovery. Has 18 years of QA/QC experience in supervisory EOD/UXO positions overseeing project health and safety matters, including oversight and interface for onsite subcontractors; implementing safety meetings, visitor orientations, inspections, training, audits, and self-assessments; providing site-specific munitions and explosives of concern awareness training; coordination with range control and adherence to installation procedures; and maintaining written safety and equipment logs/records on DoD project across the United States. Mr. Marlowe is experienced in complying with CERCLA/RCRA; DoD; EPA Region 3, and NCP regulations. His munitions experience includes, projects related to improvised explosive devices, small arms ammunition, general purpose bombs, cluster bombs, pyrotechnics, artillery projectiles, rockets, missiles, and incendiary and chemical bombs.	• OSHA 40-Hour HAZWOPER; 1996 • OSHA 8-Hour HAZWOPER Refresher; Annually • OSHA 8-Hour Hazardous Waste Operations Supervisor; 2014 • OSHA 30-Hour Construction; 2013 • OSHA 10-Hour Construction; 2017 • Naval School, Explosive Ordnance Disposal (NAVSCOLEOD) Phase 2 (surface); 1995 • Hazardous Material Safety (Canadian); 1994 • Transportation of Dangerous Goods (Canadian); 1994 • EOD/Improvised Explosive Device Course (Canadian); 1993 • DEODS NATO Officers/SNCO EOD (England) Course; 1992 • EOD Specialty Course (Canadian); 1988 • EOD Basic Course (Canadian); 1979 • OSHA Annual Respirator Medical; 2018 • Forestry-Granton Institute of Technology; 1992 • Electronics-Saskatchewan Technical Institute; 1983 • Level 1 Anti-Terrorism Training • NAVSEA Material Potentially Presenting an Explosive Hazard (MPPEH) Training, 2018 • CPR and First Aid/AED Training; Biannually	• Master EOD Technician • HFA Certified Heavy Equipment Operator • Range Safety Officer Certification (Canadian)	*Field Copy to be Signed*

Name	Project Title/Role	Education/Experience	Specialized Training	Licenses/ Certifications	Signature/Date
John Monk	UXO Quality Specialist and UXO Safety Officer (UXOSO)	**Education** • Naval EOD Mr. Monk is a Senior UXO Technical Expert with over 36 years of experience in Naval EOD/diver and munitions and MEC projects. His primary responsibilities are as a UXO Quality Control Specialist (UXOQCS)/ UXOSO and team leader for munitions response related projects. His project work focuses primarily on location, removal/disposal, and clearance of conventional, chemical/biological/radiological munitions. He is also an expert in underwater ordnance and Naval underwater diving techniques for both nitrogen and mixed gas diving operations. He has experience with identifying and resolving safety and quality issues with respect to munitions related activities. He functions as a liaison with USACE and subcontractors' safety personnel and quality personnel; and experience with oversight of all aspects of explosive safety on various DoD projects.	• EA PM Training; 2008 • OSHA 40-hour HAZWOPER Training; 1994 • OSHA 8-Hour Site Managers and Supervisors Training Course; 2015 • OSHA 8-Hour HAZWOPER Refresher; Annually • OSHA 30-Hour Construction Safety Course; 2005 • OSHA 8-Hour Hazardous Waste Operations Supervisor Training • Hazardous Waste Management and Shipping for Environmental Professionals; 2001 • USACE Construction Quality Management for Contractors Course; 2017 • Delaware Department of Natural Resources and Environmental Control Soil and Water Conservation (Blue Card) Course; 2005 • Competent Person Trenching and Excavation, West Virginia University; 2002 • Fall Prevention and Protection Competent Person Training; 2002 • Confined Space Course Certificate; 2011 • Master EOD Technician; 1996 • Explosives Blasters License-MD #G-300 • CPR and First Aid; Biannually		*Field Copy to be Signed*
Eddie Meadows	Site Health and Safety Officer	**Undergraduate Course Work** • B.S.; Environmental Sciences; Virginia Tech; 1995 Mr. Meadows has 22-year of experience in the successful completion of numerous projects and field efforts or phases of those projects, which include management; field oversight; health and safety officer; sample collection and sample custody of soil, water, sediment, and air matrixes; mobile laboratory testing; field screening; report writing, and data reduction/management; basic surveying; and remedial injection activities. He has served as Site Safety and Health Officer for several investigations, removal actions, groundwater monitoring well installations, and construction projects.	• OSHA 40-Hour HAZWOPER • OSHA 8-Hour Hazardous Waste Operations Supervisory Training • OSHA 30-Hour Construction Safety and Health Certification • Excavation Safety for Competent Person Training • Confined Space Training • USACE Construction Quality Management for Contractors • OSHA 24-Hour Fall Protection for Competent Person Training • Immunoassay Training for field screening of Polycyclic Aromatic Hydrocarbons, Polychlorinated Biphenyls, and Trinitrotoluene (TNT) • X-Ray Fluorescence Spectrum Analyzer Training • Basic Radiation Worker and Fundamentals of Radiation Training. • Respirator Fit Test		*Field Copy to be Signed*
Joe Von Uderitz, P.G.	Project Geologist	**Undergraduate Course Work** • B.S.; Environmental Studies and Geology; Alfred University; 2001 Mr. Von Uderitz is a P.G. with more than 12 years of experience in environmental site assessment and remediation. His primary responsibilities are oversight of field activities including preparing work plans, scheduling, and overseeing implementation of work plans. Oversight includes Contractor QC responsibilities of the installation and operations of treatment systems, as well as installation of monitoring and recovery wells, and development, gauging, and sampling of wells. He maintains product recovery, dual phase extraction systems, and catalytic oxidizer systems at various locations. Additionally, he has experience with construction activities and associated safety and health concerns, site inspections to evaluate work conditions for potential job site hazards, ensuring proper selection and use of personal protective equipment, use of monitoring equipment, and safety and health compliance. Provides daily health and safety briefings for personnel on multiple construction sites. Provides technical review and assisted in preparation of safety procedures for Site Safety and Health Plans and APPs.	• OSHA HAZWOPER 40-hour Training and 8-hour refresher • OSHA 30-hour Construction Safety and Health Training • USACE Construction Quality Management for Contractors Worker • The Mine Safety and Health Administration Training • 40-hour Radiation Worker I Training • Excavation Safety Training (Trenching/Shoring) • Association of Reciprocal Safety Councils Training • CPR and First Aid Certified • Permit-Required Confined Space Entrant • Permit-Required Confined Space Attendant • Permit-Required Confined Space Supervisor • General Radiation Worker Training • CPR and First Aid Certified	• P.G.- Pennsylvania (No. 005197) • P.G.-New York (No. 000144)	*Field Copy to be Signed*

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Organization: Laboratory – TestAmerica

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Darlene Bandy	PM	On file with laboratory	On file with laboratory	*Field Copy to be Signed*
Roxanne Sullivan	QA Supervisor	On file with laboratory	On file with laboratory	*Field Copy to be Signed*
Richard Clinkscales	Laboratory Director	On file with laboratory	On file with laboratory	*Field Copy to be Signed*

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QAPP Worksheet #6 – Communication Pathways

This worksheet documents specific issues (communication drivers) that will trigger the need for formal (documented) communication with other project personnel or stakeholders. Its purpose is to ensure there are procedures in place for providing notifications, obtaining approvals, and generating the appropriate documentation when handling important communications, including those involving regulatory interfaces, approvals to proceed from one Definable Feature of Work (DFW) to the next, field changes, emergencies, non-conformances, and stop-work orders.

Communication Drivers	**Responsible Entity**	**Name**	**Telephone Number**	**Procedure (Timing, Pathways, etc.)**
Contractual modification and/or program performance	USACE Contracting Officer (KO)	Kathryn Brown (Baltimore District)	410-962-2585	Overall responsibility for overseeing and monitoring the contractor's performance and assures the contractor receives impartial, fair, and equitable treatment under the Delivery Order. Ultimately responsible for the final determination of the adequacy of the contractor's performance and authorized to obligate the Government on this Delivery Order.
Contractual modification and/or program performance	USACE Contract Officer Representative (COR)	Sesh Lal (Baltimore District)	410-962-2585	Contractual modification and/or program performance. Communicates directly with USACE PM, USACE Technical Manager (TM), and EA PM/Deputy PM.
PM with USACE	USACE PM	Erin Kirby, P.G., LEP	978-318-8147	Primary USACE point-of-contact (POC). Overall management of the project. Communicates with and gives direction to EA PM. Reviews and approves project plans and their modifications. Communicates with regulators and relays information to EA PM/Deputy PM.
TM with USACE	USACE Technical Manager	Todd Beckwith	410-962-6784	Communicates with USACE PM and gives direction to EA PM. Reviews and approves project plans and their modifications.
POC with NYSDEC	NYSDEC	Steven M. Scharf, P.E.	845-786-2701	Case Manager and primary POC for State of New York. Provides regulatory oversight. Communicates with USACE PM and/or PIPC Executive Director.
POC with PIPC	PIPC Director of Science	Edwin McGowan, Ph.D.	845-786-2701 ext. 263	Primary POC for PIPC. Provides stakeholder oversight. Communicates with USACE PM and/or NYSDEC.
Contractual modification and/or program performance	EA Program Manager	Brenda Herman, P.G.	410-527-2474	Communication with USACE at the Programmatic Level regarding overall performance. Acts as an advocate for USACE to ensure that project needs are met. Supports the EA PM/Deputy PM. Provides corporate commitment to allocate necessary resources.
Contractual modification and/or program performance	EA Senior Technical Reviewer (STR), Deputy EA Program Manager	Richard Hanoski	443-632-4887	Communication with USACE at the Programmatic Level regarding overall performance. Acts as an advocate for USACE to ensure that project needs are met. Supports the EA PM/Deputy PM. Provides corporate commitment to allocate necessary resources.
Manage all project phases/overall technical lead	EA PM	Timothy Reese, P.E.	410-329-5198	Overall contractor management of the project. Maintains lines of communication between USACE and EA. Communicates with USACE POC regarding project direction as well as notification of any project issues. Ensures that project is on time and within budget. Ensures that project team maintains technical, quality, and safety and health standards. Leads communication with stakeholders. Manages subcontractors. Completes final review of all deliverables.
Contractor communication with USACE	EA PM	Timothy Reese, P.E.	410-329-5198	POC for all technical, QA, and administrative matters regarding the Contractor's implementation of the project (verbal, written or electronic).
Modifications to Contractor Program	EA PM	Timothy Reese, P.E.	410-329-5198	Coordinate fieldwork, programmatic direction, and issue resolution.
Project coordination and support to EA PM/ Deputy PM	EA STR	Daniel Hinckley, Ph.D. Michael O'Neill, PMP	765-465-4093 410-329-5142	Senior Technical Reviewer for technical approach and documents. Communicates with the EA PM/Deputy PM.
Geophysical oversight	EA Geophysics Program Lead	Michael McGuire	410-329-5147	Provides geophysical oversight during RI in accordance with the Quality Assurance Surveillance Plan (QASP).
Change to UFP-QAPP	EA Risk Assessor	Melissa Beauchemin Cynthia Cheatwood	401-287-0380 410-329-5154	Communicates with the EA PM/Deputy PM. Will notify EA PM of approval of minor change (verbal, written, or electronic); complete field change request for efficiency or changed conditions.
Change to UFP-QAPP	EA Project Chemist	Samantha Saalfield, Ph.D.	410-584-7000 ext. 5215	Communicates with the EA PM/Deputy PM. Will notify EA PM of approval of minor change (verbal, written, or electronic); complete field change request for efficiency or changed conditions.
Change to UFP-QAPP	EA PM	Timothy Reese, P.E.	410-329-5198	For field change requests, the QAPP does not need to be revised, a field change request should be sent to the USACE PM and USACE TM for approval. In the case of a QAPP addendum, amendment or revision, the QAPP must go through the USACE and EPA for approval.
Project completion and performance deficiencies	Corporate Quality Manager	Frank Barranco, Ph.D. P.E., P.G., CMQ/OE	410-329-5137	Monitors work, procedures, and documentation to ensure compliance with QC procedures and engineering practices. Develops and oversees implementation of a corrective action plan, if necessary. Reviews all aspects of project completion and stop work if deficiencies in the work are noted. Communicates with the EA PM/Deputy PM.

Communication Drivers	**Responsible Entity**	**Name**	**Telephone Number**	**Procedure (Timing, Pathways, etc.)**
Mobilization and demobilization	EA PM	Timothy Reese, P.E	410-329-5198	Communication with USACE PM and USACE TM regarding timelines and access requirements. USACE PM and USACE TM to relay information to other parties.
Coordination of field activities	EA HTRW Field Team Leader	Joseph Von Uderitz, P.G.	315-431-4610 ext. 1870	Coordination of Site activities with sub-contractors and communication of site issues and progress with the EA PM/Deputy PM, USACE PM, and USACE TM.
Modifications to/deviations from UFP-QAPP once in Execution	EA PM	Timothy Reese, P.E.	410-329-5198	A written field change request will be submitted to the USACE PM for modifications to content within the final approved UFP-QAPP.
Modifications to Technical Direction or Modification of Approved Planning Documents	EA PM	Timothy Reese, P.E.	410-329-5198	Will direct the field team/ SSHO in the implementation of the field activities.
Coordination of sample bottle/sample receipt and analytical data processing	Laboratory PM	Darlene Bandy	303-736-0188	Coordination of sample bottles, confirmation of samples, issues at the laboratory, and data availability will be communicated to the Project Chemist and/or Data Manager.
Technical support	EA SUXOS	John "JD" Marlowe	443-632-4887	Provides technical support for all munitions related projects. Coordination of field activities and oversight for project team to ensure compliance with documents. Coordination of field activities and oversight for project team to ensure compliance with documents. Manages on-land site operations. Reports to EA PM/Deputy PM regarding issues with cost, schedule, etc. Ensures modifications meet USACE requirements and overall project quality objectives. Ensures compliance with approved project documents during execution of field work. Prepares and submits SUXOS Daily Reports daily during land-based field activities.
Quality deficiencies or inconsistencies with plan execution	EA UXOSO/ QCS	John Monk or Ward Stern (alternate)	717-887-5582 (Monk cell) 256-731-9151 (Stern)	Provides technical support for all munitions related projects. Coordination of field activities and oversight for project team to ensure compliance with documents. Coordination of field activities and oversight for project team to ensure compliance with documents. Manages on-land site operations. Reports to EA PM/Deputy PM regarding issues with cost, schedule, etc. Ensures modifications meet USACE requirements and overall project quality objectives. Ensures compliance with approved project documents during execution of field work. Prepares and submits SUXOS Daily Reports daily during land-based field activities.
Laboratory oversight	EA Project Chemist	Samantha Saalfield, Ph.D.	410-584-7000 ext. 5215	Provides oversight of laboratory sample analysis and FUDS Chem activities (event planning, uploading SEDD files by lab, and data validation).
Data oversight	EA Project Chemist	Samantha Saalfield, Ph.D.	410-584-7000 ext. 5215	Provides technical oversight of data evaluation and summary in RI Report.
Analytical Corrective Actions	EA Project Chemist	Samantha Saalfield, Ph.D.	410-584-7000 ext. 5215	Report on the adequacy, status, and effectiveness of the QA program to EA PM/Deputy PM.
Technical issues during implementation of the project	EA PM	Timothy Reese, P.E.	410-329-5198	Will notify the USACE PM and USACE TM of any significant technical or QC issues during the field investigation.
Modifications to analytical laboratory responsibilities	EA Project Chemist	Samantha Saalfield, Ph.D.	410-584-7000 ext. 5215	Notify EA PM/Deputy PM within one week of performance problems encountered by the analytical laboratories by phone, email, or fax.
Field and analytical corrective actions	EA Project Chemist	Samantha Saalfield, Ph.D.	410-584-7000 ext. 5215	Communication with EA PM/Deputy PM regarding QA issues.
Modifications to analytical responsibilities	TestAmerica PM	Darlene Bandy	303-736-0188	The Regional Sample Control Center Coordinator will report project nonconformance issues within one week to the Project Chemist by phone, email, or fax.
Modifications to analytical QA responsibilities	Laboratory QA Manager	Roxanne Sullivan	303-736-0116	Report project nonconformance issues within one week to the Laboratory PM in person or by phone, email, or fax.
Release of data	EA Project Chemist	Samantha Saalfield, Ph.D.	410-584-7000 ext. 5215	No analytical data will be released until review is complete and the Project Chemist has approved the release.
Review of project deliverables	USACE Project Chemist	Yixian Zhang	978-318-8730	Review of UFP QAPP and data validation reports.
UXO Emergency in the field	EA UXOSO/QCS and SUXOS	John Monk/ JD Marlowe/ Ward Stern	Monk - 717-887-5582 (cell) Marlowe - 443-752-1775 (cell) Stern: 256-731-9151	Notify the EA PM/Deputy PM, who will relay emergency to appropriate entities. Provides direction to field staff and subcontractors.
Emergency in the field	SSHO	Eddie Meadows	410-527-2425	Notify the EA PM/Deputy PM who will relay emergency to appropriate entities. Provides direction to field staff and subcontractors.
Emergency in the field	EA Certified Industrial Hygienist	Peter Garger, CIH, CSP	410-671-6051 ext. 1417	Notify the EA PM/Deputy PM, who will relay emergency to appropriate entities. Provides direction to field staff and subcontractors.

Communication Drivers	Responsible Entity	Name	Telephone Number	Procedure (Timing, Pathways, etc.)
Safety incident, stop work order	EA UXOSO/QCS and SUXOS, EA SSHO	John Monk/ JD Marlowe/ Ward Stern/ Eddie Meadows	Monk - 717-887-5582 (cell) Marlowe - 443-752-1775 (cell) Stern: 256-731-9151 Meadows - 410-527-2425	Notify the EA PM/Deputy PM who will relay information to appropriate entities. Provides direction to field staff and subcontractors.

NOTES:
EA = EA Engineering, P.C. and Its Affiliate EA Science and Technology
EPA = U.S Environmental Protection Agency
HTRW = Hazardous toxic and radioactive waste
NYSDEC = New York State Department of Environmental Conservation
PIPC = Palisades Interstate Park Commission
PM = Project Manager
POC = Point-of-contact
QA = Quality assurance
QC = Quality control
QCS = Quality Control Supervisor
QAPP = Quality Assurance Protection Plan
RI = Remedial Investigation
SSHO = Site Safety and Health Officer
SUXOS = Senior Unexploded Ordnance Supervisor
TBD = To be determined
UFP = Uniform Federal Policy
USACE = U.S. Army Corps of Engineers
UXO = Unexploded Ordnance

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QAPP Worksheet #9 – Project Planning Summary Session

This worksheet is used to document project planning sessions and is used to provide a concise record of participants, key decisions or agreements reached, and action items. If a planning session occurs after this UFP-QAPP has been finalized, and the session results in a change to this UFP-QAPP, this worksheet will be amended accordingly.

The Technical Project Planning (TPP) Meeting #1, including the presentation materials is presented in Appendix C.

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QAPP Worksheet #10 –Conceptual Site Model

This worksheet presents available site information for the Iona Island Naval Ammunition Depot FUDS and the project's conceptual site model (CSM) as it relates to the proposed HTRW RI.

As defined in EM 200-1-12 – *Conceptual Site Models*, a CSM describes sources of contamination, as well as complete, potentially complete, or incomplete exposure pathways; current, determined, or reasonably anticipated future use of property; and potential receptors (USACE 2012). The CSM is a working, iterative model of site conditions used to assist in the visualization and communication of available information and development of DQOs and the technical approach presented in this UFP-QAPP. Information obtained during implementation of the RI will be used to address data gaps, and subsequently, update and refine the CSM in the RI report.

SITE BACKGROUND

The Navy used the Iona Island Naval Ammunition Depot between 1900 and 1947, with the major effort consisting of assembling naval ammunition for World War II. Although no ammunition was manufactured at Iona, various types of explosives were assembled on site. Activities included preparing, assembling, maintaining, inspecting, and testing ammunition; storing bulk explosives, ammunition, and ordnance material; and issuing ammunition to the fleet, shore establishments, armed merchantmen, transport, and district forces (USAGC 2018).

The Iona Island Naval Ammunition Depot FUDS is listed as a State Superfund Site (Site Code 334069) in the NYSDEC Environmental Site Remediation Database, related to the MMRP project at the site (NYSDEC 2017a). The NYSDEC site description indicates antimony, copper, and lead concentrations exceeding background and relevant ecological screening values in surface soil. Antimony, copper, lead, nickel, and zinc exceeded background concentrations and ecological screening values in sediments. Lead was listed as a COPC in surface soil for human health (NYSDEC 2017a).

SITE LOCATION

The Iona Island Naval Ammunition Depot FUDS property consists of approximately 124.2 total acres of land and inland water located on Iona Island and Round Island along the west side of the Hudson River, in the Town of Stony Point, Rockland County, New York (Figure 1). Iona Island is located within the Lower Hudson River Valley region, which includes all of Putnam, Rockland, and Westchester counties and is considered part of the Downstate New York region due to its geographical and cultural proximity to New York City.

Iona Island is located in Bear Mountain State Park on the east side of U.S. 202/Route 9W, 6 miles south/downstream of West Point Military Academy, one mile south/downstream of the Bear Mountain Bridge, and 41.2 miles north/upstream from the mouth of the Hudson River. Round Island, the southeastern part of Iona Island, was once cut off by marshes and was attached to Iona Island with fill in the early 20th century (NYSDEC and U.S. Department of Commerce 1992).

Iona Island is connected to the mainland by a narrow two-lane road off U.S. 202/Route 9W near Doodletown. The island is accessed by crossing active River Subdivision (CSX Transportation) railroad tracks and entering through an unmanned gate.

OPERATIONAL HISTORY

The following history of operational use was obtained from the Naval Ammunition Depot Iona Island FUDS, New York, Historical Photographic Analysis prepared by USAGC in 2018.

Prior to use by the military, Iona Island was utilized as a resort hotel during the Civil War. There was no documented evidence available of past use of ordnance-related items on the island prior to use by the military. The Navy acquired Iona Island from the L.H. Mace Brokerage Company of New York City in 1899 for construction of the Iona Island Naval Ammunition Depot (USACE 1998). In 1942, an additional approximately 13 acres of marshland, Round Island, was purchased and used for ammunition storage (USACE 1998)[2].

In 1903, at least one 13-inch (in.) shell exploded between Shell Houses 3 and 4 (former Buildings 210 and 209, respectively) on Iona Island. The explosion destroyed Shell Houses 3 and 4, and their contents, and damaged Shell Houses 1 and 2 (former Buildings 115 and 116, respectively) (USACE 1998). Some of the contents of the explosion thought to be included were 13-in. shells that may have been thrown out from the point of the explosion as far as 1,250 feet (ft). Other munitions stored in the area during the time of the explosion included 1-pounders, 6-pounders, and 6-in. ammunition. It is expected that the explosion involved black powder rather than high explosives.

During World War I, almost all the depth bombs and ammunition used in the Atlantic area passed through Iona. In 1914, work increased by approximately 14 percent (%). All submarines were sent to Iona Island to be filled with explosives, in addition to the regular work conducted there. In 1915, over two million pounds of powder were made up in charges and about 327 carloads of material were handled during the year and large shipments made by transport, tug, and barge. A 1919 annual report to the Secretary of the Navy states that most of the 14-in. ammunition for the Army and Navy Railroad battery was prepared at Iona Island.

After World War I, although Iona Island was one of two of the Navy's main depots on the east coast, a program of reducing personnel and material and keeping active work to a minimum was followed under the United States' general program of limitation of arms treaty. In the 1930s, Iona Island supplied ammunition of calibers to the fleet for service allowances, target practice, and reserve war requirements.

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[2] Historical records revealed discrepancies in the total acreage of the Iona Island Naval Ammunition Depot. Thus, 120 acres is the average of these sources (USACE 2004).

Between 1941 and 1945, the major activity conducted on Iona Island was assembling naval ammunition for World War II. More than 2,300 Navy ships and 2,300 merchant ships received their ammunition from Iona Island during World War II. In addition, 77 bases, 500 shore stations and 700 foreign naval ships were serviced with ammunition.

After World War II, use of the island as an ammunition depot became obsolete because of lack of expansion room to accommodate new types of ammunition. In 1947, the Department of the Navy decided to deactivate the Iona Island Naval Ammunition Depot and made the property available for restricted lease. The FUDS was re-designated as an Annex to the United States Naval Ammunition Depot, Earle, New Jersey, and in 1957, declared the Annex excess. In 1955 and 1960, the GSA utilized the Iona Island Naval Ammunition Depot FUDS through a permit for stockpile materials such as rubber and copper. In 1960, the GSA received official jurisdiction of the property and other agencies under GSA control utilized the property for record storage during the 1960s. These agencies included the following: Maritime Administration, Atomic Energy Commission, Civil Service Commission, Army Corps of Engineers, and the Navy’s Bureau of Ships. The Maritime Administration also conducted occasional trans-shipments of heavy freight at the main wharf on an occasional basis. On 30 March 1965, Iona Island was deemed evacuated after the last load of stockpiled materials left the property. In 1965, the PIPC acquired both Iona and Round islands (USACE 1998).

During interviews conducted as part of the 1998 Archives Search Report (ASR), maintenance personnel from the sign shop reported that ammunition could be seen in the Hudson River during low water conditions in the "dump" area. Aerial photos in the ASR Report locate this "dump" area south of the former piers and east of former waters’ edge near Round Island (USACE 1998).

SITE LAYOUT

This section provides information on the historical and current site layout. Information on former buildings/structures is limited and based on building titles included in the ASR (USACE 1998) and HPA (USAGC 2018).

At the time of purchase in 1899, Iona Island consisted of 116 acres of rough, rocky, and partly wooded ground and 13 acres of marsh land. The island was transformed into an ordnance plant, first called Naval Magazine and changed prior to World War I to United States Naval Ammunition Depot (USAGC 2018). Most of the native soil on Iona Island has been filled, built on at one point in time, and/or paved (USACE 1998).

Iona began as a relatively small installation. According to a 1939 Public Works of the Navy, Iona Island, NY building inventory (U.S. Navy 1939), by 1902 the following buildings had been constructed: four magazines, two fixed ammunition houses, four shell houses (fixed ammunition), three storehouses, one power house with steam, electric, and air-compressing plant, three storehouses; six hose houses, one pumphouse, one testing laboratory and telephone exchange, one locomotive house, a tin, electrical and annealing shop, one house for gunner’s residence (inspectors quarters), four double cottages for principal employees, an administrative building, gatehouse, and a stable and barn. In 1903, one shipping house and two magazines were built. By 1910, four additional hose houses, two filling houses (one bombproof), three magazines (one for bulk Explosive D), one quilting house, one primer house, one tank repair house, one pump house located by the dock, a paint and oil storage building, paint and pipe shop, labor office and dispensary, a garage and greenhouse were built. By 1920, an ammunition box storage building and cartridge case storage buildings were built, one hose house, two fuse houses, eight magazines including two subsurface magazines, one gun-cotton magazine and a dynamite magazine, one shell house and D plant, one shipping house, one storehouse, powder tank storage, a standpipe, stone crusher, a heating plant for filling houses No. 2 and No. 5, a paint and oil locket, blacksmith shop, one personnel quarters and a marine barracks, a time-clock house, wagon shed, lumber shed, garden tool house, garage and cow barn.

In 1924, a total of 106 buildings including two water storage tanks and one standpipe were present at Iona Island (USACE 1998). In the late 1920s through the 1930s, various programs of maintenance and remodeling were carried out by the Bureau of Yards and Docks in addition to other several buildings being built. For example, ten magazine buildings were remodeled for fire-proofing; three black-powder magazines and a railroad track to serve them were ordered; and two water tanks were provided, the water system enlarged, and two engine-driven generators installed. In addition, a dumping area is first identified between Round Island and Iona Island on a 1930-dated U.S. Navy layout plan (USAGC 2018).

Round Island, the southernmost portion of the depot, was utilized by the Navy for ammunition storage. The Navy filled in the area between Iona Island and Round Island to provide a connection between the two islands. Subsurface magazines were quarried out of rock on Round Island, and the rock removed was used to create a blast barrier between the magazine storage and the depot activities on Iona Island (Bluestone Environmental Group, Inc. [Bluestone] 2018).

In 1951 when the depot was deactivated, there were 146 buildings on the island (USAGC 2018). A 22 June 1965 letter presented in the ASR provides information on the site layout at the time of DoD transfer to PIPC: the roads on the island were in poor condition, with many of the buildings not served by roads. Instead, buildings served by railroad, with spurs from the West Shore Railroad leading to each warehouse and to the pier. Most buildings had been between 1914 and 1918 and were made of brick, while additional buildings constructed in 1941 were made of concrete faced cinder block. Most buildings had no natural or artificial lighting, heating, or other utilities; they were large, open warehouses with high ceilings and no partitions or separation of floors. Several homes were also present on the island, and previously served as residences for naval officers. The homes were vacant but well maintained. Redevelopment for industrial or warehousing use would have required extensive renovation of buildings, clearance of structures, and construction of roads, parking logs, and new sewer system and utility lines (USACE 1998).

The majority of buildings and structures, including building foundations, were demolished and removed by PIPC between November 1965 and December 1973 (USAGC 2018). It is possible that fill material was used during regrading following demolition and excavation/removal of foundations, and that surface and subsurface soil was significantly reworked/mixed across much of the former operations area. The FUDS has remained undeveloped since its transfer from DoD ownership to PIPC in 1965. PIPC developed demolition plans for the remaining buildings and for construction of a recreational park; however, the plans to develop the island into a recreational park were not executed. The only construction that occurred on the island was the parking lot located directly west of Iona Island and outside of the FUDS boundary. The contract plans illustrate the locations of the former buildings which PIPC removed except for a few buildings which currently remain onsite. The plans also illustrate a fill area (believed to be building demolition debris) that currently provides access between Iona Island and Round Island at Ring Meadow Marsh southeast of the former Navy dumping area (Figure 10-1) (Alion Science and Technology Corporation [Alion] 2008).

Original structures still standing include Building 201 (Empty Projectile Magazine); Building 212 (former Marine Barracks); Building 217 (Fire Station and Labor Office), Building 222 (Miscellaneous Storage Building), Building 508 (Bag Charge Magazine); and, Building 603 (Pyrotechnic Magazine) (Bluestone 2018). Building 222 (Store House) is utilized by Bear Mountain State Park for shipping and receiving. Building 212 is in disrepair but has not been demolished due to concerns with asbestos. The old roads in the main part of the former depot (near former Buildings 123 and 410) are still accessible by vehicle. The fill area between Round Island and Iona Island is vegetated, however solid ground allows the area to be traversable by foot.

PREVIOUS INVESTIGATIONS

Investigations have been ongoing at Iona Island since 1992. The following discussion of relevant historical records and previous investigations is presented in chronological order.

Initial Site Visit (1992)

USACE New York District performed an initial site visit on 30 October 1992. According to the Preliminary Assessment (USACE 1992), there was potential groundwater and soil contamination from a fuel oil spill at a former AST, coal storage, a dumping area, an incinerator, and former buildings used as a garage, paint storage, and sewage treatment plant. No damage to flora or fauna, or evidence of illegal or unauthorized dumping, was observed during the site visit (USACE 1992).

The discussion of the initial site visit in the Revised Site Survey Summary Sheet (USACE 1995a), listed the following remaining structures as beneficially used by the present owner: Building 201 (Empty Projectile Magazine); Building 212 (former Marine Barracks); Building 217 (Fire Station and Labor Office); Building 222 (Miscellaneous Storage Building); Building 508 (Bag Charge Magazine); and Building 603 (Pyrotechnic Magazine). These buildings are still visible on current aerial photographs of the site and are identified as "remaining structures" on Figure 10-1.

Data Collection Activities

In October 1996, the Greeley-Polhemus Group, Inc. (Greeley-Polhemus) and Smith Technology Corporation, under contract to USACE New York District, conducted data collection activities at

Iona Island Naval Ammunition Depot in Stony Point, New York (Greeley-Polhemus 1997). The data collection report was submitted in April 1997. Eight AOCs specific to the Iona Island Naval Ammunition Depot FUDS were targeted for investigation, including three former AST locations.

Ten soil samples were collected from the following locations for select analytes (Figure 10-2):

- Paint and Oil Storage Building 103; one shallow soil boring (currently designated AOC #1)
- Incinerator Building 121; one shallow soil boring (currently designated AOC #2)
- Sewage Disposal Plant Buildings 124 to 128; one shallow soil boring (currently designated AOC #4)
- Paint Shop and Pipe Shop Building 407; one shallow soil boring (currently designated AOC #11)
- Power House Building 410; one shallow soil boring (currently designated AOC #12)
- One former fuel-oil AST at Dock 131; one shallow soil boring (currently designated AOC #14 – Area B)
- Two former fuel-oil ASTs at Building 417; two shallow soil borings (currently designated AOC #15 – Area C)
- Former dumping area, two shallow soil borings (currently designated AOC #16 – Area D).

A stainless steel, hand-driven soil coring device was used to collect soil samples at each location from 0.0 to 2.0 ft below ground surface (bgs). Screening of the soil samples with a photoionization detector did not indicate contamination. Visual inspection of the soil samples also did not suggest the presence of contamination; however, some debris (plastic, metal, bricks, etc.) was observed on the ground surface at the former Incinerator Building site (AOC #2) and at the former dumping area (AOC #16).

Soil samples were analyzed for the following compounds (Table 10-1):

- RCRA metals, Target Compound List (TCL) semi-volatile organic compounds (SVOCs), TCL VOCs, and TCL polychlorinated biphenyls (PCBs) at the former Paint and Oil Storage Building 103 (AOC #1), Sewage Disposal Plant Buildings 124 to 128 (AOC #4), and Paint Shop and Pipe Shop Building 407 (AOC #11), and former dumping area (AOC #16) soil samples

- RCRA metals and TCL SVOCs at the former Incinerator Building 121 (AOC #2) soil sample

- TCL SVOCs and TCL VOCs at the former Power House Building 410 (AOC #12) soil sample

- TCL SVOCs and benzene, toluene, ethylbenzene, and xylene (BTEX) at the former fuel AST sites soil borings (AOCs #13, #14, and #15).

Metals (arsenic, barium, cadmium, chromium, lead, mercury, and silver), SVOCs (dinitrotoluenes [DNTs], di-n-butylphthalate, phenol, and polycyclic aromatic hydrocarbons [PAHs]), and one PCB (Aroclor 1260) were detected in the soil at concentrations exceeding NYSDEC Recommended Soil Cleanup Objectives (RSCOs), as published on 16 November 1992 (not specified as residential or industrial). Maximum concentrations of barium, cadmium, chromium, lead, mercury, and silver were detected in the samples collected near Former Building 121 (Incinerator) (AOC #2) and the former dumping area (AOC #16). Arsenic was detected at a maximum concentration in the sample from former Building 103 (Paint and Oil Storage Building) (AOC #1).

SVOC detections (primarily PAHs) were widespread; however, the sum of the detected SVOC concentrations did not exceed the 1992 Recommended Soil Cleanup Objective (RSCO) of 500 milligrams per kilogram (mg/kg) for total SVOCs in any sample (Greeley-Polhemus 1997). SVOCs (primarily 2,4-dinitrotoluene, 2,6-dinitrotoluene, and PAHs) were detected in samples from the former dumping area (AOC #16) and former Building 410 (Power House) (AOC #12). Aroclor 1260 exceeded the RSCO of 1 mg/kg in one of the two samples from the former dumping area (AOC #16). Except for typical laboratory contaminants, VOCs were not detected in the soil samples.

Greeley-Polhemus recommended evaluating site risks based on the Relative Risk Site Evaluation Program and conducting sampling to further delineate metals and SVOC contamination (Greeley-Polhemus 1997).

Military Munitions Response Program Site Inspection

Alion, with support from EA, performed an MMRP SI in 2007/2008 under contract to the U.S. Army Engineering and Support Center in Huntsville and USACE Baltimore District. The scope of the SI was restricted to the evaluation of the presence of material potentially presenting an explosive hazard (MPPEH), MEC, MD, and/or MC related to historical use of the FUDS prior to transfer. Potential releases of HTRW project were outside of the scope of the MMRP SI (Alion 2008).

The MMRP SI included a qualitative reconnaissance of Iona Island and Round Island, using both visual observations and analog geophysics (magnetometer), to identify MPPEH, MEC, or MD, as well as visual indicators of suspect areas impacted by munitions including distressed vegetation, stained soil, targets, and visual metallic debris. The qualitative reconnaissance addressed the former 1903 explosion area; the eastern shorelines along the former dock areas; areas where ordnance items were historically observed at low tide; and at the former dumping area located between Iona Island and Round Island. The total estimated acreage subject to the qualitative reconnaissance was approximately 14.9 acres. No MEC or MD was visually observed during the field event. Geophysical anomalies encountered during the reconnaissance were attributed to surface/cultural debris (Alion 2008).

MC sampling was conducted within the approximately 124.2-acre FUDS MRS-01 1903 explosion area (Figure 10-3). MRS-01 is centered between former Buildings 209 and 210. The MRS radius extends outward 1,250 ft based on the kick-out radius of 13-in. shells (USACE 2004). The 1,250-ft radius of the MRS was determined as part of the ASR (USACE 1998) and was based on DoD 6055.09-STD, DoD Ammunition and Explosives Safety Standards, dated October 1992.

In December 2007, a total of 23 surface soil samples (including 5 background samples) were collected from the 1903 Explosion MRS using a 7-point wheel composite method, from 0 to 2 in. bgs (Alion 2008). Five sediment samples (including 3 background samples) were also collected. The background samples were collected from an area west and upgradient of the FUDS boundary and outside of the limits of the 1903 Explosion Area. Background locations selected were from areas deemed unimpacted by past DoD or current owner operations and were of similar soil characteristics as the biased soil samples. There was no observed visual or magnetic evidence of MEC, MD, or other military-related disturbance at background sample locations.

Prior to sampling, research was conducted to focus the list of analytes to MC potentially associated with the munitions used when the FUDS was active (Alion 2008). As a result, the soil and sediment samples were analyzed for:

- Select Target Analyte List (TAL) Metals – antimony, copper, lead, nickel, and zinc (EPA Method 6010B) and mercury (EPA Method 7471A). Iron was also a MC of concern for the MRS, but it was not analyzed during the SI sampling event, because it is not a CERCLA hazardous substance (Alion 2008).

- Explosives—2,4,6-TNT; 4-amino (AM)-2,6- DNT; 2-AM-4,6-DNT; 2,4-DNT; 2,6-DNT; 2-nitrotoluene; 3-nitrotoluene; 4-nitrotoluene (EPA Method 8330A); and, nitroglycerin (EPA Method 8330).

No surface water or groundwater samples were collected. Screening-level human health and ecological risk assessments were performed using the 2007 MC sampling and analysis results. Chemical concentrations were compared to applicable human health criteria (residential for soil, residential and industrial for sediment), ecological screening values, and background concentrations.

Two explosives (2,4,6-TNT and 4-amino-2,6-DNT) were detected at one location, II-EA-SS-02-08, in the central portion of the Iona Island Naval Ammunition Depot FUDS, but at concentrations below applicable human health and ecological screening values in one of the 18 surface soil samples (II-EA-SS-02-08) (Table 10-2). The other 10 explosives were not detected above laboratory reporting limits. There were no explosives detected in the sediment samples (Table 10-3).

Only a qualitative comparison was done between the maximum and average concentrations and the background results. Lead concentrations exceeded background concentrations and human health screening criteria in sediment samples but were below the industrial soil criteria in surface soil samples (Tables 10-2 and 10-3). Antimony, copper, and lead exceeded background concentrations and associated ecological screening values in surface soil. In sediment, antimony, copper, lead, nickel, and zinc exceeded background concentrations and ecological screening values.

The SI recommended that a RI/FS be performed for both MEC/MD and MC, based on historical discoveries of MD, potential for MEC/MD to remain on site, and potential for risks to human health and ecological receptors from metals MC in surface soil and sediment (Alion 2008).

Underground Storage Tank Closure (CON/HTRW)

In 2011, Green Seal Environmental, Inc. (GSE) was tasked by USACE New England District to conduct UST removal and site closure activities at the Iona Island Naval Ammunition Depot FUDS (GSE 2011). Two 1,100-gallon fuel oil USTs were known to exist near Building 212. Five additional USTs were suspected on site:

- One potential 275-gallon fuel oil UST next to former Building 104
- Two potential 1,000-gallon fuel oil USTs next to former Building 201
- Two potential 500-gallon fuel oil USTs next to existing Building 222

A geophysical survey was conducted at existing Building 222, and former Buildings 201 and 104 by Hager-Richter Geoscience, Inc. under the direction of GSE on 18 August 2011, to locate the potential USTs (Figure 10-4). Three investigative methods were utilized during the study: time domain electromagnetic induction metal detection, precision utility location, and ground penetrating radar. Several anomalies, including piping and miscellaneous metal items, were detected; however, no USTs were in the geophysical investigation areas (GSE 2012).

The two 1,100-gallon fuel oil tanks were removed by GSE’s subcontractor, Charter Environmental, on 6 September 2011. The two USTs were partially covered in a mounded area adjacent to Building 212, with both tank bottoms located at surface grade. Approximately 1,000 gallons of product was pumped from the two tanks and transported to Environmental Waste Treatment, LLC in Farmingdale, New York, for disposal. The tanks were uncovered, removed from the excavation area, visually inspected, cut, and cleaned. During the inspection, the tanks were observed in good condition with no evidence of holes or leakage. On 7 September 2011, the tanks were transported to Action Metal Company, Inc. in Stony Point, New York for recycling (GSE 2012).

Confirmation soil samples were collected post-excavation from the area where the USTs were removed (treated as a single-tank excavation)3. Soil samples were collected from the sidewalls and the bottom of the excavation, in accordance with NYSDEC regulations. VOC and SVOC concentrations in the confirmation samples were either below the laboratory method detection limits or below the applicable NYSDEC Soil Cleanup Objectives. Therefore, soil remediation was not required. The overburden material removed from the mound was placed back into the excavation and regraded. No additional backfill was required (GSE 2012).

The UST Closure Report was finalized in May 2012. The Rockland County, New York Department of Health and USACE both reviewed the final UST Closure Report and declared that no further action (NFA) associated with tank removals was required at the site (USACE 2012). In the Project Closeout Memorandum for Iona Island Naval Ammunition Depot (Project No. C02NY074401) dated 10 December 2012, USACE further recommended that the associated FUDS project may be closed out.

Historical Photographic Analysis

In 2018, the Hydrologic and Environmental Analysis Branch of the U.S. Army Geospatial Center (USAGC) Warfighter Support Directorate was tasked by USACE New England District to complete a Historical Photographic Analysis (HPA) project for the former Iona Island Naval Ammunition Depot. The purpose of the study was to locate and identify, from historical imagery, maps, and drawings, former buildings that may be related to HTRW. The primary objectives were to identify the years of construction, years of use, and type of HTRW activities associated with buildings and AOCs under the FUDS and MMRP programs between the years 1903 and 1957; document the location and extent of historical disposal sites and their period of activity, including the filling of wetlands associated with disposal activities; and identify the footprint of the 1903 explosion.

USAGC reviewed/researched and geo-rectified historical records including aerial photos and commercial imagery from 1931 to 2018, historical map data and cartographic records, installation layout plans for years 1901 to 1965, United States Geologic Survey topographic maps, design drawings, and other documents regarding the use of potentially HTRW materials at the Iona Island Naval Ammunition Depot.

Explosive Hazard Evaluation

In January 2019, EA conducted a review of former buildings/structures at the Iona Island Naval Ammunition Depot FUDS at the request of USACE to identify locations where filling or possible spilling of explosive-containing materials could have occurred. EA reviewed previous documents including the ASR (USACE 1998) and HPA (USAGC 2018) and, based on limited information available (e.g. building titles), identified 20 former buildings as locations where filling or possible

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[3] The tank removal and analysis was not completed under QSM. Per the laboratory analytical report, non-detect results were reported at the method detection limits (MDLs).

spilling of explosive-containing materials could have occurred (Table 10-4). These buildings have not been previously investigated. Based on further review and input from USACE, 7 of these 20 former buildings were identified as buildings with significant potential for explosive hazard. PIPC conducted a site walk and confirmed that foundations at there are no foundations or slabs remaining at these former building locations.

- Building 609 – Mine Loading Plant
- Building 506 – Filling House #3 (Bombproof)
- Building 503 – Filling House #6
- Building 404 – Filling House #1
- Building 307 – Filling House #5
- Building 306 – Filling House #2
- Building 202 – Shell House #5 & D Plant

PHYSICAL PROFILE

Climate

The climate in Rockland County, New York is classified as humid continental and subjected to some modification by the Atlantic Ocean Minimum temperatures average 21.1 degrees Fahrenheit (°F) in January and maximum temperatures average 81.6°F in July (USACE 1997). Mean monthly air temperatures below 40°F occur from December through March and freeze dates with temperatures below 28°F generally occur from late October to mid-April (U.S. Department of Agriculture, Soil Conservation Service 1990).

Precipitation averages from 35 to 49 in. annually, with over half of the precipitation (26.14 in.) falling between May and October [National Oceanic and Atmospheric Administration (NOAA) 2017]. Annual snowfall averages 26 in. The average wind direction is southerly, with the highest mean monthly velocities of over 10 miles per hour occurring in February, March, and April (USACE 1997).

Physiography and Topography

Iona Island is located in the Hudson Highlands physiographic province of the New England Uplands. The surface of the New England Upland slopes southeastward from maximum inland altitudes around 2,200 ft to approximately 400 to 500 ft at its seaward edge (USACE 1998).

The Hudson Highlands is part of a northeast-trending mountain mass extending from Pennsylvania to Connecticut. The Hudson River cuts through the Hudson Highlands in a 15-mile-long relatively straight, north/south-oriented, narrow, steep-sided gorge with bedrock flanks between from West Point and Peekskill, New York. Channel width in the Hudson Highlands region is less than 0.6 miles (Yozzo et al. 2005). Maximum relief is about 1,600 ft where the Hudson River dissects the Hudson Highlands. Topography is relatively rugged with prevalent bedrock-controlled landforms (NYSDOT 2013). Erosional and depositional effects of glaciation are widespread and conspicuous in the Upland. Numerous hills and mountains rise above the general level of the Upland (USACE 1998).

Iona Island is a 556-acre bedrock island of the Hudson River (Figure 10-5). The southeastern part of the island, once cut off by marshes, is known as Round Island. It was attached to the south end of Iona Island with fill in the early 20th century. The hill on the western side, south of the railroad tracks, was also once treated as separate and referred to as Courtland Island.

Iona Island has rock-like terrain, with varying degrees of slopes. Elevations range from 0 ft National Geodetic Vertical Datum along the shoreline to 75 ft National Geodetic Vertical Datum (USACE 1998).

Surface Water Drainage

Iona Island is bordered on the east by the Hudson River; on the northwest by the mouth of Doodletown Bight, an expanse of shallows and mudflats; on the west and southwest by Iona Island Marsh, a tidal marsh that occupies one mile between Iona Island and the mainland (Figure 10-5). A non-climbable steel fence on top of a rubble wall and the CSX railroad separate Iona Island and the FUDS from Iona Marsh. There are no surface water bodies or drainages on the upland portion of the island within the FUDS boundary, however the shoreline areas of the island and adjoining marshes are located within, and therefore impacted by, the Hudson River.

The Hudson River originates in the Adirondack Mountains of Upstate New York, and flows southward 315 miles to the Atlantic Ocean at New York Harbor, between New York City and Jersey City. Maximum river depths are found in the Hudson Highlands between West Point and Peekskill, New York, with the deepest point of 196 ft at West Point (Yozzo et al. 2005). The lower half of the Hudson River from Troy to New York Harbor, a distance of 125.5 miles, is an estuary (drowned river valley) affected by semidiurnal tides, with two highs and two lows occurring within a 25-hour period (Yozzo et al. 2005). The tidal range averages approximately 2.9 feet (Yozzo et al. 2005). Salinity zones in the Hudson are determined by a combination of hydrographic factors, primarily the tidal surge of saline water upriver from the Atlantic Ocean and the magnitude of freshwater flow into the upper estuary. Freshwater flow in the Hudson estuary follows a typical seasonal pattern, with highest flow during the spring and lowest flow during late summer and early fall under an average runoff regime the salt front (0.5 parts per trillion) reaches Newburgh by late summer/early fall. During conditions of high freshwater runoff, usually during spring, the salt front may be pushed downriver as far as the Bronx (Yozzo et al. 2005).

Iona Island is located 41.2 miles upstream from New York Harbor and approximately 30 miles upstream of The Bronx, New York. The section of the Hudson River at Iona Island is very narrow and deep, with strong currents and a rocky bottom substrate. The width of the Hudson River at Iona Island is approximately 0.3 mile east of Iona Island, and the river in this area has a depth of approximately 165 ft. Tidal influence at Iona Island is approximately 3.5 ft, and shorelines may not be accessible during high tide conditions (Alion 2008).

Iona Island is separated from the mainland by Doodletown Brook on the west and north and Snake Hole Creek on the south. Doodletown Brook originates in Bear Mountain State Park, draining an area of approximately 2.9 square miles, and is the principal tributary to Iona Island Marsh west of Iona Island (Yozzo et al. 2005). Doodletown Brook flows east and north approximately 1,960 ft from the Bear Mountain State Park shoreline to Doodletown Bight, which flows north from the Doodletown Brook outlet approximately 2,640 ft and drains into the Hudson River near the northern end of Iona Island and then to the Hudson River, near the northern end of Iona Island.

Snake Hole Creek originates in the low marshes southwest of Iona Island and flows approximately 5,190 ft southwesterly, southeast and finally east to the Hudson River. The Creek divides Iona Island Marsh into Salisbury Meadow on the west and Ring Meadow, on the east side. The shoreline between Iona Island and Round Island adjacent to Ring Meadow was infilled by PIPC after Navy transfer of the Island in 1965.

Soil and Sediments

Most of the native soil on Iona Island has been filled, built on at one point in time, and/or paved (USACE 1998). Native soil at Iona Island and the mainland is derived from glacial till and is shallow, acidic, and nutrient poor (Yozzo 2005). The following soil mapping units were located on and immediately adjacent to Iona Island (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 2018).

- Chatfield-Rock outcrop complex; 4 to 16% slopes
- Hollis-Rock outcrop complex; 35 to 60% slopes
- Ipswich mucky peat, 0 to 2% slopes, very frequently flooded.

Chatfield-Rock outcrop is the primary native soil at Iona Island and is classified as well-drained gravelly-sandy loam soil, 20 to 40 in. deep to the restrictive feature, and is the primary native soil at Iona Island. The upland area west of Iona Island that divides Iona Marsh from Doodletown Bight contains Hollis-Rock outcrop, classified as somewhat excessively drained, with 8 to 23 in. to the restrictive feature. Ipswich mucky peat soil is found in Iona Marsh and is classified as very poorly drained, with more than 80 in. to the more restrictive feature, and up to 59 in. of muck and mucky peat (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 2018).

Shoreline Environment

In general, muddy sediments dominate the Hudson Highlands section of the Hudson River, where Iona Island is located, and there is a complicated pattern of dynamic and depositional environments between the non-depositional bedrock outcrops, which are found along the river margins (Nitsche et al. 2007). Sediments in the tidal marshes and shallows west of Iona Island consist of peat and silt and are more than 100 ft deep (U.S. Department of Commerce NOAA and NYSDEC 1982).

The western and southern portion of the island is separated from the adjacent marshes by the active River Subdivision (CSX Transportation) railroad tracks. The southern shoreline is separated from Ring Meadow by a fill area emplaced after Navy transfer of the FUDS to PIPC.

Photographs from the ASR (USACE 1998) and the SI (Alion 2008), as well as more recent photos from 2018 indicate that the shoreline along the Hudson River and Doodletown Bight areas consists primarily of riprap, gravel, cobbles, boulders, and exposed bedrock. Visual evidence of the immediate shoreline north of the dumping area between Round Island and Iona Island indicates a retaining wall spanning the shoreline, with large boulders present in the river. Aerial photographs and orthoimagery indicates that the wall is not present along the shoreline in the area of the northern dock (Figure 1-2); exposed shoreline with gravel, cobbles, and boulders is visible in this area on recent orthoimagery.

A limited area of exposed sand and gravel shoreline area is present along the shoreline of the dumping area; sediment was collected from this area during the SI (Alion 2008). This shoreline area changes to cobbles and boulders (riprap) extending southward along Round Island. Additional information on locations of exposed shoreline areas with sediment is not available. In addition, presence/absence of a shelf extending from the shoreline to the central channel of the Hudson River is unknown.

Overburden and Bedrock Geology

Field notes from the 1996 investigation document overburden at Iona Island as fill material overlying fine to coarse sand, with some silt and gravel. Overburden at Iona Island is thin, with bedrock encountered at depths of approximately 25 in. bgs during the Greeley-Polhemus soil sampling event in October 1996 (USACE 1997).

The bedrock of the New England Upland and Hudson Highlands is folded, faulted, and includes metamorphosed sediments that have been intruded by numerous plutonic masses (USACE 1997). The rock is resistant to erosion and forms rocky knobs on Iona Island that project 100 ft above the Hudson River, and hills that rise more than 1,000 ft within 0.5 miles of the island (Bear Mountain). Based on the bedrock geology map for the Lower Hudson, bedrock at Iona Island consists primarily of biotite-quartz-plagioclase paragneiss (Fisher et al. 1970).

Hydrogeology

Groundwater at and in the vicinity of Iona Island is found in both overburden and underlying bedrock. Groundwater in overburden at Iona Island was encountered at a depth of 2 ft near the former dumping area between Iona Island and Round Island during the October 1996 soil sampling event; likely because bedrock is close to the surface and infiltration, where possible, is slow (Greeley-Polhemus 1997). It is possible that a perched water table (possibly intermittent based on precipitation) is present above the less permeable bedrock. Shallow groundwater is likely influenced by the Hudson River.

Crystalline bedrock of the Hudson Highlands acts as a relatively poor aquifer. Groundwater in the gneiss and granitic rocks only occurs in fractures and joints (Heisig 2010). Bedrock groundwater at Iona Island is likely encountered at depths greater than 6 ft as based on the rock outcrop soil description reported in the Rockland County Soil Survey (Bonnell 1990).

Groundwater recharge is primarily from infiltration of local precipitation, with downward seepage of water through overburden into underlying bedrock and/or direct infiltration of precipitation on exposed bedrock surfaces. Upward seepage of water from bedrock also recharges surficial deposits in low-lying areas. Shallow groundwater flow in surficial deposits and weathered bedrock likely follows topography, with discharge to surface water bodies (i.e., Hudson River). Due to the crystalline nature of the bedrock, groundwater flow is restricted to joint and fracture systems that generally trend northeast-southwest (Olcott 1995).

Groundwater usage in the Hudson Highlands is largely limited to domestic wells along the periphery of the parklands. Maximum yields of wells completed in the crystalline rocks rarely exceed 70 gallons per minute, and limited aquifer storage in crystalline rock makes such wells susceptible to decreased yields during dry periods unless they are in hydraulic connection with surface water (Heisig 2010).

Ecological Setting

The mainland of Iona Island and the elevated topography area southwest of Iona Island dividing Iona Marsh and Doodletown Bight is classified as an upland area (Cornell Institute for Resource Information Sciences [Cornell IRIS] 2011) (Figure 10-6). Habitats surrounding Iona Island include brackish intertidal mudflats, brackish tidal marsh, freshwater tidal marsh. Terrestrial habitats on the island consist of deciduous forested uplands. Specific habitats are described in more detail in the following paragraphs.

An intertidal marsh encompasses approximately 225 acres between Iona Island and the western shore of the Hudson River and is one of the largest, undeveloped tidal wetlands on the Hudson River (Yozzo et al. 2005) (Figure 10-6). The marsh is separated from the FUDS by a non-climbable steel fence on top of a rubble wall and the CSX railroad. The National Wetlands Inventory (U.S. Fish and Wildlife Service [USFWS] 2018) classifies the marsh as an estuarine and marine wetland (E2EM1N6 – estuarine, intertidal, emergent, persistent, regularly flooded, oligohaline 0.5–5 parts per thousand salinity). Tidal mudflats submerged aquatic vegetation beds, and small areas of rocky uplands also occur in the area. In Doodletown Bight, the northern portion of the marsh, mudflats are visible at low tide (Yozzo et al. 2005).

The southern end of Iona Island has two areas listed as freshwater forested/shrub wetland (palustrine, scrub-shrub, broad-leaved deciduous, temporary flooded tidal). The marshes that separate Iona Island and Round Island from the mainland were filled in the early 20th century, with a Navy dumping area located along the Hudson River side of the islands and an area of fill on the western shoreline placed by PIPC following Navy transfer of the FUDS in 1965. There is also a small (0.35 acre) freshwater emergent wetland on the western side of the island (palustrine, emergent, persistent, semi-permanently flooded) (USFWS 2018). The Hudson River is classified as estuarine and marine deep water (estuarine, subtidal, unconsolidated bottom, subtidal, oligohaline 0.5-5 parts per thousand salinity).

Native vegetation within the marsh is dominated by narrow leaf cattail (*Typha angustifolia*) with common reed (*Phragmites* spp.) and swamp rose mallow (*Hibiscus moscheutos*). Crack willow (*Salix fragilis*) is present at the mouth of Doodletown Brook within the tidal swamp. Compaction of soil, saltwater intrusion, and site disturbance have resulted in a significant presence of invasive species (estimated at 60% of the vegetation on the island). Recent wetland restoration has been conducted on site, with approximately 50% of the marsh restored from invasive species (including *Phragmites* spp.) to native vegetation such as cattails (Bluestone 2018).

Iona Island Marsh is especially important for marsh-nesting birds. Probable or confirmed breeding species include herons, least bittern (*Ixobrychus exilis*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), Virginia rail (*Rallus limicola*), belted kingfisher (*Ceryle alcyon*), marsh wren (*Cistothorus palustris*), and red-winged blackbird (*Agelaius phoeniceus*).

Resident wildlife species in the area include muskrat (*Ondatra zibethicus*), white-tailed deer (*Odocoileus virginianus*), box turtle (*Terrapene carolina*), Northern water snake (*Nerodia sipedon*), timber rattlesnake (*Crotalus horridus*), red fox (*Vulpes* Vulpes), rat snake (*Pantherophis* spp.) and green frog (*Rana clamitans*).

The upland terrestrial areas of the island consist of deciduous, rocky woodland communities including oaks (*Quercus* spp.), ashes (*Fraxinus* spp.), birches (*Betula* spp.), willows (*Salix* spp.), red maple (*Acer rubrum*), and elms (*Ulmus* spp.). The woodlands are maintained for their value as cover, perch sites, and buffer zones. Towards the center of the island where historical buildings once stood, open grasslands and low-lying shrubs dominate the landscape.

Threatened and Endangered Species

Threatened species are species that may become endangered if conditions surrounding the species begin, or continue, to deteriorate. Endangered species are species whose prospects for survival in an area are assumed to be in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, or disease. Species of special concern is any species that does not meet the criteria of an endangered or threatened species but is particularly vulnerable and could easily become an endangered, threatened, or extirpated species due to restricted distribution, low or declining numbers, specialized habitat needs or limits, or other factors. Special concern species are established by policy, not by regulation, and are used for planning and informational purposes; they do not have the legal weight of endangered and threatened species.

Bird species and their status for New York are provided in the following table.

Species	Common Name	Status
Haliaeetus luciocephalids	Bald eagle	Threatened
Ixobrychus exilis	Least bittern	Threatened
Setophaga cerulea	Cerulean warbler	Special Concern
Vermivora chrysoptera	Golden-winged warbler	Special Concern
Pandion haliaetus	Osprey	Special Concern
Circus cyaneus	Northern harrier	Threatened
Podilymbus podiceps	Pied-billed grebe	Threatened

The United States Fish and Wildlife Service (USFWS) identifies species that are known to or are believed to occur in Rockland County, New York and are provided in the following table.

Group	Species	Common Name	Status
Plants	*Isotria medeoloides*	Small whorled pogonia	Threatened
Mammals	*Myotis sodalis*	Indiana bat	Endangered
Mammals	*Myotis septentrionalis*	northern long-eared bat	Threatened
Reptiles	*Clemmys muhlenbergii*	bog turtle	Threatened

In addition, Atlantic sturgeon (*Acipenser oxyrhynchus*) and shortnose sturgeon (*Acipenser brevirostrum*) live primarily in the ocean but migrate to coastal rivers for spawning. In New York, spawning and nursery grounds for juveniles are located in the Lower Hudson River. Both species are classified as Endangered by National Marine Fisheries Service (NMFS) and are protected in the State of New York.

CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USE

Iona Island was designated a National Natural Landmark in 1974 by the National Park Service. Iona Island is currently under the administration of the PIPC and maintained by staff of Bear Mountain State Park. Public use at the island is limited to educational outings and history tours. Site access is limited to authorized employees of Bear Mountain State Park who use a few of the remaining buildings for storage, to researchers who work in the marsh areas, and to guided tour groups six to eight times per year between May and October. The island is partially fenced, and the main gate is unmanned, which allows for limited access to Iona Island from Bear Mountain State Park. Boating along the Hudson River is open to the public, and because the shoreline of Iona Island is not fenced, there is potential for recreational users of the Hudson River to access the island via the shoreline. Additionally, the island has been historically used for camping. The Boy Scouts have used the Site within the past 5 years for activities.

In 1965, when GSA conveyed the property to the Palisades Interstate Park Commission, it was under a "restrictive clause" (park purposes only) (USACE 1995). The majority of Iona Island is currently open space. There is a parking lot and scenic overlook located directly west of Iona Island. While PIPC developed plans for construction of a recreational park, these plans were not fully executed, although some stormwater sewers were partially installed. In addition, although a developer has proposed plans for constructing an environmental center/nature center, these plans have not been approved. There are no current plans to develop the island for recreational purposes and no anticipated future use of the site other than its current use as a conservation area. There are no anticipated construction plans other than the possibility of converting existing buildings for use or constructing a new storehouse.

Subsurface utilities information at the Iona Island Naval Ammunition Depot FUDS is not available. Previous investigation documents including the ASR and HPA did not include information on utilities, piping, building sumps, wash-out areas, or wastewater retention ponds. Two potential sewer discharge pipes were identified in historical installation layout maps from 1934 and 1947 (USAGC 2018). One 10-in. diameter discharge pipe reportedly extended offshore into the Hudson River in the area between Iona Island and Round Island. A second discharge pipe identified as an outfall sewer on trestle reportedly extended off the shoreline in the area southeast of Building 201.

A description of Iona Island from 1937 presented in the ASR states that a fresh water supply consisted of a rainwater collection system into two reservoirs of 2,000,000-gallon capacity connected by equalizer pipe, which was pumped and stored in two steel tanks with a of combined capacity of 4,200,000 gallons. The Iona Island War Diary from 1945 presented in the ASR states that on 10 December a new water supply system involving a pipeline to Doodletown was placed in partial use pending completion of some final pump house piping. This system had sufficient capacity to furnish this Depot with its entire freshwater requirements under normal operating conditions (USACE 1998).

Shallow overburden groundwater at Iona Island is not used as a potable or non-potable water source. Bedrock groundwater and surface water at Iona Island are not used as a potable water source. In the 1990s, the water supply line that supplied Iona Island broke (near NYS Route 9W) on the causeway. Bear Mountain State Park did not repair the waterline break and a bedrock well was installed (March 2997) behind the existing storehouse (Building 222). During well installation, bedrock fracking was used to get the well to yield water. Per Charlie Tonneson, Bear Mountain Park Engineering Department, this new well is not treated and is used for non-potable purposes only (bottled water is brought on Iona Island for drinking purposes).

Land use surrounding Iona Island is recreational and military, with Bear Mountain State Park along the western shore of the Hudson River and Camp Smith along the eastern shore. The site is also surrounded by the Iona Island/Doodletown Bird Conservation Area (NYSDEC 2017). For the portions of the adjacent Bear Mountain State Park that are open to the public, recreational opportunities include hiking, boating, and bird watching. There is no public canoeing or kayaking allowed in the marshes surrounding Iona Island. Access to the marsh is limited to guided canoe and kayak trips.

Iona Island is part of the much larger Hudson River National Estuarine Research Reserve and Significant Coastal Fish and Wildlife Habitat Area, managed under New York’s Coastal Management Program (Alion 2008). In addition, the Iona Island Marsh became a registered

National Natural Landmark in 1971. The island is considered a bald eagle sanctuary (Levine 2011).

HTRW SOURCE AREAS

Bluestone Environmental Group, Inc. (Bluestone) was contracted by the USACE, New England District, to conduct a background/historical records review and site visit at the Iona Island Naval Ammunition Depot, to determine the next steps toward completing investigations of contamination at the site. Bluestone reviewed previous documents, aerial photographs, and available information and identified 19 AOCs located in the locations/footprints former buildings/structures that were eligible for further inclusion in the HTRW project. These AOCs include the locations/footprints of 16 former buildings, 4 former above-ground storage tanks (ASTs)[4], a former dumping area, 2 former coal storage areas, and 3 former transformers where contaminants related to the facilities or from historic processes during the site's commission as an ammunition depot may be present (Figure 2). Information on the exact usage of these former structures/facilities is limited. The buildings have been identified based on building titles included in the ASR (USACE 1998) and HPA (USAGC 2018):

- ***AOC #1: Former Building 103*** – Paint and Oil Storage
- ***AOC #2: Former Building 121*** – Incinerator
- ***AOC #3: Former Building 123*** – Garage Building
- ***AOC #4: Former Buildings 124 to 128*** – Sewage Disposal Plant (and Suspected Outfall)
- ***AOC #5: Former Building 207*** – Marine Garage Building
- ***AOC #6: Former Building 213*** – Paint Locker for Building 202
- ***AOC #7: Former Building 215*** – Garage Building
- ***AOC #8: Former Building 219*** – Garage Building
- ***AOC #9: Former Building 220*** – Garage Building
- ***AOC #10: Former Building 406*** – Tin, Electrical, and Annealing Shop Building
- ***AOC #11: Former Building 407*** – Paint Shop and Pipe Shop

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[4] The ASTs themselves are not the AOCs. The FUDS-eligible AOCs are the former AST locations/footprints. The ASTs were removed but the sites were not formally closed out and were not included in the CONHTRW project. The footprints of the former ASTS are therefore being evaluated under the HTRW

- ***AOC #12: Former Building 410*** – Power House

- ***AOC #13: Area A*** **–** One Former Fuel Oil AST (2,500 gallons); located near Former Building 233

- ***AOC #14: Area B*** **–** One Former Fuel Oil AST (size unknown); located near Dock 131

- ***AOC #15: Area C*** **–** Two Former Fuel Oil ASTs (size unknown); located near Former Building 417

- ***AOC #16: Area D*** **–** Dumping Area

- ***AOC #17: Area E*** **–** Former Coal Trestle and Storage Area; located near Former Building 410

- ***AOC #18: Area F*** **–** Former Coal Storage Area; located near Former Building 215

- ***AOC #19: Three Former Transformers*** **–** T1 northwest of Building 406, T2 near Area D, and T3 northeast of Building 220.

Activities conducted at the former buildings/structures and potential AOC-specific contaminants related to those activities have been interpreted based on building names presented in the ASR (USACE 1998) and HPA (USAGC 2019) (Table 10-5).

ADDITIONAL POTENTIAL SOURCE AREAS

An additional review of the former buildings was conducted during preparation of this UFP-QAPP at the request of the USACE to identify locations where filling or possible spilling of explosive-containing materials could have occurred. Seven former explosive storage and filling operations buildings were identified as having significant potential for explosive hazard. These former buildings have not been previously investigated, and the presence of explosives in environmental media related to these buildings is currently unknown. While these buildings are not currently included in the HTRW project at the Iona Island Naval Ammunition Depot FUDS and were not scoped in the existing contract, they are being considered for evaluation during this HTRW RI pending direction of contracting offer.

- Building 609 – Mine Loading Plant
- Building 506 – Filling House #3 (Bombproof)
- Building 503 – Filling House #6
- Building 404 – Filling House #1
- Building 307 – Filling House #5
- Building 306 – Filling House #2
- Building 202 – Shell House #5 & D Plant

PRELIMINARY CONTAMINANTS OF POTENTIAL CONCERN

This HTRW RI is being conducted in accordance with the CERCLA process, and relies on applicable federal requirements, regulations, and guidance documents. During RI report preparation, the most recent EPA screening values will be used for evaluating detected constituents. As such, an evaluation of previous discrete analytical sample data was conducted to identify contaminants detected at concentrations above current EPA screening values and background concentrations (Tables 10-1 to 10-3). The following screening values were used:

- EPA Industrial Soil Regional Screening Levels (RSLs) (updated May 2019).

- EPA Residential Soil RSLs. A restrictive clause is in place for the island that it shall only be used for park purposes only; therefore, residential development is unlikely to occur at the Site (USACE 1995). However, EPA Residential Soil RSLs are included to assess for potential children receptors at the Site, including site visitation for nature walks and potential camping.

- EPA Ecological Soil Screening Levels (EcoSSLs) (February 2005 through April 2008)

- EPA Region 4 Marine/Estuarine Sediment Screening Benchmarks (EPA 2018)

Widespread metals and PAH detections were reported in surface and/or subsurface soil or sediment at concentrations exceeding EPA screening values; therefore, metals and PAHs have been identified as the preliminary contaminants of potential concern (COPCs).

The preliminary COPCs for this investigation vary by AOC and are based on a review of the CSM. A comprehensive list of preliminary COPCs identified for this HTRW RI include the following:

- TAL metals
- PAHs
- BTEX
- Aroclor PCBs
- Explosives residues

A detailed discussion of the preliminary COPCs list is provided below and Table 10-5 provides a brief CSM summary by AOC and identifies preliminary COPCs list for each.

Selection of Preliminary COPCs

The following individual analytes were reported in surface and/or subsurface soil or sediment at concentrations exceeding both EPA residential and industrial soil RSLs:

- Metals (arsenic, cadmium, and lead) related to DoD activities

- Explosives (2,4-DNT and 2,6-DNT) at AOC #16 - Area D (Dumping Area).

- PCBs (Aroclor 1260); AOC #16 – Area D [Dumping Area]. PCBs were reported at concentrations above residential soil RSLs in two subsurface soil samples collected at AOC #16 - Area D (Dumping Area), which is located along the shoreline and within the tidal flood zone of the Hudson River (Greeley-Polhemus 1997). PCBs were not reported at concentrations above EPA screening values in samples collected from other areas of Iona Island located outside the zone of tidal influence. As AOC #16 - Area D (Dumping Area) is influenced by the Hudson River, PCBs in this location could be attributed to Hudson River contamination. From 1947 to 1977, approximately 1.3 million pounds of PCBs entered the Hudson River from two General Electric capacitor manufacturing plants located in Fort Edward and Hudson Falls, New York. According to the EPA, the Hudson River PCBs Superfund Site encompasses nearly 200 miles of the Hudson River from Hudson Falls, New York, to the Battery in New York City (EPA 2017).

Additional analytes were reported in subsurface soil or sediment at concentrations exceeding EPA residential soil RSLs only:

- Metals (antimony, copper, and zinc) related to DoD activities

- PAHs (benzo[a]anthracene, benzo(a)pyrene, benzo[b]fluoranthene, and dibenz[a,h]anthracene) related to DoD activities

The following analytes were reported in surface soil, subsurface soil and/or sediment at concentrations exceeding Eco SSLs:

- Metals (antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, silver, and zinc) related to DoD activities

- PAHs (benzo[a]anthracene, benzo[b]fluoranthene, chrysene, dibenz[a,h]anthracene, fluoranthene, indeno(l,2,3-c,d)pyrene, and pyrene) related to DoD activities.

Additional Preliminary COPCs

Additional contaminants, while not previously detected above screening values, have been identified for individual AOCs based on historical use of former buildings/structures as follows:

- BTEX and PAHs at AOC # 13 – Area A (one former fuel oil AST located near former building 23), AOC #14 – Area B (one former fuel oil AST located near Dock 131), AOC #15 - Area C (two former fuel oil ASTs located near former building 417). BTEX is a common constituent in fuel oil. Subsurface soil samples at AOC #14 - Area B, and AOC #15 - Area C) were collected for analysis of VOCs during the 1996 Data Collection Activities (Greeley-Polhemus 1997) (Figure 10-2; Table 10-1). While VOCs related to site activities were not detected in subsurface soil at these locations[5], these AST sites were not formally closed out. PAHs were reported elevated concentrations above EPA residential RSLs (benzo[a]pyrene) and ecological SSLs (fluoranthene and indeno[l,2,3-c,d]pyrene) at AOC #14 – Area B. Soil has not been previously evaluated at AOC # 13 – Area A.

- PCBs at AOC #19 - three former transformers. These areas have not been previously investigated, and PCBs are the primary contaminants associated with transformers.

- Explosives at additional 7 former explosive storage and filling operations buildings. These areas have not been previously investigated. The former buildings have been identified as potential significant explosive hazard based on limited information (e.g. building titles) included in the ASR (USACE 1998) and HPA (USAGC 2018) and input from USACE.

Solvents may potentially have been stored or used at former buildings including former Building 103 – Paint and Oil Storage; former Buildings 123, 207, 215, 219, and 220 – former garages; former Building 213 – Paint Locker for Former Building 202; and former Building 407 – Paint Shop and Pipe Shop Solvents may also have been disposed of at AOC #16 - Area D (Dumping Area) or conveyed from former buildings to the sewage disposal plant. Contamination related to former solvents would include volatile organic compounds (VOCs), primarily trichloroethylene (TCE) and tetrachloroethylene (PCE) and their degradation products (1,2-dichloroethylene [DCE], and vinyl chloride). Solvent-related VOCs were not reported in subsurface soil samples collected at former Building 103, former Building 407, the former sewage disposal plant, or AOC #16 - Area D (Dumping Area). In addition, due to the length of time since deactivation of the Iona Island Naval Ammunition Depot (70 years), the physical environment of the site (tidally influenced by the Hudson River, and the physical characteristics of solvent-related VOCs (high solubility and mobility), it is unlikely that solvent-related contamination would remain in environmental media at the site and as such have not been identified as COPCs.

RELEASE MECHANISMS

Release mechanisms include those physical processes that contribute to the introduction and distribution of a contaminant in the environment. The potential primary release mechanisms for site contaminants from former buildings/structures at the Iona Island FUDS during operational use included accidental spills, direct releases to the ground, and improper disposal including dumping. These primary release mechanisms may have resulted in contamination of soil at and/or beneath former buildings/structures. The Iona Island Naval Ammunition Depot was deactivated in 1947, and the majority of buildings and structures, including building foundations, were demolished and removed by PIPC between November 1965 and December 1973 (USAGC 2018). Soil onsite has been significantly reworked and removed during demolition of former structures and excavation and regrading following demolition. Therefore, any contaminants present in surface and shallow subsurface soil were likely spread over much of the operational area.

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[5] Low levels of VOCs identified in the samples (1,1-dichloroethene, acetone, and methylene chloride) were attributable to laboratory blank contamination, and therefore were artifacts of the analytical method.

Contaminants in surface and shallow subsurface soil may have been transported to a range of exposure media (including air, subsurface soil, groundwater, surface water, and sediment) through secondary and tertiary release mechanisms. Secondary release mechanisms from surface and shallow subsurface soil to other media include the following:

- Infiltration and leaching to underlying subsurface soil and shallow groundwater
- Overland runoff and erosion into surface water and sediment.
- Soil removal/reworking

Potential contaminants may have leached/infiltrated into the subsurface through gravity and/or percolation of precipitation/surface water, thus migrating to the subsurface soil and groundwater; leaching/infiltration may be ongoing if a soil source is present at Iona Island, particularly at AOC #16 - Area D (Dumping Area). In addition, contaminants may have been transported along the surface via overland runoff and erosion and ultimately deposited in shoreline sediments; these release mechanisms may be historically significant but are unlikely to contribute to current exposure pathways due to the vegetated nature of the soil.

Buildings were demolished and soil was reworked following Navy transfer of the FUDS property to PIPC in 1965. The estimated timeframe for building removal was 1965 to 1972. Contaminants in surface and subsurface soil were likely mobilized beyond the footprint of the AOCs during demolition of former buildings/structures and reworking of surface and subsurface soil. Volatilization and/or wind erosion mechanisms were potentially historically significant but are unlikely to contribute to current exposure pathways due to the vegetated nature of the soil and the volatility of some of the contaminants.

Tertiary release mechanisms from contaminated secondary media may include the following:

- Discharge from groundwater to sediment and surface water

- Infiltration from subsurface soil and shallow groundwater to deeper bedrock groundwater.

- Uptake of contaminants from abiotic media (e.g., soil) into prey tissue that is consumed by wildlife.

FATE AND TRANSPORT PATHWAYS

Constituents released through deposition may have remained in surface soil by adsorbing to soil particles. When released to the environment, constituents such as some metals and PAHs tend to sorb to soil, sediment, and other organic materials. Some toxic forms of metals (e.g., mercury) accumulate in animal tissue, while others (e.g., lead) accumulate in plants. Natural processes such as adsorption, ion exchange, complexation, and precipitation can cause metals to become immobilized and therefore not bioavailable.

A variety of demolition and decommissioning activities have occurred on the island since operations ceased. Buildings were demolished, storage tanks have been removed, and imported fill may have been placed over much of the former operational areas. Reworking of surface and subsurface soil during demolition is another major pathway for constituents that bind to soil particles, such as metals and PAHs, to be widely dispersed across the site. Site demolition and regrading potentially released and mixed lead-based paint particles into the soil. While metals may generally sorb/bond to soils, very fine paint chips/particles would result in a more sporadic hit-or-miss distribution of contamination.

Due to the chemical properties of the site constituents and time elapsed since potential releases, active physical processes such as diffusion and volatilization would not be considered significant contributors to contaminant migration. Vapors and particulates in ambient air could be potential exposure media. However, due to the significant amount of vegetative cover present throughout the site, and time since release and chemical properties of the constituents, this transport pathway is unlikely to contribute to a significant exposure under current or future land use conditions.

As described above, the types of constituents previously detected or potentially present in site soils would be bound to soil particles but could migrate via advective transport (bulk movement) or desorption (leaching) with the flow of surface water or groundwater toward the adjacent marshes and the Hudson River. Desorption would be dependent on the solubility of the individual chemical and the properties of the soil. For example, if upland soils have lower organic carbon, some contaminants could leach from that soil into groundwater, and flow towards the river and sediment that may have higher organic carbon to which the contaminant could adsorb to.

EXPOSURE MEDIA

The primary media of concern for human health and ecological receptors are surface soil and subsurface soil. Secondary media that could be impacted include groundwater. In addition, historical deposition of constituents, such as metals, PCBs, and PAHs, into nearshore sediments is possible. These contaminants may have been transported as particulate complexes in groundwater and/or overland runoff onto the shoreline. However, the Hudson River has a long history of environmental pollution related to industrial discharges, sewage, and pollution runoff, with contaminants including but not limited to PCBs, heavy metals (cadmium, chromium, copper, lead, mercury, nickel, lead, zinc), PAHs, and organochlorine pesticides (e.g., dichlorodiphenyltrichloroethane [DDT] and chlordane) (Wall et al. 1998).

POTENTIAL EXPOSURE PATHWAYS

In general, an exposure pathway consists of the following components:

- Source and mechanism of chemical release to the environment (e.g., spill)
- Environmental transport medium (e.g., surface soil)
- POC with the contaminated medium (exposure point)
- Exposure route at the exposure point (e.g., dermal contact with surface soil).

If all four components are present (or potentially present), the pathway is considered complete (or potentially complete). Each pathway defines a unique mechanism by which potential receptors are directly or indirectly exposed to constituents. The following definitions are used to identify exposure pathways:

- ***Complete Exposure Pathway***—There is confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified). Exposure is evaluated quantitatively.

- ***Potentially Complete Pathway*—**Under current site conditions, there is a confirmed receptor and media interaction that may be anticipated in the future. Exposure is evaluated quantitatively.

- ***Incomplete Exposure Pathway*—**There is no receptor and media interaction. No evaluation is conducted.

POTENTIAL HUMAN HEALTH RECEPTORS

Based on the identified preliminary CSM, the current human receptors at the site are the following:

- Bear Mountain State Park employees
- Researchers
- Recreational users
- Campers (historical use by boy scouts)
- Trespassers

The future use of Iona Island is anticipated to remain consistent with current use and will continue to be maintained by park employees and be used as an area for research. Hypothetical future plans for Iona Island may include recreational use and construction of a nature or retreat center; however, these plans are not currently approved. The island is currently used by a limited number of recreational canoers who must obtain a permit for access. Current and future potential recreational users include canoers and campers. Potential campers who would have a higher level of direct exposure to on-site soil than recreational users are considered a separate category of use.

Communication with the Director of Development and Special Projects at PIPC indicates that their construction or redevelopment is unlikely at the site for the foreseeable future; however, it is possible that existing structures could be renovated or improved. Potential future work could involve repair to existing foundations. Construction workers in this limited future scenario could be potential receptors. Therefore, potential future human receptors include the following:

- Bear Mountain State Park employees
- Researchers
- Campers

- Trespassers
- Construction workers
- Recreational users.

In the 1990s, the water supply line that supplied Iona Island broke (near NYS Route 9W) on the causeway. Bear Mountain State Park did not repair the waterline break and a bedrock well was installed (March 1997) behind the existing storehouse (Building 222). According to the Bear Mountain Park Engineering Department, this new well is not treated and is used for non-potable purposes only (bottled water is brought on Iona Island for drinking purposes). The well is under pressure to obtain water due to low water yields. As a result, groundwater is not used as a potable water source on Iona Island; therefore, there is no potential exposure to contaminants in groundwater used as drinking water for current users. In addition, in 1965, when GSA conveyed the property to the Palisades Interstate Park Commission, it was under a "restrictive clause" (park purposes only) (USACE 1995). Therefore, Iona Island will not be developed for commercial or residential use in the future, and there is no potential exposure to contaminants in groundwater used as drinking water for future users.

Construction workers may be exposed to groundwater during subsurface construction activities. However, this exposure is limited to perched water located above the bedrock.

Current and future human receptors are identified in the preliminary human health CSM on Figure 10-7. Additional details on the evaluation of potential risks to human receptors can be found in the Human Health Risk Assessment Work Plan provided in Appendix D.

POTENTIAL ECOLOGICAL RECEPTORS

Selection of representative ecological receptor species for evaluation is based primarily on the following:

- The likelihood of a species to use the site and the area immediately surrounding it

- The potential for exposure to constituents based on the feeding habits and life history of the organisms/feeding guild represented by the receptor species

- The availability of life history and exposure information for the selected receptor species

- The availability of toxicity information for the representative receptor species

- The societal importance of the species (e.g., threatened and/or endangered species, species of special concern).

Terrestrial plants, invertebrates, and wildlife (e.g., birds and mammals) are the primary ecological receptors that could be exposed to contaminants in soil via incidental ingestion and direct contact.

Ecological exposure to volatiles or particulates in air via inhalation is not significant because the site is vegetated and quantitative exposure parameters for inhalation risks to wildlife are unavailable. Dermal contact with soil is also considered *de minimis* due to feathers and fur on terrestrial wildlife that limits exposure to soil. However, grooming of fur and feathers as well as foraging results in incidental soil ingestion by wildlife. As such, the ingestion of food items that have accumulated chemical constituents as well as incidental ingestion of soil are complete exposure pathways for terrestrial-feeding birds and mammals. Furthermore, uptake of and direct contact with potential constituents into plant roots is another complete exposure pathway. The proposed terrestrial receptors to be considered for evaluation in the ecological risk assessment (ERA) are based on feeding guilds and include the following:

- Terrestrial plant community
- Terrestrial invertebrate community, as represented by the earthworm (*Lumbricus terrestris*)
- Herbivorous mammals, as represented by meadow vole (*Microtus pennsylvanicus*)
- Insectivorous mammals, as represented by short-tailed shrew (*Blarina brevicauda*)
- Insectivorous birds, as represented by American robin (*Turdus migratorius*)
- Predatory (carnivorous) mammals, as represented by red fox (*Vulpes vulpes*)
- Predatory (carnivorous) birds, as represented by red-tailed hawk (*Buteo jamaicensis*).

Aquatic receptors including fish, benthic invertebrates, and aquatic-feeding wildlife could be exposed to constituents in sediment and/or surface water via ingestion. In addition, bottom-dwelling fish and benthic invertebrates could also be exposed to constituents in sediment via dermal absorption. Aquatic-feeding birds and mammals could consume constituents that have accumulated in sediments, benthic invertebrates, aquatic plants, and fish tissue.

However, it is currently unknown if sufficient habitat to support long-term populations of aquatic organisms exists along Iona Island's shoreline. It is also unknown if sediments along the shoreline present a "sink" for historical constituents. Field investigation is needed to evaluate whether substantial shoreline habitat exists along the river. In addition, little is known about the sediments and possible ecological receptors that may exist along the western edge of the island in the wetlands area. This area will also be explored to evaluate the nature of the sediment and whether or not populations of aquatic receptors exist along the shoreline. This Phase I Shoreline Reconnaissance Survey will aide in the development of an aquatic CSM.

Receptors that inhabit transitional areas (i.e., wetlands) include reptiles and amphibians. These organisms could utilize both soil and sediment habitats. However, due to the lack of toxicological information, exposure factors, and ecological screening values for these species, only a qualitative evaluation of potential risks is possible.

The terrestrial ecological CSM is depicted on Figure 10-8a; the preliminary aquatic ecological CSM is depicted on Figure 10-8b. The CSM is an iterative process and will be updated as necessary as new data are collected. Additional details regarding the ecological conceptual site models and the shoreline survey can be found in Section 2.1 of the Ecological Risk Assessment Work Plan presented in Appendix E.

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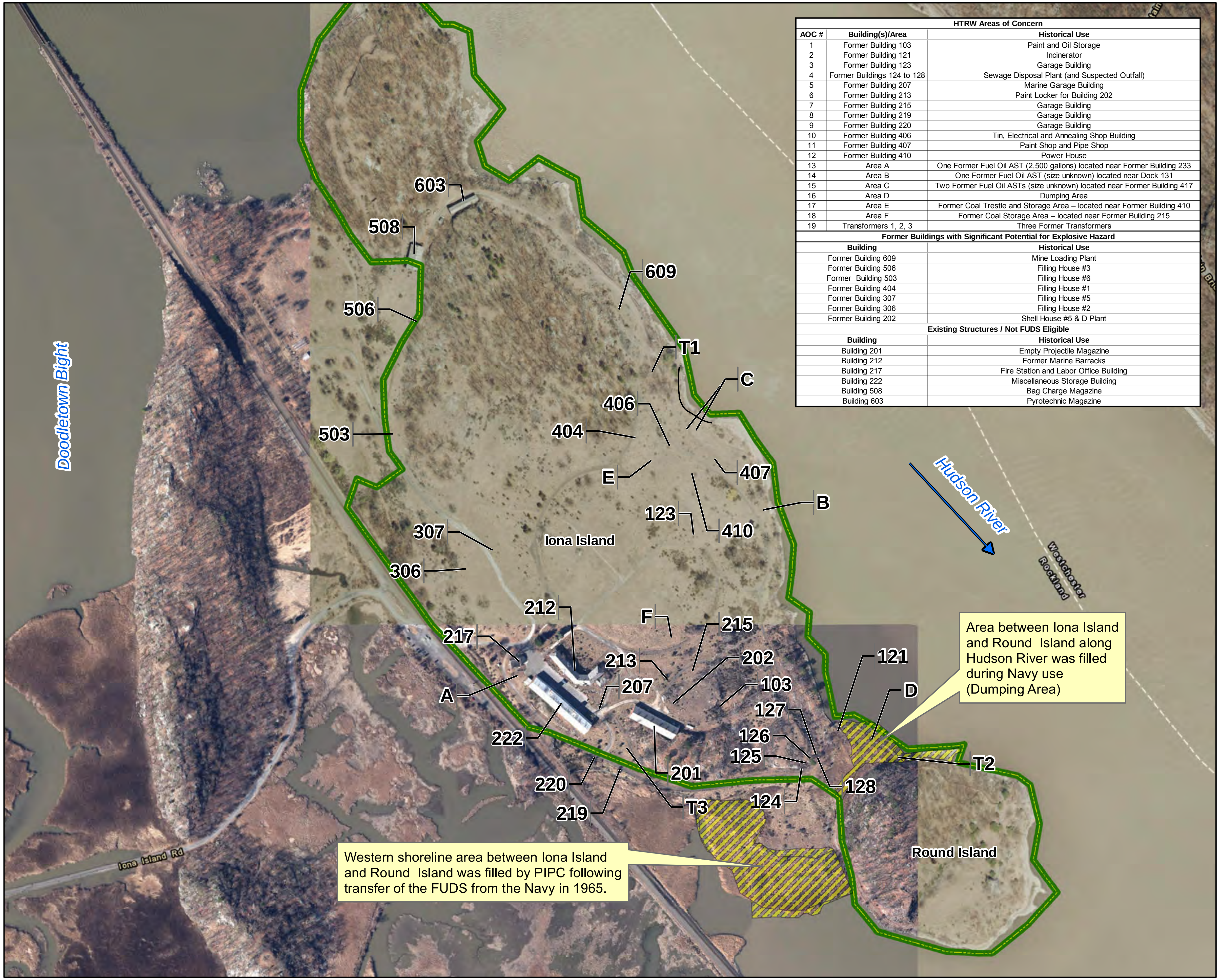


Area between Iona Island and Round Island along Hudson River was filled during Navy use (Dumping Area)

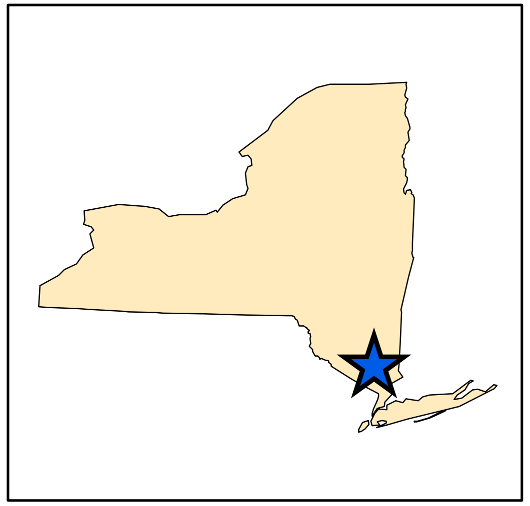
Western shoreline area between Iona Island and Round Island was filled by PIPC following transfer of the FUDS from the Navy in 1965.

HTRW Areas of Concern		
AOC #	**Building(s)/Area**	**Historical Use**
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Former Buildings with Significant Potential for Explosive Hazard	
Building	**Historical Use**
Former Building 609	Mine Loading Plant
Former Building 506	Filling House #3
Former Building 503	Filling House #6
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

Existing Structures / Not FUDS Eligible	
Building	**Historical Use**
Building 201	Empty Projectile Magazine
Building 212	Former Marine Barracks
Building 217	Fire Station and Labor Office Building
Building 222	Miscellaneous Storage Building
Building 508	Bag Charge Magazine
Building 603	Pyrotechnic Magazine

VICINITY MAP



Legend

🟩 FUDS Boundary

▨ Disturbed Ground/Fill Area

0 400 800

Feet

1 in = 400 ft

N

FIGURE 10-1

Current Site Layoute

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 6/18/2019

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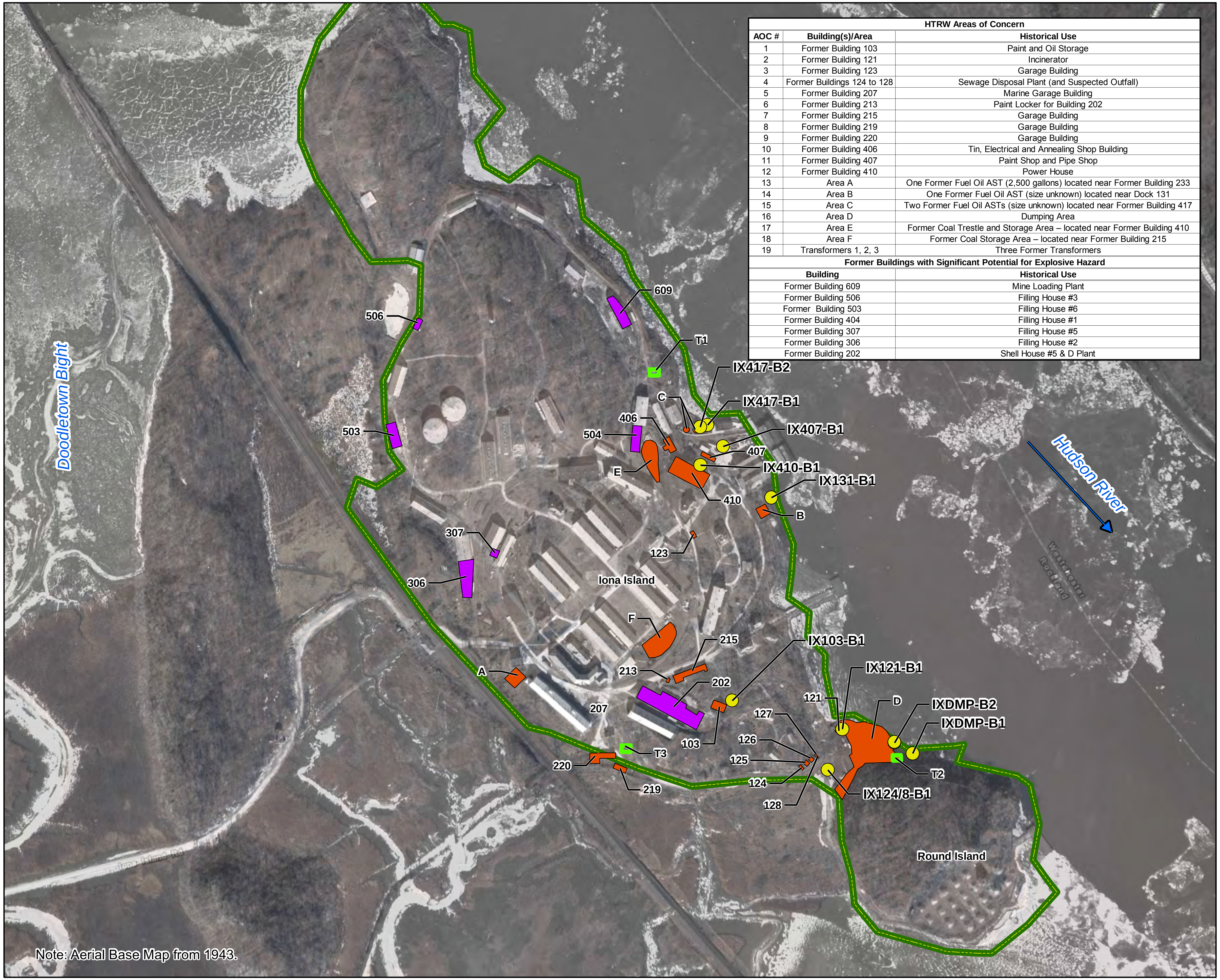

HTRW Areas of Concern		
AOC #	Building(s)/Area	Historical Use
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
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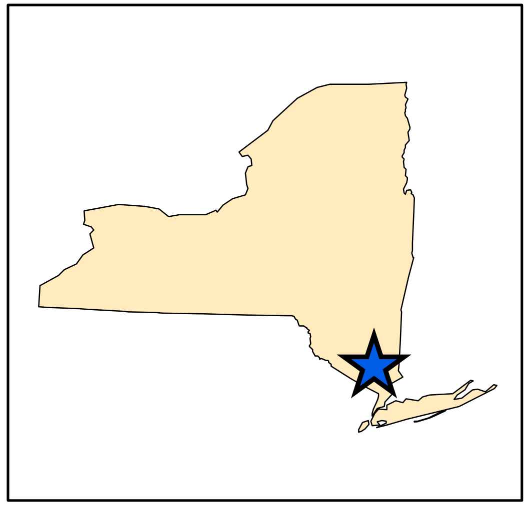
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Former Buildings with Significant Potential for Explosive Hazard	
Building	Historical Use
Former Building 609	Mine Loading Plant
Former Building 506	Filling House #3
Former Building 503	Filling House #6
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

Note: Aerial Base Map from 1943.

VICINITY MAP



Legend

- FUDS Boundary
- 🟥 HTRW Project Areas of Concern
- 🟩 FormerTransformers
- 🟪 Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
- ● 1996 Subsurface Soil Sample Location

0 400 800
Feet
1 in = 400 ft
N

FIGURE 10-2
1996 Data Collection Activities

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service
Source: Greeley-Polhemus 1997

Map Date: 4/16/2019

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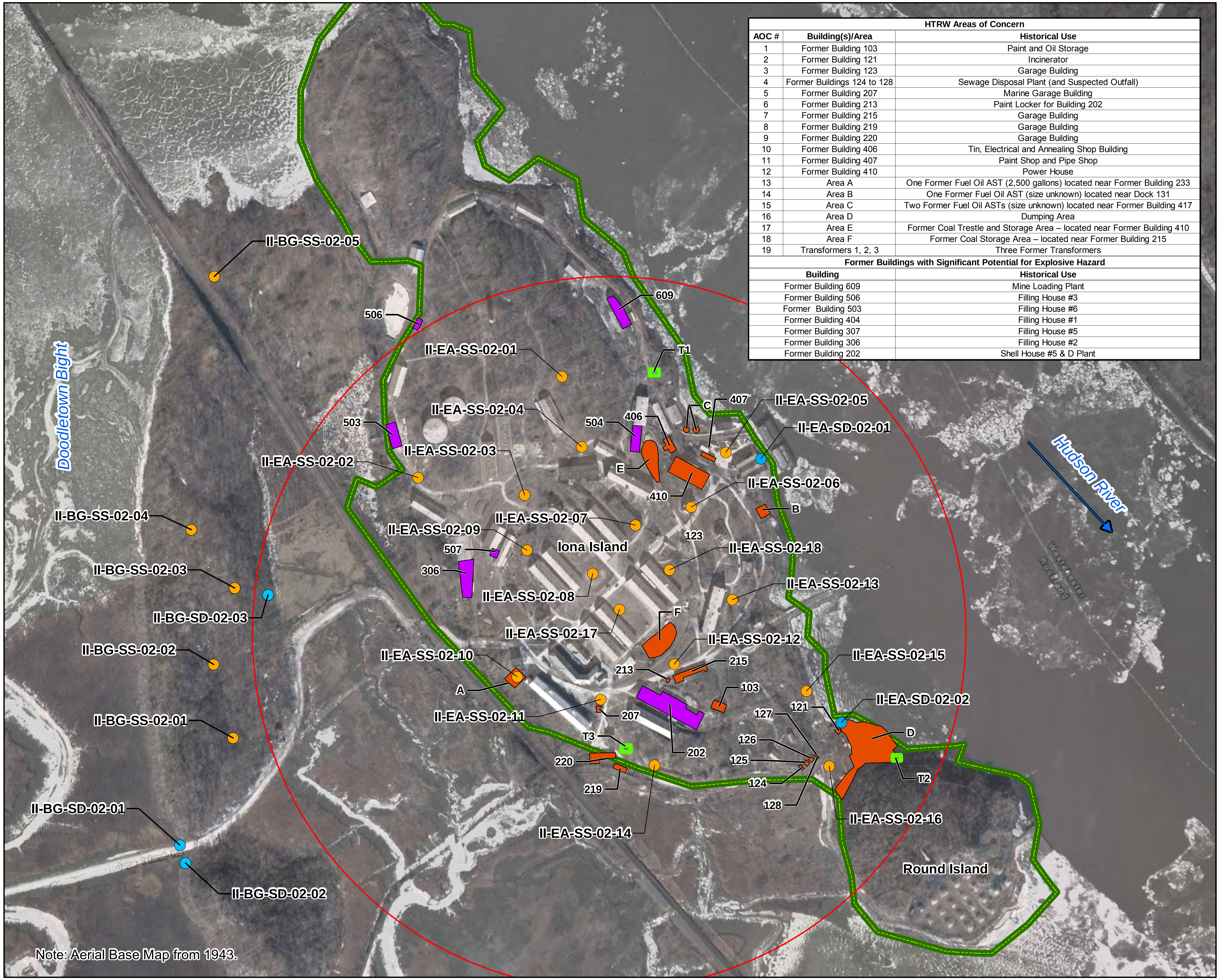

HTRW Areas of Concern		
AOC #	Building(s)/Area	Historical Use
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3	Former Building 123	Garage Building
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8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
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19	Transformers 1, 2, 3	Three Former Transformers

Former Buildings with Significant Potential for Explosive Hazard	
Building	Historical Use
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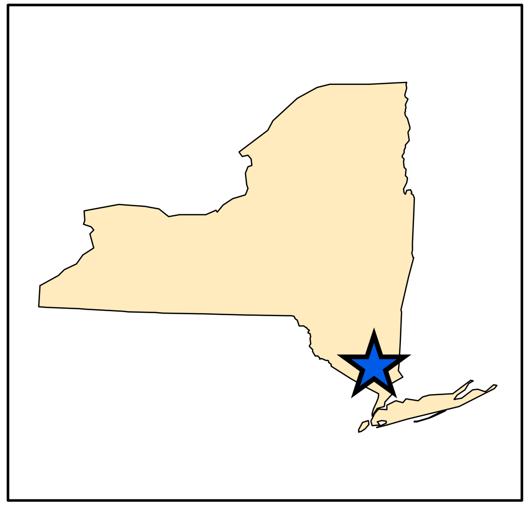
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

VICINITY MAP



Legend

🟩	FUDS Boundary
🟧	HTRW Project Areas of Concern
🟩	FormerTransformers
🟪	Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
□	1903 Explosion Area
●	2007 Surface Soil Sample
●	2007 Sediment Sample

0 400 800
Feet
1 in = 400 ft
N

FIGURE 10-3
2007 Site Inspection

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

EA®

Aerial: ESRI ArcGIS Online Map Service
Source: Alion 2008

Map Date: 4/16/2019

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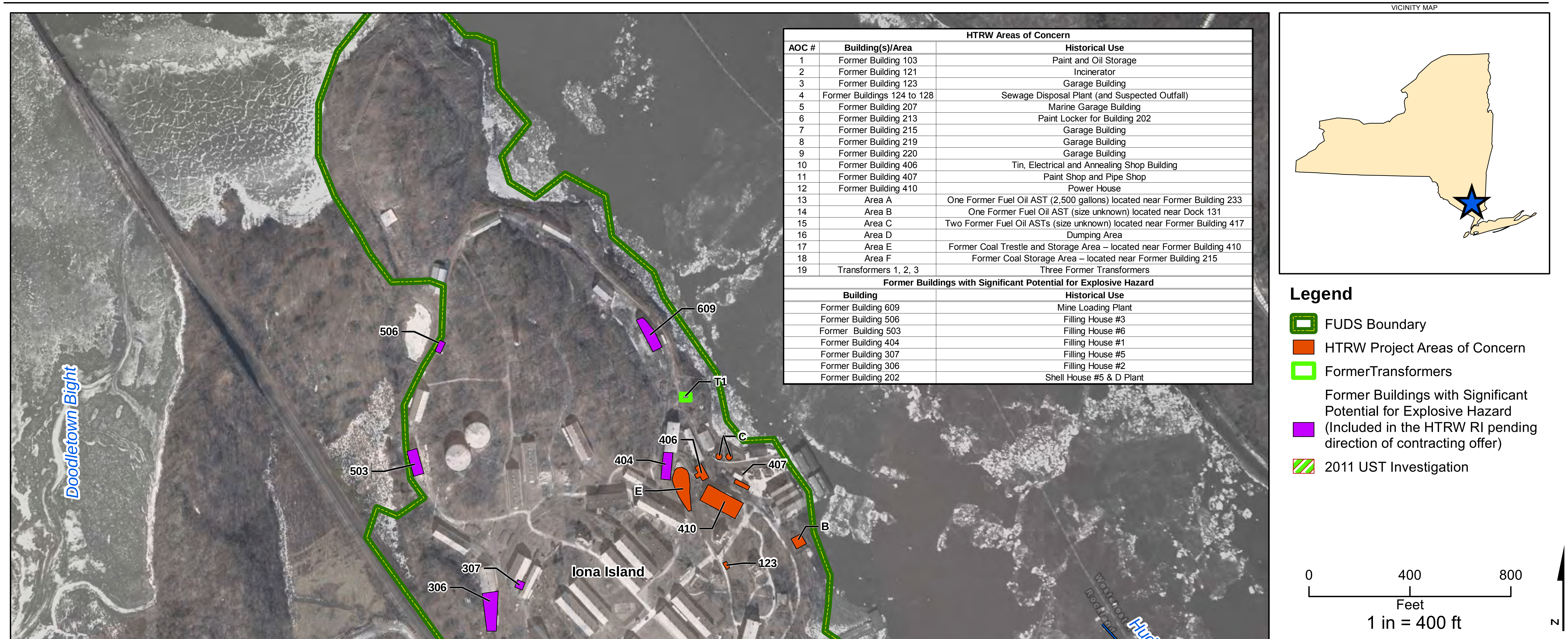

HTRW Areas of Concern

AOC #	Building(s)/Area	Historical Use
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Former Buildings with Significant Potential for Explosive Hazard

Building	Historical Use
Former Building 609	Mine Loading Plant
Former Building 506	Filling House #3
Former Building 503	Filling House #6
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

FIGURE 10-4
2011 Underground Storage Tank Closure

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service
Source: GSE 2011

Map Date: 4/16/2019

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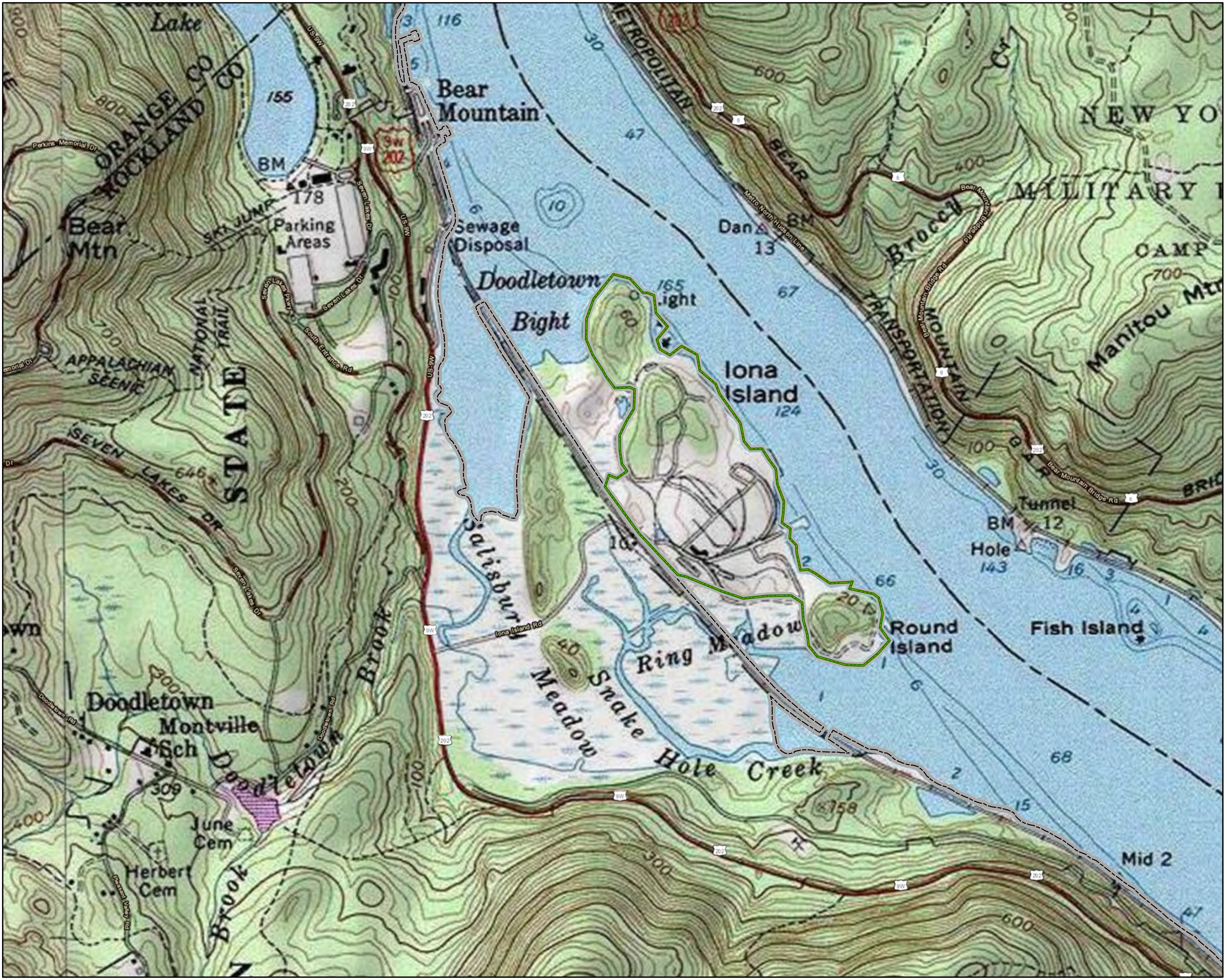
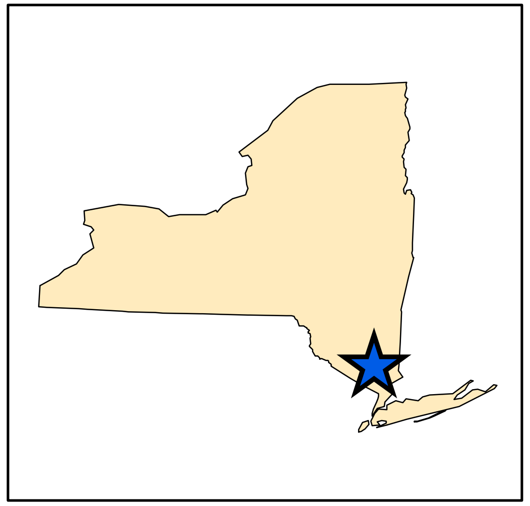


VICINITY MAP



Legend

🟩 FUDS Boundary

▨ Bear Mountain State Park Boundary

0 1,000 2,000
Feet
1 in = 1,000 feet

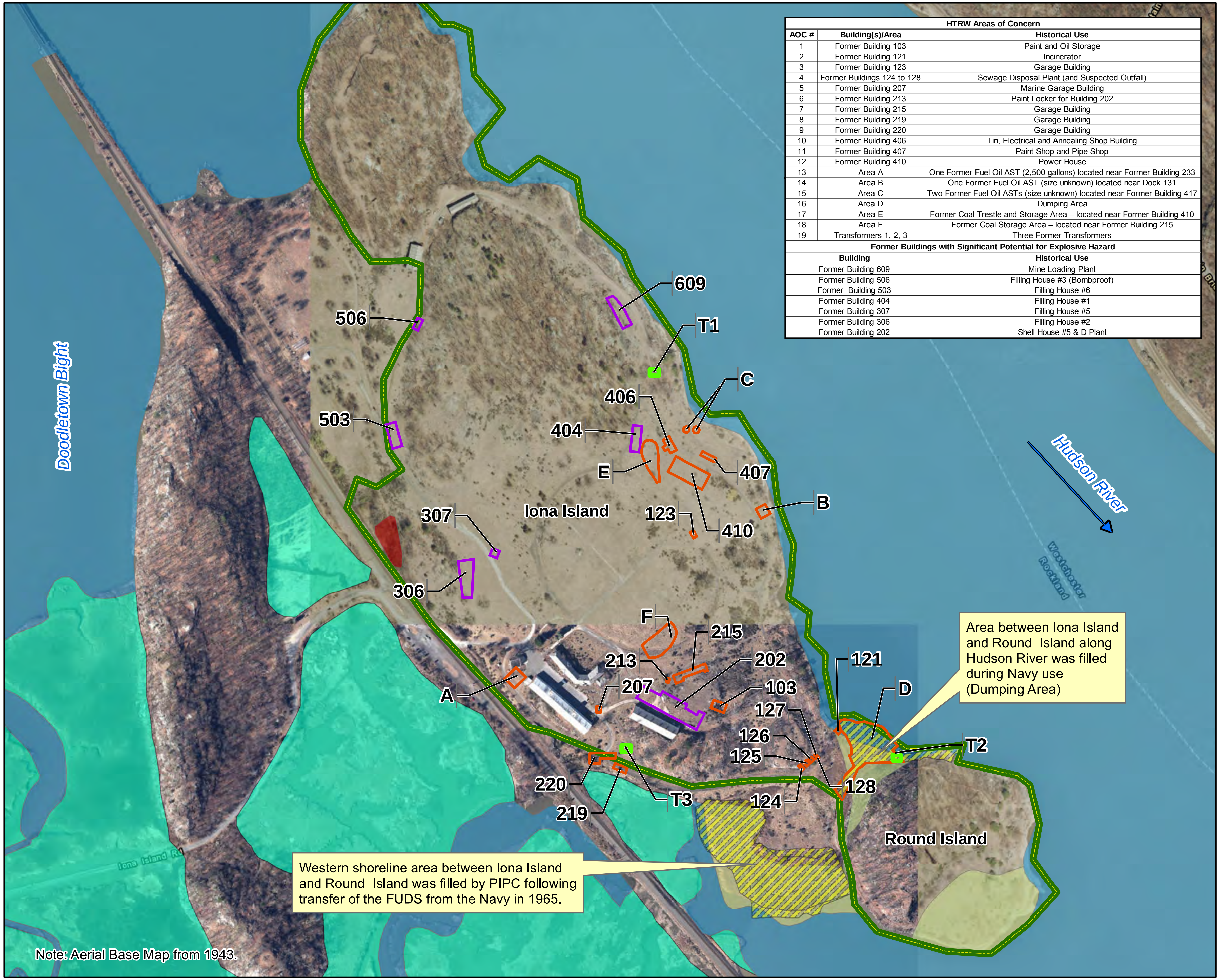
N

FIGURE 10-5
Topography and Hydrology

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PROGRAM
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 4/10/2019



Area between Iona Island and Round Island along Hudson River was filled during Navy use (Dumping Area)

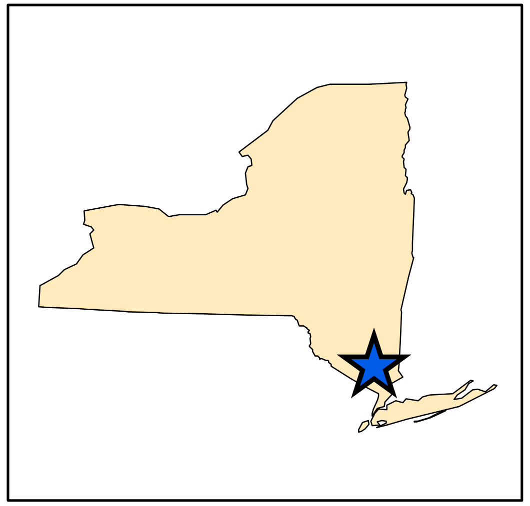
Western shoreline area between Iona Island and Round Island was filled by PIPC following transfer of the FUDS from the Navy in 1965.

Note: Aerial Base Map from 1943.

HTRW Areas of Concern		
AOC #	**Building(s)/Area**	**Historical Use**
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Former Buildings with Significant Potential for Explosive Hazard	
Building	**Historical Use**
Former Building 609	Mine Loading Plant
Former Building 506	Filling House #3 (Bombproof)
Former Building 503	Filling House #6
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

VICINITY MAP



Legend

- 🟩 FUDS Boundary
- 🟧 HTRW Project Areas of Concern
- 🟩 FormerTransformers
- 🟪 Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending a contract modification)
- ▨ Disturbed Ground/Fill Area

Wetland Type

- 🟦 Estuarine and Marine Deepwater
- 🟦 Estuarine and Marine Wetland
- 🟥 Freshwater Emergent Wetland
- 🟩 Freshwater Forested/Shrub Wetland

0 400 800
Feet
1 in = 400 ft

N

FIGURE 10-6
Wetland Resources

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

EA®

Aerial: ESRI ArcGIS Online Map Service

Map Date: 6/18/2019

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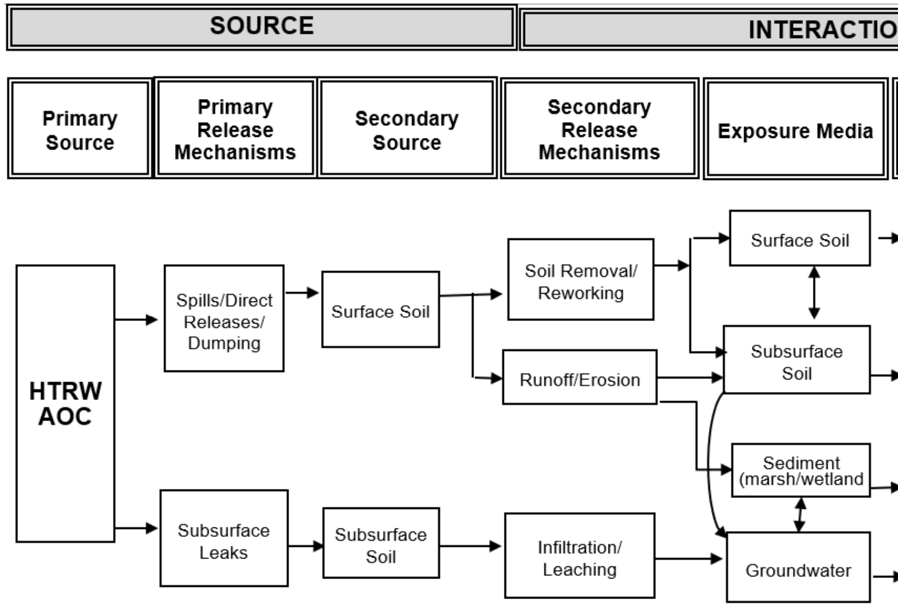

HUMAN RECEPTORS

Exposure Media	Exposure Routes	Current and Future Park Personnel	Future Construction Workers	Current and Future Trespassers	Current and Future Researchers	Current and Future Recreational Users	Current and Future Campers/Boy Scouts
Surface Soil	Incidental Ingestion	●	◑	●	●	●	●
	Direct Contact	●	◑	●	●	●	●
	Inhalation (VOC/Particulates)	●	◑	●	●	●	●
Subsurface Soil	Incidental Ingestion	○	◑	○	○	○	●
	Direct Contact	○	◑	○	○	○	●
	Inhalation (VOC/Particulates)	○	◑	○	○	○	●
Sediment (marsh/wetland	Incidental Ingestion	◑	○	◑	●	◑	◑
	Direct Contact	◑	○	◑	●	◑	◑
	Inhalation (VOC/Particulates)	○	○	○	○	○	○
Groundwater	Incidental Ingestion	○	◑	○	○	○	○
	Direct Contact	○	◑	○	○	○	○
	Inhalation (VOC/Particulates)	○	◑	○	○	○	○

LEGEND

- ● Complete Pathway; confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified).
- ◑ Potentially Complete Pathway; receptor and media interaction; however, the exposure may be limited, either due to the type of receptor or the nature of the source, and has not been confirmed.
- ○ Incomplete Pathway; no receptor and media interaction. No evaluation is conducted.

NOTES
Surface soil = defined as the interval from 0 to 6 inches bgs.
Subsurface soil = defined as the interval from 6 to 36 inches bgs.

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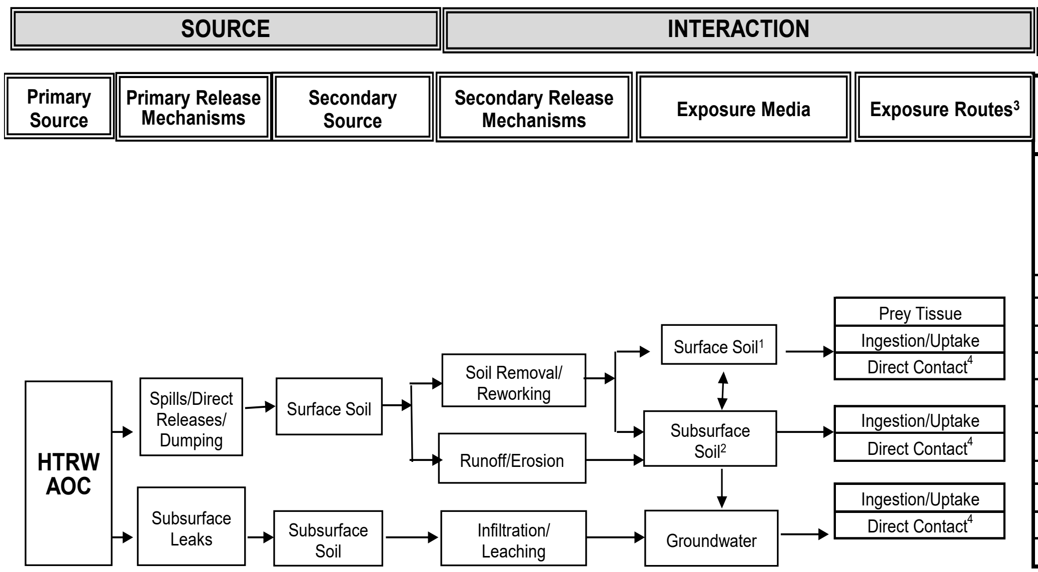
Iona Island Human Health Conceptual Site Model

Figure 10-7



Terrestrial Habitats

Exposure Media	Exposure Routes[3]	Terrestrial Plants	Soil Invertebrates	Herbivourous Mammals (e.g., meadow vole)[5]	Insectivorous Birds (e.g., American robin)	Insectivorous Mammals (e.g., short-tailed shrew)[5]	Predatory Birds (e.g., red-tailed hawk)	Predatory Mammals (e.g., red fox)[5]	Reptiles and Amphibians[6]
Surface Soil[1]	Prey Tissue	○	○	●	●	●	●	●	◑
	Ingestion/Uptake	●	●	●	●	●	●	●	◑
	Direct Contact[4]	●	●	◑	◑	◑	◑	◑	◑
Subsurface Soil[2]	Ingestion/Uptake	●	●	●	○	●	○	●	◑
	Direct Contact[4]	●	●	◑	○	◑	○	◑	◑
Groundwater	Ingestion/Uptake	○	○	○	○	○	○	○	○
	Direct Contact[4]	○	○	○	○	○	○	○	○

LEGEND

● Complete Pathway; confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified).

◑ Potentially Complete Pathway; there is potential receptor and media interaction that may be anticipated.

○ Incomplete Pathway; no receptor and media interaction. No evaluation is conducted.

NOTES

1. Surface soil = defined as the interval from 0 to 6 inches bgs.
2. Subsurface soil = defined as the interval from 6 to 36 inches bgs.
3. The inhalation pathway for volatile constituents is considered de minimus due to vegetatative cover and the volatility of the constituents and therefore is not shown in the CSM.
4. Direct contact pathways for mammals and birds is limited by fur and feathers and is considered incidental soil ingestion during grooming.
5. Mammals such as voles, shrews, and foxes may be exposed to subsurface soil during burrowing activities.
6. Reptiles and amphibians are evaluated qualitatively due to the lack of ecotoxicity values for these receptors.
7. The groundwater/surface water interaction is addressed in Figure 8b.

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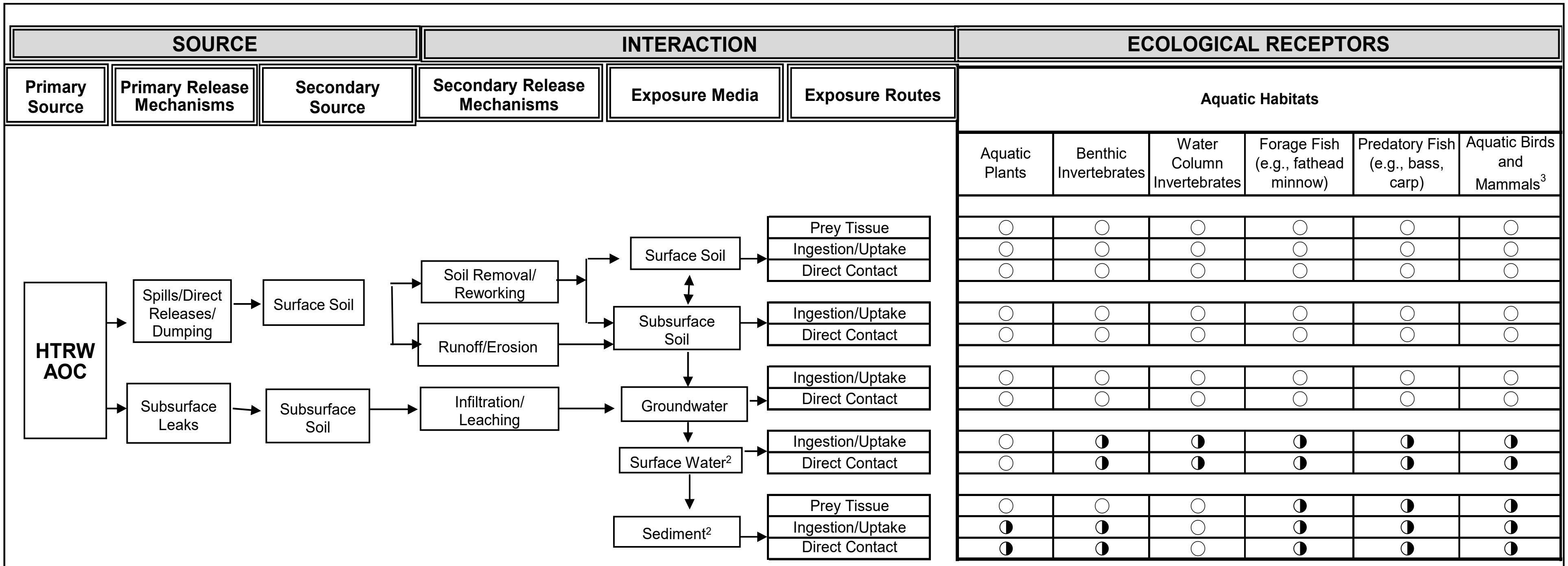
Iona Island Terrestrial Ecological Conceptual Site Model

Figure 10-8a



Exposure Media	Exposure Routes	Aquatic Plants	Benthic Invertebrates	Water Column Invertebrates	Forage Fish (e.g., fathead minnow)	Predatory Fish (e.g., bass, carp)	Aquatic Birds and Mammals[3]
Surface Soil	Prey Tissue	○	○	○	○	○	○
	Ingestion/Uptake	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○
Subsurface Soil	Ingestion/Uptake	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○
Groundwater	Ingestion/Uptake	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○
Surface Water[2]	Ingestion/Uptake	○	◑	◑	◑	◑	◑
	Direct Contact	○	◑	◑	◑	◑	◑
Sediment[2]	Prey Tissue	○	○	○	◑	◑	◑
	Ingestion/Uptake	◑	◑	○	◑	◑	◑
	Direct Contact	◑	◑	○	◑	◑	◑

LEGEND

- ● Complete Pathway; confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified).
- ◑ Potentially Complete Pathway; there is potential receptor and media interaction that may be anticipated.
- ○ Incomplete Pathway; no receptor and media interaction. No evaluation is conducted.

NOTES

1. The CSM is preliminary and will be updated as additional information is collected. Confirmation of sufficient habitat and/or use by these receptors will be confirmed during a Phase I Shoreline Reconnaissance Survey.
2. Surface water and sediment are potentially complete exposure pathways because exposure to site-related constituents along the shoreline has not been confirmed.
3. Aquatic birds and mammals may include benthivorous and/or piscivorous wildlife.

Iona Island Preliminary Aquatic Ecological Conceptual Site Model[1]

Figure 10-8b

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Table 10-1 Data Collection Activities Soil Analytical Results, April 1997

					Location	Former Building 103 - Paint & Oil Storage	Former Building 121 – Incinerator	Former Sewage Disposal Plant	Former Building 407 – Paint Shop and Pipe Shop	Former Building 410 – Power House	Former Fuel Oil AST Near Dock 131	Former Fuel Oil ASTs Near Former Building 417		Former Dump Area	
					Sample ID	**IX103-B1**	**IX121-B1**	**IX124/8-B1**	**IX407-B1**	**IX410-B1**	**IX131-B1**	**IX417-B1**	**IX417-B2**	**IXDMP-B1**	**IXDMP-B2**
					Depth (ft)	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**	**0.0-2.0**
					Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
					Sample Date										
Analyte	**CAS**	**EPA Residential Soil RSL Value[1]**	**EPA Industrial Soil RSL Value[1]**	**EPA Ecological Soil Screening Level[2]**	**Units**	**10/2/1996**	**10/2/1996**	**10/2/1996**	**10/3/1996**	**10/3/1996**	**10/3/1996**	**10/2/1996**	**10/2/1996**	**10/2/1996**	**10/2/1996**
RCRA Metals															
Arsenic	7440-38-2	0.68	3.0	19 (p)	mg/kg	**82.9**	2.5 B	5.1	**28.8**	NT	NT	NT	NT	(<0.13 U)	**24.5**
Barium	7440-39-3	1,500	22,000	333 (i)	mg/kg	42.3	**1,240**	36.8 B	69.2	NT	NT	NT	NT	289	**509**
Cadmium	7440-43-9	7.1	98	0.36 (m)	mg/kg	**0.97**	**220**	**0.44 B**	**0.56 B**	NT	NT	NT	NT	**5.8**	9.9
Chromium	16065-83-1	12,000	180,000	26 (a)	mg/kg	8.6	19.3	20.0	16.9	NT	NT	NT	NT	**26.2**	**244**
Lead	7439-92-1	400	800	11(a)	mg/kg	**118**	**8,990**	**84.7**	**542**	NT	NT	NT	NT	**1,270**	**9,160**
Mercury	7439-97-6	1.1	4.6	NS	mg/kg	0.13	0.61	0.22	0.35	NT	NT	NT	NT	0.58	0.25
Selenium	7782-49-2	39	580	0.52 (p)	mg/kg	0.48 B	**0.95 B**	**1.2 B**	**0.68 B**	NT	NT	NT	NT	(<0.30 U)	1.2 B
Silver	7440-22-4	39	580	4.20 (a)	mg/kg	(<0.54 U)	(<3.6 U)	(<0.71 U)	(<0.64 U)	NT	NT	NT	NT	1.5 B	**16.3**
SVOCs															
2,4-dinitrotoluene	121-14-2	1.7	7.4	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	68
2,6-dinitrotoluene	606-20-2	0.36	1.5	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	2.8
2-methylnaphthalene	91-57-6	24	300	29.0 (i)	mg/kg	(<0.37 U)	0.037 J	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	0.041	(<0.41 U)	(<0.047 U)
acenaphthalene	208-96-8	NS	NS	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.024 J	0.040 J	(<0.37 U)	(<0.36 U)	0.044 J	(<0.41 U)	(<0.047 U)
acenaphthene	82-32-9	360	4,500	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.087 J	(<0.37 U)	(<0.36 U)	0.032 J	(<0.41 U)	(<0.047 U)
anthracene	120-12-7	1,800	23,000	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.038 J	0.16 J	(<0.37 U)	(<0.89 U)	0.087 J	(<0.41 U)	(<0.047 U)
benzo(a)anthracene	56-55-3	1.1	21	1.1 (m)	mg/kg	0.065 J	0.20 J	(<0.44 U)	0.39	**1.1**	(<0.37 U)	0.25 J	0.61	(<0.41 U)	0.072 J
benzo(a)pyrene	50-32-8	0.11	2.1	1.1 (m)	mg/kg	0.072 J	0.21 J	(<0.44 U)	0.45	0.96	(<0.37 U)	0.28 J	0.65	0.066 J	0.062 J
benzo(b)fluoranthene	205-99-2	1.1	21	1.1 (m)	mg/kg	0.11 J	0.28 J	0.062 J	0.66	**1.1**	(<0.37 U)	0.40 J	0.87	(<0.41 U)	0.11 J
benzo(g,h,i)perylene	191-24-2	NS	NS	1.1 (m)	mg/kg	0.048 J	0.18 J	(<0.44 U)	0.31 J	0.7	(<0.37 U)	0.24 J	0.48	(<0.41 U)	0.052 J
benzo(k)fluoranthene	207-08-9	11	210	1.1 (m)	mg/kg	0.040 J	0.11 J	(<0.44 U)	0.25 J	0.42	(<0.37 U)	0.17 J	0.35 J	(<0.41 U)	0.054 J
bis(2-ethylhexyl)phthalate	117-81-7	39	160	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.036 JB	0.019 JB	(<0.37 U)	(<0.36 U)	0.037 JB	(<0.41 U)	0.032 JB
Butyl Benzyl Phthalate	85-68-7	290	1,200	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.038 J	0.024 J	(<0.37 U)	(<0.36 U)	0.026 J	(<0.41 U)	(<0.047 U)
carbazole	86-74-8	NS	NS	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.055 J	(<0.37 U)	(<0.36 U)	0.050 J	(<0.41 U)	(<0.047 U)
chrysene	218-01-9	110	2,100	1.1 (m)	mg/kg	0.087 J	0.24 J	(<0.44 U)	0.45	**1.1**	(<0.37 U)	0.28 J	0.75	(<0.41 U)	0.11 J
di-n-butylphthalate	84-74-2	630	8,200	NS	mg/kg	0.14 J	0.15 J	0.037 J	0.4	0.29 J	0.12 J	(<0.36 U)	0.16 J	0.18 J	26
dibenz(a,h)anthracene	53-70-3	0.11	2.1	1.1 (m)	mg/kg	(<0.37 U)	0.055 J	(<0.44 U)	0.084 J	**0.15 J**	(<0.37 U)	0.076 J	0.099 J	(<0.41 U)	(<0.047 U)
dibenzofuran	132-64-9	7.3	100	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.040 J	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	(<0.047 U)
diethyl phthalate	84-66-2	5,100	66,000	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.097 J	0.039 J	(<0.37 U)	0.34 J	(<0.37 U)	(<0.41 U)	(<0.047 U)
fluoranthene	206-44-0	240	3,000	1.1 (m)	mg/kg	**0.10 J**	**0.33 J**	0.076 J	**0.41**	**1.8**	(<0.37 U)	**0.32 J**	**0.9**	**0.16 J**	**0.17 J**
fluorene	86-73-7	240	3,000	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.088 J	(<0.37 U)	(<0.36 U)	0.024 J	(<0.41 U)	(<0.047 U)
indeno(l,2,3-c,d)pyrene	193-39-5	1.1	21	1.1 (m)	mg/kg	0.053 J	0.20 J	(<0.44 U)	0.38	0.73	(<0.37 U)	0.26 J	**0.53**	(<0.41 U)	0.058 J
n-nitrosodiphenylamine (2)	86-30-6	NS	NS	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	(<0.36 U)	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	1.1
naphthalene	91-20-3	3.8	17	29.0 (i)	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	(<0.36 U)	0.027 J	(<0.37 U)	(<0.36 U)	(<0.37 U)	(<0.41 U)	(<0.047 U)
phenanthrene	85-01-8	NS	NS	29.0 (i)	mg/kg	(<0.37 U)	0.15 J	(<0.44 U)	0.12 J	0.75	(<0.37 U)	0.088 J	0.38	(<0.41 U)	0.10 J
phenol	108-95-2	1,900	25,000	NS	mg/kg	(<0.37 U)	(<0.43 U)	(<0.44 U)	0.026 J	0.020 J	(<0.37 U)	(<0.36 U)	0.03 J	0.067 J	(<0.047 U)
pyrene	129-00-0	180	2,300	1.1 (m)	mg/kg	0.11 J	0.32 J	0.067 J	0.43	**2.0**	(<0.37 U)	0.30 J	1.0	0.13 J	0.12 J
VOCs															
1,1-Dichloroethene	75-35-4	23	100	NS	mg/kg	0.002 JB	NT	0.002 JB	0.002 JB	0.002 JB	NT	NT	NT	0.002 JB	0.002 JB
Acetone	67-64-1	6,100	67,000	NS	mg/kg	0.013 B	NT	0.005 JB	0.018 B	0.004 JB	NT	NT	NT	0.016 B	0.005 JB
Methylene Chloride	75-09-2	35	320	NS	mg/kg	0.001 JB	NT	(<0.013 U)	0.002 SB	0.002 JB	NT	NT	NT	(<0.013 U)	0.002 JB
PCBs															
Aroclor 1260	11096-82-5	0.24	0.99	NS	mg/kg	(<0.038 U)	NT	(<0.05 U)	0.14	NT	NT	NT	NT	**1.2**	**0.28**

1. United States Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) Table, EPA, November 2018. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.
2. EPA Ecological Soil Screening Levels (ECO-SSLs), February 2005 - April 2008. (a) = Avian; (i) = Soil Invertebrates; (m) = Mammalian; (p) = Plants
3. New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document (NYSDEC and NYSDOH 2006)

NOTES:
mg/kg = Milligram(s) per kilogram
B = Compound detected in one or more quality assurance / quality control blank sample(s)
J =Estimated concentration
NS = No standard
NT = Not tested
U =The analyte was not detected. Reporting limits for the non-detects were not defined.
Bold values exceed NYSDEC background concentrations and EPA Ecological Soil Screening Levels.
Red concentrations meet or exceed EPA Residential Soil RSLs.
Concentrations highlighted in yellow are at or exceed EPA Industrial Soil RSLs.
Shaded values indicate detection limits are higher than screening values.

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Table 10-2 Site Investigation Soil Analytical Results, 2007

					Location[1]	Bldg 601 Magazine No. 1	Bldg 601 Magazine No. 1	Bldg 502 Magazine No. 4	Bldg 308 Quarters No. 3	Bldg 601 Magazine No. 1	Bldg 407 Paint Shop and Pipe Shop	Bldg 112 Quarters No. 2	Bldg 419 Mine Storage	Bldg 310 Hose House	Bldg 316 Semi Sub-Surface Magazine	Bldg 217 Fire Station and Labor Office	Bldg 222 Miscellaneous Storage Building	Bldg 215 Garage	Bldg 108 Storehouse No. 2	Bldg 203 Stone Crusher	Bldg 104 Pump House No. 2
					Sample ID:	**II-EA-SS-02-01**	**FD#1**	**II-EA-SS-02-02**	**II-EA-SS-02-03**	**II-EA-SS-02-04**	**II-EA-SS-02-05**	**II-EA-SS-02-06**	**II-EA-SS-02-07**	**II-EA-SS-02-08**	**II-EA-SS-02-09**	**II-EA-SS-02-10**	**II-EA-SS-02-11**	**II-EA-SS-02-12**	**II-EA-SS-02-13**	**II-EA-SS-02-14**	**II-EA-SS-02-15**
					Parent Name:	**NA**	**II-EA-SS-02-01**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
					Depth (in.)	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**
					Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
					Sample Date:																
Analyte	**CAS**	**EPA Residential Soil RSL Value[2]**	**EPA Industrial Soil RSL Value[2]**	**Ecological Soil Screening Level [3]**	**Units**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**
Metals																					
Antimony	7440-36-0	3.1	47	0.27 (m)	mg/kg	**2.4 J**	**2 J**	**0.71 J**	(<0.29 UJ)	**0.52 J**	**0.86 J**	**0.67 J**	(<0.3 UJ)	1.2 J	**0.33 J**	(<0.32 UJ)	**0.68 J**	(<0.3 UJ)	**0.58 J**	**1.6 J**	**1.6 J**
Copper	7440-50-8	310	4,700	28 (m)	mg/kg	36.1	34.2	20.3	**52.9**	31.9	**76.1**	**44**	24.3	**64.1**	**106**	17.5	27.9	21.1	30.6	**112**	31.9
Lead	7439-92-1	400	800	11 (a)	mg/kg	**98.1 J**	**96.7 J**	**209 J**	**178 J**	**121 J**	**319 J**	**202 J**	**33.1 J**	**772 J**	**11.8 J**	**47.2 J**	**66.5 J**	**50.1 J**	**161 J**	**195 J**	**220 J**
Mercury	7439-97-6	1.1	4.6	NS	mg/kg	0.54 J	0.56 J	0.21 J	0.087 J	0.2 J	0.37 J	0.3 J	0.089 J	0.053 J	0.028 J	0.09 J	0.12 J	0.094 J	0.35 J	0.44 J	0.57 J
Nickel	7440-02-0	150	2,200	130 (m)	mg/kg	20	19.5	8.8	18.8	20.9 J	21.6 J	19.1 J	19.6 J	16.8 J	16.4	14	13.3	15	18 J	21.9	16.3 J
Zinc	7440-66-6	2,300	35,000	46 (a)	mg/kg	**82.4**	**74.2**	**54.5**	**80.3**	**96.4 J**	**134 J**	**129 J**	**69 J**	**234 J**	**66.3**	**69.8**	**75.5**	**76.3**	**104 J**	**134**	**93.4 J**
Explosives																					
2,4-dinitrotoluene	121-14-2	1.7	7.4	NS	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
2,6-dinitrotoluene	606-20-2	0.36	1.5	NS	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
2-amino-4,6-dinitrotoluene	35572-78-2	15	230	NS	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
2-nitrotoluene	88-72-2	3.2	15	NS	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
3-nitrotoluene	99-08-1	0.63	8.2	NS	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
4-amino-2,6-dinitrotoluene	19406-51-0	15	230	NS	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	0.044	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)
4-nitrotoluene	99-99-0	25	140	NS	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
Nitroglycerin	55-63-0	0.63	8.2	NS	mg/kg	(<8.1 U)	(<8 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<7.9 U)	(<4 U)
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	16	230	NS	mg/kg	(<0.16 U)	(<0.16 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.16 U)	(<0.08 U)
TNT	118-96-7	3.6	51	NS	mg/kg	(<0.081 U)	(<0.08 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	0.013 J	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.079 U)	(<0.04 U)

1. Location refers to the nearest former building.

2. United States Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) Table, EPA, November 2018. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.

3. EPA Ecological Soil Screening Levels (ECO-SSLs), February 2005 - April 2008. Lowest values presented: (a) = Avian; (i) = Soil Invertebrates; (m) = Mammalian; (p) = Plants

4. New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document (NYSDEC and NYSDOH 2006)

NOTES:

BG=background sample

J=Analyte is present. Reported value may not be accurate or precise.

NS = No standard

NT = Not tested

U=Not detected (i.e. less than method detection limits for metals and less than reporting limits for explosives). The associated number indicates the approximate sample concentration necessary to be detected.

UJ=Not detected, quantitation limit may be inaccurate or imprecise.

Bold values exceed either SI concentrations and/or EPA Ecological Soil Screening Levels, whichever is higher.

Red concentrations exceed EPA Residential Soil RSLs.

Concentrations highlighted in yellow meet or exceed EPA Industrial Soil RSLs.

Shaded values indicate detection limits are higher than any screening values.

Table 10-2 Site Investigation Soil Analytical Results, 2007

					Location[1]	**Bldg 104 Pump House No. 2**	**Bldgs 124-127 Sewage Disposal Plant**	**Bldg 210 Shell House**	**Bldg 210 Shell House**	**Bldg 115 Shell House**	**Background**	**Background**	**Background**	**Background**	**Background**
					Sample ID:	**FD#2**	**II-EA-SS-02-16**	**II-EA-SS-02-17**	**FD#4**	**II-EA-SS-02-18**	**II-BG-SS-02-01**	**II-BG-SS-02-02**	**II-BG-SS-02-03**	**II-BG-SS-02-04**	**II-BG-SS-02-05**
					Parent Name:	**II-EA-SS-02-15**	**NA**	**NA**	**II-EA-SS-02-17**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
					Depth (in.)	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**	**0-2**
					Matrix	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**	**Soil**
					Sample Date:										
Analyte	**CAS**	**EPA Residential Soil RSL Value2**	**EPA Industrial Soil RSL Value2**	**Ecological Soil Screening Level [3]**	**Units**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**	**12/4/2007**
Metals															
Antimony	7440-36-0	3.1	47	0.27 (m)	mg/kg	**2.1 J**	**0.6 J**	**0.46 J**	(<0.31 UJ)	(<0.29 UJ)	**1.5 J**	**1.8 J**	**1.8 J**	**1.1 J**	**1.9 J**
Copper	7440-50-8	310	4,700	28 (m)	mg/kg	35.1	**73.8**	26.3	26.5	41.4	**45.7**	**54.9**	**55.1**	12.3	**45.7**
Lead	7439-92-1	400	800	11 (a)	mg/kg	**239 J**	**101 J**	**132 J**	**131 J**	**33.5 J**	**178 J**	**201 J**	**88.2 J**	**24.4 J**	**164 J**
Mercury	7439-97-6	1.1	4.6	NS	mg/kg	0.66 J	0.46 J	0.087 J	0.073 J	0.068 J	0.82 J	0.58 J	0.56 J	0.14 J	0.52 J
Nickel	7440-02-0	150	2,200	130 (m)	mg/kg	18.2	12.3 J	13 J	13.5	9.8 J	26.8	23.4	13.5	12.1	22.5
Zinc	7440-66-6	2,300	35,000	46 (a)	mg/kg	**105**	**136 J**	**102 J**	**96.6**	**67.2 J**	**268**	**212**	**53.4**	**57**	**124**
Explosives															
2,4-dinitrotoluene	121-14-2	1.7	7.4	NS	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	NT	NT	NT	NT	NT
2,6-dinitrotoluene	606-20-2	0.36	1.5	NS	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	NT	NT	NT	NT	NT
2-amino-4,6-dinitrotoluene	35572-78-2	15	230	NS	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	NT	NT	NT	NT	NT
2-nitrotoluene	88-72-2	3.2	15	NS	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	NT	NT	NT	NT	NT
3-nitrotoluene	99-08-1	0.63	8.2	NS	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	NT	NT	NT	NT	NT
4-amino-2,6-dinitrotoluene	19406-51-0	15	230	NS	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	NT	NT	NT	NT	NT
4-nitrotoluene	99-99-0	25	140	NS	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	NT	NT	NT	NT	NT
Nitroglycerin	55-63-0	0.63	8.2	NS	mg/kg	(<4 U)	(<4 U)	(<4 U)	(<4 U)	(<4 U)	NT	NT	NT	NT	NT
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	16	230	NS	mg/kg	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	(<0.08 U)	NT	NT	NT	NT	NT
TNT	118-96-7	3.6	51	NS	mg/kg	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	(<0.04 U)	NT	NT	NT	NT	NT

1. Location refers to the nearest former building.
2. United States Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) Table, EPA, May 2018. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.
3. EPA Ecological Soil Screening Levels (ECO-SSLs), February 2005 - April 2008. (a) = Avian; (i) = Soil Invertebrates; (m) = Mammalian; (p) = Plants
4. Background soil concentrations, as presented in New York State Brownfield Cleanup Program - Development of Soil Cleanup Objectives -Technical Support Document Tables 9.1-9 and 9.2-1 (NYSDEC and NYSDOH 2006)

NOTES:
BG = Background sample
J=Analyte is present. Reported value may not be accurate or precise.
NS = No standard
NT = Not tested
U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.
UJ = Not detected, quantitation limit may be inaccurate or imprecise.
Bold values are at or exceed either NYSDEC background concentrations and/or EPA Ecological Soil Screening Levels, whichever is higher.
Red concentrations meet or exceed EPA Residential Soil RSLs.
Concentrations highlighted in yellow are at or exceed EPA Industrial Soil RSLs.
Shaded values indicate detection limits are higher than any screening values.

Table 10-3 Site Investigation Sediment Analytical Results, 2007

				Sample ID:	II-EA-SD-02-01	II-EA-SD-02-02	FD#3 Duplicate of II-EA-SD-02-02	II-BG-SD-02-01	II-BG-SD-02-02	II-BG-SD-02-03
				Depth (in.)	0-6	0-6	0-6	0-6	0-6	0-6
				Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
				Sample Date:	12/4/2007	12/4/2007	12/4/2007	12/4/2007	12/4/2007	12/4/2007
Analyte	**CAS**	**EPA Industrial Soil RSL Value[1]**	**EPA Ecological Sediment Screening Value [2]**	**Units**						
Metals										
Antimony	7440-36-0	47	2	mg/kg	0.55 J	**22.3 J**	**43.3 J**	1.1 UJ	1.4 UJ	1.9 J
Copper	7440-50-8	4,700	18.7	mg/kg	**48.8**	**1,110**	**2,740**	**45.8**	**46.1**	**104**
Lead	7439-92-1	800	30.2	mg/kg	**79 J**	**2,340 J**	**5,030 J**	**64.5 J**	**117 J**	**100 J**
Mercury	7439-97-6	4.6	0.13	mg/kg	0.082 J	0.026 J	0.05 J	**0.47 J**	**0.68 J**	**0.45 J**
Nickel	7440-02-0	220	15.9	mg/kg	20.6 J	**53.1 J**	**85.4**	**31.6**	**29.8**	**35.7**
Zinc	7440-66-6	35,000	124	mg/kg	**184 J**	**2,470 J**	**2,980**	**178**	**217**	**224**
Explosives										
2,4-dinitrotoluene	121-14-2	7.4	0.029	mg/kg	0.04 U	0.04 U	0.04 U	NT	NT	NT
2,6-dinitrotoluene	606-20-2	1.5	0.296	mg/kg	0.04 U	0.04 U	0.04 U	NT	NT	NT
2-amino-4,6-dinitrotoluene	35572-78-2	230	0.052	mg/kg	0.04 U	0.04 U	0.04 U	NT	NT	NT
2-nitrotoluene	88-72-2	15	3.448	mg/kg	0.08 U	0.08 U	0.08 U	NT	NT	NT
3-nitrotoluene	99-08-1	8.2	4.787	mg/kg	0.08 U	0.08 U	0.08 U	NT	NT	NT
4-amino-2,6-dinitrotoluene	19406-51-0	230	0.07	mg/kg	0.04 U	0.04 U	0.04 U	NT	NT	NT
4-nitrotoluene	99-99-0	140	4.534	mg/kg	0.08 U	0.08 U	0.08 U	NT	NT	NT
Nitroglycerin	55-63-0	82	0.133	mg/kg	4 U	4 U	4 U	NT	NT	NT
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	230	NS	mg/kg	0.08 U	0.08 U	0.08 U	NT	NT	NT
TNT	118-96-7	51	0.112	mg/kg	0.04 U	0.04 U	0.04 U	NT	NT	NT

1. Location refers to the nearest former building.

2. United States Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) Table for Soil, USEPA, November 2018. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.
3. EPA Region 4 Sediment Screening Values for Hazardous Waste Sites, Marine/Estuarine Sediment Screening Value (March 2018)

NOTES:
J = Analyte is present between the method detection limit and the reporting limit.
NS = No standard
NT = Not tested
U=Not detected (i.e. less than method detection limits for metals and less than reporting limits for explosives). The associated number indicates the approximate sample concentration necessary to be detected.
UJ = Not detected, quantitation limit may be inaccurate or imprecise.
Bold values exceed EPA Ecological Sediment Screening Values.
Concentrations highlighted in yellow meet or exceed USEPA Industrial Soil RSLs.
Shaded values indicate detection limits are higher than screening values.

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Table 10-4 Former Buildings on Iona Island Naval Ammunition Depot Associated with Ammunition and Explosives

Building No. [a, b, c, g, 1, 2]	Building Name [a, b, c, g]	Year Built [a, c]	Built Purpose or Use [c, f]	Foundation [a, b, f]	Notes [b, c, e]	Extent of Explosives Residues Presence (EM 385-1-97)			Other Basis/Notes
						Table I.5-1 Item No. [3]	Solid, Liquid, Gas	Significant or Limited	
101	Fuze House #1 Fuze Magazine (g)	1943	Magazine (Storage)[f]	Concrete	"Ammunition is almost always present" (b) 101A: 113,317 Time Fuzes. (g) 101B: 118,544 fuzes (g)	29, 30, 94	Solid (low possibility of traces of spilled explosives)	Limited	
102	Primer House Primer Magazine (g)	1910	Magazine (Storage)[f]	Stone	"Ammunition is almost always present" (b) 102A: 577,233 Primers (g) 102B; 92,131 Fuzes, time and b.d. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
108	Inert Storehouse (g) Store House Number 2		Storage		First floor: 3" ctg. Cases, 5"/38 test cases, 5"/50 and 4"/50 ammunition boxes (g). Second floor: Rocket staves, 3"/50 and 44"/50 ammunition boxes. (g)	54	Solid	Limited	Possible use of store house in 1947 to store National Stock Pile Material (Crude Rubber). (p)
111	Shipping Houses #1 & #2	1903	Unknown Packaging and shipping (g)	Unknown Wood, located on wharf (b)	Ammunition being ship or received at the wharf would pass thru this building to be loaded on or off Lighters or ships.	45, 55, 97	Solids (Small possibility of minor spills due to accidentally punctured containers of ammunition or bulk explosives)	Limited	"At intervals, a small amount of ammunition may be kept in them for a short period but not generally" (b)
114	Testing Laboratory	1902	Testing Smokeless Powder and Telephone Exchange (Test)[f]	Stone	Laboratory testing of smokeless powder	94	Solid (low possibility of traces of spilled explosives)	Limited	Likely small amounts of smokeless power.
115	Loaded Projectile Magazine (Shell House #1)	1902	Surface Magazine for H.E. (n) (Storage)[f]	Stone	"Ammunition is almost always present" (b) Contents in 1944, TNT-Loaded projectiles 3"/23, 3"/50, 4"/50, 5"/51; D-Loaded projectiles 5"/38, 5"/47, 12", 14", 16". Total NEW 123,534 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
116	Loaded Projectile Magazine (Shell House #2)	1902	Surface Magazine for H.E. (n) (Storage)[f]	Stone	"Ammunition is almost always present" (b) TNT-Loaded projectiles 40mm, 3"/23, 3"/50; D-Loaded projectiles 5"/38, 152mm, 6" and 8". Total NEW 181,432 lbs. H.E.(g)	94	Solid (low possibility of traces of spilled explosives)	Limited	

117	Fuze House #2 Fuze Magazine (g) Detonating Fuse Magazine (f)	1912 1918	Magazine (Storage)[f]	Concrete	117A: Destructors, detonators, boosters, igniters, blasting caps. (g) 117B: 368,520 (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
201	Projectile Magazine (Fixed Ammunition House #3) Small Arms (g) Empty Projectile Magazine (f)	1910	Magazine (Storage)[f]	Stone	Empty Projectile Magazine/Existed in 1992 (e) “Ammunition is almost always present” (b) 201A: Small Arms (g) 201B: Inert 20mm, 1-pdr., 3”/50, 4”/50, 5”/38, 6”/47, 6”/53, 7” AP, 8”, all BL&P (g) 201C: Small Arms(g) 201D: 6”, 5”38, 7”, 5”/51, 8”/55, BL&P (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	This building is divided into four storage areas to help provide safety in storage. Map dated 1947 shows this building as an Empty Projectile Magazine, but reference (g) dated 1942 reflects that small arms ammunition was stored there.
202	Shell House #5 & Explosive “D” Plant	1912	(Shop)[f]	Stone/Concrete	Walls-brick; Floor – wood; Roof – Tin laid on wood, with wood rafters (b) “Ammunition is almost always present” (b) Explosive “D” Loading Plant (h) Two buildings labeled Vacuum System Housing (no building number) are located on the right and left sides of Building 202, map dated 1947. (f)	22, 54, 63, 67-74, 97	Solid (dusts)	Significant	“D Plant” Bulk ammonium picrate? No production at Iona Depot. Possible loading of explosives into large projectiles? Document on Storage references the erection of Special buildings for “sifting” explosive “D” circa 1945. (h) This process could possibly require an explosives dust vacuum collection system. Listed on 1958 Real Estate Annex Building 226 was a one-story concrete lean-to attached to Building 202 (r).
203	Inert Storehouse (g) Stone Crusher (f)	1914 (f)	Storage (g)		First floor: 20mm projs., 1-pdr., 3-pdr., 6-pdr., 5”/25 and 5”/38 projs., cardboard, belt links. Second floor: 5”/25, 5”/38, 6”//47 ctg. cases, supports, silk.(g)	54	Solid	Limited	Stone Crusher is listed on the 1928-12-31 map as Building 203, and shown on 1917 Revised map (f)
209	Loaded Projectile Magazine (Shell House #4)	1902	Surface Magazine for H.E. (n) (Storage)[f]	Stone	“Ammunition is almost always present” (b) Explosive D-loaded 3”/50 AP, 5”/25 AA, 5”/38 AAC, 5”/38 common, 6”/47 common and TNT-loaded 4”/50HC. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
210	Loaded Projectile Magazine (Shell House #3)	1902	Surface Magazine for H.E. (n) (Storage)[f]	Stone	“Ammunition is almost always present” (b) 20mm, 40mm and 1.10, 397,745 lbs. S.P., 109,303 lbs. G.C. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
216	Fuze Magazine (sub-surface) Fuze Magazine (g)	1941	Magazine (Storage)[f]	Concrete	Existed in 1992/photo (e) Potential drum? 10,468 det. Fuzes (g)	94	Solid (low possibility of traces of	Limited	

							spilled explosives)		
222	Inert Storehouse (g)		Storage (g)		First floor: 20mm, 40mm boxes, ctgs., tubes. Second floor: 3”, 5”/25, 5”/38, 6”47 and 5”/51 space blocks, 5”, 6” cork plugs, 5”, 6”, 8”, 14” and 16” grommets, 5” false covers. (g)	55	Solid	Limited	
226	Maintenance (r)	1946	Maintenance (Ammunition and Explosive)	Concrete	Listed on 1958 Real Estate Annex as a one-story concrete lean-to attached to Building 202 (r).	97	Solid	Limited	
305	Storehouse #3 Inert Storehouse (g)	1942	Ammunition Storage	Concrete	3”/50, 4”/50, 8”/47 dummy ctgs.: 3:/50 ctg. cases, emtpy “D: boxes: 16: Drill chgs. (g)	94	Solid	Limited	
306	Filling House #2 Cartridge Filling House and Reforming Plant (f)	1939	Maintenance (Shop)[f] Maintenance (Cartridge Filling Shop) (r)	Concrete	Attached to Bldg 313, Cartridge Case Storage(c) This building was attached to Building 313 and had a Vertical Electric Conveyor System to assist in moving material (r).	54, 97	Solid	SIGNIFICANT	““At intervals, a small amount of ammunition may be kept in them for a short period but not generally” (b) Possible loading of explosives? Map dated 1947 shows this building was used to fill cartridge Cases(f)
307	Filling House #5 Projectile Filling House (f)	1940	Maintenance (Shop)[f] Maintenance (Projectile Filling House) (r)	Concrete		54, 63, 67-74, 97	Solid	SIGNIFICANT	“At intervals, a small amount of ammunition may be kept in them for a short period but not generally” (b) Possible loading of explosives? Map dated 1947 shows this building was used to fill projectiles (f)
309	Fixed Ammunition House #1 Fixed Ammunition and Semi-Fixed Magazine (g)	1902	(Storage)[f] Surface Magazine for H.E. (n)	Stone	“Ammunition is almost always present” (b) 309A: 3”50 AA, ill., shorts, H.C., common and A.P ctgs. B.C. powder: 850 lbs., S.P. powder: 18,260 lbs. in tanks. (g) 309B: 4”/50 common and target. B.C. Powder: 5,685 lbs. S.P. powder: 42,600 lbs tank and boxes. (g) 309C: 4’/50 Target, common, H.C., 6”/47 ctgs. B.C. powder: 2,992 lbs. S.P. powder: 68,230 lbs. tanks and boxes. (g) 309D: 3”50 and 4” illum. Ctgs. B.C. powder: 800 lbs. S.P. powder: 42,975 lbs. in boxes. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
311	Fixed Ammunition House #2 Fixed Ammunition and Semi-Fixed Magazine (g)	1902	Surface Magazine for H.E. (n) (Storage)[f]	Stone	“Ammunition is almost always present” (b) 311A: 1-pdr., 3-pdr., 8-pdr., 3”/23 and 3”/50 in boxes. B.C. powder: 3,885 lbs., S.P.: 19, 176 lbs. (g) 311 B: 5”/25 Target AA, and Catapult. B.C. powder 39,070 lbs. S.P. powder: 68,672 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	

					311C: 5"/38 ctgs, and catapult. S.P.: 59,760 lbs. in tanks. (g) 311D: 5"38 Ctgs. S.P. powder: 42,960 lbs. in tanks. (g)				
312	Ammunition Box Storage Inert Storehouse (g)	1917	Ammunition Storage	Concrete	Ctg. tanks, extractors and supports. (g)	94, 97	Solid (low possibility of traces of spilled explosives)	Limited	"At intervals, a small amount of ammunition may be kept in them for a short period but not generally" (b)
313	Cartridge Case Storage Inert Storehouse (g)	1917	Ammunition Storage	Concrete	5", 6": and catapult ctg. cases. (g)	94, 97	Solid (low possibility of traces of spilled explosives)	Limited	"At intervals, a small amount of ammunition may be kept in them for a short period but not generally" (b)
314	Loaded Projectile Magazine (Shell House #7)	1917	Surface Magazine for H.E. (n) (Storage)[f]	Concrete	"Ammunition is almost always present" (b) In boxes: 3"/23 target, 3"/50 AA, HC, and common. 3" and 5"/38 illum. Projectiles. 1 pdr. And 6 pdr. Projectiles. 22,420 lbs. B.C., 131,220 lbs. S.P. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
315	Troop Housing (Women's Rest Room) (r)	1943	Alternate use: Employee Change House (r)	Cinder Block (r)		6	Solid	Limited	
316	Wet-gun-cotton Magazine High Explosive Magazine (g) Semi-Sub Surface Magazine (f)	1918	Magazine (Storage)[f]	Concrete	Empty in 1944 (g)	94	Solid	1,mited	Shown as Semi-Sub Surface Magazine on map dated 1928-12-31 (f) Shown as also being used as a paint locker on map dated 1947, (f)
401	Inert Storehouse(g) Store House Number 1 (f)		Inert Storage		Misc. ordnance material, milk cloth. (g)	55	Solid	Limited	Shown as Store House Number #1 (f)
402	Locomotive House (f)	1902	Maintenance (Ammunition and Explosives) (r)	Concrete	Built for use as a Maintenance (Ammunition and Explosive, with an alternate use as a Locomotive Repair Shop (r)	97	Solid	Limited	Shown on maps dated 1930 and 1934 as a Locomotive House (f)
403	Quilting House	1906	Maintenance (Ammunition and Explosives) (Shop)[f]	Concrete		97	Solid	Limited	"At intervals, a small amount of ammunition may be kept in them for a short period but not generally" (b)
404	Filling House #1 Bag Charge Filling House (f)	1939	Maintenance (Ammunition and Explosives) (Shop)[f]	Concrete	Attached to Bldg 404, Powder Storage Building(c) This building is attached to Building 421 (r)	54, 97	Solid	SIGNIFICANT	"At intervals, a small amount of ammunition may be kept in them for a short period but not generally" (b) Possible loading of explosives?
405	Maintenance (Ammunition and Explosives) (r)	1928 (f) 1940	Maintenance (Ammunition and Explosives) (r)	Concrete		54	Solid	Limited	Shown as Tank Repair House on map dated 1928-12-31 *f)

	Tank Repair House (f)								
415	Explosive D Magazine (Semi sub-surface Magazine) Smoke Storage (g) Unfusing Plant (f)	1907	Magazine (Storage)[f]	Stone/Concrete	126 Mk. 2 smoke floats; 31 Mk. 1 smoke floats. (g)	29, 94, 97	Solid (low possibility of traces of spilled explosives)	Limited	"At intervals, a small amount of ammunition may be kept in them for a short period but not generally" (b) This magazine in authorized to store up to 30,000 lbs. Explosive D. (g) Shown as Unfusing Plant on map dated 1928-12-31. (f)
416	Troop Housing (Rest Room) (r) Cement Shed (f)	1943 (r)	Alternate use: Employee Change House (r)	Concrete		6	Solid	Limited	Shown as Cement Shed on map dated 1928-12-31. (f)
418	Projectile Magazine (Shell House #6) Fixed Ammunition and Semi-Fixed Magazine (g) Empty Projectile Storehouse (f)	1917	Surface Magazine for H.E. (n) Ammunition Storage (g)	Concrete	"Ammunition is almost always present" (b) Loaded 3"50 AA, AP and HC, 4"/50 common, 3"/50, 4"/50 Target. In boxes and tanks. B.C. powder: 20,264 lbs. S.P. powder: 145,836 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	Shown on map dated 1947 as an Empty Projectile Storehouse (f)
419	Mine Storage #1 Inert Storehouse (g) Tank Storehouse (f)	1917	Ammunition Storage	Concrete	"Ammunition is almost always present" (b) 3", 4", 5" and 16' tanks and fuze covers. 3"/50 ammunition boxes. (g)	94	Solid	Limited	The building in 1942 was used for inert storage (g), before that it was used to store H.E. Mines.
420	Mine Storage #2 Inert Storehouse (g)	1917	Ammunition Storage	Concrete	"Ammunition is almost always present" (b) 1 pdr., 3 pdr., 8 pdr., 3", 4", 5", 6:, and 8" dummy drill ctgs. 5' and 8" corks, 5", 6", and 8" Drill projectiles, 6"/47 and 8" empty projs. (g)	94	Solid	Limited	The building in 1942 was used for inert storage (g), before that it was used to store H.E. Mines.
421	Tank (Powder) Storage Building Inert Storehouse (g)	1942	Ammunition Storage	Concrete	3", 5" and 6" ctg. Tanks. (g) This building is attached to Building 404 (r)	97	Solid	Limited	"At intervals, a small amount of ammunition may be kept in them for a short period but not generally" (b)
423	Smoke Stowage (g) Smoke Drum Storehouse (f)	1942 (r)	Stowage (g) Ammunition Storage (r)	Concrete (r)	3,000 Smoke pots, 38 FS generators, 62 FM generators, 30 FS Drums (British), 26 FS Drums. (g) Chemical Munitions (j)	94	Solid (low possibility of traces of spilled explosives)	Limited	Shown on map dated 1947 as a Smoke Drum Storehouse (f)
425	Unknown Maintenance (Ammunition and Explosive) (r) Storage for US Marine Corps Guards Munition and guns(f)	1945	Maintenance (Shop)[f]	Unknown Concrete (r)	Listed on 1992 Site Survey Summary Report part of OEW project.(e)	94	Solid (low possibility of traces of spilled explosives)	Limited	Shown on map dated 1947 for Storage of Marine Ammunition, Guns and Equipment (f)
502	Magazine #4 Bulk S.P. Magazines (g)	1902	Magazine	Concrete	"Ammunition is almost always present" (b) 502A: 40mm, 3"/23, 3"/50, 1-pdr. Bulk S.P. 128,300 lbs. S.P.(g) 502B: Bulk 3"/50 pdr. 85,682 lbs. S.P. (g) 502C: Bulk 5"/25, 5"/38 S.P. 112,555 lbs. (g) 502D: Bulk 1-pdr., 6-pdr., 3"/50 S.P. 47,418 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	Used to store Smokeless Powder, 1928. (q) 1942-07-31, during the transfer of 110 lbs. cans of smokeless powder from Compartment A, one can was dropped and caused an explosion. This smokeless powder was to be used in the

									assembly of 3//23 cartridges, shrapnel at one of the Filling Houses. (s)
503	Filling House #6 Charge Assembly House (f)	1942	Maintenance (Ammunition and Explosives) (Shop)[f]	Concrete	Powder awaiting sale (b) “Ammunition is almost always present” (b)	54, 63, 67-74, 82 97	Solid	SIGNIFICANT	Possible assembly of cartridges, shrapnel rounds. Possible loading of explosives? Enclosure B, para 2 (j) Use of fusible links on opening between rooms normally indicates that maintenance on ammunition is being performed. This could be anything from repackaging to rebuilding.
504	Magazine #5 Bag Charge Magazine (g)	1903 (r)	Magazine (Storage)[f]	Stone	“Ammunition is almost always present” (b) 504A: 5”/51 Bag chgs. 29, 375 lbs. S.P. (g) 504B: 3”/50 ctgs., 4”/50 ctgs. For overhaul. 25,440 lbs. S.P. (g) 504C: 5”/58 ctgs., semi-fixed. 54,260 lbs. S.P. (g) 504D: 5’/38 ctgs., semi-fixed. 60,000 lbs. S.P. (g) 504E: 5”/51 Bag Chgs. 42,050 lbs. S.P. (g)	80, 82, 94	Solid (individual grains)	Limited	Shown on map dated 1947 as Bag Charge Magazine (f)
505	Hosehouse (g) Fire Station (r)	1904 (r)	Miscellaneous Magazine in 1942 (g)	Concrete (r)	Naptha, smokeless powder, 155 lbs., S.P. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
506	Filling House #3 (Bombproof) Bombproof (f)	1906	Maintenance (Storage)[f] Maintenance (Ammunition and Explosives) (r)	Brick		54, 59, 63, 67-74, 97	Solid	SIGNIFICANT	“At intervals, a small amount of ammunition may be kept in them for a short period but not generally” (b) Possible loading of explosives? Maintenance on ammunition involved a number of operations such as those listed in the 1928 Annual report. (q) Shown on map dated 1947 as only a Bombproof. (f)
508	Magazine #6 Bulk S.P. Magazine (g) Bag Charge Magazine (f)	1903	Magazine (Storage)[f]	Stone	Bag Charge Magazine/Existed in 1992 (e) Walls-brick; Floor – wood; Roof – Tin laid on wood, with wood rafters (b) “Ammunition is almost always present” (b) 508A: French 152mm ctgs. 62,760 lbs. S.P. (g) 508B: 6”/47, 8”/45, 16”/50 Bulk S.P. 70,540 lbs. S.P. (g) 508C: 8”/55 Bag chgs., catapult ctgs. 46,535 lbs. S.P. (g) 508D: 16”50 Bulk pdr. 25,850 lbs. S.P. (g)	80, 82, 94	Solid (individual grains)	Limited	Used to store Smokeless Powder, 1928. (q) Shown on map dated 1947 as Bag Charge Magazine (f)

509	Magazine #2 Bulk S.P. Magazine (g)	1902	Magazine (Storage)[f]	Stone	"Ammunition is almost always present" (b) 509A: 3"38 semi-fixed ctgs. 23,295 lbs. (g) 509B: 4"/50, 5"/38, 5"/51 bulk S.P. 151,054 lbs. S.P. (g) 509C: 16"/45 chgs. Bag. 227,728 lbs. S.P. (g) 509D: 5"/38 bulk pdr. 100,776 lbs. S.P. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	Used to store Smokeless Powder, 1928. (g)
510	Magazine #3 Bulk S.P. Magazine (g)	1902	Magazine (Storage)[f]	Stone	"Ammunition is almost always present" (b) 510A: 3"38 bulk pdr. 128,130 lbs. S.P. (g) 510B: 3"/50, 5"/38 bulk pdr. 191,747 lbs. S.P. (g) 510C: 4"/50, 5"/38 bulk pdr. 180,218 lbs. S.P. (g) 510D: 5"38 ctgs., semi-fixed. 6,635 lbs (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
511	Latrine (g) Storage (r) Not in Use (f)	1902 (r)	Miscellaneous Magazine (g) Storage (r)	Concrete	4,000 catapult pyralin wads. (g)	54	Solid	Limited	Shown on map dated 1947 as Not in Use (f)
512	Sub-surface Magazine #1 High Explosive Magazine (g) Segregation Magazine (f)	1917	Magazine (Storage)[f]	Concrete	"Ammunition is almost always present" (b) Pyralin wads, bulk black powder; torpedo impulse charges. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	Shown on map dated 1947 as a Segregation Magazine (f)
513	Dynamite House (f)					94	Solid (low possibility of traces of spilled explosives)	Limited	Shown as Dynamite House on map dated 1928-12-31, located outside of depot fence on west side. Not the same as the Dynamite House Building 616 located on the west side of the railroad track. (f)
601	Magazine #1 Bulk S.P. Magazine (g)	1902	Magazine (Storage)[f]	Stone	"Ammunition is almost always present" (b) 601A: 40mm AA (g) 601B: 6"/47 ctgs. and bulk S.P. 76,905 lbs, S.P. (g) 601C: Bulk S.P. and 6"/47 ctgs., 16:/50 bag chgs. 103,118 lbs. (g) 601D: 6"/47 ctgs., 6"/58 bulk S.P. 57,948 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
603	Magazine #7 Pyrotechnic Magazine (g)	1914	Magazine (Storage)[f]	Stone	Pyrotechnic Magazine/Existed in 1992 (e) Walls-brick; Floor-wood; Roof-Asbestos laid on wood, with wood rafters (b) "Ammunition is almost always present" (b) 603A: Pyrotechnics Wt. unknown (g) 603B: Pyrotechnics Wt. unknown (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	Possible use of magazine in 1947 to store National Stock Pile Material (Crude Rubber). (p)
604	Magazine #8 Bulk S.P. Magazine (g)	1914	Magazine (Storage)[f]	Stone	"Ammunition is almost always present" (b) 6"/53 Bag chgs. 14"/45 chgs., 5"/51 bulk S.P. 86,348 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	

606	Magazine #9 Semi-Fixed Ammunition Magazine (g)	1908	Magazine (Storage)[f]	Stone	“Ammunition is almost always present” (b) 606A: 5”/38 ctgs., semi-fixed, S.P. powder: 78,570 lbs. (g) 606B: 5”/38 ctgs., semi-fixed, S.P. powder: 83,240 lbs. (g) 606C: 5:/38 ctgs., semi-fixed, S.P powder: 62,250 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	Possible use of magazine in 1947 to store National Stock Pile Material (Crude Rubber). (p)
609	Mine Loading Plant Inert Storehouse (g) Miscellaneous Storehouse (f)	1918	Ammunition Storage (Storage)[f]	Concrete	“Ammunition is almost always present” (b) 8”:, 10”, 14” and 16” dummy chgs., steel plugs, 3” and 5” covers, drill projectiles, flashless pellets. (g) Mine filling operation with melted TNT. (i)	5, 48, 54, 56, 97	Solid, Liquids and Gas	Significant	Document date 17 Dec. 1942 Shown as Mine Loading Plant on map dated 1928-12-31 (f) Plant was discontinued by late 1942 and kettles used to melt TNT were removed. (i) Shown on a map dated 1947 as a Miscellaneous Storehouse (f) See 1918 Annual Report/Navy Department on detail info on Mine Loading Plant. (t)
610	High Explosive Magazine (Gun Cotton House) High Explosive Magazine (g) Black Powder Magazine (f)	1939	Magazine (Storage)[f]	Stone or Concrete (uncertain) Concrete (r)	“Ammunition is almost always present” (b) Bulk Explosive D, 47,500 lbs. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	This was a one story, underground, concrete building (r)
611	Sub-surface Magazine #2 Black Powder Magazine (g)	1917	Magazine (Storage)[f]	Concrete	Described as “Black Powder Magazine”/Existed in 1992/photo (e) Walls-concrete; Floor-concrete; Roof-Concrete (b) “Ammunition is almost always present” (b) Y-Gun Chgs. Torpedo Ing. Chgs. 1,920 lbs. S.N. B.P., 675 lbs. S.P. B.P. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	This was a one story, underground, concrete building (r)
612	Sub-surface Magazine #1 Fire Station (r)	1941 1939 (r)	Magazine (Storage)[f]	Concrete		94	Solid	Limited	This was a one story, cinder block building (r)
613[d]	Sub-surface Magazine E Black Powder Magazine (g)	1931	Magazine (Storage)[f]	Concrete	Bulk Black Powder (shell), ignition ends, illum. Burster chgs., catapult ign. chgs. 5,955 lbs. B.P.(g)	94	Solid (low possibility of traces of spilled explosives)	Limited	This was a one story, underground, concrete building (r)
614[d]	Sub-surface Magazine F Black Powder Magazine (g)	1931	Magazine (Storage)[f]	Concrete	Bulk Black Powder: 4,553 lbs. Sodium Nitrate, 4,525 lbs. Sp. Hex. Powder (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	This was a one story, underground, concrete building (r)
615[d]	Sub-surface Magazine G Black Powder Magazine (g)	1931	Magazine (Storage)[f]	Concrete	Bulk Black Powder: 4,500 lbs. Cannon, 5,850 lbs. Sp. Hex. (g)	94	Solid (low possibility of traces of	Limited	This was a one story, underground, concrete building (r)

							spilled explosives)		
616	Dynamite Magazine (f)	1915 or 1931	Magazine (Storage)[f] Miscellaneous Magazine (g)	Concrete (Buried Block/Concrete)	Empty 1942 (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	This was a one story, underground, concrete building (r)
617	Unknown Small Arms Storage (g)	Unknown 1942 (r)	Magazine (Storage)	Concrete (Buried Block/Concrete)	Listed on 1992 Site Survey Summary Report part of OEW project.(e) 617 A: Empty (g) 617 B: 12,701 – Drift signals (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
701 #1 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) British bag chgs. and loaded 12-pdr. Cartridges.(g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
702 #2 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) British 12-pdrs., 4" and 4.7 projs. (fuzed). (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
703 #3 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) British Illum. And target rockets, smoke float igniters, pyrotechnics, time fuzes, TNT demolition blocks, rocket motors. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
704 #4 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) British time fuzes (proj.), primacord, rocket motors, H.E. loaded projectiles, scrap Explosive D powder.(g).	94	Solid (low possibility of traces of spilled explosives)	Limited	
705 # 5 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) Mk 28 proj. Fuzes, 1,200 hand grenade fuzes, fragmentation and smoke grenades, 497 bombs (Mk. 2 incendiary instr.), smoke candles. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
706 #6 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) British 12 pr. ctgs., 4 " ctgs., rocket apparatus with H.E. rockets, rocket motors. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
707 #7 Round	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e)	94	Solid (low possibility of	Limited	

Island (g)					H.E. loaded 3"/50 common, surveyed tetryl boosters, distress signals, unserviceable pyrotechnics; 20mm (14,400 rds.). (g)		traces of spilled explosives)		
708 #8 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) Gas identification sets with detonators; CW spray guns, smoke candles, bulk CN, aircraft bomb exp. Incendiary, smoke float ingiters. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
709 #9 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) 228 Demolition outfits, M104; 1 Demolition chg., HE	94	Solid (low possibility of traces of spilled explosives)	Limited	
710 #10 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) 666 Smoke pots, Mks. 1 and 2. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
711 # 11 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) British H.E. loaded 12-pdrs, 4" projectiles and rockets, 9,800 lbs. Scrap Explosive D. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
712 #12 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) 24,000 lbs. Scrap Explosive D. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
713 #13 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) H.E. loaded British 18-pdrs. and 4" projs. Mk. 136 rocket fuzes (1,164) (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
714 #14 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) TNT, Depth chg. Pistols, pistol extenders, British, H.E., loaded 4" projs., French 4" propelling chgs, French primers, 4,200 lbs. Crap Explosive D. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
715 #15 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) Smoke pots M4A2, H.E. loaded mortar shells with Point det. Fuzes; mortar illum. Shells with M-83 fuze. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	

716 #16vRound Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) British rocket motors and rocket bodies and apparatus of unknown description, "tubes ejectors" (British) and 20mm and 40mm AA. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
717 #17 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) Pyrotechnics, smoke pots, igniters, torpedo detonators, exploder mechanisms Mk. 3, 20mm AA. (g) Chemical Munitions (j)	94	Solid (low possibility of traces of spilled explosives)	Limited	
718 #18 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) 280 Smoke Pots M4A2. (g) Chemical Det. Sets (k)(j)	94	Solid (low possibility of traces of spilled explosives)	Limited	This survey dated 1946-04-25 helps establish the Navy's process for disposal of Chemical material at NAD (o).
719 #19 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) 960 Smoke Pots Mk. III. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
720 #20 Round Island (g)	Sub-surface Magazines High Explosive Magazine(g)	1942 (r)	Magazine (Storage)	Concrete	Listed on 1992 Site Survey Summary Report part of OEW project.(e) 25,500 lbs. Scrap Explosive D. (g)	94	Solid (low possibility of traces of spilled explosives)	Limited	
No building number	Solder Reclamation Furnace (f)	1928			Solder was used to seal edges of metal containers to provide water/air tight containers. The reclamation process was to use a furnace to melt the solder from damaged containers that had been used to store powder or explosives.	37	Solid (small amounts of unburned explosive may remain in the incinerator)	Limited	No building number, shows up north of Building 101, outside fence left of Building 121 Incinerator on map dated 1928-12-31 (f)

[a]1998, ASR, Appendix E; Public Works of the Navy Building List, July 1939
[b]1998, ASR, Appendix E; Public Works Memo, 9 November 1927
[c]1998, ASR, Appendix F; Legal Description of Iona Island, 1940 (date uncertain)
[d]1998 ASR, Appendix E; Inspector of Ordnance in Charge memo, 27 August 1931
[e]1998 ASR, Appendix E; 1995 Findings of Fact, Site Survey Summary Sheet, dated 30 October 1992
[f]2018 HPA, 1965 Appraisal of Iona and Round Island

(g) 1944-10-07 Ltr. Monthly Rpt. of Stowage of Ammunition (reports use of building and type of ammunition stored in 1944.
(h) 1945-00-00 Comments on building Explosive "D: Plants
(i) 1942-12-17 Survey Request, Disposal of Kettles removed from Mine Loading Plant
(i) 1946-02-11 Report of Inspection of NAD Iona Island, NY, see Enclosure A, para 3 for burning grounds, Enclosure B, para 2 for fusible links in building 503, para. 2 and 3 for chemical stored in magazines 17 and 18.
(k)1946-03-01 Ltr. Storage of Chemical Ammunition
(l) 1946-12-02 Ltr. Disposal of Ammunition, Report of
(m) 1946-03-14 Ltr. Disposition of Ammunition, Records of
(n) 1946-04-04 Ltr. Inspection of NAD, para. 3.d
(o) 1946-04-25 Survey Request, Gas Identification Sets, Det. M1. Dumping at Sea
(p) 1947-04-18 Ltr., Storage of Crude Rubber
(q) 1928-08-23 Annual Report, examples of ammunition maintenance activities
(r) 1958-05-01 Real Estate and Building Annex
(s) 1942-07-31 Board of Investigation, Request for. Building 502, Smokeless powder.
(t) 1918 Annual Report/Navy Department, Mine Loading Plant

[Note 3] Explanations of type of ammunition or explosives operation/facility phase of explosive released from Table I.5-1/EM 385-1-97 is provided below:

5 – Cast loading
22 –Explosives or explosives dust vacuum collection
29 – Fuze installation or removal
30 – Fuze liner removal
45 – Loading dock
54 – Pack/unpack bay in a maintenance or production building
55 – Packaging and shipping
56- 63 – Pressing, low speed, automated or manual (normally used in the press loading of larger items, such as projectiles and warheads
67 – Projectile base plate assembly or removal
68 – Projectile crimping
69 – Projectile fin assembly or removal
70 – Projectile main charge pressing
71 – Projectile ogive assembly or removal
72 – Projectile pull-apart (from cartridge case)
73 – Projectile rotating band or obturator assembly or removal
74 – Projectile seating
94 – Storage (e.g., earth covered magazines, aboveground magazines, covered storage pads, service magazines)
97 – Temporary storage bay in a maintenance or production building

🟨 Note 1 - Buildings potentially remaining; confirmation required.
🟧 Note 2 - Building requires more information about specific operations that would indicate a source of potential <u>significant</u> explosives residue and would need to be revised to include operations such as cast loading (Item #5 of Table I.5-1/EM 385-1-97).

General Notes: Section 5 (*Building and Installed Equipment Containing Explosive Residues That Present Explosion Hazards*) in Engineering Manual 385-1-97 *Explosives Safety and Health Requirements Manual* and Department of Army Pamphlet 385-64 *Ammunition and Explosives Safety Standards* is specific to real property which includes buildings and installed equipment. The guidance provides safety requirements for former operating buildings and any installed equipment when there is a potential of residual explosives that present an explosive hazard.

Limited explosives residues – Involves minor release of explosives in the immediate operating area with very little migration. Operations involving exposed explosives where there is <u>no mass high speed</u> handling generally do not produce more than limited presence.

Significant explosives residues – Caused by operations that can result in extensive migration of significant amounts of explosives in the building and its installed equipment. Can be released in solid, liquid, or vapor form. Can migrate into cracks, voids, behind wall and roof panels, drains, roof rafters, porous surfaces, etc. Solids) operations capable of generating explosive dusts result in significant migration and residual presence. Liquids) In process liquid explosives can leave residues in pipes and vessels. Spills, and wash-down of equipment can carry explosives into cracks in the floor and into drains and sumps. Gases) When solid explosives are heated, can volatilize into the air and migrate about the building. After condensation, the explosive is again a solid.

Table 10-5 Areas of Concern for Further Investigation at the Former Iona Island Naval Ammunition Depot

AOC Number	Building/Structure	Historical Activities	Potential AOC-Specific Contaminants	Historical Sampling Results[(1.2)]	Potential Release to Environment	COPC Specific Analyte List
1	Former Building 103	Storage of paint and oil; likely solvent use.	Solvents from paints (VOCs and SVOCs); Petroleum Oil Lubricants (POL); and metals.	October 1996 – elevated metals (arsenic, lead) and PAHs in shallow subsurface soil sample IX103-B1 December 2007 – no samples collected	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years). SVOCs from paints would have polymerized.	TAL metals, PAHs
2	Former Building 121	Former incinerator; historical records do not indicate whether municipal solid waste or hazardous waste was burned in the incinerator.	Residual organics and metals; PAHs from incomplete combustion.	October 1996 – elevated metals (arsenic, barium, cadmium, lead) and PAHs in shallow subsurface soil sample IX121-B1 December 2007 – elevated metals (lead) detected in sediment sample II-EA-SD-02-02 collected near this AOC	Volatilization of ash particles into air and soil deposition; potential land disposal; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater.	TAL metals, PAHs
3	Former Building 123	Former garage; historical records do not indicate if this building was used for equipment or materials storage.	Solvents (VOCs and SVOCs), POL, and metals.	No samples collected to date	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. Note: VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL metals, PAHs
4	Former Buildings 124, 125, 126, 127, and 128	Sewage Disposal Plant.	Chlorides, organic compounds (VOCs and SVOCs), metals, microorganisms.	October 1996 – elevated metals (arsenic, lead) in shallow subsurface soil sample IX124/8-B1. Low concentrations of PAHs (below screening criteria). December 2007 – elevated metals (antimony, copper, lead, mercury, zinc) in surface soil sample II-EA-SS-02-16	Chemical spills; leaks from sewer lines/ tanks to surface water or groundwater; land disposal of sludge. Note: VOCs (including from POLs) are unlikely to be present in soil due to characteristics of VOCs (high solubility and mobility) and due to the time since deactivation (70 years). Due to the time since deactivation (70 years), microrganisms from DoD use are likely not present.	TAL metals, PAHs
5	Former Building 207	Former garage used by the Marines; historical records do not indicate if this building was used for equipment or materials storage.	Solvents (VOCs and SVOCs), POL, and metals.	No samples collected to date	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL metals, PAHs
6	Former Building 213	Storage of paint; likely solvent use.	Solvents from paints (VOCs and SVOCs) and metals	No samples collected to date	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years). SVOCs from paints would have polymerized.	TAL metals, PAHs
7	Former Building 215	Former garage; historical records do not indicate if this building was used for equipment or materials storage.	Solvents (VOCs and SVOCs), POL, and metals.	No samples collected to date	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL metals, PAHs
8	Former Building 219	Former garage; historical records do not indicate if this building was used for equipment or materials storage.	Solvents (VOCs and SVOCs), POL, and metals.	No samples collected to date	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL metals, PAHs
9	Former Building 220	Former garage; historical records do not indicate if this building was used for equipment or materials storage.	Solvents (VOCs and SVOCs), POL, and metals.	No samples collected to date	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL metals, PAHs

Table 10-5 Areas of Concern for Further Investigation at the Former Iona Island Naval Ammunition Depot

AOC Number	Building/Structure	Historical Activities	Potential AOC-Specific Contaminants	Historical Sampling Results[1.2]	Potential Release to Environment	COPC Specific Analyte List
10	Former Building 406	Tin, electrical and annealing shop	Solvents (VOCs and SVOCs), POL, and metals.	No samples collected to date	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL metals, PAHs
11	Former Building 407	Paint shop and pipe shop; likely solvent use	Solvents (VOCs and SVOCs), POL, and metals	October 1996 – elevated metals (arsenic, lead) and PAHs in shallow subsurface soil sample IX407-B1 December 2007 – elevated metals in surface soil sample (II-EA-SS-02-05) collected near this AOC	Volatilization of VOCs to air; spills to surface soil; overland flow to surface water/ sediment; leaching to subsurface soil and groundwater. **Note:** VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL metals, PAHs
12	Former Building 410	Power house; coal ash (including fly ash, bottom ash, and/or sludge).	PAHs and metals (such as arsenic, cadmium, and mercury)	October 1996 – highest detected PAHs at site, in shallow subsurface soil sample IX410-B1; metals were not tested December 2007 – no samples collected	Volatilization of ash particles into air and soil deposition; potential land disposal; leaching to subsurface soil and groundwater; overland flow to surface water / sediment.	TAL metals, PAHs
13	Former fuel oil AST	One former 2,500-gallon fuel oil AST located near Former Building 233.	VOCs/BTEX, PAHs	October 1996 - no site-related VOCs in shallow subsurface soil.	Leaching to subsurface soil and groundwater; overland flow to surface water / sediment. Note: VOCs are unlikely to be present in soil due to characteristics of VOCs (high solubility and mobility) and due to the time since deactivation (70 years); however, as BTEX is a primary component of fuel oil, BTEX is retained for further evaluation.	BTEX, PAHs
14	Former fuel oil AST	One former fuel oil AST (size unknown) located near Dock 131.	VOCs/BTEX, PAHs	No samples collected to date	Leaching to subsurface soil and groundwater; overland flow to surface water / sediment. Note: VOCs are unlikely to be present in soil due to characteristics of VOCs (high solubility and mobility) and due to the time since deactivation (70 years); however, as BTEX is a primary component of fuel oil, BTEX is retained for further evaluation.	BTEX, PAHs
15	Former fuel oil AST	Two former fuel oil ASTs (size unknown) located near Former Building 410.	VOCs/BTEX, PAHs	October 1996 - no site-related VOCs in shallow subsurface soil.	Leaching to subsurface soil and groundwater; overland flow to surface water / sediment. Note: VOCs are unlikely to be present in soil due to characteristics of VOCs (high solubility and mobility) and due to the time since deactivation (70 years); however, as BTEX is a primary component of fuel oil, BTEX is retained for further evaluation.	BTEX, PAHs
16	Dump Area	Historical records suggest that construction debris was used as fill between Iona and Round Island; the content of the dump is unknown but may have contained waste or munitions debris.	Unknown contents – could include solvents, paints, POL (VOCs and SVOCs); PCBs, explosives, and metals	October 1996 – elevated metals (arsenic, barium, cadmium, chromium, lead, silver); PAHs; explosives compounds (2,4-dinitrotoluene, 2,6-dinitrotoluene) in shallow subsurface soil samples IXDMP-B1, -B2; one PCB compound (Aroclor 1260) detected in sample IXDMP-B1 December 2007 – no samples collected	Leaching to subsurface soil and groundwater; overland flow to surface water / sediment. Note: VOCs (including from POLs) are unlikely to be present in soil due to characteristics of solvent related VOCs (high solubility and mobility) and due to the time since deactivation (70 years).	TAL Metals, PAHs, PCBs, Explosives
17	Former Coal Trestle and Storage Area – located near Former Building 410	Coal storage for the power house.	Metals (such as arsenic, cadmium, and mercury), SVOCs	No known sampling to date	Soil deposition; leaching to subsurface soil and groundwater; soil deposition; potential land disposal.	TAL metals, PAHs
18	Former Coal Storage Area – located near Former Building 215	Coal stored on a concrete foundation for use at the Depot.	Metals (such as arsenic, cadmium, and mercury), SVOCs	No samples collected to date	Soil deposition; leaching to subsurface soil and groundwater; soil deposition; potential land disposal.	TAL metals, PAHs
19	Former transformers	Electrical transformersfor Depot.	PCBs	No known sampling to date	Leaching to subsurface soil and groundwater; overland flow to surface water / sediment.	PCBs.

NOTES:

1. Low (estimated) detections of 1,1-dichloroethene, acetone, and methylene chloride were detected in all of the samples analyzed for VOCs in October 1996. The samples were qualified as "B" because the compounds were detected in one or more of the QA/QC blank samples and/or "J" because the detected concentration was less than the quantitation limit
2. The December 2007 MMRP SI samples were not selected based on proximity to the HTRW AOCs (sampled previously by Greeley), they were selected for broad coverage of the 1903 Explosion Area.

NOTES:

AOC = Area of concern
AST = Above ground storage tank
BTEX = Benzene, toluene, ethylbenzene, and xylenes
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
POL = Petroleum oil and lubricants
SOP = Standard operating procedure
SVOC = Semi-volatile organic compound
TAL = Target analyte list
VOC = Volatile organic compound

QAPP Worksheet #11 – Project Quality Objectives

This worksheet is used to develop and document project DQOs using a systematic planning process that follows the EPA DQO process and documents the environmental decisions that need to be made and the level of data quality needed. The DQO process is outlined in EPA's 2006 guidance document, *Guidance on Systematic Planning Using the DQOs Process* (EPA/240/B-06/001, February 2006) (EPA 2006). The specific QA/QC requirements developed for the site are consistent with those presented in the DoD Quality Systems Manual (QSM), Version 5.2 (DoD 2018).

DQOs are both qualitative and quantitative statements that define the type, quality, and quantity of data necessary to support the decision-making process during project activities. The objective of this UFP-QAPP is to establish standard procedures so that the integrity, accuracy, precision, completeness, and representativeness of collected samples are maintained, and the required DQOs are achieved.

The DQO process provides a systematic procedure for defining the criteria that a data collection design should satisfy. The DQO process established by EPA, and incorporated into the 2012 UFP-QAPP guidance, consists of seven steps that are used during the planning of the data collection process to ensure that field and analytical activities, and the resulting data, meet the project objectives.

The DQOs were developed using the following 7-step process, which is the process designed to: (1) clarify study objectives and decisions to be made based on the data collected (Steps 1 and 2), (2) define the most appropriate type of data to collect (Steps 3 and 7), (3) determine the most appropriate conditions for collecting the data (Steps 4, 5, and 7), and (4) specify acceptable decision error limits based on the consequences of making an incorrect decision (Step 6). The project DQOs are presented below.

1. State the problem (describe concisely the problem to be studied).

Environmental media (surface and subsurface soil, sediment, and groundwater) may have been impacted as a result of historical use of the site as an ammunition depot by the Navy. Further investigation is needed to evaluate the nature and extent of environmental impact and determine if concentrations of contaminants pose an unacceptable risk to human health and/or ecological receptors. There are insufficient existing data to evaluate nature and extent of contaminants and to conduct human health and ecological risk assessments at the Iona Island FUDS. Much of the existing data were generated from biased sampling designs and there is an insufficient quantity of data. Therefore, a remedial investigation is proposed to address these insufficiencies.

Nineteen AOCs have been identified for further investigation and include the locations/footprints of 26 former structures/site facilities at the Iona Island Naval Ammunition Depot FUDS. These include 16 former buildings, 4 former ASTs, a former dumping area, 2 former coal storage areas, and 3 former transformers, all of which were previously identified as being eligible for further investigation under the HTRW project of the FUDS Program (Figure 2). The AOCs are listed below.

- ***AOC #1: Former Building 103*** – Paint and Oil Storage
- ***AOC #2: Former Building 121*** – Incinerator
- ***AOC #3: Former Building 123*** – Garage Building
- ***AOC #4: Former Buildings 124 to 128*** – Sewage Disposal Plant (and Suspected Outfall)
- ***AOC #5: Former Building 207*** – Marine Garage Building
- ***AOC #6: Former Building 213*** – Paint Locker for Building 202
- ***AOC #7: Former Building 215*** – Garage Building
- ***AOC #8: Former Building 219*** – Garage Building
- ***AOC #9: Former Building 220*** – Garage Building
- ***AOC #10: Former Building 406*** – Tin, Electrical, and Annealing Shop Building
- ***AOC #11: Former Building 407*** – Paint Shop and Pipe Shop
- ***AOC #12: Former Building 410*** – Power House
- ***AOC #13: Area A*** **–** One Former Fuel Oil AST (2,500 gallons); located near Former Building 233
- ***AOC #14: Area B*** **–** One Former Fuel Oil AST (size unknown); located near Dock 131
- ***AOC #15: Area C*** **–** Two Former Fuel Oil ASTs (size unknown); located near Former Building 417
- ***AOC #16: Area D*** **–** Dumping Area
- ***AOC #17: Area E*** **–** Former Coal Trestle and Storage Area; located near Former Building 410
- ***AOC #18: Area F*** **–** Former Coal Storage Area; located near Former Building 215

- ***AOC #19: Three Former Transformers*** – T1 northwest of Building 406, T2 near Area D, and T3 northeast of Building 220.

The former buildings, ASTs, transformers, and structures have been removed, and building foundations were either removed or have been buried/overgrown; therefore, the AOCs have been identified based on historical documentation/records, historical drawings, and aerial photographs that were added to GIS software.

As detailed in Worksheet #10, the preliminary COPCs for this investigation vary by AOC and are based on a review of the CSM. A comprehensive list of preliminary COPCs identified for this HTRW RI include the following:

- TAL metals
- PAHs
- BTEX
- Aroclor PCBs
- Explosives residues.

A detailed discussion of the preliminary COPCs is provided below, and Table 10-5 provides a brief CSM summary by AOC and identifies preliminary COPCs. TAL metals and PAHs were reported in surface and/or subsurface soil at concentrations above EPA screening levels during the 1996 Data Collection Activities (Greeley-Polhemus 1997) and/or 2007 Site Inspection (Alion 2008) (Tables 10-1 and 10-2; Figure 11-1) and are identified as preliminary COPCs at the Iona Island Naval Ammunition Depot. TAL metals and PAHs are considered COPCs at AOCs #1 through #18.

Additional preliminary COPCs have been identified for several of the AOCs, based on previous analytical results and/or former use of individual structures:

- BTEX (common constituent in fuel oil) and PAHs at AOC #13 - Area A (footprint of one former fuel oil AST located near former Building 233), AOC #14 - Area B (footprint of one former fuel oil AST located near Dock 131), and AOC #15 – Area C (footprints of two former fuel oil ASTs located near former Building 417): subsurface soil samples at Areas B and C were collected for analysis of VOCs during the 1996 Data Collection Activities (Greeley-Polhemus 1997) (Figure 10-2; Table 10-1). While VOCs related to site activities were not detected in subsurface soil at these locations, these AST sites were not formally closed out and were not included in the CONHTRW project.

- PCBs at AOC #19 (three former transformers): the former transformer locations have not been previously investigated. The primary COPCs associated with transformers are PCBs. Therefore, Aroclor PCBs will be evaluated in soil at these locations.

- Explosives and PCBs at AOC #16 - Area D (Dumping Area): 2,4-DNT, 2,6-DNT, and PCBs were detected in AOC #16 - Area D (Dumping Area) during the 1996 Data Collection Activities (Greeley-Polhemus 1997) at concentrations above EPA screening values (Figure 10-2 and Table 10-2).

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Seven additional former buildings were identified as having a significant potential for explosive hazard based on limited information available in previous documents (including the ASR [USACE 1998] and HPA [USAGC 2018]) and input from USACE. The buildings and slabs have been removed, and soil has been reworked. These former buildings have not been previously investigated; explosives residues have been identified as COPCs based on former use. While it is not anticipated that an explosives hazard is present, the potential exposure risk from remaining explosives residues to human and ecological receptors is not currently known.

- Building 609 – Mine Loading Plant
- Building 506 – Filling House #3 (Bombproof)
- Building 503 – Filling House #6
- Building 404 – Filling House #1
- Building 307 – Filling House #5
- Building 306 – Filling House #2
- Building 202 – Shell House #5 & D Plant.

2. Identify the goals of the study; state the decisions to be made to solve the problem.

The objective of the HTRW RI is to collect environmental analytical data at the Iona Island Naval Ammunition Depot FUDS that are scientifically defensible and representative of site conditions to:

- Evaluate the nature and extent of potential impacts associated with former structures and/or operations

- Evaluate potential risks to human health and ecological receptors

- Collect sufficient data to complete an FS, if necessary.

Specific goals are as follows:

- At the 19 HTRW AOCs, evaluate the nature and extent of contaminants associated with former DoD activities in environmental media at concentrations above human health and/or ecological screening values.

- At the 7 additional former buildings identified as having significant potential for explosive hazard, evaluate the presence or absence of explosives in surface and subsurface soil at concentrations above screening values. These former buildings have not been previously investigated and are not currently included in the HTRW project at the Iona Island Naval Ammunition Depot FUDS. Although these buildings are not currently included in the HTRW project at the Iona Island Naval Ammunition Depot FUDS and were not scoped in the existing contract, they are being considered for evaluation during this HTRW RI pending direction from the contracting offer to confirm the presence/absence of explosives constituents in soil and to evaluate potential exposure risk from remaining explosives residues to human and ecological receptors.

- Update/refine the HTRW project site-specific human health and ecological (terrestrial and aquatic) CSMs as data are collected and data gaps are filled. For example, exposure pathways that are currently considered potentially complete could become complete.

- Identify initial applicable or relevant and appropriate requirements (ARARs).

- Prepare human health and ecological risk assessments to evaluate whether the environmental impacts associated with DoD activities at the former buildings/structures included in this HTRW RI pose an unacceptable risk to human health or the environment. Additional details on guidance for conducting the human health and ecological risk assessments are provided in the attached Risk Assessment Work Plans (Appendices D and E).

This HTRW RI will be the first comprehensive investigation of the Iona Island Naval Ammunition Depot FUDS. A two-phased approach will be employed during this RI to facilitate data collection, evaluation, and discussion. Phase I will be conducted to evaluate the presence or absence and nature and extent of constituent concentrations in surface soil from 0-6 in. bgs and shallow subsurface soil from 6-36 in. bgs or refusal. The Phase I investigation area is presented in Figure 11-1.

A Phase I shoreline reconnaissance survey will be conducted by field biologists along the eastern and western sides of Iona Island and along the active River Subdivision (CSX Transportation) railroad tracks. The shoreline reconnaissance survey areas are presented in Figure 11-2. The shoreline reconnaissance survey will be conducted to identify potential pathways (i.e., channels, drainage ditches, culverts, sewage outfalls/discharge pipes, etc.) that lead to the shoreline environment, evaluate whether there are barriers to overland transport from Iona Island to the shoreline (e.g., the railroad), and conduct and a receptor and resource inventory evaluation. Field biologists will document potential aquatic receptors and evaluate whether the benthos provides suitable habitat for aquatic organisms. As part of this survey, sediment samples will be collected for grain size and TOC analysis to screen physical characteristics of sediment, evaluate whether sediments could be a potential “sink” for site-related contaminants, and inform the design of the Phase II investigation (if needed). The information gathered during the shoreline reconnaissance survey will be used to evaluate the source-pathway-receptor interaction to better understand the shoreline environment, refine the aquatic CSM, and develop a path forward for subsequent investigation/sampling during Phase II, if needed.

A Human Health Risk Assessment (HHRA), Screening-Level Ecological Risk Assessment (SLERA), and, if necessary, a Refined Screening-Level Ecological Risk Assessment (RSLERA) will be conducted using the Phase I analytical data to evaluate whether constituent concentrations present a potential risk to human and terrestrial ecological receptors. Appendix D provides details on how the HHRA will be performed and Appendix E provides details on how the SLERA and RSLERA will be performed. A Phase I data summary report will be prepared to present the results of the Phase I data evaluation, shoreline habitat evaluation, and risk assessments.

Once a determination can be made regarding the extent of impacts to soil, and potential risk to human health and terrestrial ecological receptors, the Phase II investigation will be conducted (if needed) to further refine impacts to environmental media and COPC migration routes, and evaluate potential impacts to aquatic receptors.

The Phase II investigation, including media to be sampled, sampling locations, and analytes will be contingent upon the results of the Phase I investigation and will be presented in an addendum to this UFP-QAPP. The following decisions will be made to identify additional investigation activities for the Phase II investigation:

- Is the nature of the contaminants related to historical DoD use/activities present in environmental media at concentrations that exceed background (where applicable) **<u>and</u>** applicable human health and/or ecological screening levels?

  — If analytical data indicate that contaminants in environmental media are at concentrations greater than both background (where applicable) and applicable screening levels, then the need for site-specific risk assessments will be evaluated.

- Do the Phase I analytical data sufficiently delineate the nature and extent of impacts and exposure routes in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs or refusal)?

  — The Phase I data will be reviewed with the project team to evaluate whether results provide sufficient delineation to meet project objectives. If results of the Phase I surface soil and/or shallow (6-36 in. bgs) subsurface soil analytical data indicate that impacts are present (i.e. concentrations exceed both background and human health and ecological screening levels), **and** the nature and extent of the impacts indicative of potential risk as determined by methods set forth for a screening level HHRA (USACE 1999) are not sufficiently delineated, then the project team will discuss whether to conduct additional surface and/or shallow subsurface sampling at step-out locations. If the project team agrees, then a Phase II supplemental sampling plan for surface and/or shallow (6-36 in. bgs) subsurface soil sampling at step-out locations will be prepared as an addendum to this UFP-QAPP. Based on data generated during the Phase I investigation, environmental media, analytes, or investigation areas may be identified for removal from additional RI activities with concurrence from regulatory agencies and stakeholders.

- If shallow (6-36 in. bgs) subsurface soil samples identify site-related COPCs at concentrations that exceed background and screening levels during Phase I, **and** if a screening level HHRA (USACE 1999) indicates risk to human health, **and** if deeper subsurface soil is present as based on Phase I soil boring logs and observations, then the project team will discuss whether to conduct deeper subsurface soil sampling (36 in. to refusal or a maximum of 10 ft bgs) to evaluate the risk to potential future human receptors (i.e. construction workers) that could be exposed to deeper subsurface soil during subsurface construction activities (for example, in the event that an environmental center/nature center is constructed at the site). If the project team agrees, then a Phase II supplemental sampling plan for advancement of deeper soil borings and collection of deeper subsurface soil will be prepared as an addendum to this UFP-QAPP.

- If shallow (6-36 in. bgs) subsurface soil collected in the overburden identify site-related COPCs at concentrations that exceed background and human health screening levels during Phase I, **and** if there is shallow groundwater present in overburden material as based on Phase I soil boring logs and observations, then the project team will discuss whether to conduct overburden groundwater sampling to evaluate risk to potential future human receptors (i.e. construction workers) that could be exposed to shallow groundwater during subsurface construction activities (for example, in the event that an environmental center/nature center is constructed at the site). If the project team agrees, then a Phase II supplemental sampling plan for installation of temporary overburden monitoring wells and collection of overburden groundwater samples will be prepared as an addendum to this UFP-QAPP.

- If shallow (6-36 in. bgs) subsurface soil collected in the overburden identify site-related COPCs at concentrations that exceed background and human health screening levels during Phase I, **and** if there is reason to believe that bedrock groundwater may be impacted, then the project team will discuss whether to conduct bedrock groundwater sampling to evaluate concentrations in bedrock water that is currently used as a non-potable water supply, and to evaluate potential risk to future human receptors in the event that a potable bedrock well were to be installed at the site. If the project team agrees, then a Phase II supplemental sampling plan for collection of bedrock groundwater from the existing non-potable bedrock well will be prepared as an addendum to this UFP-QAPP.

- If Phase I analytical data do not indicate the need for contingent and/or supplemental sampling at an individual AOC/area or in a specific media, and if the following bullets do not indicate the need for additional investigation, then the RI report will be finalized.

- Does the shoreline reconnaissance survey conducted during the Phase I investigation indicate substantial habitat exists along the shoreline of Iona Island that could be a “sink” for contaminants and aquatic receptors are present in that area?

  - If the shoreline reconnaissance survey indicates that there is a direct or indirect pathway for site-related contaminants to reach the shoreline, and the shoreline provides sufficient suitable habitat for aquatic organisms which are present, and that sediment physical characteristics (e.g., fine grains, high TOC) are such that the site-related contaminants could adsorb onto the sediments thus creating a “sink” for contaminants, then the project team will discuss whether to conduct sediment sampling. If the project team agrees, then a Phase II supplemental sampling plan for establishment and sampling of sediment decision units (DUs) will be prepared as an addendum to this UFP-QAPP. Sediment results would be used in an aquatic human health and ecological risk assessment.

- Do additional data need to be collected to support development of the HHRA or Baseline Ecological Risk Assessment (BERA)?

  - If results of the RSLERA indicate potential ecological risks as defined by hazard quotients greater than 1.0 at an individual AOC/area or in a specific media, then additional data may be collected to refine the risk estimates and more accurately predict potential risks in the BERA.

  - If results of the RSLERA do not indicate any potential ecological risks because hazard quotients are below 1.0 at an individual AOC/area or in a specific media, then no additional data are needed.

  - If results of the HHRA indicate potential risks that could be refined or eliminated based on reducing uncertainty, then additional data may be collected to refine the exposure estimates.

  - If the results of the HHRA do not indicate any potential human health risks, then no additional data are needed.

- Do the results of the HHRA and BERA indicate unacceptable risk[6] to human health or the environment?

  - If the results of the HHRA and BERA indicate that COPC concentrations may pose a potential risk to human health and/or the environment at one or more of the 19 AOCs or in a specific media, then remedial alternatives will be developed to address those potential risks to move the FUDS forward through the remedial process and determine an appropriate final remedy for the site. It should be noted that only areas with

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[6] Unacceptable risks for ecological receptors are defined as BERA risks greater than a hazard quotient of 1.

unacceptable risks attributable to DoD activities require remedial action. Only those specific constituents identified as contaminants of concern (COCs) will be carried forward to the FS for development of remedial alternatives.

— If the RSLERA finds potential risk for any given receptor, and if additional data will be useful to further support development of the BERA, then additional data (e.g., toxicity testing and/or tissue analysis) will be conducted during Phase II.

In addition to the above decisions, additional investigation of HTRW AOCs may be conducted under Phase II pending the results of the MMRP RI field work and analysis (Table 1). For example, if buried drums are identified during the geophysical and/or intrusive investigation (particularly in AOC #16 - Area D Dumping Area), then appropriate sampling of drum contents and surrounding soils will be conducted as needed to evaluate drum contents and the potential for release to environmental media.

3. Identify the information inputs; identify information and supporting measurements needed to make the decisions and describe the source(s) of the information.

Existing investigative and analytical data for the 19 HTRW AOCs and 7 former buildings identified as having significant potential for explosive hazard are limited or unavailable. The majority of former buildings/structures, including the 7 former buildings identified as having a significant potential for explosive hazard, have not been previously investigated. Only two environmental investigations have occurred at the Iona Island Naval Ammunition Depot FUDS within the past 30 years (i.e., 1996 and in 2007 as detailed in Worksheet #10). The type of media sampled, sample locations, depths, and analyte lists differed between the two investigations. During the October 1996 Data Collection Activities (Greeley-Polhemus 1997), subsurface soil from eight AOCs was investigated from 0 to 2 ft bgs. Each sample was analyzed for SVOCs, and select locations were sampled for RCRA metals, VOCs, and PCBs. No other media were sampled. The 2007 Site Inspection targeted the 1903 Explosion MRS, with surface soil samples collected at 18 onsite locations across the 1903 explosion area for analysis of MC-related metals and explosives. Sediment sampling was limited to two onsite locations along the Hudson River shoreline. Groundwater samples were not collected during either investigation.

As a result, multi-media sampling is needed to fill existing data gaps to characterize the nature and extent of constituents that may have been released to the environment as a result of historical use and activities. The impacts of constituent concentrations will be evaluated by assessing potential exposure pathways and risks to human and ecological receptors.

Information inputs for the Phase I investigation include the following:

- Available historical data from previous studies including the 1996 Data Collection Activities (Greeley-Polhemus 1997) and 2007 Site Inspection (Alion 2008)

- Onsite and offsite/background surface soil (from 0-6 in. bgs) and shallow subsurface soil (from 6-36 in. bgs or refusal) data collected using Incremental Sampling Methodology (ISM)

- Information gathered during the shoreline reconnaissance survey

- Discrete sediment TOC and grain size analytical data

- Data validation and data quality assessment
- Applicable screening levels[7]

- Shoreline reconnaissance survey

- TOC and grain size data to characterize the nature of the shoreline sediments.

The results from the Phase I investigation will determine potential Phase II investigation activities, which will be presented in an addendum to this UFP-QAPP. Conducting sampling in an iterative way allows for focusing the more expensive tasks (e.g., well installation, tissue sampling, toxicity testing, and/or benthic community metrics) only to those receptors and areas found to have potential risk in the RSLERA. Phase II activities may include the following:

- Additional sampling of onsite surface soil and/or shallow and/or deep subsurface soil as necessary to refine impacts to these environmental media at any given AOC/area.

- Supplemental sampling of other environmental media (i.e., sediment, surface water, and/or overburden and bedrock groundwater) as necessary.

- Toxicity testing (i.e. tissue sampling, toxicity testing, and/or benthic community metrics) to further support development of the BERA.

4. Define the boundaries of the Study; specify conditions (i.e., time periods and spatial locations).

While this HTRW project RI addresses the 19 AOCs, previously detected COPCs in subsurface soil and metals in surface and/or subsurface soil during previous investigations (Table 10-5) indicate that these COPCs were likely mobilized beyond the footprint of the AOCs during demolition of former buildings/structures and reworking of surface and subsurface soil

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[7] Project screening levels are presented in Worksheet #15. Additional details on the screening values can be found in the Human Health and Ecological Risk Assessment Work Plans in Appendices D and E, respectively. The lowest EcoSSL is provided in Worksheet #15. The compilation of EcoSSLs is discussed in Section 2 of the Ecological Risk Assessment Work Plan, Appendix E. The full list of EcoSSLs is provided in Attachment 4 of the Ecological Risk Assessment Work Plan.

(Tables 10-1 and 10-2). Therefore, the area targeted for investigation has been expanded beyond the footprint of former structures/buildings to encompass areas where elevated metals and/or PAHs were previously detected in surface and/or subsurface soil at concentrations above both background and applicable screening levels (Figure 11-1). The Phase I HTRW investigation area covers the majority of the former operational area. This is the most likely area expected to be used by human receptors (site workers, researchers, etc.). Sampling environmental media throughout the former operational area, rather than at each individual AOC, will allow for a complete delineation of metals PAHs in soil. Furthermore, because human and ecological receptors are not confined to artificial AOC boundaries and could be exposed to soil throughout the entire area, the sampling design represents a more accurate, site-specific exposure area to assess potential exposure and risk at the Iona Island Naval Ammunition Depot FUDS.

Several metals are naturally occurring in soil. In addition, PAHs are also present in the environment from both natural sources (e.g., forest fires) and human activities (e.g., petroleum products). Therefore, background soil sampling will be conducted to establish regional background metal and PAH concentration ranges in surface and subsurface soil. Eight non-contiguous background sampling areas have been identified within Bear Mountain State Park. These areas are outside the influence of the Iona Island Naval Ammunition Depot FUDS. Based on soil maps generated using soil data from the Soil Survey of Rockland County, New York, soil within the background areas is the same as the soil unit mapped within the Phase I investigation area (Chatfield rock outcrop complex, rolling) (Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture 2018). Therefore, soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, soil reaction, and other features are expected to be similar between the Phase I investigation area and the background locations.

The eastern (Hudson River) and western (Iona Marsh) shorelines of Iona Island and the eastern and western sides of the active River Subdivision (CSX Transportation) railroad tracks will be explored during the Phase I investigation to gain a better understanding of migration pathways from Iona Island to the shoreline, as well as depositional environments and receptor resources at the shoreline, and to guide development of the Phase II investigation (if needed). The shoreline reconnaissance areas are presented on Figure 11-2. As discussed under Step 2 of this 7-step DQO process, should the results of the Phase I investigation indicate source-pathway-receptor interaction, including a pathway from Iona Island to the shoreline, potential habitat and/or receptors, and if physical parameters indicate a sink of contaminants, then sediments will be collected for chemical parameters as part of the Phase II investigation. Sediment sampling conducted as part of Phase II to evaluate potential site impacts to the Iona Island shoreline would occur at locations along the shoreline that are representative of significant habitat, could present a potential exposure pathway to human or ecological receptors, and could potentially be impacted by site-related contaminants. An addendum to this UFP-QAPP detailing the sampling and analysis for sediment chemistry will be submitted should a Phase II for sediment sampling be necessary.

The footprints/locations of seven additional former buildings identified as having a significant potential for explosive hazard are being included in this HTRW RI pending direction from the contracting offer. These buildings were identified as locations where filling or possible spilling of explosive-containing materials could have occurred. Information regarding utilities, piping, building sumps, or other additional release pathways for explosives at these locations is not available. While the buildings have been demolished and building slabs have been removed, there is a potential for residual explosives material to be in soil and to present a potential explosives hazard. The former buildings have not been previously evaluated. The buildings and slabs have been removed, and soil has been reworked. Sampling at the locations/footprints of these former buildings is proposed to confirm the presence/absence of explosives constituents in soil and to evaluate potential exposure risk from remaining explosives residues to human and ecological receptors.

5. Develop the analytic approach.

The following presents the approach for the Phase I investigation. Additional sampling/investigation phases (i.e., Phase II) if deemed necessary, will be presented in an addendum to this UFP-QAPP.

Prior to field sampling, an eQAPP within FUDSChem will be created; the eQAPP will be fully compliant with the project UFP-QAPP, incorporating methods, sample types, and quality specifications (Limit of Detection [LOD], Limit of Quantitation [LOQ], Holding Time, QC Sample Acceptance Limits, etc.).

As presented in Table 10-5, previous investigations reported widespread detections of metals and PAHs in surface soil and/or subsurface soil throughout the site (Figure 11-1). Therefore, surface soil and subsurface soil samples will be collected to evaluate the nature and extent of these COPCs, impacts related to former DoD activities, and evaluate potential risk to human and ecological receptors. In addition, AOC-specific COPCs may be present in environmental media, including explosives residues and PCBs at AOC #16 – Area D (Dumping area), and PCBs at AOC #19 - three former transformer locations. Surface soil samples (from 0-6 in. bgs) and shallow subsurface soil samples ((from 6-36 in. bgs or refusal) will be collected to evaluate these AOC-specific COPCs.

The former AST locations (AOC #13 - Area A (footprint of one former fuel oil AST located near former Building 233), AOC #14 - Area B (footprint of one former fuel oil AST located near Dock 131), and AOC #15 – Area C (footprints of two former fuel oil ASTs located near former Building 417) were not included in the CONHTRW project and have not been formerly closed out. Subsurface soil samples at AOC #14 - Area B (one former fuel oil AST located near Dock 131), and AOC #15 - Area C (two former fuel oil ASTs located near former Building 417) were collected for analysis of VOCs and SVOCs during the 1996 Data Collection Activities (Greeley-Polhemus 1997) (Figure 10-2; Table 10-1). VOCs related to site activities were not detected in subsurface soil at these locations, and, except for PAHs at AOC #15 - Area C, SVOCs related to site activities were not detected in subsurface soil at these locations at concentrations above EPA screening criteria. Soil at AOC #13 - Area A (footprint of one former fuel oil AST located near former Building 233) was not previously investigated.

Analytical parameters for the former AST locations were selected based on site history/previous investigation results and in accordance with the following NYSDEC policy and guidance: Division of Environmental Remediation (DER)-10 – Technical Guidance for Site Investigation and Remediation, Program Policy (NYSDEC, 2010a); Final Commissioner Policy (CP)-51 / Soil Cleanup Guidance, “Table 3 – Soil Cleanup Levels for Fuel Oil Contaminated Soil” (NYSDEC, 2010b); and, DER “Frequently Asked Questions (FAQs) on New York's Oil Spill Response & Remediation Program” (NYSDEC, 2018). These analytical parameters include Method 8260 VOCs, plus the ten highest Tentatively Identified Compounds (TICs) for the volatiles, and Method 8270 SVOCs, plus 20 highest TICs for the semivolatiles. Based on the chemical properties of VOCs and the time elapsed since potential releases, active physical processes such as diffusion and volatilization of VOCs would not be considered significant contributors to contaminant migration and as such, TCL VOCs are not included as preliminary COPCs. However, as BTEX is a common constituent in fuel oil, BTEX will be analyzed in soil at AOCs encompassing the footprints of former ASTs. As PAHs were previously reported in soil at concentrations above EPA residential soil RSLs at AOC #15 - Area C (benzo(a)pyrene) and ecological SSLs (fluoranthene), PAHs will be analyzed in soil at former AST locations.

A shoreline reconnaissance survey will be conducted to identify the presence/absence of sufficient habitat and aquatic receptors (Figure 11-2). Results will be used to evaluate whether or not sediment chemistry data should be collected as part of the Phase II investigation.

The seven additional former buildings identified having a significant potential for explosive hazard have not been previously investigated. The buildings and slabs have been removed, and soil has been reworked. The presence/absence of explosives residue in soil and potential exposure risk associated with these former building locations is unknown. Pending direction of the contracting officer, surface soil samples will be collected to confirm the presence/absence of explosives constituents in soil and to evaluate potential exposure risk from remaining explosives residues to human and ecological receptors.

Surface and/or shallow subsurface soil samples collected during the Phase I HTRW RI will be submitted for laboratory and onsite analysis of one or more of the following parameters:

- TAL metals by EPA Methods 6010C/6020A
- Mercury by EPA Methods 7471B
- PAHs by EPA Method 8270D selected ion monitoring (SIM)
- BTEX by EPA Method 8260B

  Aroclor PCBs by EPA Method 8082A

- Explosives residues by EPA Method 8330B

- Soil pH via field test kit

Sediment samples collected during the Phase I HTRW RI will be submitted for laboratory and onsite analysis of one or more of the following parameters:

- TOC by Walkley-Black

- Grain size by ASTM D422.

Laboratory analytical services for soil samples (TAL metals, BTEX, Aroclor PCBs, and explosives residues analyses) will be provided by TestAmerica. Laboratory analytical services for sediment samples (TOC and grain size analyses) will be subcontracted by TestAmerica to Kahtadin Analytical Services, LLC.

6. Specify performance or acceptance criteria.

This UFP-QAPP provides a description of the data analysis and QA/QC measurements to be conducted as part of the HTRW project RI. The QA/QC measures are used to evaluate and document the quality of the data that are obtained, which will reduce the likelihood that the planned approach could result in a failure to achieve the project objectives. Analytical performance or measurement criteria are described in Worksheets #12 and #28.

Laboratory analytical services will be provided by DoD-certified laboratories, TestAmerica and Kahtadin Analytical Services, LLC. A copy of the DoD Environmental Laboratory Accreditation Program (ELAP) certification for each laboratory is included in Appendix F. TestAmerica laboratory is also certified in ISM sample processing and analyses. Laboratory analyses will be conducted in accordance with the DoD QSM Version 5.2 (December 2018). Data will be validated as described in Worksheets #34 through #36, and data usability will be assessed as described in Worksheet #37. A discussion of acceptable limits for decision errors related to data screening is presented under the heading “How good do the data need to be to support the environmental decision,” below.

7. Develop the plan for obtaining data; evaluate the results of the previous steps and develop the most resource-efficient design for data collection.

Details pertaining to the sampling plan are provided in subsequent worksheets as follows:

- Worksheet #14 and #16 provides the project tasks and schedule

- Worksheet #17 provides the sample design and rationale

- Worksheet #18 provides additional detail on sample locations, media, suite of analytes, and sample collection tools

- Worksheet #20 provides information on QC samples
- Worksheets #26 through #28 in the UFP-QAPP provide specific detail on the analytical requirements.

Who will use the data?

The RI data will primarily be used by EA and USACE in conjunction with NYSDEC and PIPC to further characterize the Iona Island Naval Ammunition Depot FUDS and for decision making on the path forward.

What will the data be used for?

The data generated during the Phase I investigation will be used to update the human health and ecological CSMs and eliminate data gaps. Analytical and shoreline reconnaissance survey data will be evaluated to support decision making at the site, including the necessity for further investigation during Phase II, following the decision statements presented under Step 2 of the 7- step DQO development process.

Available analytical results collected during the Phase I investigation (and subsequent phases, if conducted) will be used to evaluate the presence/absence of COPCs in environmental media associated with the 19 AOCs and 7 former buildings identified as having a significant potential for explosive hazard and which have not been previously investigated; the nature and extent of COPCs associated with the 19 AOCs in environmental media; and the potential exposure pathways and risk to human and ecological receptors. The data will be used to prepare a HHRA and ERA to evaluate whether concentrations of constituents in environmental media pose unacceptable risks to human and/or ecological receptors at an individual AOC/area or in a specific media. If potential risks exist to human or ecological receptors, remedial alternatives will be developed and evaluated for a given AOC/area and/or specific media.

The analytical data obtained as a result of the environmental investigation activities will be compared to background concentrations obtained during the HTRW RI (TAL metals and PAHs), and applicable EPA screening levels in accordance with CERCLA as follows. Consideration will be given to other screening values through the CERCLA ARAR process with the input of Counsel:

- EPA residential and industrial RSLs for soil (most recent version at the time of report preparation) (note that a deed restriction is in place noting that there is to be no residential development at the site (USACE 1995); however EPA Residential soil RSLs are included to assess for children receptors including site visitation for nature walks and potential camping)
- EPA Region 4 EcoSSLs (March 2018) and screening values presented in Attachment 4 to the Ecological Risk Assessment Work Plan (Appendix E).

Contaminants with concentrations greater than their respective screening values and background values will be further evaluated in the HHRA and SLERA. Details on conducting the human health and ecological risk assessments can be found in Appendices D and E, respectively.

EPA does not have overall guidance values for sediment. Therefore, should sediment sampling for COPCs be conducted during the Phase II investigation, EPA regional values or private literature articles will be used to develop sediment screening levels in the addendum to this UFP-QAPP.

What type of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?

Data needs for the Phase I investigation are summarized in Worksheet #17, which includes sample matrices, target analytes/analytical groups, laboratory methods, and sampling techniques. A summary of data needs is provided below.

Surface soil (from 0-6 in. bgs) and shallow subsurface soil (from 6-36 in. bgs or refusal) COPC data will be collected during Phase I to evaluate previously identified COPC concentrations in environmental media (Table 10-5); and soil BTEX, PCB, and explosives data will be collected to evaluate HTRW AOC/area-specific COPCs. In addition, surface soil explosives data will be collected to evaluate the presence or absence of explosives residues and associated exposure risk associated with the seven former buildings identified as having a significant potential for explosive hazard. The Phase I investigation area is presented in Figure 11-1.

A Phase I shoreline reconnaissance survey will be conducted to evaluate the source-pathway-receptor interaction, including the presence/absence of pathways from Iona Island to the shoreline, the types of depositional environments, and presence/absence of sufficient habitat and aquatic receptors. TOC and grain size analytical data will be collected to evaluate the physical characteristics of the sediment, and to evaluate whether sediments could be a potential “sink” for site-related contaminants. The shoreline reconnaissance survey areas are presented in Figure 11-2.

If additional sampling is necessary to evaluate the nature and extent of contaminants, an addendum to the this UFP-QAPP will detail the Phase II data collection/investigation.

Incremental Surface and Shallow Subsurface Soil Sampling

ISM will be used to assess COPCs in surface and subsurface soil across the Phase I HTRW investigation area and at the 7 former buildings identified as having a significant potential for explosive hazard (pending direction of contracting offer). As documented by the Interstate Technology Regulatory Council (ITRC) ISM guidance document (ITRC 2012), “ISM is a structured composite sampling and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling.” The “volume of soil targeted for sampling” is called a DU or sampling unit (SU).

The main reason for selecting ISM over discrete soil sampling is that ISM addresses the issue of potential "hot spots," and reduces the errors that could occur from traditional discrete sampling, including missing areas of high concentrations (if no samples are located in that area) or overestimating the nature of constituent concentrations by assuming a single high detection is representative of a much larger area than truly exists (ITRC 2012).

The primary source of error associated with discrete sampling is the extreme variability of the soil matrix. When contamination is present as distinct grains/particles, such as lead paint chips, results can be hit-or-miss depending on the presence/absence of the particle in the discrete sample. Even at an undisturbed site, there is a high variability of constituent concentrations. Concentrations varying by orders of magnitude can exist immediately adjacent to each other, and if the location of a discrete sample misses this variability, this could lead to an incorrect estimate of the mean concentrations. Within the risk assessment process, estimates of the reasonable maximum exposure are quantified using the 95th percentile upper confidence limit of the site discrete data. If the data collected fail to capture the true constituent concentration distribution due to soil variability, then the reasonable maximum exposure may be biased. Further complicating this problem at Iona Island Naval Ammunition Depot FUDS is the removal of buildings and reworking of soil. Constituents associated with a given AOC may have been moved to locations far from their original source. Elevated metal concentrations and widespread and sporadic PAH concentrations were reported in soil samples collected from within the former operational area in previous investigations.

Establishment of Decision Units (DUs)

ISM is sufficiently robust such that, if the DUs have been appropriately designed, elevated concentrations will be detected, and because the study is phased, DUs with elevated concentrations that may result in potential risks can and will be examined in greater detail during additional phases of work, as necessary.

A DU is defined as the smallest unit about which a decision will be made. The size and depths for appropriate DUs are dependent upon the types of decisions that need to be made. For this RI there are many types of decisions that need to be made, and consequently different types of DUs. Establishing DUs must also consider depth, and for Iona Island both surface (0-6 in. bgs) and shallow subsurface (6-36 in. bgs) DUs will be sampled.

The goal of the RI is to determine extent of contamination and to determine if there is an unreasonable exposure risk to receptors from site COCs. Nineteen HTRW AOCs addressing 26 former buildings/structures have been identified as potential source areas where contaminants related former DoD activities may have originated and are detailed in Table 10-5.

Little is known about sources and release of contaminants at Iona Island. The majority of the former buildings/structures have not been previously investigated, and information on these buildings is limited (i.e., usage is based on building titles presented in the ASR [USACE 1998] and HPA [USAGC] 2018). DUs have been established in the area where these features existed to determine if they served as a source of contaminants to the environment (Figures 11-4 and 11-5).

The demolition of former buildings/structures and reworking of soil may have mixed surface and subsurface soil throughout and across much of the former operational areas. For these general areas, 19 DUs sized at approximately 1-acre each (200 ft x 200 ft; DU-1 through DU-19) have been established to address contamination originating from 15 of the 19 HTRW AOCs (i.e., AOCs #1 through 12 [former HTRW buildings], AOC #16 – Area D [Dumping Area; further discussed below], AOC #17 – Area E [Former Coal Trestle and Storage Area near Former Building 410], and AOC #18 – Area F [Former Coal Storage Area near Former Building 215]), and locations where elevated concentrations of COPCs were detected in soil during previous investigations. The remaining AOCs (i.e., AOCs #13, 14, and 15 [which address four former fuel oil ASTs] and AOC #19 [which addresses three former transformer locations]) are discussed below (Figure 11-4). Seven additional approximately 1-acre (e.g., 200 x 200 ft or 100 x 400 ft) sized DUs (EXDU-1 through EXDU-7) have been established to address potential explosives contaminants at the seven former buildings identified as having a significant potential for explosive hazard (Figure 11-5). The approximately 1-acre size of these DUs was established for two reasons: 1) the incremental sampling procedure has been optimized based on this size DU and has been demonstrated to be statistically valid (ITRC 2007) and 2) this represents the smallest area for which human or ecological receptors may be exposed. The American robin, which will be representing the vermivorous bird guild in the ecological risk assessment, has an extremely small foraging range that is essentially equivalent to 1-acre. Likewise, a potential researcher at the area may only be exposed to an acre. AOC #16 – Area D (Dumping Area) could represent a source of contaminants to the environment from materials placed there, and three surface and subsurface 1-acre (200 ft x 200 ft) DUs (DU-17 through DU-19) have been established in the former Dumping Area to determine if it is a source of contaminants.

As discussed under Step 2 of the 7-step DQO process, one of the goals of this RI is to evaluate the nature and extent of potential impacts associated with former structures and/or operations at the Iona Island Naval Ammunition Depot FUDS. In order to accomplish that goal for significantly smaller structures identified as HTRW AOCs (i.e., AOCs #13, 14, and 15 [which address four former fuel oil ASTs] and AOC #19 [which addresses three former transformer locations]),6 smaller sized at 60 ft x 60 ft DUs (DU-20 through DU-25) were established around these structures to evaluate presence/absence of COPCs at these locations. If analytical results from one or more of these smaller DUs indicate presence of elevated concentrations of COPCs, then larger 200 ft x 200 ft DUs would be established over the smaller DU(s) and the surface soil will be sampled during Phase II to generate exposure concentrations that will be used in the risk assessments.

Incremental sampling allows for simple area weighting of exposure concentrations for each DU. The overall concentration for the larger DU is calculated by area weighting the smaller DU with the larger DU. Similarly, concentrations in multiple DUs (e.g., for human or ecological receptors that have larger exposure areas) can be averaged together to generate the appropriate exposure concentration for that particular receptor.

The concept of DUs fits readily into establishing exposure point concentrations for both human and ecological receptors in a risk assessment. For example, in general, weighted means will be calculated when a volume of soil is stratified into surface and subsurface DUs that are independently sampled for estimates of exposure for a construction worker; however, a site recreator or researcher is unlikely to be exposed to subsurface soil so exposure will be limited to surface soil for these receptors. As noted above, the American robin has a small foraging range, but many ecological receptors have larger foraging ranges. The red-tailed hawk, which is representative of the predatory bird guild, has a minimum foraging range of 500 acres. This range likely encompasses the entire Iona Island FUDS. Concentrations of contaminants in incremental samples represent the upper 95th percentile of concentration within that given DU, and concentrations from multiple DUs can be averaged and area-normalized (using ITRC calculators) to estimate exposure to the larger habitat range receptors. Additional details on how exposure point concentrations will be calculated for the SLERA can be found in Section 2.3.1 of the Ecological Risk Assessment Work Plan presented in Appendix E.

Both metals and PAHs can be present from natural or man-made sources not related to former DoD activities. Background values calculated from discrete samples cannot be compared directly to ISM DU results; therefore, eight non-contiguous background area DUs (BADU-1 through BADU-8), each approximately 1-acre in size (200 x 200 ft) and located in the same soil type as the Phase I investigation area (Chatfield-rock outcrop complex, rolling) will be sampled for surface and subsurface soil for comparison to measured site concentrations (Figure 11-3). These DUs will be located in areas with similar soil conditions as that encountered in DUs established at Iona Island. Background DU locations are presented in Figure 11-3; however, locations may be refined based on soil conditions encountered during the Phase I field investigation.

Incremental Soil Sample Collection

Incremental soil samples are prepared by collecting multiple increments of soil from a specified DU and physically combining these increments into a single sample, referred to as the “incremental sample.” Within each onsite and background DU, separate incremental samples will be collected that are representative of surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) to investigate potential risk to ecological and human receptors.

The ITRC ISM guidance document (ITRC 2012) states that a minimum of 30 to 50 increments is sufficient for most DUs. USEPA SW-846 Method 8330B recommends collecting 30 or more evenly spaced increments to build a sample with a total mass greater than 1 kg. Therefore, 30 soil increments will be collected at each of the smaller 60 ft x 60 ft DUs (i.e. DU-20 through DU-25) for each representative soil depth (i.e., 30 surface soil increments collected from 0 to 6 in., 30 subsurface soil increments collected from 6 to 36 in. bgs, and 30 subsurface increments collected from greater than 36 in. bgs [if encountered]). At the larger approximately 1-acre sized (200 x 200 ft or 100 x 400 ft) DUs (i.e. DU-1 through DU-19 and EXDU-1 through EXDU-7), and the eight background DUs (BADU-1 through BADU-8), the number of increments for each representative soil depth will be increased to 50. The use of 50 increments is sufficiently representative to estimate the reasonable unbiased estimate of concentrations across the DU, whether surface or subsurface soil, as recommended in ITRC (2012).

ITRC (2012) notes that ISM requires randomness. Therefore, surface soil increments locations and subsurface soil boring and increment locations will be randomly determined prior to field mobilization using the methods presented below and further detailed in Worksheet #14.

For surface soil, increment locations for each DU will be randomly determined for each DU using the random sampling within a grid approach (stratified random sampling; USEPA 1995b). With random sampling within a grid, the DU is overlain with a sampling grid and soil increments are collected from random locations determined in each grid cell. The 60 x 60 ft DUs will each be divided into 30 grid cells, each approximately 10 x 12 ft in area, and the approximately 1-acre sized (200 x 200 ft or 100 x 400 ft) DUs will each be divided 50 grid cells, each approximately 20 ft by 40 ft in area. The location of the increments sample within each cell (to be located via data collection pad or flagging the DU perimeter) will be randomly selected (i.e., typically varying between the four corners or center of each grid box) to generate an unbiased estimate of the mean and variance. Surface soil increments will be collected using plungers capable of collecting soil equivalent to 20 grams in volume.

For subsurface soil, three randomly located hand-auger soil borings will be advanced in each of the 60 ft x 60 ft DUs (i.e. DU-20 through DU-25), and five randomly located hand-auger soil borings will be advanced at each of the approximately 1-acre sized (200 x 200 ft) DUs (i.e., DU-1 through DU-19) and background DUs (BADU-1 through BADU-8)[8]. An onsite geologist will log soil core intervals, soil core recovery, and geological characteristics (color, moisture, texture, grain size, sorting, lithology, etc.). Geological characteristic data will be evaluated to determine if different background locations need to be selected (i.e., if soil onsite differs from background soil), and to evaluate the potential for overburden groundwater sampling during Phase II (i.e., if saturated soils are encountered).

Ten individual soil increments will be collected from each soil boring, producing a total of 30 subsurface soil increments for each 60 ft x 60 ft DU and 50 subsurface soil increments for each of the approximately 1-acre sized DU. 10 increments will come from each soil boring, and with subsurface soil sample intervals of specified lengths (6 in. to 36 in.). Sample increments depths within each interval will be randomly generated for each boring, starting from a random depth within the subsurface sampling interval. The first increment will be collected from this random starting depth. The other nine increments will be collected at given intervals below the random starting depth to cover the entire length of the boring, pending the total depth of the boring (i.e. if bedrock is encountered above 36 in. bgs). Since the starting depth for increment collection is random, the other depths will be random. Adjacent soil borings will be advanced as needed to collect enough increments for each increment. If there is no or shallow subsurface soil is limited

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[8] Subsurface soil is not being collected from approximately 1-acre sized DUs (200 x 200 ft or 100 x 400 ft) established over the footprints/locations of the seven additional former buildings identified as having a significant potential for explosive hazard.

to 12 inches bgs in the DU, it will be documented in the field logbook and no subsurface samples will be collected for the DU. The field crew will attempt to collect subsurface soil at a minimum of five locations per DU to determine if there is shallow subsurface soil between 12 and 36 inches bgs and if not present they will notify the EA project manager who in turn will notify the USACE and discuss path forward.

Surface and subsurface soil incremental samples may be submitted for one or more of the analysis for the COPCs depending on site history/former use and previous investigation results as presented in Worksheet #10 and Table 10-5. Worksheet #17 details the specific analyses at each DU.

Triplicate Sampling

ISM data approximate an estimate of the 95% upper confidence limit of the mean by using increments in the field (30-50 for this study) and further integration in the laboratory by the selection of 30 increments for analysis once the samples have been dried, sieved, and milled. The collection of replicates from a DU estimates the total variance associated within the DU. It takes a minimum of three replicates to calculate the 95% upper confidence limit of the mean using either the student-t or Chebychev statistical tests. Therefore, replicate samples will consist of triplicate samples, including the initial ISM sample plus two additional samples. Triplicate samples will be collected at each onsite DU. Triplicate samples will not be collected at offsite background DUs (BADU-1 through BADU-8).

Incremental Surface and Subsurface Soil Sampling Background Comparison

The background comparison will be performed consistent with Decision Mechanism 4, Section 7.2.4 of ITRC (2012). As discussed in this guidance, because of the special characteristics associated with incremental sampling (low variance, small sample sizes), background comparison requires careful consideration. For this project, eight independent background DUs (BADU-1 through BADU-8) will be sampled (both surface and subsurface soil). As a result, standard background comparison techniques will be performed on the data including:

1. Quantile-Quantile plots to examine for potential outliers
2. Results from the site DUs will be compared to the background 95% upper prediction limit (UPL) based on the appropriate number of future/independent site samples (k=3 for DUs with triplicates). The 95% UPL will be computed using EPA's ProUCL software (EPA 2015a), taking into account the distribution of the detected data. If the background data contains non-detect results, then the Kaplan-Meier method will be used to compute the sample mean and variance. Individual IS results will be compared to the 95% UPL, and if site concentrations exceed the UPL, it will be determined that site concentrations exceed background.

Due to the robustness of the background dataset, statistics such as Upper Tolerance Limits or Upper Predictive Limits will be calculated. Additional information is presented in Worksheet #14.

Shoreline Reconnaissance Survey

Four areas have been identified for inclusion in the Phase I Shoreline Reconnaissance Survey, including the Hudson River Shoreline (Recon Area 1), the Iona Marsh Shoreline (Recon Area 2), the western FUDS boundary between Iona and Round Island (Recon Area 3), and the eastern and western sides of the active River Subdivision (CSX Transportation) railroad tracks (Recon Area 4). The survey areas are presented on Figure 11-2.

The extent of the reconnaissance areas along the Hudson River Shoreline (Recon Area 1) and the Iona Marsh Shoreline (Recon Area 2), was based off of the location of former buildings/structures and site topography, which would influence the direction of overland flow/transport of COPCs from Iona Island to the shoreline. The western FUDS boundary between Iona and Round Island is considered a separate recon area to evaluate potential overland transport from AOC #16 - Area D (Dumping Area) and the presence of potential transport pathways (drainage swales, channels, outfalls, etc.) in this area. The FUDS boundary is being evaluated in this area, rather than the Iona Marsh shoreline, as a non-DOD fill area is located southwest of the FUDs boundary along the Iona marsh shoreline; this area was filled by PIPC following transfer of the FUDS from the Navy in 1965, and therefore, is not subject to investigation under the FUDS program. The eastern and western sides of the active River Subdivision (CSX Transportation) railroad tracks is being evaluated in order to identify potential pathways (i.e., conduits, channels, etc.) that could allow for overland transport from Iona Island to the shoreline beneath the railroad. If no pathways are identified, then the railroad, which is an elevated area between Iona Island and the shoreline, likely serves as a barrier to overland transport from Iona Island to the shoreline.

The Phase I Shoreline Reconnaissance Survey in Recon Areas 1 through 4 will consist of an exploration conducted by EA field biologists on foot during low tide. In addition, reconnaissance along the shoreline in Recon Areas 1 and 2 will include a survey by boat during high tide. The reconnaissance will be conducted to 1) to identify potential pathways (i.e., channels, conduits, swales, outfalls), and/or barriers to overland flow and contaminant transport from Iona Island to the shoreline; 2) evaluate the benthos and determine if it provides suitable habitat for aquatic organisms; 3) document any observed aquatic receptors; and 4) collect up to 6 discrete sediment samples for analysis of grain size and TOC that will be used to screen physical characteristic of sediment and evaluate whether sediments could be a potential “sink” for site-related contaminants. Sediment samples will be collected from a depth of 0-6 in. using appropriate sampling equipment (disposable scoops or decontaminated stainless steel scoops/spoons).

How good do the data need to be to support the environmental decision?

The data must be good enough to support two important decisions, 1) are site concentrations greater than risk-associated screening concentrations (action levels) and 2) are site concentrations greater than background concentrations. Background decisions that will be made are discussed above in “Incremental Surface and Subsurface Soil Sampling Background Comparison”. To address the first decision the data generated from DUs at Iona Island will be used to determine if site concentrations exceed human health and ecological risk screening levels to determine if they may be site Contaminants of Potential Concern (COPCs) that require additional investigation for nature, extent, and risk. Decision Mechanism No. 3, Comparison of the 95% UCL on the Mean of Replicate Data from the DU to an Action Level from ITRC (2012) will be used to identify COPCs at the site. As noted in the call-out box for this decision mechanism "Comparison of the 95% UCL on the mean of replicate ISM results is most useful when the chance of underestimating the true mean must be minimized." DUs will be sampled in triplicate and the 95% UCL estimated using the calculator included with ITRC (2012). The 95% UCL will be directly compared with appropriate risk screening values (found in WS No. 15), and if it is larger the chemical should be identified as a COPC that may deserve additional investigation with respect to background, fate, transport and risk. The use of the 95% UCL for this decision is consistent with ISTM (2012) guidance and sufficiently conservative that chemicals will not be missed as COPCs.

Sources of Error

Total study error potential is equally attributable to sampling and measurement error because of the steps and sample volume associated with the planned sample collection and analysis. Successfully managing the magnitude of total study error is the result of understanding the error sources, generating an appropriate sampling design, and choosing accurate measurement techniques.

The sources of decision error for surface and shallow subsurface soil data are equally attributable to sampling or measurement error. This conclusion is based upon review of the sampling and analysis strategy. The sampling design is straightforward, and the analysis will be performed using the services of a DoD ELAP accredited laboratory with standard methods.

The quality of sampling and analysis must be at a level that results in representative, precise, and reproducible data. The data generated will be sufficient for the intended use. Data of sufficient quality for use in evaluation and decision making in this project will be defined as data that are produced following the specified SOPs and meeting the established criteria in this UFP-QAPP, including precision, accuracy, comparability, representativeness, completeness, and sensitivity.

The data need to be of adequate quality to make the decisions established for this site. The purpose of this is to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels. Worksheet #12 presents the measurement performance criteria applicable to the analytical sampling associated with this effort.

How much data are needed (number of samples for each analytical group, matrix, and concentration)?

The number of samples for each analytical group and matrix is presented in Worksheet #18. Field QC samples intended to provide an indication of the consistency of sample collection and analyses are listed on Worksheet #20 and further detailed below.

Incremental Surface and Subsurface Soil Sampling

Nineteen onsite surface and subsurface soil DUs sized at approximately 1 acre (200 x 200 ft) have been established to address HTRW AOCs and areas where previous investigations reported elevated concentrations of COPCs (DU-1 through DU-19). Eight background DUs sized at approximately 1-acre (200 x 200 ft) have been established to evaluate background concentrations of metals and PAHs (Figure 11-4) (BADU-1 through BADU-8). Surface soil samples will be collected from 0-6 in. bgs within each DU. Shallow subsurface soil samples will be collected from 6-36 in. bgs. Surface and shallow subsurface soil samples collected the 19 onsite approximately 1-acre sized DUs [DU-1 through DU-19] and each of the 8 offsite background approximately 1-acre sized DUs [BADU-1 through BADU-8]) will be analyzed for the following parameters as presented in Table 17-2 and Worksheet #18:

- TAL metals by EPA Method 6010C/6020A
- Mercury by EPA Method 7471B
- PAHs by EPA Method 8270D SIM
- Soil pH by field test kit.

In addition to the above parameters, surface and shallow subsurface soil samples collected at three of the approximately 1-acre sized (200 x 200 ft) DUs established to address AOC #16 – Area D (Dumping area; DU-17, DU-18, and DU-19) will be analyzed for the following parameters (Table 17-2 and Worksheet #18):

- PCBs by EPA Method 8082A
- Explosives residues by Method 8330B.

Three smaller 60 x 60 ft DUs have been established to address the AOCs #13, #14, and #15 (locations/footprints of four former fuel oil ASTs; DU-20, DU-21; and DU-22). Surface and shallow subsurface soil samples collected from these three DUs will be analyzed for the following parameters (Table 17-2 and Worksheet #18):

- BTEX by EPA Method 8260B (subsurface soil only)
- PAHs by EPA Method 8270D SIM (surface and subsurface soil)
- Soil pH by field test kit (each 60 x 60 ft DU) (surface and subsurface soil)
- Soil pH by field test kit.

Three smaller 60 x 60 ft DUs have been established to address AOC #19 (three former transformer locations; DU-23, DU-24, and DU-25). Surface and shallow subsurface soil samples from these three DUs will be analyzed for the following parameters (Table 17-2 and Worksheet #18):

- PCBs by EPA Method 8082A
- Soil pH by field test kit.

Seven approximately 1-acre sized DUs have been established at former buildings identified as having a significant potential for explosive hazard. (EXDU-1 through EXDU-7) Surface soil samples from these seven DUs will be analyzed for explosives residues by Method 8330B (pending direction of contracting offer) (Table 17-2 and Worksheet #18).

Field QC samples for surface and subsurface soil incremental samples will include methanol field and trip blanks for BTEX samples. The analytical laboratory will also perform matrix spike/matrix spike duplicates (MS/MSD) on soil samples at a rate of 1 per 20 samples as required by the analytical method.

Shoreline Reconnaissance Survey

During the shoreline reconnaissance survey, 6 discrete sediment grab samples will be collected for analysis of the following parameters (3 samples from the Hudson River shoreline [Recon Area 1] and 3 samples from the Iona Marsh shoreline [Recon area 2]):

- TOC by Walkley Black
- Grain size by ASTM D422.

Field QC samples will not be collected for discrete sediment samples.

Who will collect and generate the data?

EA field personnel, including a UXO technician for avoidance, will conduct the environmental sampling. EA field geologists will collect environmental samples, and EA field biologists will conduct the shoreline reconnaissance survey.

Surface and subsurface soil samples will be analyzed by TestAmerica. Sediment samples will be analyzed by Kahtadin Analytical Services, LLC. The analytical laboratories will generate portable document format (PDF) laboratory reports and upload Stage 2A staged electronic data deliverables (SEDDs) to FUDSChem.

Where, when, and how should the data be collected/generated?

Where: The Phase I investigation area is presented in Figure 11-1. The areas to be investigated during the shoreline reconnaissance survey are presented in Figure 11-2. Onsite surface and shallow subsurface soil DUs are presented on Figures 11-4 and 11-5. Additional detail, including DU coordinate information, is provided in Worksheet #18.

While the investigation area is generally accessible, features may result in constraints on individual sampling locations. Investigation constraints for surface and subsurface soil include the presence of roads/pavement, former building foundations, currently existing buildings, exposed bedrock, break walls, trees/vegetation, etc. Phase I sampling locations will be adjusted as necessary based on site observations and field conditions.

When: The Phase I field investigation is scheduled to commence in Spring 2020. The project schedule is presented in Worksheets #14 and #16.

How: Further detail on the field tasks and methods is presented in Worksheet #14. Analytical sampling SOPs are listed in Worksheet #23 and provided in Appendix G.

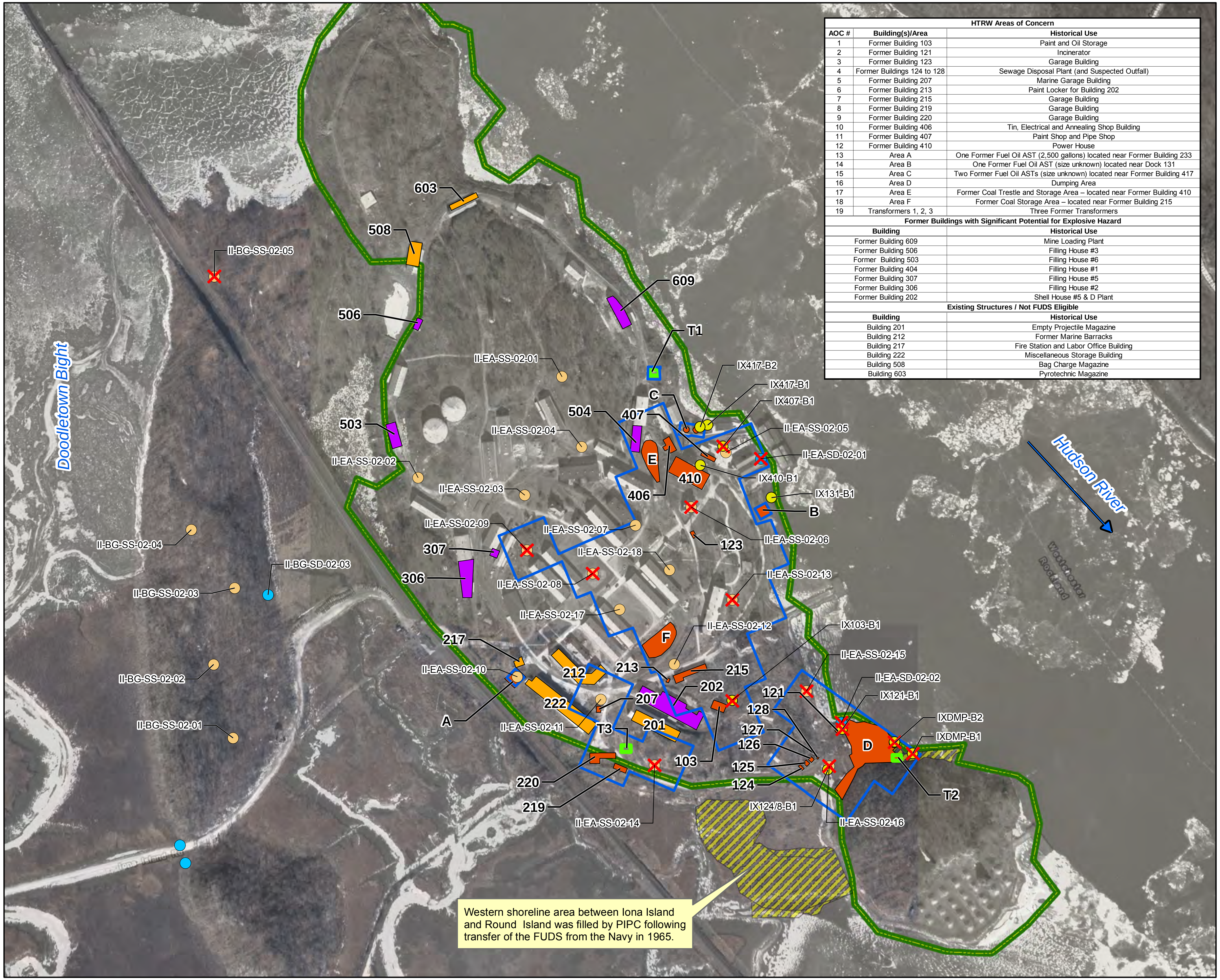
How will the data be reported?

Once a SEDD is successfully uploaded and certified by the analytical laboratory in FUDSChem, an Automated Data Review (ADR) process will be automatically initiated. The ADR will perform a Stage 2A data validation by comparing the SEDD to the approved eQAPP, summarizing QC outliers in an ADR Report, and applying data validation qualifiers to associated results. The "first review" EA chemist will perform a Stage 2B data validation based on the initial ADR Stage 2A validation. The data validator will review the ADR Report against the PDF laboratory report to 1) verify/modify the ADR qualification of the sample results and to 2) supplement the ADR review with a manual review of QC elements that were not included in the ADR review. The data validator will complete the data review checklist and prepare a data validation report that summarizes the data validation findings. The "second reviewer" EA chemist will review the data validation report and sign off as the second reviewer. The data validation report will then be uploaded to the FUDSChem library.

How will the data be archived?

Data will be managed in the FUDSChem per the requirements specified in the New England District Data Management Plan.

Data will be transferred to the project stakeholders upon completion of the project. Retrieval of data by others will be at the discretion of the project stakeholders. The length of time that records will be archived will be at the discretion of the project stakeholders.



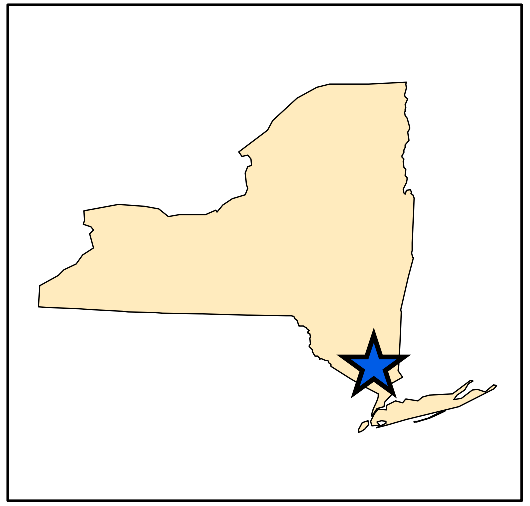
Western shoreline area between Iona Island and Round Island was filled by PIPC following transfer of the FUDS from the Navy in 1965.

HTRW Areas of Concern		
AOC #	**Building(s)/Area**	**Historical Use**
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Former Buildings with Significant Potential for Explosive Hazard	
Building	**Historical Use**
Former Building 609	Mine Loading Plant
Former Building 506	Filling House #3
Former Building 503	Filling House #6
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

Existing Structures / Not FUDS Eligible	
Building	**Historical Use**
Building 201	Empty Projectile Magazine
Building 212	Former Marine Barracks
Building 217	Fire Station and Labor Office Building
Building 222	Miscellaneous Storage Building
Building 508	Bag Charge Magazine
Building 603	Pyrotechnic Magazine

VICINITY MAP



Legend

- 🟩 FUDS Boundary
- 🟥 HTRW Project Areas of Concern
- ☐ FormerTransformers
- 🟪 Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
- 🟧 Remaining Structure (Not FUDS Eligible)
- ▨ Disturbed Ground/Fill Area
- ● 1996 Subsurface Soil Sample Location
- ● 2007 Surface Soil Sample
- ● 2007 Sediment Sample
- ✕ Previous Elevated Concentration of COPC
- ☐ Phase I Investigation Area

0 400 800
Feet
1 in = 400 ft

N

FIGURE 11-1
Phase I Investigation Area

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

EA®

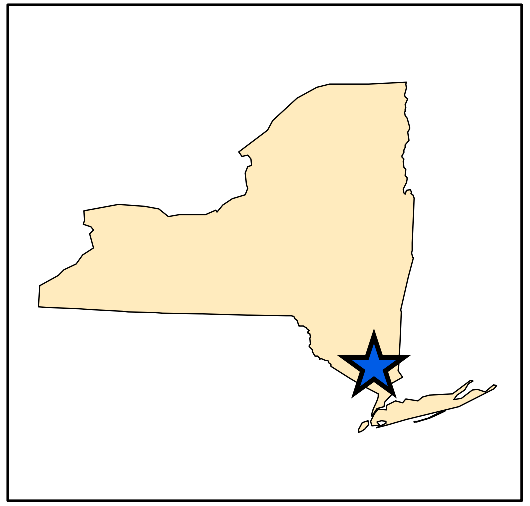
Aerial: ESRI ArcGIS Online Map Service

Map Date: 6/18/2019

\\lovetonGIS\GISdata\Federal\Northeast\NewYork\IonaIsland\MXD\IRPQAPP\Figure11-1_PhaseI_InvestigationArea.mxd

Western shoreline area between Iona Island and Round Island was filled by PIPC following transfer of the FUDS from the Navy in 1965.

VICINITY MAP



Legend

■	HTRW RI Footprints of Former Buildings/Structures
▨	Disturbed Ground/Fill Area
🟫	Upland
🟩	Marsh/Wetland
—	10-ft Topographic Contour

Phase I Shoreline Reconnaissance Areas

—	Recon Area 1 Hudson River Shoreline
▪▪▪▪	Recon Area 2 Iona Marsh Shoreline
▪▪▪▪	Recon Area 3 Western Shoreline Between Iona and Round Island
═	Recon Area 4 CSX Railroad Tracks (East and West Sides)

0 400 800
Feet
1 in = 400 ft

N

FIGURE 11-2
Phase I Shoreline Reconnaissance Survey Areas

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

EA®

Aerial: ESRI ArcGIS Online Map Service

Map Date: 6/7/2019

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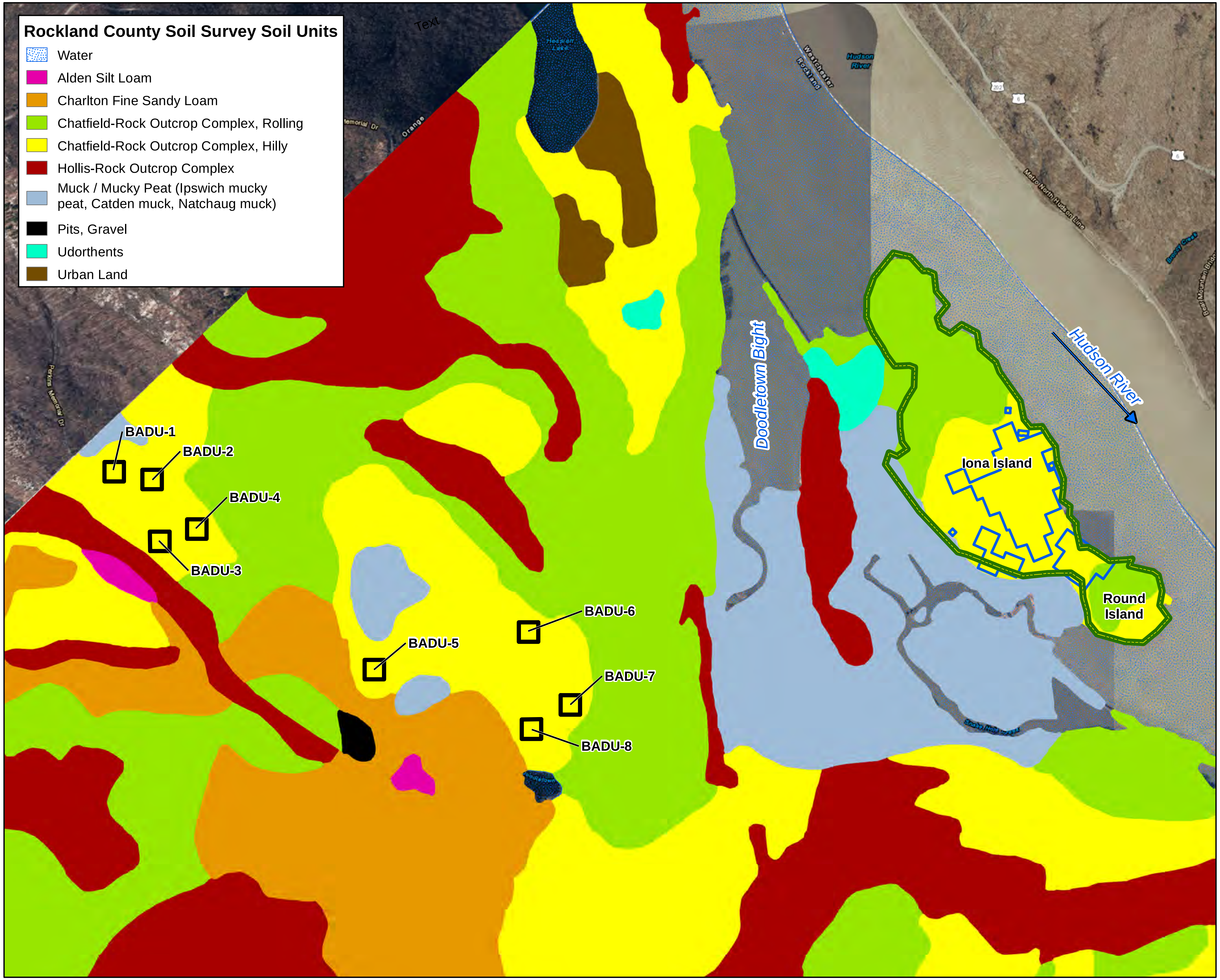
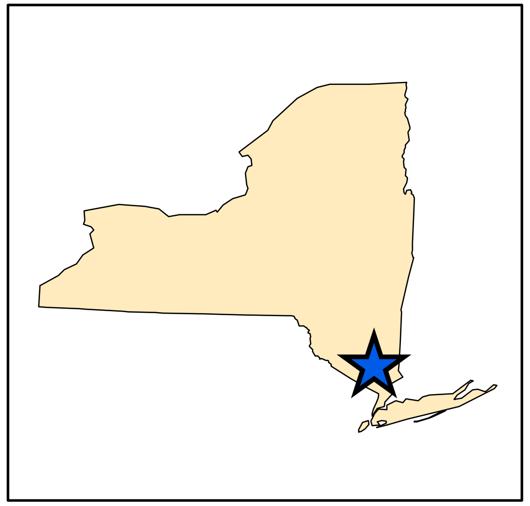


VICINITY MAP



Legend

🟩 FUDS Boundary

🟦 Phase I Investigation Area

⬛ Bear Mountain State Park 200x200 ft surface and subsurface soil DU

0 1,000 2,000

Feet

1 in = 1,000 ft

N

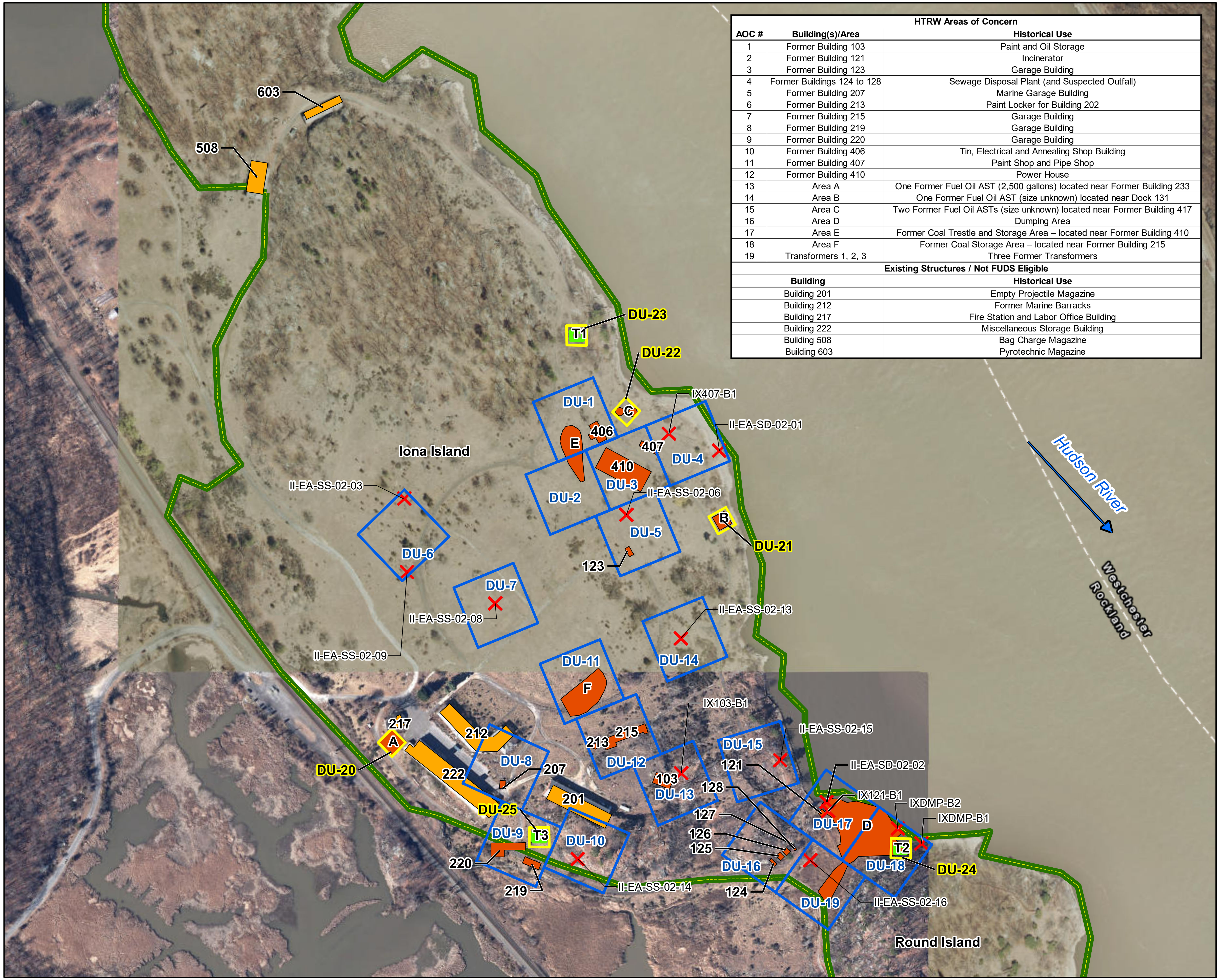
FIGURE 11-3
Phase I Background Sampling Locations

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PROGRAM
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 6/19/2019

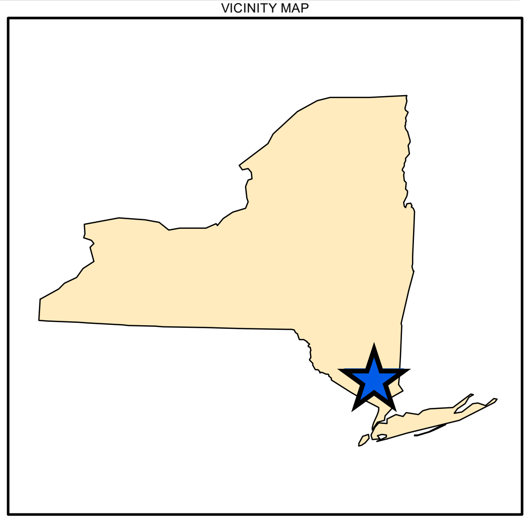
\\lovetonGIS\GISdata\Federal\Northeast\NewYork\IonaIsland\MXD\IRPQAPP\Figure11-3_ProposedBackgroundDU.mxd



HTRW Areas of Concern		
AOC #	**Building(s)/Area**	**Historical Use**
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Existing Structures / Not FUDS Eligible	
Building	**Historical Use**
Building 201	Empty Projectile Magazine
Building 212	Former Marine Barracks
Building 217	Fire Station and Labor Office Building
Building 222	Miscellaneous Storage Building
Building 508	Bag Charge Magazine
Building 603	Pyrotechnic Magazine

VICINITY MAP



Legend

🟩	FUDS Boundary
🟥	HTRW Project Areas of Concern
🟩	FormerTransformers
🟧	Remaining Structure (Not FUDS Eligible)
✕	Previous Elevated Concentration of COPC
☐	200 ft x 200 ft DU
☐	60 ft x 60 ft DU

0 300 600
Feet
1 in = 300 ft

N

FIGURE 11-4
HTRW Project AOC Incremental Sampling Decision Units

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

EA®

Aerial: ESRI ArcGIS Online Map Service

Map Date: 9/17/2019

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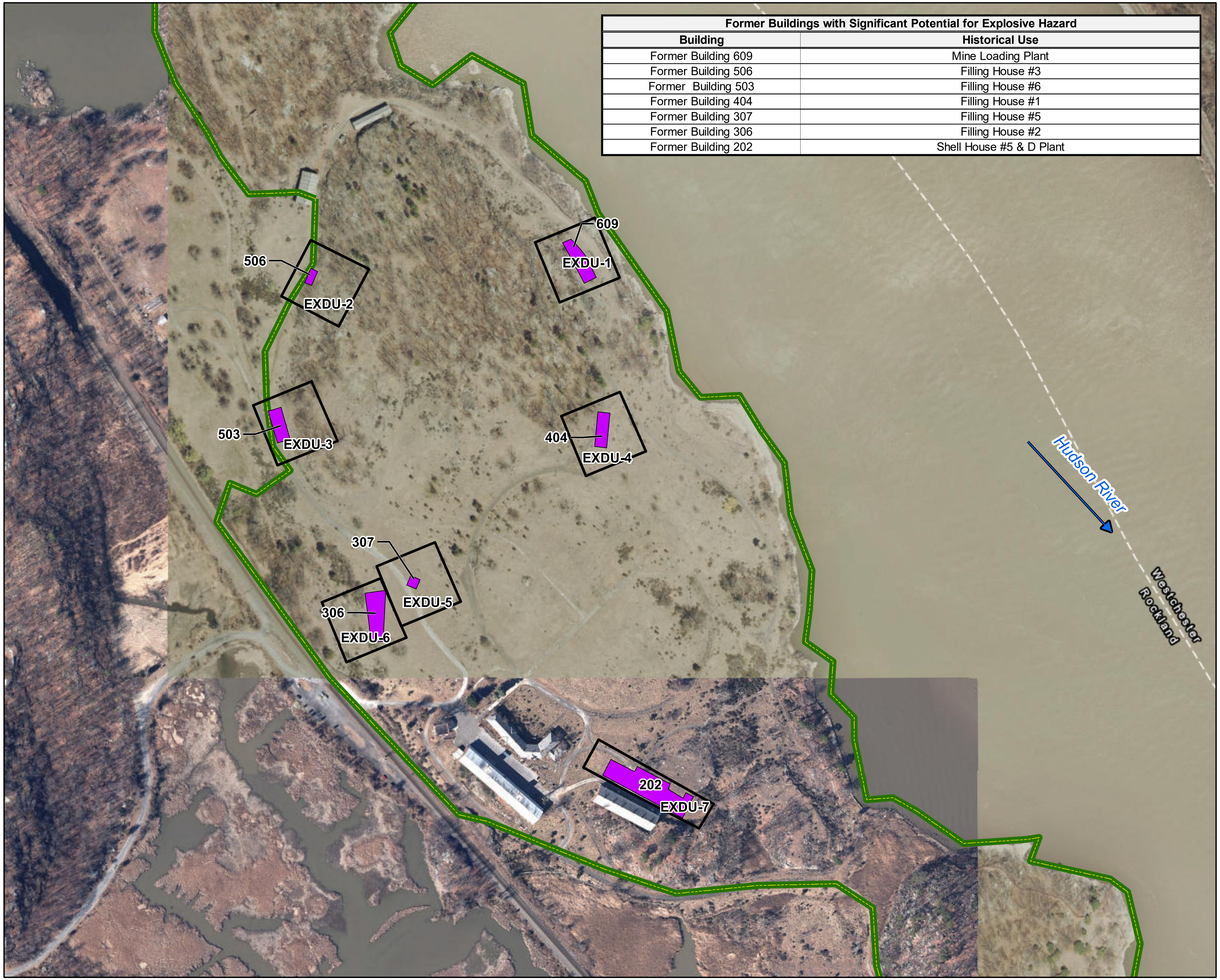
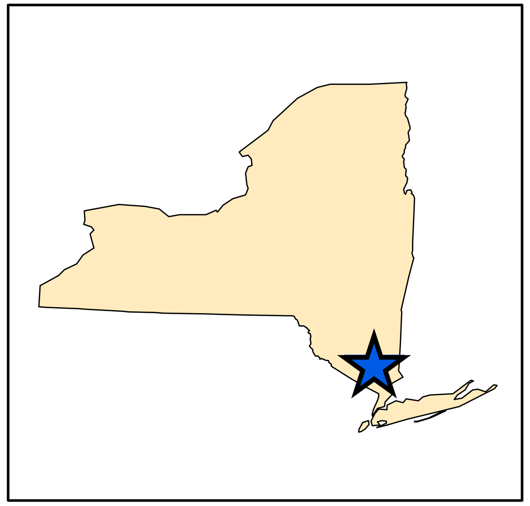


Former Buildings with Significant Potential for Explosive Hazard	
Building	**Historical Use**
Former Building 609	Mine Loading Plant
Former Building 506	Filling House #3
Former Building 503	Filling House #6
Former Building 404	Filling House #1
Former Building 307	Filling House #5
Former Building 306	Filling House #2
Former Building 202	Shell House #5 & D Plant

VICINITY MAP



Legend

🟩	FUDS Boundary
■	Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
☐	1 Acre DU

0 300 600
Feet
1 in = 300 ft

N

FIGURE 11-5
Decision Units for Buildings with Significant Potential for Explosive Hazard

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 11/15/2019

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QAPP Worksheet #12 – Measurement Performance Criteria

This worksheet documents the quantitative measurement performance criteria in terms of precision, bias, and sensitivity for laboratory measurements and is used to guide the selection of appropriate measurement techniques and analytical methods. Measurement performance criteria are developed to ensure collected data will satisfy the DQOs documented on Worksheet #11 and are provided in the following worksheets.

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Table 12-1 Measurement Performance Criteria for TAL Metals – Soil Method 6010C

Matrix	Soil
Analytical Group	TAL Metals
Concentration Level	Low

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**[3]	**QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)**
SOP 001 SOP 002 SOP 004 SOP 016 SOP 025 SOP 057	SW6010C/ DV-MT-0021	Completeness	100% for each DU/analyte//data use	NA	S&A
		Precision	RPD <50% for discrete samples	Replicate (ISM samples)	S&A
		Accuracy/bias/ contamination	No target analyte ≥ ½ LOQ or >1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater	Blanks (method, equipment, and/or instrument)	S&A
		Accuracy/bias	90 to 110%R	ICV and CCV	A
		Accuracy/bias	80 to 120%R	Low-level calibration check (only if one-point calibration is used)	A
		Accuracy/bias	ICS-A: the non-spiked analytes < LOD, ICS-AB: within ±20% of expected value	ICS	A
		Accuracy	%R per DoD QSM 5.2, Table C-3/C-4 or laboratory limits if not available	LCS, MS, and MSD	A
		Precision	RPD<20%	MS and MSD	A
		Accuracy/bias	5-fold dilution within ±10% of original value for results > 50x LOQ	Serial dilution	A
		Accuracy/bias	Within ±20% of expected value for results < 50x LOQ	Post-digestion spike	A

1) Referenced SOPs for sampling procedures are presented in Worksheet 21.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:

% = Percent
%R = Percent recovery
CCV = Continuing calibration verification
DoD = Department of Defense
DU = Decision Unit
ICP = Inductively coupled plasma
ICS = Interfering element check standards
ICV = Initial calibration verification
ISM = Incremental sampling methodology
LCS = Laboratory control sample
LOD = Limit of detection
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
NA = Not applicable
QC = Quality control
QSM = Quality Systems Manual
RPD = Relative percent difference
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 12-2 Measurement Performance Criteria for TAL Metals – Soil Method 6020A

Matrix	Soil
Analytical Group	TAL Metals
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance[3]	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
SOP 001 SOP 002 SOP 004 SOP 016 SOP 025 SOP 057	SW6020A/DV-MT-0022	Completeness	100% for each DU/analyte/data use	NA	S&A
		Precision	RPD ≤50% for discrete samples	Replicate (ISM samples)	S&A
		Accuracy/bias/ contamination	No target analyte ≥ ½ LOQ or ≥1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater	Blanks (method, equipment, and/or instrument)	S&A
		Accuracy/bias	90 to 110%R	ICV and CCV	A
		Accuracy/bias	80 to 120%R	Low-level calibration check (if one-point calibration)	A
		Accuracy	%R per DoD QSM 5.2, Table C-5/C-6	LCS, MS, and MSD	A
		Precision	RPD≤20%	MS and MSD	A

1) Referenced SOPs for sampling procedures are presented in Worksheet 21.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:

% = Percent
%R = Percent recovery
CCV = Continuing calibration verification
DoD = Department of Defense
DU = Decision Unit
ICV = Initial calibration verification
ISM = Incremental sampling methodology
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
QC = Quality control
QSM = Quality Systems Manual
RPD = Relative percent difference
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 12-3 Measurement Performance Criteria for Mercury – Soil Method SW7471

Matrix	Soil
Analytical Group	Mercury
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance3	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
SOP 001 SOP 002 SOP 004 SOP 016 SOP 025 SOP 057	ISM; SW7471/ DV-MT-0016	Completeness	100% for each DU/analyte//data use	NA	S&A
		Precision	RPD ≤50% for discrete samples	Replicate (ISM samples)	S&A
		Accuracy/bias/ contamination	No target analyte ≥ ½ LOQ or ≥1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater	Blanks (method, equipment, and/or instrument)	S&A
		Accuracy/bias	90 to 110%R	ICV and CCV	A
		Accuracy/bias	80 to 120%R	Low-level calibration check (if one-point calibration)	A
		Accuracy	%R per DoD QSM 5.2, Table C-5/C-6	LCS, MS, and MSD	A
		Precision	RPD≤20%	MS and MSD	A

1) Referenced SOPs for sampling procedures are presented in Worksheet 21.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:

% = Percent.
%R = Percent recovery
CCV = Continuing calibration verification
DoD = Department of Defense
DU = Decision Unit
ICV = Initial calibration verification
ISM = Incremental sampling methodology
LCS = Laboratory control sample
LOQ = Limit of quantitation.
MS = Matrix spike
MSD = Matrix spike duplicate
QC = Quality control
QSM = Quality Systems Manual
RPD = Relative percent difference
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 12-4 Measurement Performance Criteria for Semi-Volatile Organic Compounds – Soil Method 8270D SIM

Matrix	Soil
Analytical Group	PAHs by SIM
Concentration Level	Low/Trace

Sampling Procedure[1]	**Analytical Method/SOP[2]**	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance[3]**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)**
SOP 001 SOP 002 SOP 004 SOP 016 SOP 025 SOP 057	SW8270D/8270D SIM/ DV-MS-0002, DV-MS-0012	Completeness	100% for each DU/analyte//data use	NA	S&A
		Precision	RPD ≤50% for discrete samples	Replicate (ISM samples)	S&A
		Accuracy/bias/ contamination	No target analyte ≥ ½ LOQ or ≥1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater	Blanks (method, equipment, and/or instrument)	S&A
		Accuracy/bias	≤20%D	ICV and CCV	A
		Qualitative ID	RRT of each target analyte within ±0.06 RRT units	RRT	A
		Instrument Performance	Tune criteria consistent with SW8270D	Mass spectrometer tuning check DFTPP	A
		Sensitivity	Retention time ±30 seconds from retention time of the IS of the calibration mid-point standard and extracted ion current profile area within -50% to +100% of area from calibration mid-point standard, or CCV on days when ICAL is not performed	IS	A
		Accuracy	%R per DoD QSM 5.2, Table C-25/C-26/C-27/C-28 or laboratory limits if not available	LCS, MS, MSD	A
		Precision	RPD≤20%	MS and MSD	A
		Accuracy	%R per DoD QSM 5.2, Table C-25/C-26/C-27/C-28 or laboratory limits if not available	Surrogate standards	A

1) Referenced SOPs for sampling procedures are presented in Worksheet 21.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:
% = Percent
%D = Percent difference
%R = Percent recovery
CCV = Continuing calibration verification
DFTPP = Decafluorotriphenylphosphine
DoD = Department of Defense
DU = Decision Unit
ICV = Initial calibration verification
ID = Identification
IS = Internal standard
ISM = Incremental sampling methodology
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
QC = Quality control
QSM = Quality Systems Manual
RPD = Relative percent difference
RRT = Relative retention time
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 12-5 Measurement Performance Criteria for BTEX – Soil Method 8260B

Matrix	Soil
Analytical Group	BTEX
Concentration Level	Low

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**[3]	**QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)**
SOP 001 SOP 002 SOP 004 SOP 016 SOP 025 SOP 057	EPA SW-846 Method 8260B/DV-MS-0010	Completeness	100% for each DU/analyte//data use	NA	S&A
		Precision	RPD ≤50% for discrete samples	Replicate (ISM samples)	S&A
		Accuracy/bias/ contamination	No target analyte ≥ ½ LOQ or ≥1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater	Blanks (method, trip, field, equipment, and/or instrument)	S&A
		Accuracy/bias	≤20 %D	ICV and CCV	A
		Qualitative ID	RRT of each target analyte within ±0.06 RRT units of most recent mid-point ICAL or CCV	RRT	A
		Instrument performance	Tune criteria consistent with SW8260B	Mass spectrometer tuning check BFB	A
		Sensitivity	RT ±10 seconds from RT of the IS of the calibration mid-point standard and extracted ion current profile area within -50% to +100% of area from calibration mid-point standard, or CCV on days when ICAL is not performed	IS	A
		Accuracy	%R per DoD QSM 5.2, Table C-23/C-24 or laboratory limits if not available	LCS, MS, and MSD	A
		Precision	RPD≤20%	MS and MSD	A
		Accuracy	%R per DoD QSM 5.2, Table C-23 or laboratory limits if not available	Surrogates	A

1) Referenced SOPs for sampling procedures are presented in Worksheet 21.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:

% = Percent
%D = Percent difference
%R = Percent recovery
BFB = Bromofluorobenzene.
BTEX = Benzene, toluene, ethylbenzene, and xylenes
CCV = Continuing calibration verification
DoD = Department of Defense
DU = Decision Unit
ICV = Initial calibration verification
IS = Internal standard
ISM = Incremental sampling methodology
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
NA = Not applicable
QC = Quality control
QSM = Quality Systems Manual
RPD = Relative percent difference
RRT = Relative retention time
RSD = Relative standard deviation
RT = Retention time
SOP = Standard operating procedure
TCL = Target compound list
VOC = Volatile organic compound

Table 12-6 Measurement Performance Criteria Polychlorinated Biphenyls as Aroclors – Soil Method SW8082A

Matrix	Soil
Analytical Group	PCB Aroclors
Concentration Level	Low

Sampling Procedure[1]	Analytical Method/SOP[2]	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance[3]	QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)
SOP 001 SOP 002 SOP 004 SOP 016 SOP 025 SOP 057	SW8082A/DV-GC-0021	Completeness	100% for each DU/analyte//data use	NA	S&A
		Precision	RPD ≤50% for discrete samples	Replicate (ISM samples)	S&A
		Accuracy/bias/ contamination	No target analyte ≥ ½ LOQ or ≥1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater	Blanks (method, equipment, and/or instrument)	S&A
		Accuracy/bias	≤20%D	ICV and CCV	A
		Accuracy	%R per DoD QSM 5.2, Table C-17/C-18 or laboratory limits if not available	LCS, MS, MSD	A
		Accuracy	Results from primary and secondary columns ≤40% RPD	Confirmation of positive results	A
		Precision	RPD≤20%	MS and MSD	A
		Accuracy	%R per DoD QSM 5.2, Table C-17/C-18 or laboratory limits if not available	Surrogate	A

1) Referenced SOPs for sampling procedures are presented in Worksheet 21.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:

% = Percent
%D = Percent difference.
%R = Percent recovery
CCV = Continuing calibration verification
DoD = Department of Defense
DU = Decision Unit
ICV = Initial calibration verification
ISM = Incremental sampling methodology
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
NA = Not applicable
QC = Quality control
QSM = Quality Systems Manual
RPD = Relative percent difference
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 12-7 Measurement Performance Criteria for Explosives – Soil Method 8330B

Matrix	Soil
Analytical Group	Explosives
Concentration Level	Low

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**[3]	**QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)**
SOP 001 SOP 002 SOP 004 SOP 016 SOP 025 SOP 057	EPA 8330B/ DV-LC-0002	Precision	RPD ≤ 50% when detected in both samples ≥ sample specific LOQ	Field Duplicate	S & A
		Accuracy/bias (contamination and representativeness)	No target analyte ≥ ½ LOQ or >1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater	Blanks (methods, equipment, and/or instrument)	S & A
		Accuracy/method bias in ideal matrix	%R per DoD QSM 5.2 limits, Table C-36/C-37 or laboratory limits if not available	LCS / MS / MSD	A
		Precision	RPD ≤ 20%	MS / MSD	A
		Accuracy/bias	%R per DoD QSM 5.2 limits, Table C-36/C-37 or laboratory limits if not available	Surrogate Compounds	A
		Completeness	100% for each DU/analyte/data use	100% for each DU/analyte/data use	A

1) Referenced SOPs for sampling procedures are presented in Worksheet 2.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:
% = Percent
%D = Percent difference
%R = Percent recovery
DoD = Department of Defense
LSC = Laboratory control sample
MS = Matrix spike
MSD = Matrix spike duplicate
QC = Quality control
QSM = Quality Systems Manual
RPD = Relative percent difference
SOP = Standard operating procedure

Table 12-8 Measurement Performance Criteria for Total Organic Carbon – Sediment Method Walkley-Black

Matrix	Sediment
Analytical Group	Total Organic Carbon
Concentration Level	Low

Sampling Procedure[1]	**Analytical Method/SOP**[2]	**Data Quality Indicators**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**[3]	**QC Sample Assesses Error for Sampling (S), Analytical (A) or Both (S&A)**
SOP 001 SOP 002 SOP 004 SOP 016 SOP 021	Walkley-Black / CA-741	Accuracy/Bias	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL	Blanks (methods, equipment, and/or instrument)	S & A
		Accuracy/ Representativeness	Temperature ≤ 6 degrees Celsius.	Cooler Temperature Indicator	S & A
		Precision	Relative Percent Difference (RPD) ≤ 50% if both results are >5 x LOQ	Field Duplicate	S & A

1) Referenced SOPs for sampling procedures are presented in Worksheet 2.
2) Referenced SOPs for the analytical method are presented in Worksheet 23.
3) MS/MSDs will be performed on soil samples at a rate of 1 per 20 samples as required by the analytical method.

NOTES:
% = Percent
LOQ = Limit of quantitation
RL = Reporting limit
SOP = Standard operating procedure

QAPP Worksheet #13 – Secondary Data Criteria and Limitations

Data Type	Data Source (originating organization, report title, and date)	Data Generator(s)	How data may be used (if deemed usable during data assessment stage)	Factors affecting reliability of data and limitations on data use
Preliminary Report	USACE, Potentially Hazardous Waste Site Preliminary Assessment No. C02NY0744, Iona Island Naval Ammunition Depot, Stony Point, New York, November 1992.	Summary of site visit conducted on 30 October 1992.	Development of the CSM, including site history.	This information is valid.
Memorandum	USACE, DERP-FUDS Inventory Project Report for Site No. C02NY0744, Iona Island Naval Ammunition Depot, Stony Point, New York, March 1993.	Recommendation of further investigation for hazardous/toxic waste and ordnance explosive waste. Determination that the site had been utilized by the Navy as an ammunition depot and that there were eligible categories under the DERP-FUDs program.	Information on FUDS eligibility/FUDS categories at the Site.	This information is valid.
Summary Sheet	Project Summary Sheet (Revised) for DERP-FUDS HTRW Project No. C02NY074402, Iona Island Naval Ammunition Depot, Stony Point, New York, Site No. C02NY0744, July 1994	Description of HTRW project category at the site, including former buildings and structures.	Information on FUDS eligibility/FUDS categories at the site.	This information is valid.
Memorandum	USACE, Site Survey Summary Sheet (Revised) for DERP-FUDS Site No. C02NY0744, Iona Island Naval Ammunition Depot, Stony Point, New York, 1995.	Description of CON/HTRW, HTRW, and OEW project categories at the Site.	Information on FUDS eligibility/FUDS categories at the site.	This information is valid.
Investigation report	The Greeley- Polhemus Group, Inc., Data Collection Activities at DERP-FUDS Sites: Iona Island Naval Ammunition Depot Stony Point, New York (DERP-FUD Site No. C02NY0744) and U.S. Naval Training Device Center, Sands Point, New York (DERP-FUD Site No. C02NY0758), April 1997.	Analytical sampling of RCRA metals, SVOCs, VOCs, and PCBs to evaluate whether soil was impacted by DoD-related activities at 8 AOCs.	Previous soil sampling analytical results for 8 AOCs.	The report focused on a limited number of AOCs. These data are valid.
Archives search report (ASR)	USACE, ASR Findings, Iona Island Naval Ammunition Depot, March 1998.	Compilation of historical information to evaluate possible use or disposal of ordnance at the site. Presented current and historical photographs and historical site layout drawings.	Development of the CSM, including site history and physical environment.	This information is valid.
Archives search report	USACE, ASR Supplement, Iona Island Naval Ammunition Depot, November 2004.	Documentation of historical use and ordnance items found at the site.	Development of the CSM, including site history.	This information is valid.
Investigation report	Alion Science and Technology, Final Site Inspection Report for the Iona Island Naval Ammunition Depot, September 2008.	Investigation focusing on the 1903 explosion area to evaluate the presence of MEC or MC related to historical use of the site and evaluate if the site warranted further response action. The investigation included soil and sediment sampling for MC (select metals and explosives) and preparation of a munitions and explosives of concern risk assessment.	Development of the CSM, including site history, physical environment, and potential exposure pathways. Previous soil and sediment sampling analytical results focusing on the 1903 explosion area to evaluate potential contaminants in the area.	The report focused on the MMRP region and potential releases by HTRW were outside the scope of this report. Analytical data are valid.
UST removal action closure report	Green Seal Environmental, Inc., Final Underground Storage Tank Removal Action Closure Report, Formerly Used Defense Site Project #C02NY074401 Iona Island (Naval Ammunition Depot), Tomkins Cove, New York, May 2012.	Documentation of closure and site investigation of two fuel oil USTs and associated piping, and geophysical survey investigation of additional potential fuel oil USTs.	Information CON/HTRW FUDS category at the site. UST soil analytical results for VOCs and SVOCs.	The report focused on previously identified and suspected UST locations. Analytical data are valid.
Memorandum	USACE, Project Closeout Memorandum, Iona Island Naval Ammunition Depot, December 2012.	Documentation of UST removal action and closure. Recommendation for no further action with the UST removals and closeout of the FUDS CON/HTRW project.	Information CON/HTRW FUDS category at the Site.	This information is valid.
Report	U.S. Army Geospatial Center, Former Naval Ammunition Depot Iona Island, New York Historical Photographic Analysis, September 2018.	Analysis of historical photographic records and historical map data relative to the Site. Presents historical drawings/maps/property plans from 1091 to 1965. Presents and analyzes aerial photographs from the early 1930s to present day.	Development of the CSM, including site history, site layout, former building/structure locations/usage, and current use.	This information is valid.

NOTES:
CSM = Conceptual site model
CON/HTRW = Containerized Hazardous Toxic and Radioactive Waste
DERP = Defense Environmental Restoration Program
FUDS = Formerly Used Defense Sites
HTRW = Hazardous, Toxic and Radiological Waste
MC = Munitions constituents
MEC = Munitions and Explosives of Concern
MMRP = Military Munitions Response Program
No. = Number
OEW = Ordnance and Explosive Waste
SVOC = Semi-volatile organic compound
USACE = United States Corps of Engineers
VOC = Volatile organic compound

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QAPP Worksheets #14 and #16 – Project Tasks and Schedule

This worksheet lists the project-specific sampling tasks to be performed in support of the Iona Island Ammunition Depot FUDS HTRW RI. A general HTRW project schedule presenting the tasks and planned start and end dates is presented at the end of this worksheet in Figure 14-1. The schedule will be modified as necessary during the field activities based on weather or any access issues.

As discussed in the introduction, a separate UFP-QAPP for the MMRP MEC investigation will be implemented concurrently with this HTRW investigation and a crosswalk between the MMRP and HTRW QAPPs is presented in Table 1. The schedule, shown as Figure 14-1 and Table 1 (crosswalk summary) incorporates various planning and sequencing aspects of the RIs. Different environmental time windows and locations that need to be integrated during field activities include 1) overwintering of the bald eagle (mid-December through mid-February and dependent on the winter weather season in the area) along the Hudson River shoreline of Iona Island and 2) the nesting/fledging of the least bittern (mid-April through mid-July) in the marsh grasses to the west of Iona Island. It should be noted that these environmental time windows and locations do not prohibit field work at these times; however, fieldwork requires additional coordination with the Bear Mountain State Park POC prior to entering these areas.

PHASING OF HTRW WORK

The primary onsite and offsite tasks to be completed for the Phase I HTRW project RI are presented in this worksheet. Field tasks will be conducted in accordance with this UFP-QAPP. Field and analytical SOPs are presented in Worksheets #20 and #21.

Phase II investigative activities, if necessary, will be identified based on the results of the Phase I investigation and discussion with the USACE and stakeholders. Results of the MMRP RI will also be reviewed to determine if additional investigation is needed (for example, if drums are identified during the MMRP RI investigation of AOC #16 – Area D [Dumping area]). The Phase II and any subsequent tasks will be presented in an addendum to this UFP-QAPP.

FUDSCHEM DATA MANAGEMENT – EA

Prior to field sampling, an eQAPP within FUDSChem will be created; the eQAPP will be fully compliant with the project UFP-QAPP, incorporating methods, sample types, and quality specifications (Limit of Detection [LOD], Limit of Quantitation [LOQ], Holding Time, QC Sample Acceptance Limits, etc.). The pre-population of sampling event information (location information, sample type, matrix, methods, etc.) will also be performed to ensure accurate database field matching and status tracking within FUDSChem.

MOBILIZATION AND DEMOBILIZATION TASKS – EA, SUBCONTRACTORS

Mobilization/demobilization will occur two times based on the proposed field schedule to accommodate a phased approach to the investigation. Mobilization tasks will include the following:

- Notify USACE and PIPC prior to mobilizing equipment and field personnel to the Site.
- Coordinate with field personnel and subcontractors as needed; ensure staff have proper certification (e.g., OSHA, DoD Explosives Safety TP-18).
- Procure field equipment and supplies.
- Identify and set up office space and equipment staging/storage areas, as needed.
- Order sample bottles and field monitoring equipment. Sample bottle requirements are presented in Worksheet #19 and #30. The equipment necessary to execute the field work and complete the project tasks is detailed below and, in the SOPs, identified in Worksheet #21.
- Coordinate with CSX Transportation to perform RI activities along the River Subdivision railroad line.
- Mobilize field and subcontractor staff to the site.

Demobilization will include removing field equipment and supplies, returning rented equipment, performing general cleanup, and organizing and finalizing field documentation.

SITE SPECIFIC TRAINING – EA, SUBCONTRACTORS

A field kickoff meeting will be conducted during mobilization to provide site-specific training to the field personnel. The field kickoff meeting may include the following attendees: USACE, EA, relevant subcontractors, and PIPC (to assist with natural resource and cultural resource awareness training).

The field team will review the following:

- Project plans (i.e., UFP-QAPP, APP/SSHP)
- PIPC expectations and code of conduct for the field team during RI activities
- Site hazards/site safety and health concerns, evacuation plans and procedures/route to the hospital

- Safety procedures
- Procedures to minimize environmental impacts
- Procedures to identify natural or cultural resources
- Procedures to be employed if/when natural or cultural resources are identified; an Environmental Protection Plan (EPP) is provided in Appendix B.

HEALTH AND SAFETY TASKS – EA, SUBCONTRACTORS

The HTRW project RI field activities will be conducted according to the APP (Appendix A), which has been submitted under a separate cover (EA 2018). Each team member will read and sign the USACE-accepted APP and receive site-specific training that covers site safety, emergency procedures, QC (pass/fail criteria), general daily activities protocols, site communication, and general site layout including safe areas, and natural resource/environmental and cultural/archaeological concerns. Site-specific training will be conducted by the SSHO, and a MEC awareness briefing will be conducted by a qualified UXO Technician as applicable.

Entrance briefings and safety meetings will be conducted prior to the start of fieldwork to familiarize the team personnel with site health and safety requirements, the objectives and scope of field activities, and chain-of-command. Personnel mobilized to the site will meet requirements for OSHA hazardous waste operations training and medical surveillance requirements as specified in the APP. Site personnel will also be trained to perform the specific tasks to which they are assigned. At no time will site personnel be tasked with performing an operation or duty for which they do not have appropriate training. The field team will be familiar with sample locations and will identify related field support areas and requirements.

Anomaly avoidance procedures will be utilized for sampling efforts. UXO support will be conducted to reduce/remove the potential for exposure to MEC or MPPEH if encountered during field activities. Site workers will be aware of the potential for UXO and use the Recognize, Report, and Retreat protocol if a MEC/UXO item is encountered during RI field activities. If a MEC/UXO item is found, the item will be marked and immediately reported to the Senior Unexploded Ordnance Supervisor (SUXOS).

INVESTIGATIVE TASKS – EA, SUBCONTRACTORS

The Phase I field investigative tasks are presented in this worksheet. The sampling design and rationale is presented in detail in Worksheet # 17. Field SOPs that will be used in support of field sampling activities are listed in Worksheet #21 and provided in Appendix H.

Establishment of Decision Units

A total of 25 onsite surface and subsurface soil DUs have been established to address HTRW AOCs and locations where elevated concentrations of COPCs were detected during previous investigations (DU-1 through DU-25), including 19 DUs sized at approximately 1 acre (200 x 200 ft) (DU-1 through DU-19) and 6 smaller DUs sized at 60 x 60 ft (DU-20 through DU-25). An additional 7 approximately 1-acre sized DUs (200 x 200 ft or 100 x 400 ft) have been established at former buildings identified as having a significant potential for explosive hazard (EXDU-1 through EXDU-8). A total of 8 offsite background DUs have been established in Bear Mountain State Park (BADU-1 through BADU-8). Worksheet #11 presents the decision criteria used to establish DUs.

DU vertex coordinates are presented in Worksheet #18. DU boundaries will be located in the field with a hand-held GPS unit (typically to within sub-meter) and marked with a highly visible marker (i.e., high-visibility flagging and a stake), prior to sample collection. Surface and subsurface soil incremental samples will be collected from each DU as detailed in the surface soil and subsurface soil subsections below.

Incremental Soil Sampling

Incremental soil sampling will be conducted in accordance with EA SOP 057 and ITRC ISM (ITRC 2012). Single incremental samples will be collected from each background DU (BADU-1 through BADU-8). Onsite DUs will be sampled in triplicate (initial ISM sample plus two additional samples) as presented in Worksheet #11 to calculate the 95% upper confidence limit of the mean using either the student-t or Chebychev statistical tests.

Each incremental sample collected from each approximately 1-acre (200 x 200 or 100 x 400 ft) sized DU (DU-1 through DU-19, EXDU-1 through EXU-7, and BADU-1 through BADU-8) will be comprised of 50 increments of soil, while each incremental sample collected from each smaller 60 x 60 ft DU (DU-20 through DU-25) will be comprised of 30 increments of soil. Worksheet #11 presents the decision criteria used to determine the number of increments comprising each incremental sample. DUs and sample increments locations will be cleared by a UXO technician prior to sample collection.

Surface and/or subsurface soil incremental sample will be submitted to Test America for sample preparation and laboratory analysis based on the CSM presented in Worksheet #10 (including the list of COPCs presented in Table 10-5). Analytical methods are detailed below. The rationale for each analysis per media and at each DU is presented in Worksheet #17 (Tables 17-1 and 17-2).

- TAL metals by EPA Method 6010C/6020A (surface and subsurface soil from each of the 19 approximately 1-acre [200 x 200 ft] sized DUs established to address HTRW AOCs and associated COPCs [DU-1 through DU-19] and surface and subsurface soil from each of the 8 offsite background approximately 1-acre [200 x 200 ft] sized DUs [BADU-1 through BADU-8])

- Mercury by EPA Method 7471B (surface and subsurface soil from 16 of the approximately 1-acre [200 x 200 ft] sized DUs established to address HTRW AOCs and associated COPCs [DU-1 through DU-5, DU-8 and DU-9, DU-11 through DU-19] and surface and subsurface soil from each of the 8 offsite background approximately 1-acre [200 x 200 ft] sized DUs [BADU-1 through BADU-8])

- PAHs by EPA Method 8270D SIM (surface and subsurface soil from 14 of the approximately 1-acre [200 x 200 ft] sized DUs established to address HTRW AOCs and associated COPCs [DU-1 through DU-5, DU-8 and DU-9, DU-11 through DU-13, and DU-16 through DU-19], surface and subsurface soil from each of the 8 offsite background approximately 1-acre [200 x 200 ft] sized DUs [BADU-1 through BADU-8], and surface and subsurface soil from 3 of the smaller 60 x 60 ft DUs established to address AOCs #13, #14, and #15 [locations/footprints of 4 former fuel oil ASTs DU-20, DU-21, and DU-22])

- PCBs by EPA Method 8082A (surface and subsurface soil from 3 of the approximately 1-acre [200 x 200 ft] sized DUs established to address AOC #16 – Area D [Dumping area; DU-17, DU-18, and DU-19] and surface and subsurface soil from 3 of the smaller 60 x 60 ft DUs established to address AOC #19 [three former transformer locations; DU-23, DU-24, and DU-25])

- Explosives residues by Method 8330B (surface and subsurface soil from 3 of the approximately 1-acre [200 x 200 ft] sized DUs established to address AOC #16 – Area D [Dumping area; DU-17, DU-18, and DU-19], and surface soil only from 7 additional approximately 1-acre [200 x 200 ft or 100 x 400 ft] sized DUs established at former buildings identified as having a significant potential for explosive hazard [pending direction of contracting offer; EXDU-1 through EXDU-7]).

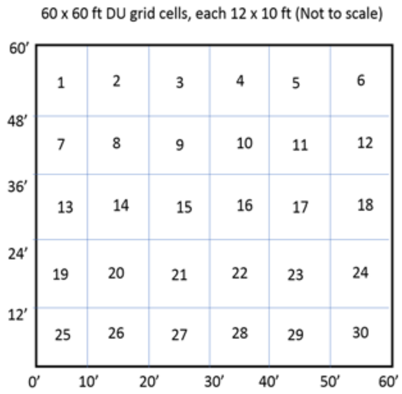
- BTEX by EPA Method 8260B (subsurface soil only from 3 of the smaller 60 x 60 ft DUs established to address AOCs #13, #14, and #15 [locations/footprints of 4 former fuel oil ASTs DU-20, DU-21, and DU-22]).

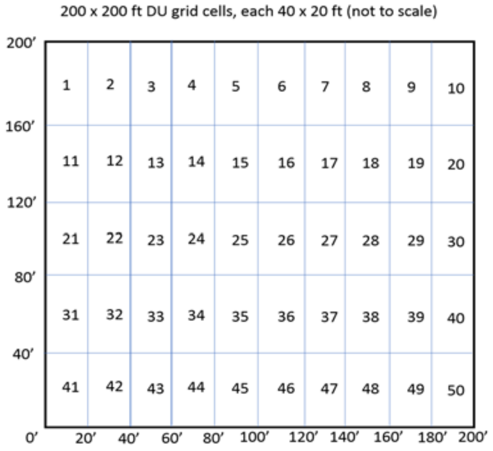
Each incremental soil sample will be collected in a laboratory-approved bag or container large enough to accommodate the total 1 kilogram volume for analysis. Incremental samples collected for analysis of BTEX (EPA Method 8260B) will be collected using VOC coring devices (e.g., Encore®, Terra Core, or similar) and will be placed in laboratory preserved jars with methanol.

The pH for soil samples will be determined in the field using a pH meter in accordance with USEPA Method 9045D "Soil and Waste pH." Field pH is being determined in the field due to time restraints regarding holding times for pH. The pH probe will be calibrated in accordance with the manufacturer's guidance and recorded in the field book. At a minimum, each system must be calibrated at two points that bracket the expected pH of the samples and are approximately three pH units or more apart. Approximately 20 grams of soil will be mixed with 20 milliliters of deionized water and thoroughly mixed and homogenized. The suspension will then be allowed to rest to allow most of the suspended clay to settle out from the suspension. The solution will then be used to determine the pH of the soil, which will be recorded in the field book.

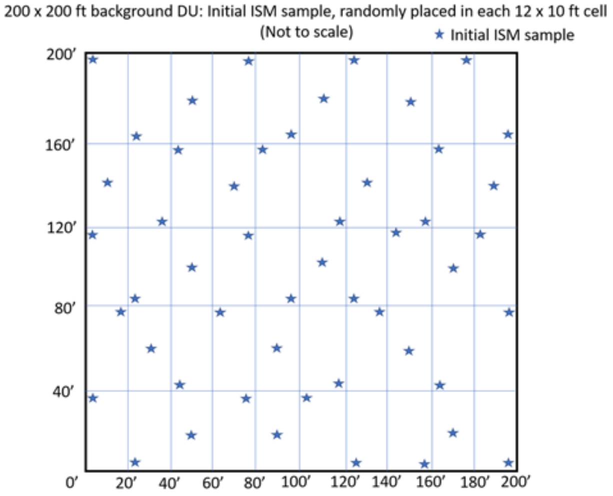
Surface Soil (0-6 in. bgs) Incremental Sample Collection

Surface soil increments will be collected from each onsite and background DU using the random sampling within grid pattern, as discussed in Worksheet #11 (USEPA 1995b). Grids will be established over each 60 x 60 ft DU (30 grid cells per DU, each approximate 10 x 12 ft in area) and each approximately 1-acre (200 x 200 ft or 100 x 400 ft) sized DU (50 grid spaces per DU, each approximate 20 by 40 ft in area). The DU corners will be flagged and grids will be generated using GIS and labeled sequentially as presented below and field located via data collection pad or flagging the DU perimeter.

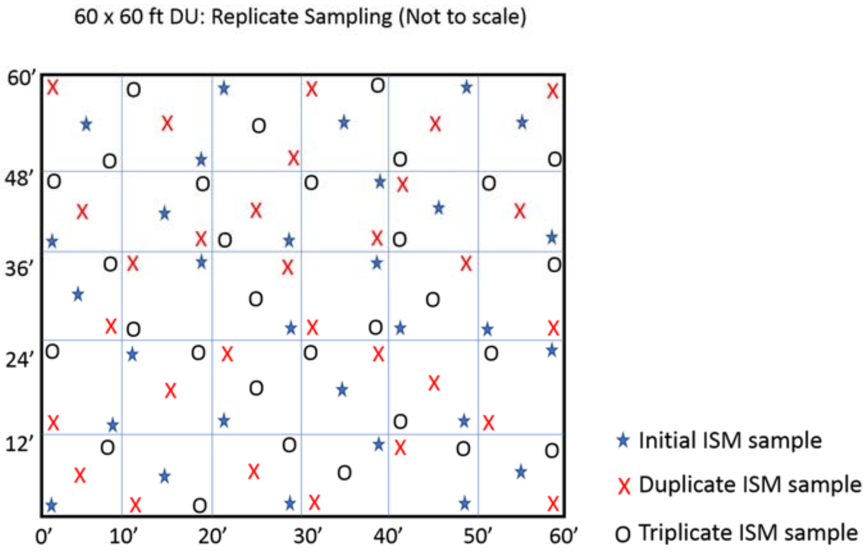


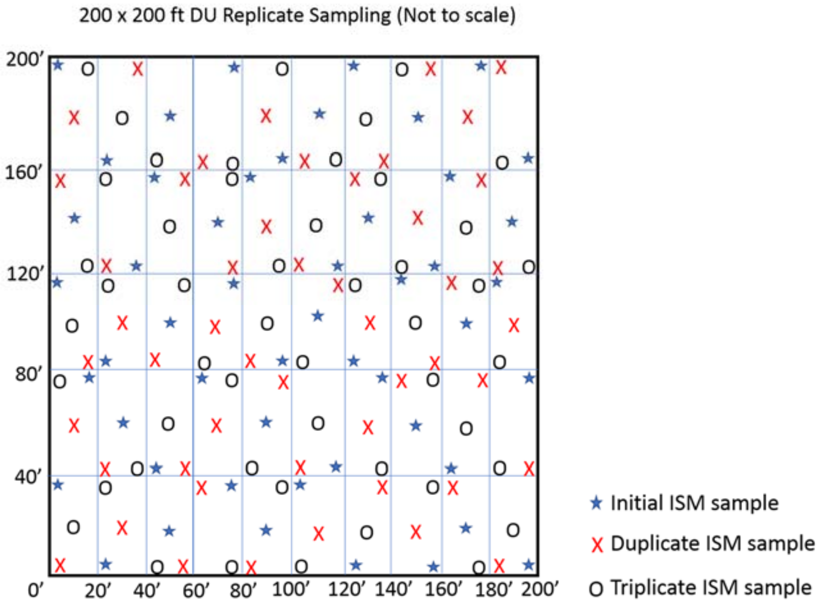


Surface soil increments will be randomly located within grid cells (i.e., varying between the four corners or center of each grid box) in order to generate an unbiased estimate of the mean and variance. An example of increment locations for a single background DU is presented below.



Triplicate incremental samples will be collected within each onsite DU. Each of the incremental samples (initial sample plus two additional samples) will be comprised of soil increments taken from different, randomly selected locations within each gridded area. Increments for each sample will not be collected from the same locations or co-located together. Examples of surface soil increment locations in onsite DUs are presented below.





Coordinate information for each random increment location will be generated using GIS and provided to the field sampling team on a data collection pad prior to field mobilization. Increment locations will be moved within the grid cell, if possible, as needed to avoid concrete, exposed bedrock, pavement, or other features that will inhibit collection of a surface soil increment. Should the entire grid cell be impervious / inaccessible, the increments specified for those grid cells will be collected in other grid cells that are accessible with that same DU such that a total of 30 or 50 increments are collected from the DU as appropriate.

Surface soil increments of equal volume will be collected using a dedicated incremental sampling tool with plungers collecting soil equivalent to approximately 20 grams in volume (EA SOP 057). The depth of each increment of soil will be approximately 6 in., which is the length of the incremental sampling tool's sampling plunger attachment. Each of the increments of soil will be 20 grams, which will provide a total weight of 1 kilogram of soil.

Subsurface Soil

Shallow subsurface soil incremental samples will be collected from hand auger soil borings advanced within random grid cells at each DU. Single incremental samples will be collected from each background DU (BADU-1 through BADU-8), while triplicate samples will be collected at each onsite DU (DU-1 through DU-25). Subsurface soil samples will not be collected from EXDU-1 through EXDU-7.

Hand auger soil borings will be advanced to bedrock/refusal or a maximum depth of 36-in. bgs (EA SOP 025). Soil borings will be advanced by or under the full-time supervision of an EA Field Geologist. A continuous soil core will be collected at each boring location for lithologic characterization by the EA Field Geologist (EA SOP 025). The following information will be recorded on soil boring logs: soil core interval, soil core recovery, geological characteristics (color, moisture, texture, grain size, sorting, lithology, etc.).

Each incremental sample from the approximately 1-acre (200 x 200 ft) sized DUs (DU-1 through DU-19 and BADU-1 through BADU-8) will be comprised of 10 soil increments collected from each of 5 borings randomly located within each DU (generating a total of 50 increments per incremental sample), while each incremental sample from the smaller 60 x 60 ft DUs (DU-20 through DU-25) will be comprised of 10 soil increments collected from each of 3 borings randomly located within each DU (generating a total of 30 increments per incremental sample). Three sets of borings will be advanced at each onsite DUs in order to collect triplicate samples (i.e. 15 total borings in each approximately 1-acre sized DU and 9 borings in each smaller 60 x 60 ft DU).

A random number generator will be used to select the grid cell locations for each incremental sample boring in each DU, and borings will be located in the center of the randomly selected grid cell. Soil boring locations will be plotted in GIS and proposed soil boring coordinate information will be provided to the field sampling team prior to mobilization. A hand-held GPS unit will be used in the field to locate (typically to within sub-meter) proposed soil boring locations. The exact locations of the soil borings may be shifted from the center of the randomly selected grid cells as needed to avoid hardscapes, subsurface utilities, or other features that may impede soil boring advancement.

The ten individual subsurface soil increments from a single boring will be collected from random depth intervals (EA SOP 057). For each set of 10 increments, the first increment will be collected from a random starting depth within each interval. The remaining 9 increments will be collected at given depth below the random starting depth to cover the entire length of the boring. For example, within the 6-36 in. bgs depth interval at one boring, the random starting depth for increment collection may be 12-26 in. bgs. The remaining increments will be collected at 1-in. intervals throughout the remainder of the interval. If there is no or shallow subsurface soil is limited to 12 inches bgs in the DU, it will be documented in the field logbook and no subsurface samples will be collected for the DU. The field crew will attempt to collect subsurface soil at a minimum of five locations per DU to determine if there is shallow subsurface soil between 12 and 36 inches bgs and if not present they will notify the EA project manager who in turn will notify the USACE and discuss path forward.

Each subsurface soil increment will be 20 grams, which will provide a total weight of approximately 1 kilograms of soil. Adjacent soil borings will be advanced as needed to collect enough soil for each increment.

Shoreline Reconnaissance Survey

The shoreline reconnaissance survey will be conducted by field biologists along four reconnaissance areas, including the Hudson River shoreline (Recon Area 1), Iona Marsh shoreline (Recon Area 2), the western FUDS boundary between Iona and Round Island (Recon Area 3), and the eastern and western sides of the active River Subdivision (CSX Transportation) railroad tracks (Recon Area 4). The shoreline reconnaissance survey in Recon Areas 1 through 4 will consist of an exploration conducted by EA field biologists on foot during low tide. In addition, reconnaissance along the shoreline in Recon Areas 1 and 2 will include a survey by boat during high tide. Potential transport pathways to the shoreline (e.g., swales, culverts, channels, outfalls, discharge pipes, etc.), and the type of material/environment encountered along the shoreline (i.e., man-made structures such as rip-rap or retaining walls; exposed bedrock; gravel, cobble, or boulder shorelines) will be documented and photographed.

In addition, a receptor and resource inventory evaluation will be conducted along the shoreline (Recon Areas 1 and 2). Channel bathymetry and water depth at the shoreline will be recorded to evaluate the presence of any mudflats or habitat areas that may exist before the river bottom drops off into the deeper navigation channel. Undercuts beneath the shoreline will be documented. The lateral extent and thickness of soft-bottom sediments that could provide significant habitat will be measured and recorded. Observed wetland plant species and aquatic receptors will be documented and photographed.

Discrete sediment grab samples will be collected from 6 locations (3 samples collected along the Hudson River shoreline and 3 samples collected along the Iona Marsh shoreline) to evaluate the physical characteristics of the sediment and evaluate the potential for sediments to act as a “sink” for site-related constituents. Samples will be collected according to EA SOP 21 from a depth of 0-6 in. using appropriate sampling equipment (disposable scoops or decontaminated stainless steel scoops/spoons). Sediment samples will be submitted to Kahtadin Analytical Services, LLC for analysis of the following parameters:

- TOC by Walkley Black
- Grain size by ASTM D422.

Data Gap Sampling – Additional Phases of Work

The Phase I analytical data, the results of the Phase I Shoreline Reconnaissance Survey, and the decision criteria presented in Worksheet #11 (Step 2 of the 7-step DQO process) will be reviewed to determine if additional investigation is needed (i.e., Phase II). If it is determined that the collection of additional environmental media (e.g., surface and/or subsurface soil; overburden and/or bedrock groundwater; and/or sediment) is warranted, then an addendum to this UFP-QAPP will be prepared to present the DQOs for the Phase II investigation and the sampling methodology (including the media to be sampled, sampling locations, field tasks/methods, and analyses).

SAMPLE COLLECTION TASKS

Prior to collecting field samples, samplers will don clean, protective gloves. Samples will be collected for constituents listed in Worksheet #18. Sample containers will be provided by the analytical laboratory and will be pre-preserved for those constituents that require chemical preservation, as detailed in Worksheet #19 and #30.

FIELD QUALITY CONTROL TASKS

QC tasks will be overseen by EA's Field Team Leader and/or QC Manager. Requirements for calibration, maintenance, testing, and inspection of field equipment are summarized in Worksheet #22.

Field QC samples are intended to provide an indication of the consistency of sample collection and analyses over the course of the program. Field QC samples are listed on Worksheet #20 and include methanol field and trip blanks for BTEX samples as follows. Sampling locations are presented in Worksheet #18. The analytical laboratory will perform MS/MSD on soil samples at a rate of 1 per 20 samples as required by the analytical method.

Methanol Field and Trip Blanks

Methanol field and trip blanks (bottles containing methanol with no sample added) are required for ISM soil samples that will be composited in methanol in the field (i.e. BTEX samples). Field and trip blank bottles will be supplied by the laboratory in unopened, 40-milliliter volatile organic analyte (VOA) vials filled with laboratory-grade, analyte-free water.

A methanol field blank is a clean sample of matrix that is carried to the sampling site, opened in the field under the same conditions and for the same amount of time as the sample bottles, sealed, and transported to the laboratory. Field blank analytical results are used to detect and identify any VOC contaminants encountered in the field. A minimum of one methanol field blank will be collected daily when BTEX samples are collected.

A methanol trip blank is a clean sample of matrix that is carried to the sampling site and transported to the laboratory for analysis without having been exposed to sampling (e.g., bottle caps have not been removed. Trip blank analytical results are used to detect and identify any VOC contaminant of the samples from travelling to and from the lab. A minimum of one methanol trip blank will accompany each cooler containing soil samples sent to the laboratory for BTEX analysis.

SAMPLE HANDLING AND MANAGEMENT TASKS – EA

Samples will be placed in an iced cooler and maintained at less than 6 degrees Celsius (°C) (but not frozen) immediately upon collection. Samples will be labeled, packed, and shipped to the analytical laboratory, and tracked by secure chain-of-custody protocol in accordance with SOP 001 and SOP 004 as detailed in Worksheet #26 and #27. Records concerning the custody and condition of the samples will be maintained in field and laboratory records.

EQUIPMENT DECONTAMINATION TASKS – EA

Non-disposable, reusable equipment that may directly or indirectly contact samples will be decontaminated between sampling locations in accordance with SOP 005. This equipment includes, but is not limited to, incremental sampling tools used to collect incremental soil samples; drilling augers used during soil boring advancement; ponar dredges used during sediment sampling; stainless steel scoops or bowls used to composite discrete soil or sediment samples; and water level meters used to measure water depths in temporary wells.

Reusable personal protective equipment (PPE) or clothing that becomes contaminated during site work will be appropriately cleaned before reuse or will be disposed of and replaced.

INVESTIGATIVE DERIVED WASTE MANAGEMENT TASKS – EA, SUBCONTRACTORS

Expendable waste used in completing the sampling (including used PPE and general trash, dedicated acetate sleeves, temporary well casing and tubing, plastic spoons/scoops, etc.) will be bagged and properly disposed of as general debris/trash.

Decontamination wash water (deionized water and non-phosphate soap) will be limited and will be contained in 5-gallon buckets. Whether or not the disposal of wash water offsite is required will be determined among project stakeholders, and if necessary, the wash water will be characterized prior to disposal.

Soil cuttings generated during soil boring advancement will be returned to borings following removal of temporary wells. Decontamination fluids used during equipment decontamination tasks will be discarded to the ground surface.

LABORATORY ANALYSIS TASKS – LABORATORY

The analytical laboratory will process and analyze field samples and field QC samples according to the sample chain-of-custody documents, and the requirements of this UFP-QAPP. Ball mill grinding will be utilized during laboratory sample processing of TAL metals, PAH, explosives, and PCB soil samples collected using ISM as some of the PAHs are likely to volatilize or degrade during puck mill grinding due to heat generation by the process. Samples will be air dried and mortar and pestle milling will be utilized to minimize potential analyte losses during internal standard sample preparation.

BTEX soil increments will be combined in a laboratory provided jar with methanol. Grinding and air drying does not apply to the BTEX samples, which will be processed according to the procedure for analysis of a typical soil sample for BTEX analysis.

Analytical parameter methods for each sample are presented in Worksheet #18. Analytical SOPs are listed in Worksheet #23 and provided in Appendix G. Project screening levels and laboratory reference limits for analytes are presented in Worksheet #15. Samples will be analyzed for one or more of the following parameters as presented in Table 7-2 and Worksheet #18:

- TAL metals by EPA Method 6010C/6020A
- Mercury by EPA Method 7471B
- PAHs by EPA Method 8270D SIM
- BTEX by EPA Method 8260B
- Aroclor PCBs by EPA Method 8082A
- Explosives by Method 8330B
- TOC by Walkley Black
- Grain size by ASTM D422.

LABORATORY QUALITY CONTROL TASKS – LABORATORY

Laboratory QC tasks provide an indication of accuracy, precision, and sensitivity of analytical methods for each analytical batch of field samples that are analyzed. The project laboratory will be responsible for conducting laboratory QC procedures and reporting laboratory QC results in accordance with laboratory SOPs. The laboratory QA Manager is responsible for ensuring that laboratory internal QC checks are conducted in accordance with applicable methods and protocols, the laboratory's QA manual and the requirements of this UFP-QAPP.

The laboratory QC samples are method specific, as detailed in Worksheets #12 and #28. Internal and continuing calibration verification will be conducted for applicable equipment as summarized in Worksheets #24 and #25. Laboratory QC samples including method blanks, laboratory control samples (LCS), MS/MSDs, and calibration check standards will be prepared and analyzed in accordance with the analytical method requirements and laboratory SOPs as listed in Worksheet #23 and provided in Appendix G.

LABORATORY REPORTING TASKS – LABORATORY

Analytical data will be reviewed by the laboratory QC Manager prior to providing the data to EA. The analytical laboratory will provide SEDD (Stage 2A) deliverables in accordance with the most recently published SEDD specification (e.g., Specification 5.2), as well as PDFs of the final analytical reports, including supporting documentation such as chromatograms and instrument calibrations. The laboratory will upload the SEDD files directly into the FUDSChem.

DATA VERIFICATION AND VALIDATION TASKS – EA

Review activities for analytical data and other project inputs are summarized in Worksheets #34, #35, and #36. Analytical data will be verified by the EA Project Chemist for completeness upon receipt. Corrective actions will be made upon decision of necessity to maintain the overall quality of the project data.

Once a SEDD is successfully uploaded and certified by TestAmerica in FUDSChem, an Automated Data Review (ADR) process will be automatically initiated. The ADR will perform a Stage 2A data validation by comparing the SEDD to the approved eQAPP, summarizing QC outliers in an ADR Report, and applying data validation qualifiers to associated results. The "first review" EA chemist will perform a Stage 2B data validation based on the initial ADR Stage 2A validation. The data validator will review the ADR Report against the PDF laboratory report to 1) verify/modify the ADR qualification of the sample results and to 2) supplement the ADR review with a manual review of QC elements that were not included in the ADR review. The data validator will complete the data review checklist and prepare a data validation report that summarizes the data validation findings. The "second reviewer" EA chemist will review the data validation report and sign off as the second reviewer. The data validation report will then be uploaded to the FUDSChem library.

FUDSCHEM DATA MANAGEMENT – EA, LABORATORY

Analytical data will be managed in the FUDSChem per the requirements specified in the New England District Data Management Plan to ensure data deliverables follow Performance Work Statement data requirements. Other types of data that will be uploaded to FUDSChem include spatial information pertaining to sample locations (northing, easting, and elevation) and soil boring log information. The center of each DU will be used as the location coordinates in FUDSChem. Shape files of the DUs will be provided to Synetics to be uploaded to FUDSChem.

DOCUMENTATION AND RECORDS TASKS – EA

A bound field logbook will be used to record information about each field activity as detailed in SOP 059. Field activities will be recorded daily with black or blue waterproof ballpoint pens. Each page of field notes will be numbered and dated, and initials of crew members will be defined. Errors will be crossed out with a single line, initialed and dated, and correct data entered adjacent to the error. Pertinent information will be logged in the field logbook as follows:

- Personnel onsite and times onsite and offsite.
- Site conditions (including presence of airborne particulates [soot, dust, etc.], and presence of unusual odors) and visitors onsite (as well as arrival and departure times) for each day are recorded.
- The weather entry for each day including cloud cover (partly cloudy, full sun, etc.), precipitation (type and intensity), wind direction, temperature, wind speed, and humidity.
- Daily tasks completed and the start/end time of tasks and references to applicable field sheets.
- Sample collection information (location, matrix, sample identification number, date and time of sample collection, and analyses to be completed).
- Collection of QA/QC samples.
- Field screening results.
- References, such as maps or photographs of the sampling site.

The field logbooks will be maintained as follows:

- The cover of the field logbooks will list the project name, location, activities, name of contact and telephone number, start/end date, and time of logbook entries.
- No pages will be removed from the field logbooks.
- When author releases a specific field logbook, the new author will print his/her name, and will sign the field logbook prior to making any entries in the field logbook.

Field forms/field sheets will be maintained by the sampling team to provide a daily record of significant events, observations, and measurements taken during the field investigation. The field forms/field sheets are intended to provide sufficient data and observations to enable the field team to reconstruct events that occur during the project. Field forms/field sheets will include daily field logs, daily calibration forms and checklists, sample collection forms and checklists, and QC forms/checklists as provided in Appendix I. Additional field forms including health and safety forms (provided in the APP [Appendix A]) and chain-of-custody forms provided by the analytical laboratory will be completed for this project. Photographs will be used to document standard field procedures and conditions as well as unusual conditions observed during field activities.

EA will gather documentation of field work and data collection and generation activities, review it for completeness, include it in reports as warranted, and place it in a central project repository.

ASSESSMENT/AUDIT TASKS – EA

SOPs will be reviewed prior to the performance of tasks. Assessment and oversight tasks are detailed in Worksheets #31, #32, and #33 of this UFP-QAPP. Independent technical review and deliverable checks will be performed to assess the quality of field and reporting tasks. The Project Development Team will perform interdisciplinary checks to ensure minimal interference between tasks. The EA PM will be responsible for responding to the assessment findings, including corrective actions.

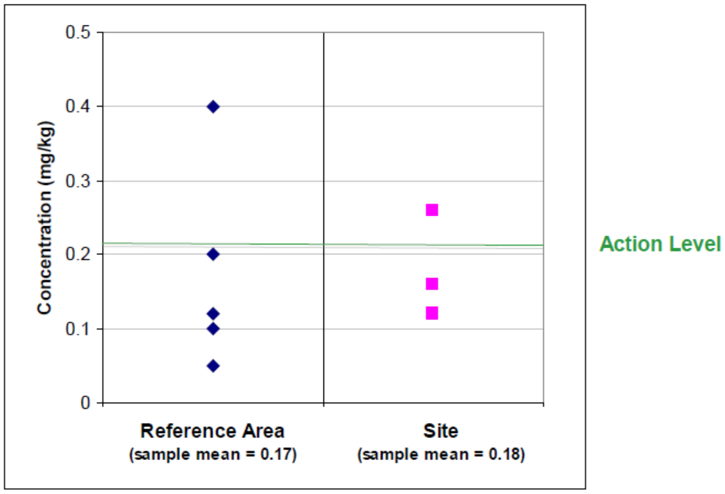
No external project-specific laboratory audits are planned by EA. The Laboratory QA Manager will conduct assessments of the laboratory procedures and data as described in the laboratory's QA manual. The laboratory is periodically audited through the DoD ELAP as part of their accreditation process.

DATA EVALUATION TASKS – EA

A data package will be generated for this project by the analytical laboratory and will include a case narrative, chain-of-custody record, QC summary data, sample results, standards data, raw QC data, and bench sheets for each analytical method. The concentration measurements not known to be in error will be considered valid; suspect outliers will not be removed from the data set and will be included in the analyses. Concentrations below the MDL will be reported as non-detect at the LOD with a U qualifier (e.g., if the LOD is 0.5 microgram per liter [µg/L], a concentration below the MDL will be set at 0.5 µg/L); a positive concentration detected below the LOQ but above the MDL will be at the concentration with a J qualifier (e.g., 0.2 µg/L J).

BACKGROUND EVALUATION TASKS – EA

The background comparison will be performed consistent with Decision Mechanism 4, Section 7.2.4 of ITRC (2012). As discussed in this guidance, because of the special characteristics associated with incremental sampling (low variance, small sample sizes), background comparison requires careful consideration. A variety of background comparisons are discussed and will be applied to the Iona Island background comparison. As discussed in ITRC (2012) a qualitative graphical comparison is initially suggested, as shown below:

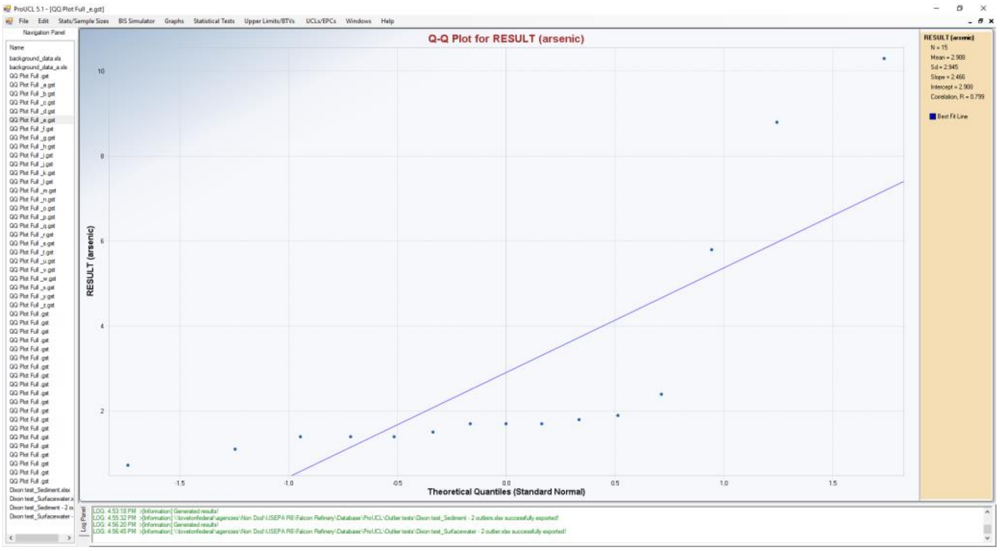


In the above example, each dot refers to individual IS results for the background/reference and site DUs. The action level has been added for informational purposes, and the example shows that site concentrations are the same as reference concentrations and further evaluation is not necessary.

Beyond the simple graphical presentation of background comparisons, the ITRC (2012) guidance indicates that EPA's background guidance (EPA 2002) can be used when sufficient background data are available. For this project, eight independent background DUs will be sampled (both surface and subsurface soil). As a result, standard background comparison techniques described in EPA (2002) can and will be performed as necessary on the data including:

- Quantile-Quantile (Q-Q) plots to examine for potential outliers
- Outlier statistical tests (specifically the Dixon's outlier test)
- Derivation of 95% Upper Tolerance Limits (UTLs; EPA 2002) and/or 95% Upper Predictive Limits (UPL; EPA 2015b), for point-by-point comparison to site data
- Student-t tests or Wilcoxon rank sum tests to determine if site concentrations are significantly higher than background.

An example Q-Q plot is shown below to demonstrate outlier identification.



```
LOG: 4:53:18 PM >[Information] Generated results!
LOG: 4:55:32 PM >[Information] \\lovetonfederal\agencies\Non Dod\USEPA R6\Falcon Refinery\Database\ProUCL\Outlier tests\Dixon test_Sediment - 2 outliers.xlsx successfully exported!
LOG: 4:56:20 PM >[Information] Generated results!
LOG: 4:56:45 PM >[Information] \\lovetonfederal\agencies\Non Dod\USEPA R6\Falcon Refinery\Database\ProUCL\Outlier tests\Dixon test_Surfacewater - 2 outlier.xlsx successfully exported!
```

Each point on the above plot represents a background sample, and the three high concentration data points do not fit what would be expected from the rest of the dataset. In this case a Dixon's outlier statistical test was performed which indicate these three points are outliers and they were subsequently removed from the background dataset.

Following removal of outliers, the UTL or UPL will be calculated using ProUCL 5.1 or the most recent version. Point-by-point comparison of site DU concentrations to the UTL or UPL provides a 95% confidence that that site concentration is above or below the background value. It is important to note that the total error is cumulative, in that there is a 5% probability of deciding a site concentration is less than background when it actually is not, and if a second point is compared there is a total 10% total probability.

In addition to point-by-point comparisons, statistical distribution tests can be performed to evaluate if the distribution of site data is significantly higher than the distribution of background data. These tests can be performed using a Student-t test for normally distributed data. If the data are nonparametrically distributed, the Wilcoxon Rank Sum test can be performed.

RISK ASSESSMENT TASKS – EA

The ERA and HHRA will focus on quantifying exposures that result in potential risk. The risk assessments will follow various CERCLA guidance (e.g., EPA 1989, 1997, 1998, 2015) and the USACE Risk Assessment Handbook, Volume I and II (USACE 2010). Specific details regarding the processes that will be followed for conducting the HHRA and ERA are presented in associated work plans in Appendices D and E, respectively. The ERA will consist of a SLERA and RSLERA, and if, necessary, a BERA. Flowcharts for conducting the ERA have been developed by USACE New England District (NAE) and are presented as Attachment 1 to the Ecological Risk Assessment Work Plan in Appendix E.

PHASE I REPORTING TASKS – EA

Phase I results will be presented in a Phase I RI Data Summary Report for review by USACE, NYSDEC, and PIPC. A technical project planning meeting will be held to gain government and stakeholder input and document decision points regarding potential implementation of Phase II data collection and analysis, if required.

PHASE II ACTIVITIES – EA, PROJECT TEAM

Following completion of Phase I field activities, a review of analytical results, and preparation and submittal of the Phase I RI Data Summary Report, the Project Team will evaluate whether sufficient data have been collected to resolve the DQOs, and whether analytical results are as expected based on historical results and current site conditions. If unexpected results are found, and/or additional investigation is necessary to meet project objectives or support development of the HHRA and ERA, the Project Team will develop the Phase II sampling design and rationale. Phase II activities, if needed, will be addressed under an addendum to this UFP-QAPP.

REMEDIAL INVESTIGATION REPORT– EA

The EA Team will prepare an RI report in accordance with CERCLA and will document the results of the HTRW RI field activities and risk assessments. The RI report will present existing site conditions, the findings from the field efforts, an evaluation of the nature and extent of contamination, and the potential hazard or risk to human health and the environment. Preliminary Draft, Draft, Draft Final, and Final versions of the RI report will be prepared.

Data generated as part of the RI will be used to support the evaluation of remedial alternatives (as necessary) in an FS. If analytical results and risk assessments indicate that COPC concentrations pose a potential risk to human health and/or the environment, then remedial alternatives will be developed to address those potential risks and to move forward through the remedial process toward respective future land use (i.e., conservation area) as a part of the FS. It should be noted that only unacceptable risks require remedial action. Only those specific constituents identified as COCs will be carried forward to the FS for development of remedial alternatives.

FEASIBILITY STUDY – EA

Based on the results of the RI, a FS report will be prepared to support an informed risk management decision regarding a potential remedial approach that would be the most appropriate, cost effective, and protective of public health and the environment. The FS will be conducted in accordance with the most recent versions of EPA Guidance for Conducting RIs and FSs Under CERCLA (EPA/540/G-89/004) (EPA 1988) and NYSDEC Division of Environmental Remediation-10 (NYSDEC 2010a). The FS will present remedial action objectives to address hazards/risks to receptors identified during the RI including construction workers, recreational users, trespassers, and potential ecological receptors. The FS will also present the identification and screening of remedial technologies; selection of remedial technologies for alternative development;

identification of ARARs; development of remedial alternatives; and evaluation of alternatives against National Contingency Plan criteria.

The FS will follow a standard format that includes evaluation of general response actions, technology screening, selection of process options, alternative assembly/analysis, and consideration of ARARs. ARARs are promulgated enforceable requirements. The compliance with ARARs mandate arises under CERCLA when an onsite remedial action is required because of unacceptable risk found through the CERCLA risk assessment process. Potential state ARARs are considered during the remedial alternative evaluation at the FS phase of the CERCLA process. Therefore, New York State requirements would be considered in the context of the ARARs process under two contexts: (1) a stated excess cancer risk or (2) chemical-specific standards based on a specified excess cancer risk level.

Detailed analysis of alternatives will include consideration of the nine threshold, balancing, and modifying criteria specified by the National Contingency Plan (overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; short-term effectiveness; implementability; total cost [30-year present worth]; State or Support Agency acceptance; and Community Acceptance). The remedial alternatives evaluated will be protective of public health and the environment, compliant to the maximum extent practicable with cleanup objectives, reflective of a preference for treatment over simple disposal, and will be cost effective.

A minimum of three alternatives will be included in the FS: (1) no action; (2) alternative(s) that achieves unrestricted use/unlimited exposure, and (3) alternative(s) that makes the site safe for current and respective future land use (i.e., conservation area). The no action alternative assumes the site would stay in its present condition and is evaluated as a procedural requirement and as a basis for comparison. Additional remedial alternatives will be developed using key guidance and relevant technologies to address site-related contamination issues identified during the RI.

The following alternatives may be included in the FS:

- No Action—A required alternative as a baseline to compare to other remedies
- Land use controls (LUCs)
- Removal to remediate to a protective condition that requires LUCs
- Removal to remediate to unlimited use/unrestricted exposure.

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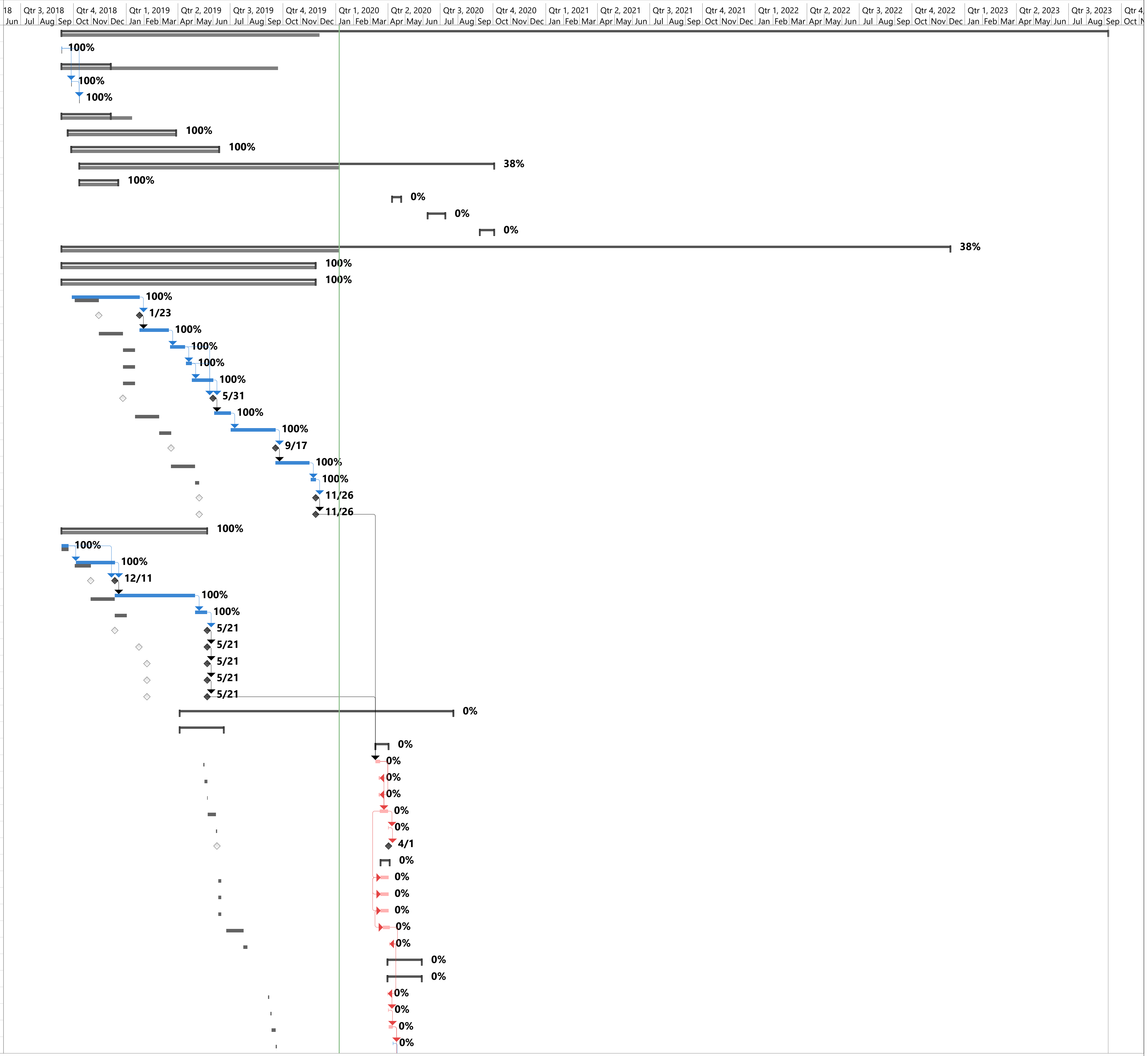
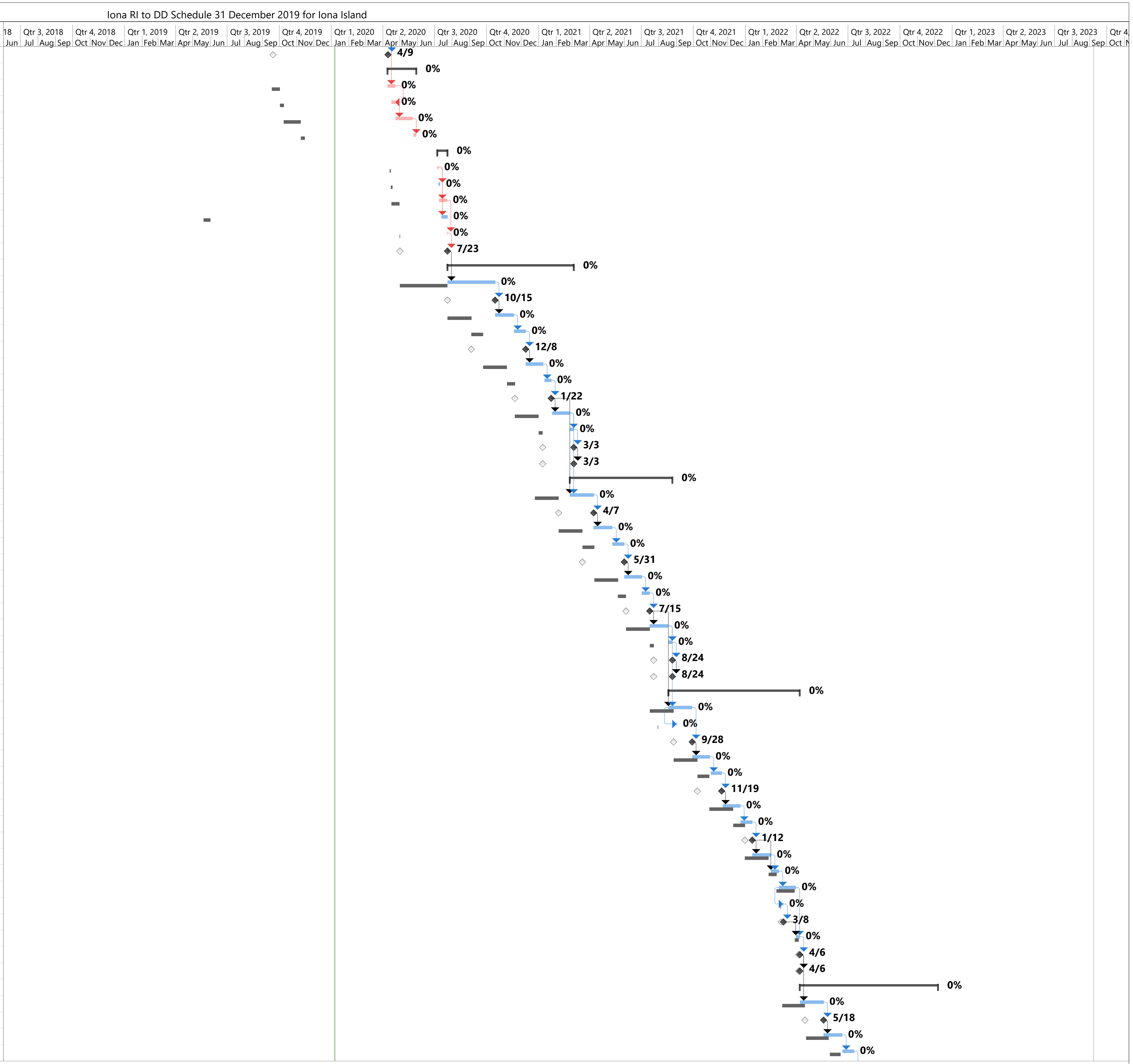
Iona RI to DD Schedule 31 December 2019 for Iona Island

ID	Task Name	Duration	Start	Finish
1	**Iona Island FUDS - RI through DD at MRS-02 - MMRP - 1903 Explosion and 19 HTRW**	**1304 days**	**Mon 9/10/18**	**Thu 9/7/23**
2	Notice to Proceed / Award (10 September 2018) - Iona Island FUDS	1 day	Mon 9/10/18	Mon 9/10/18
3	**CLIN 0001 Project Management Plan**	**62 days**	**Mon 9/10/18**	**Tue 12/4/18**
4	Kick-off Meeting with USACE and EA	1 day	Thu 9/27/18	Thu 9/27/18
5	Site Walk with USACE and Park Rangers	1 day	Thu 10/11/18	Thu 10/11/18
6	**CLIN 0001a - Project Management Plan (PMP)**	**62 days**	**Mon 9/10/18**	**Tue 12/4/18**
13	**CLIN 0001b Community Relations Plan (CRP)**	**135 days**	**Fri 9/21/18**	**Thu 3/28/19**
26	**Explosives Siting Plan (ESP) - To be completed by USACE**	**184 days**	**Thu 9/27/18**	**Tue 6/11/19**
36	**CLIN 0001c Meetings**	**517 days**	**Thu 10/11/18**	**Fri 10/2/20**
37	**CLIN 0001c-2 Technical Project Planning (TPP) Meeting #1 - Present MMRP**	**48 days**	**Thu 10/11/18**	**Mon 12/17/18**
47	**CLIN 0001c-3 TPP Meeting #2 - Present Digital Geophysical Mapping (DGM)**	**12 days**	**Wed 4/8/20**	**Thu 4/23/20**
54	**CLIN 0001c-4 TPP Meeting #3 - Present Advanced Geophysical Classification**	**23 days**	**Mon 6/8/20**	**Thu 7/9/20**
61	**CLIN 0001c-5 TPP Meeting #4 - Present MMRP Intrusive Results and**	**19 days**	**Tue 9/8/20**	**Fri 10/2/20**
68	**CLIN 0002 MMRP MRS-1 1903 Explosion**	**1107 days**	**Mon 9/10/18**	**Tue 12/6/22**
69	**CLIN 0002a-2 MMRP MRS-1 1903 Explosion - Remedial Investigation (RI) UFP**	**317 days**	**Mon 9/10/18**	**Tue 11/26/19**
70	**MMRP MRS-1 1903 Explosion - RI Work Plan (UFP-QAPP WP to include**	**317 days**	**Mon 9/10/18**	**Tue 11/26/19**
71	Preliminary Draft RI Work Plan Preparation	84 days	Fri 9/28/18	Wed 1/23/19
72	Submission of Preliminary Draft Remedial Investigation Work Plan	0 days	Wed 1/23/19	Wed 1/23/19
73	USACE Review	37 days	Thu 1/24/19	Fri 3/15/19
74	RLSO of Preliminary Draft RI Work Plan Preparation	20 days	Mon 3/18/19	Fri 4/12/19
75	USACE Back check RLSO Preliminary Draft RI Work Plan	8 days	Mon 4/15/19	Wed 4/24/19
76	Draft RI Work Plan Preparation	27 days	Thu 4/25/19	Fri 5/31/19
77	Submission of Draft RI Work Plan	0 days	Fri 5/31/19	Fri 5/31/19
78	Army Stakeholder Review of Draft RI Work Plan	21 days	Mon 6/3/19	Mon 7/1/19
79	Draft Final RI Work Plan Preparation	56 days	Tue 7/2/19	Tue 9/17/19
80	Submit Draft Final RI Work Plan	0 days	Tue 9/17/19	Tue 9/17/19
81	Draft Final RI Work Plan Review by NYSDEC and Property Owners	43 days	Wed 9/18/19	Fri 11/15/19
82	Final RI Work Plan Preparation	7 days	Mon 11/18/19	Tue 11/26/19
83	Submission of Final Remedial Investigation Work Plan	0 days	Tue 11/26/19	Tue 11/26/19
84	Final RI Work Plan Approval	0 days	Tue 11/26/19	Tue 11/26/19
85	**Accident Prevention Plan (APP) with Site Safety and Health Plan (SSHP) and**	**182 days**	**Mon 9/10/18**	**Tue 5/21/19**
86	Develop Site Specific Hazard Evaluation for USACE Review	10 days	Mon 9/10/18	Fri 9/21/18
87	Preliminary Draft APP / SSHP Preparation	48 days	Fri 10/5/18	Tue 12/11/18
88	Submission of Preliminary Draft APP / SSHP	0 days	Tue 12/11/18	Tue 12/11/18
89	USACE Review	100 days	Wed 12/12/18	Tue 4/30/19
90	Draft APP / SSHP Preparation	15 days	Wed 5/1/19	Tue 5/21/19
91	Submission of Draft APP / SSHP	0 days	Tue 5/21/19	Tue 5/21/19
92	Army Stakeholder Review of Draft APP / SSHP	0 days	Tue 5/21/19	Tue 5/21/19
93	Final APP / SSHP Preparation	0 days	Tue 5/21/19	Tue 5/21/19
94	Submission of Final APP / SSHP	0 days	Tue 5/21/19	Tue 5/21/19
95	Final APP / SSHP Accepted	0 days	Tue 5/21/19	Tue 5/21/19
96	**CLIN 0002b MMRP MRS-1 1903 Explosion - Remedial Investigation Field Work**	**341 days**	**Thu 4/4/19**	**Thu 7/23/20**
97	**Field Session #1 - MMRP MRS-1 1903 Explosion**	**55 days**	**Thu 4/4/19**	**Wed 6/19/19**
98	**CLIN 0002b-1 Field Work Session #1 - MMRP MRS-1 1903 Explosion - Digital**	**17 days**	**Tue 3/10/20**	**Wed 4/1/20**
99	Mobilization, Site Setup, Brush Clearing, and Surface Clearance	6 days	Tue 3/10/20	Tue 3/17/20
100	DGM Mob in, Blind Seeding, etc.	2 days	Mon 3/16/20	Tue 3/17/20
101	DGM Instrument Verification Survey (IVS)	2 days	Mon 3/16/20	Tue 3/17/20
102	DGM Survey	10 days	Wed 3/18/20	Tue 3/31/20
103	Demobilization DGM	1 day	Wed 4/1/20	Wed 4/1/20
104	Completion of Field Work	0 days	Wed 4/1/20	Wed 4/1/20
105	**Data Processing #1 - DGM Data**	**12 days**	**Thu 3/19/20**	**Fri 4/3/20**
106	DGM Data Analysis	10 days	Thu 3/19/20	Wed 4/1/20
107	Target Anomaly Identification	10 days	Thu 3/19/20	Wed 4/1/20
108	Potential Disposal Feature Identification	10 days	Thu 3/19/20	Wed 4/1/20
109	Review of Data with USACE (and Stakeholders if Requested)	10 days	Mon 3/23/20	Fri 4/3/20
110	Completion of Data Processing and Finalization of Cued List	1 day	Fri 4/3/20	Fri 4/3/20
111	**Field Session #2 - MMRP MRS-1 1903 Explosion**	**44 days**	**Tue 3/31/20**	**Fri 5/29/20**
112	**CLIN 0002b-2 Field Work Session #2 - MMRP MRS-1 1903 Explosion -**	**44 days**	**Tue 3/31/20**	**Fri 5/29/20**
113	Mobilization, Site Setup, and Equipment Testing	1 day	Tue 3/31/20	Tue 3/31/20
114	AGC IVS	1 day	Wed 4/1/20	Wed 4/1/20
115	Reacquire and Cued Survey Anomalies with AGC	5 days	Thu 4/2/20	Wed 4/8/20
116	Demobilization	1 day	Thu 4/9/20	Thu 4/9/20



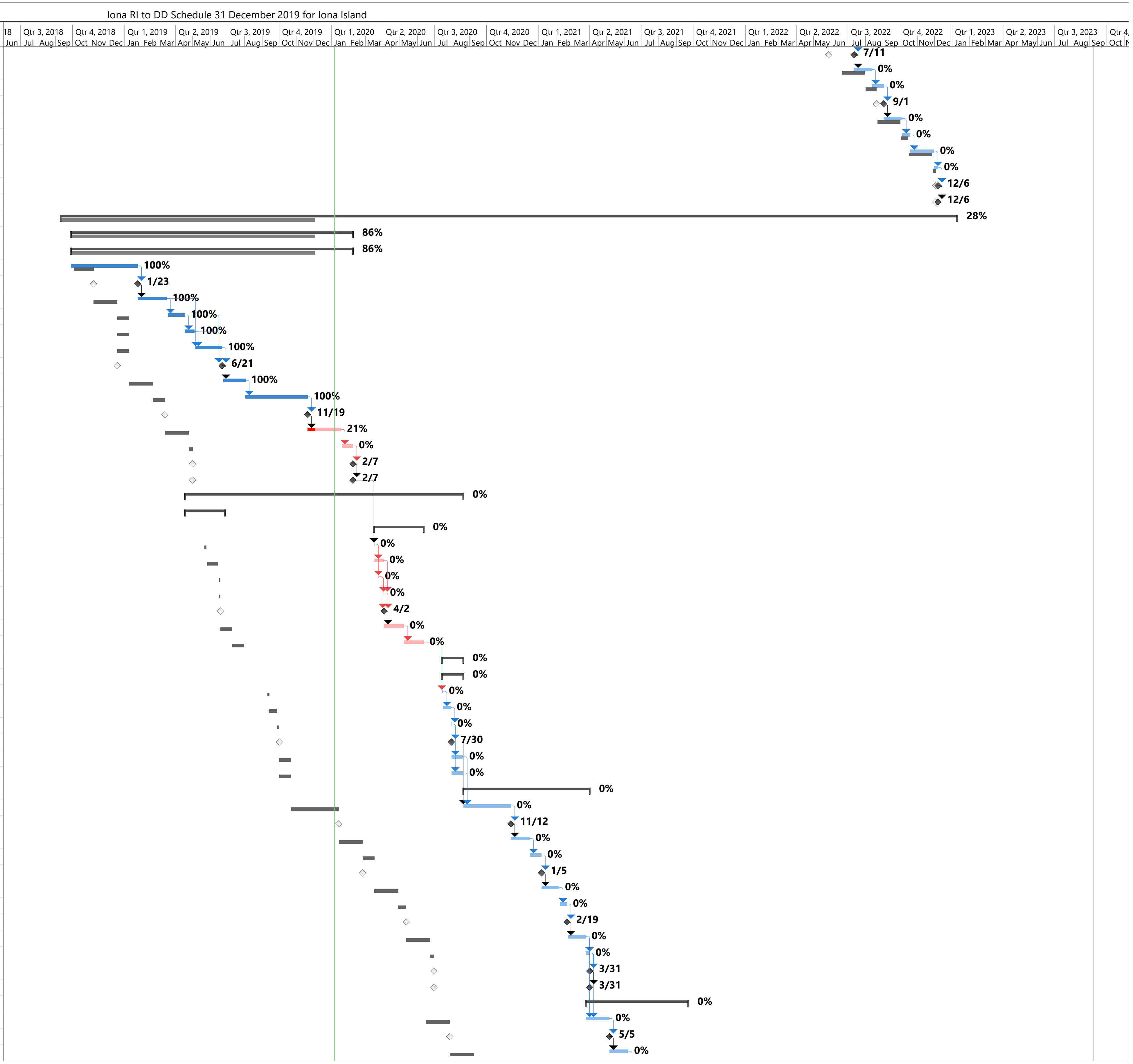
Critical	▬	Task	▬	Manual Task	▬	Duration-only	▬	Baseline Milestone	◇	Summary	⎴	External Tasks	▬	Inactive Milestone	◇
Critical Split	┈	Split	┈	Start-only	[	Baseline	▬	Milestone	◆	Manual Summary	⎴	External Milestone	◇	Inactive Summary	⎴
Critical Progress	▬	Task Progress	▬	Finish-only	]	Baseline Split	┈	Summary Progress	▬	Project Summary	⎴	Inactive Task	▬	Deadline	⬇

ID	Task Name	Duration	Start	Finish
117	Completion of Field Work	0 days	Thu 4/9/20	Thu 4/9/20
118	**Data Processing #2 - AGC Data**	**37 days**	**Thu 4/9/20**	**Fri 5/29/20**
119	AGC Data Analysis	10 days	Thu 4/9/20	Wed 4/22/20
120	Generate "dig list" targets for Intrusive Investigation	5 days	Thu 4/16/20	Wed 4/22/20
121	Review of Data with USACE (and Stakeholders if Requested)	22 days	Thu 4/23/20	Fri 5/22/20
122	Completion of Data Processing	5 days	Mon 5/25/20	Fri 5/29/20
123	**CLIN 0002b-3 Field Work Session #3 - MMRP MRS-1 1903 Explosion - Intrusive**	**14 days**	**Mon 7/6/20**	**Thu 7/23/20**
124	Mobilization and Site Setup	2 days	Mon 7/6/20	Tue 7/7/20
125	Reacquisition of Selected AGC Anomalies	3 days	Wed 7/8/20	Fri 7/10/20
126	Intrusive Investigation of Selected AGC Anomalies as well as Shoreline,	10 days	Thu 7/9/20	Wed 7/22/20
127	Dive on Three Loading Dock Areas, Video of Underwater Environment, and	9 days	Mon 7/13/20	Thu 7/23/20
128	Demobilization of Land and Dive UXO Teams	1 day	Thu 7/23/20	Thu 7/23/20
129	Completion of Field Work	0 days	Thu 7/23/20	Thu 7/23/20
130	**CLIN 0002c RI Report for MMRP MRS-01 1903 Explosion**	**159 days**	**Fri 7/24/20**	**Wed 3/3/21**
131	Preliminary-Draft RI Report Preparation	60 days	Fri 7/24/20	Thu 10/15/20
132	Submission of Preliminary-Draft Remedial Investigation Report	0 days	Thu 10/15/20	Thu 10/15/20
133	USACE Review	23 days	Fri 10/16/20	Tue 11/17/20
134	Draft RI Report Preparation	15 days	Wed 11/18/20	Tue 12/8/20
135	Submission of Draft RI Report	0 days	Tue 12/8/20	Tue 12/8/20
136	Army Stakeholder Review of Draft RI Report	23 days	Wed 12/9/20	Fri 1/8/21
137	Draft Final RI Report Preparation	10 days	Mon 1/11/21	Fri 1/22/21
138	Submit Draft Final RI Report for Review by NYSDEC and Property Owners	0 days	Fri 1/22/21	Fri 1/22/21
139	Draft Final RI Report Review by NYSDEC and Property Owners	23 days	Mon 1/25/21	Wed 2/24/21
140	Final RI Report Preparation	5 days	Thu 2/25/21	Wed 3/3/21
141	Submission of Final Remedial Investigation Report (including EDD and GIS Data)	0 days	Wed 3/3/21	Wed 3/3/21
142	Final RI Report Approval	0 days	Wed 3/3/21	Wed 3/3/21
143	**CLIN 0002d Feasibility Study (FS) for MMRP MRS-01 1903 Explosion (If Required)**	**129 days**	**Thu 2/25/21**	**Tue 8/24/21**
144	Preliminary Draft FS Preparation	30 days	Thu 2/25/21	Wed 4/7/21
145	Submission of Preliminary Draft Feasibility Study Report	0 days	Wed 4/7/21	Wed 4/7/21
146	USACE Review	23 days	Thu 4/8/21	Mon 5/10/21
147	Draft FS Report Preparation	15 days	Tue 5/11/21	Mon 5/31/21
148	Submission of Draft FS Report	0 days	Mon 5/31/21	Mon 5/31/21
149	Army Stakeholder Review of Draft FS Report	23 days	Tue 6/1/21	Thu 7/1/21
150	Draft Final FS Report Preparation	10 days	Fri 7/2/21	Thu 7/15/21
151	Submit Draft Final FS to NYSDEC & Property Owners Review	0 days	Thu 7/15/21	Thu 7/15/21
152	NYSDEC and Property Owners Review	23 days	Fri 7/16/21	Tue 8/17/21
153	Final FS Preparation	5 days	Wed 8/18/21	Tue 8/24/21
154	Submission of Final Feasibility Study Report	0 days	Tue 8/24/21	Tue 8/24/21
155	Final FS Approval	0 days	Tue 8/24/21	Tue 8/24/21
156	**CLIN 0002e Proposed Plan (PP) for MMRP MRS-01 1903 Explosion**	**166 days**	**Wed 8/18/21**	**Wed 4/6/22**
157	Preliminary Draft PP Preparation	30 days	Wed 8/18/21	Tue 9/28/21
158	Discuss (via teleconference) with Project Delivery Team Preliminary Draft of	1 day	Wed 9/1/21	Wed 9/1/21
159	Submission of Preliminary Draft Proposed Plan	0 days	Tue 9/28/21	Tue 9/28/21
160	USACE Review	23 days	Wed 9/29/21	Fri 10/29/21
161	Draft PP Preparation	15 days	Mon 11/1/21	Fri 11/19/21
162	Submission of Draft PP	0 days	Fri 11/19/21	Fri 11/19/21
163	Army Stakeholder Review of Draft PP	23 days	Mon 11/22/21	Wed 12/22/21
164	Draft Final PP Preparation	15 days	Thu 12/23/21	Wed 1/12/22
165	Submit Draft Final PP to NYSDEC and Property Owners Review	0 days	Wed 1/12/22	Wed 1/12/22
166	NYSDEC and Property Owners Review	23 days	Thu 1/13/22	Mon 2/14/22
167	Incorporate NYSDEC & Property Owners Comments	10 days	Tue 2/15/22	Mon 2/28/22
168	Public Notice in Local Paper (30 Calendar Day Comment Period)	22 days	Tue 3/1/22	Wed 3/30/22
169	Public Meeting	1 day	Tue 3/8/22	Tue 3/8/22
170	Completion of Proposed Plan Public Meeting	0 days	Tue 3/8/22	Tue 3/8/22
171	Final PP Preparation	5 days	Thu 3/31/22	Wed 4/6/22
172	Submission of Final Proposed Plan	0 days	Wed 4/6/22	Wed 4/6/22
173	Final PP Approval	0 days	Wed 4/6/22	Wed 4/6/22
174	**CLIN 0002f Decision Document (DD) for MMRP MRS-01 1903 Explosion**	**174 days**	**Thu 4/7/22**	**Tue 12/6/22**
175	Preliminary Draft Decision Document Preparation	30 days	Thu 4/7/22	Wed 5/18/22
176	Submission of Preliminary Draft Decision Document	0 days	Wed 5/18/22	Wed 5/18/22
177	USACE Review	23 days	Thu 5/19/22	Mon 6/20/22
178	Draft Decision Document Preparation	15 days	Tue 6/21/22	Mon 7/11/22



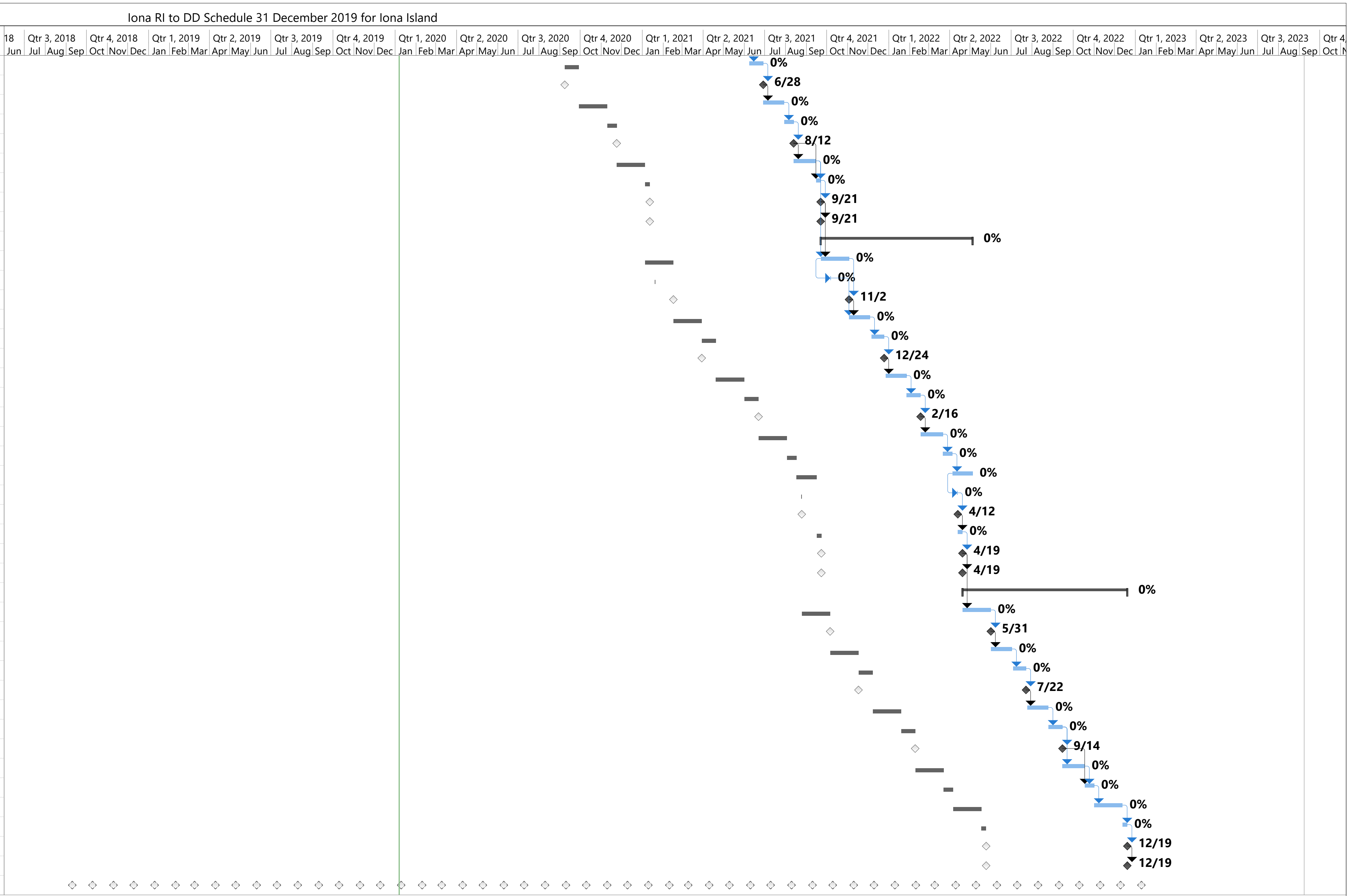
Critical	▬	Task	▬	Manual Task	▬	Duration-only	▬	Baseline Milestone	◇	Summary	┌─┐	External Tasks	▬	Inactive Milestone	◇
Critical Split	┈	Split	┈	Start-only	[	Baseline	▬	Milestone	◆	Manual Summary	┌─┐	External Milestone	◇	Inactive Summary	┌─┐
Critical Progress	▬	Task Progress	▬	Finish-only	]	Baseline Split	┈	Summary Progress	▬	Project Summary	┌─┐	Inactive Task	▬	Deadline	⇩

ID	Task Name	Duration	Start	Finish
179	Submission of Draft Decision Document	0 days	Mon 7/11/22	Mon 7/11/22
180	Army Stakeholder Review of Draft Decision Document	23 days	Tue 7/12/22	Thu 8/11/22
181	Draft Final Decision Document Preparation	15 days	Fri 8/12/22	Thu 9/1/22
182	Submit Draft Final DD to NYSDEC and Property Owners for Review	0 days	Thu 9/1/22	Thu 9/1/22
183	NYSDEC and Property Owners Review	23 days	Fri 9/2/22	Tue 10/4/22
184	Incorporate NYSDEC and Property Owners Comments	10 days	Wed 10/5/22	Tue 10/18/22
185	USACE HQ Review	30 days	Wed 10/19/22	Tue 11/29/22
186	Final Decision Document Preparation	5 days	Wed 11/30/22	Tue 12/6/22
187	Submission of Final Decision Document	0 days	Tue 12/6/22	Tue 12/6/22
188	Final Decision Document Approval	0 days	Tue 12/6/22	Tue 12/6/22
189	**CLIN 0003 HTRW AOCs**	**1131 days**	**Mon 9/10/18**	**Tue 1/10/23**
190	**CLIN 0003a RI WP - HTRW AOCs**	**356 days**	**Fri 9/28/18**	**Fri 2/7/20**
191	**HTRW AOCS - RI Work Plan (HTRW investigations) (APP to be completed**	**356 days**	**Fri 9/28/18**	**Fri 2/7/20**
192	Preliminary Draft RI Work Plan Preparation	84 days	Fri 9/28/18	Wed 1/23/19
193	Submission of Preliminary Draft Remedial Investigation Work Plan	0 days	Wed 1/23/19	Wed 1/23/19
194	USACE Review	37 days	Thu 1/24/19	Fri 3/15/19
195	RLSO of Preliminary Draft Preparation	22 days	Mon 3/18/19	Tue 4/16/19
196	USACE Back check RLSO of Preliminary Draft RI Work Plan	13 days	Wed 4/17/19	Fri 5/3/19
197	Draft RI Work Plan Preparation (Including HHRA and Ecological Work Plans)	35 days	Mon 5/6/19	Fri 6/21/19
198	Submission of Draft RI Work Plan	0 days	Fri 6/21/19	Fri 6/21/19
199	Army Stakeholder Review of Draft RI Work Plan	29 days	Mon 6/24/19	Thu 8/1/19
200	Draft Final RI Work Plan Preparation (includes CX backcheck)	78 days	Fri 8/2/19	Tue 11/19/19
201	Submit Draft Final RI Work Plan	0 days	Tue 11/19/19	Tue 11/19/19
202	Draft Final RI Work Plan Review by NYSDEC & Property Owners	43 days	Wed 11/20/19	Fri 1/17/20
203	Final RI Work Plan Preparation	15 days	Mon 1/20/20	Fri 2/7/20
204	Submission of Final Remedial Investigation Work Plan	0 days	Fri 2/7/20	Fri 2/7/20
205	Final RI Work Plan Approval	0 days	Fri 2/7/20	Fri 2/7/20
206	**CLIN 0003b Remedial Investigation Field Work - HTRW AOCs**	**351 days**	**Thu 4/18/19**	**Thu 8/20/20**
207	**Field Session #1 - HTRW AOCs**	**50 days**	**Thu 4/18/19**	**Wed 6/26/19**
208	**CLIN 0003b-1 RI Fieldwork for Initial HTRW AOCs Sampling (Soil) for AOCs**	**64 days**	**Mon 3/16/20**	**Thu 6/11/20**
209	Mobilization & Site Setup	1 day	Mon 3/16/20	Mon 3/16/20
210	Field Sampling (Incremental Sampling)	12 days	Tue 3/17/20	Wed 4/1/20
211	Shoreline Reconnaissance	1 day	Tue 3/24/20	Tue 3/24/20
212	Demobilization	1 day	Thu 4/2/20	Thu 4/2/20
213	Completion of Field Work	0 days	Thu 4/2/20	Thu 4/2/20
214	Data Analysis	25 days	Fri 4/3/20	Thu 5/7/20
215	Data Validation	25 days	Fri 5/8/20	Thu 6/11/20
216	**Field Session #2 - HTRW AOCs**	**28 days**	**Tue 7/14/20**	**Thu 8/20/20**
217	**CLIN 0003b-2 RI Fieldwork for Data Gap Sampling of HTRW AOCs**	**28 days**	**Tue 7/14/20**	**Thu 8/20/20**
218	Mobilization and Site Setup	2 days	Tue 7/14/20	Wed 7/15/20
219	Field Sampling	10 days	Thu 7/16/20	Wed 7/29/20
220	Demobilization	1 day	Thu 7/30/20	Thu 7/30/20
221	Completion of Field Work	0 days	Thu 7/30/20	Thu 7/30/20
222	Data Analysis (2nd visit)	15 days	Fri 7/31/20	Thu 8/20/20
223	Data Validation (2nd Visit)	15 days	Fri 7/31/20	Thu 8/20/20
224	**CLIN 0003c RI Report for HTRW AOCs**	**159 days**	**Fri 8/21/20**	**Wed 3/31/21**
225	Preliminary-Draft RI Report Preparation	60 days	Fri 8/21/20	Thu 11/12/20
226	Submission of Preliminary-Draft Remedial Investigation Report	0 days	Thu 11/12/20	Thu 11/12/20
227	USACE Review	23 days	Fri 11/13/20	Tue 12/15/20
228	Draft RI Report Preparation	15 days	Wed 12/16/20	Tue 1/5/21
229	Submission of Draft RI Report	0 days	Tue 1/5/21	Tue 1/5/21
230	Army Stakeholder Review of Draft RI Report	23 days	Wed 1/6/21	Fri 2/5/21
231	Draft Final RI Report Preparation	10 days	Mon 2/8/21	Fri 2/19/21
232	Submit Draft Final RI Report for Review by NYSDEC & Property Owners	0 days	Fri 2/19/21	Fri 2/19/21
233	Draft Final RI Report Review by NYSDEC & Property Owner's	23 days	Mon 2/22/21	Wed 3/24/21
234	Final RI Report Preparation	5 days	Thu 3/25/21	Wed 3/31/21
235	Submission of Final Remedial Investigation Report	0 days	Wed 3/31/21	Wed 3/31/21
236	Final RI Report Approval (including EDD and GIS Data)	0 days	Wed 3/31/21	Wed 3/31/21
237	**CLIN 0003d FS for HTRW AOCs**	**129 days**	**Thu 3/25/21**	**Tue 9/21/21**
238	Preliminary Draft FS Preparation	30 days	Thu 3/25/21	Wed 5/5/21
239	Submission of Preliminary Draft Feasibility Study Report	0 days	Wed 5/5/21	Wed 5/5/21
240	USACE Review	23 days	Thu 5/6/21	Mon 6/7/21



Critical		Task		Manual Task		Duration-only		Baseline Milestone	◇	Summary		External Tasks		Inactive Milestone	◇
Critical Split		Split		Start-only	[	Baseline		Milestone	◆	Manual Summary		External Milestone	◇	Inactive Summary	
Critical Progress		Task Progress		Finish-only	]	Baseline Split		Summary Progress		Project Summary		Inactive Task		Deadline	⬇

ID	Task Name	Duration	Start	Finish
241	Draft FS Report Preparation	15 days	Tue 6/8/21	Mon 6/28/21
242	Submission of Draft FS Report	0 days	Mon 6/28/21	Mon 6/28/21
243	Army Stakeholder Review of Draft FS Report	23 days	Tue 6/29/21	Thu 7/29/21
244	Draft Final FS Report Preparation	10 days	Fri 7/30/21	Thu 8/12/21
245	Submit Draft Final FS to NYSDEC & Property Owners Review	0 days	Thu 8/12/21	Thu 8/12/21
246	NYSDEC & Property Owners Review	23 days	Fri 8/13/21	Tue 9/14/21
247	Final FS Preparation	5 days	Wed 9/15/21	Tue 9/21/21
248	Submission of Final Feasibility Study Report	0 days	Tue 9/21/21	Tue 9/21/21
249	Final FS Approval	0 days	Tue 9/21/21	Tue 9/21/21
250	**CLIN 0003e - PP for HTRW AOCs**	**161 days**	**Wed 9/22/21**	**Wed 5/4/22**
251	Preliminary Draft PP Preparation	30 days	Wed 9/22/21	Tue 11/2/21
252	Discuss (via teleconference) with Project Delivery Team Preliminary Draft of	1 day	Wed 10/6/21	Wed 10/6/21
253	Submission of Preliminary Draft Proposed Plan	0 days	Tue 11/2/21	Tue 11/2/21
254	USACE Review	23 days	Wed 11/3/21	Fri 12/3/21
255	Draft PP Preparation	15 days	Mon 12/6/21	Fri 12/24/21
256	Submission of Draft PP	0 days	Fri 12/24/21	Fri 12/24/21
257	Army Stakeholder Review of Draft PP	23 days	Mon 12/27/21	Wed 1/26/22
258	Draft Final PP Preparation	15 days	Thu 1/27/22	Wed 2/16/22
259	Submit Draft Final PP to NYSDEC & Property Owners Review	0 days	Wed 2/16/22	Wed 2/16/22
260	NYSDEC & Property Owners Review	23 days	Thu 2/17/22	Mon 3/21/22
261	Incorporate NYSDEC & Property Owners Comments	10 days	Tue 3/22/22	Mon 4/4/22
262	Public Notice in Local Paper (30 Calendar Day Comment Period)	22 days	Tue 4/5/22	Wed 5/4/22
263	Public Meeting	1 day	Tue 4/12/22	Tue 4/12/22
264	Completion of Proposed Plan Public Meeting	0 days	Tue 4/12/22	Tue 4/12/22
265	Final PP Preparation	5 days	Wed 4/13/22	Tue 4/19/22
266	Submission of Final Proposed Plan	0 days	Tue 4/19/22	Tue 4/19/22
267	Final PP Approval	0 days	Tue 4/19/22	Tue 4/19/22
268	**CLIN 0003f DD for HTRW AOCs**	**174 days**	**Wed 4/20/22**	**Mon 12/19/22**
269	Preliminary Draft Decision Document Preparation	30 days	Wed 4/20/22	Tue 5/31/22
270	Submission of Preliminary Draft Decision Document	0 days	Tue 5/31/22	Tue 5/31/22
271	USACE Review	23 days	Wed 6/1/22	Fri 7/1/22
272	Draft Decision Document Preparation	15 days	Mon 7/4/22	Fri 7/22/22
273	Submission of Draft Decision Document	0 days	Fri 7/22/22	Fri 7/22/22
274	Army Stakeholder Review of Draft Decision Document	23 days	Mon 7/25/22	Wed 8/24/22
275	Draft Final Decision Document Preparation	15 days	Thu 8/25/22	Wed 9/14/22
276	Submit Draft Final DD to NYSDEC & Property Owners for Review	0 days	Wed 9/14/22	Wed 9/14/22
277	NYSDEC & Property Owners Review	23 days	Thu 9/15/22	Mon 10/17/22
278	Incorporate NYSDEC & Property Owners Comments	10 days	Tue 10/18/22	Mon 10/31/22
279	USACE HQ Review	30 days	Tue 11/1/22	Mon 12/12/22
280	Final Decision Document Preparation	5 days	Tue 12/13/22	Mon 12/19/22
281	Submission of Final Decision Document	0 days	Mon 12/19/22	Mon 12/19/22
282	Final Decision Document Approval	0 days	Mon 12/19/22	Mon 12/19/22
283	**Monthly Status Report (Completed when DDs are Finalized)**	**1131 days**	**Mon 9/10/18**	**Tue 1/10/23**



Critical	━	Task	━	Manual Task	━	Duration-only	━	Baseline Milestone	◇	Summary	┏━┓	External Tasks	━	Inactive Milestone	◇
Critical Split	┈	Split	┈	Start-only	[	Baseline	━	Milestone	◆	Manual Summary	┏━┓	External Milestone	◇	Inactive Summary	┏━┓
Critical Progress	━	Task Progress	━	Finish-only	]	Baseline Split	┈	Summary Progress	━	Project Summary	┏━┓	Inactive Task		Deadline	⇩

QAPP Worksheet #15 – Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

This worksheet presents analytical methods, analytes, the lowest screening values for human and ecological risk[9], and achievable laboratory limits including LOQs, LODs, and MDLs. The purpose of this worksheet is to determine if laboratory limits will be meet project action limits (i.e., screening values).

The MDL is the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration at the 99% level of confidence. Although a result at or above the MDL indicates that the analyte is present, the absence of a result at or above the MDL is inconclusive (i.e., one cannot confidently state whether the analyte is present or absent), because the false negative rate at the MDL is 50%. The MDL is used to determine the LOD for each analyte and matrix as well as for preparatory and cleanup methods routinely used on samples.

The LOD is the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a 99% confidence level. If a sample has a true concentration at the LOD, there is a minimum probability of 99% of reporting a detection (a measured value greater than or equal to the MDL) and a 1% chance of reporting a non-detect (a false negative). Due to the false negative rate at the LOD (1%), the laboratory will report non-detectable values as less than the LOD.

The LOQ is the lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias. The LOQ is typically larger than the LOD (but may be equal to the LOD, depending upon the acceptance limits for precision and bias). Quantitative concentration results within specified limits of precision and bias can only be achieved at or above the LOQ; however, the analytical laboratory may identify analytes between the MDL and the LOQ. In these instances, the laboratory will report concentration values between the MDL and the LOQ as estimated (J) values.

To meet MQOs for sensitivity, the LODs for non-detects and LOQs for detections need to be less than the projects action levels (PALs). When MQOs for sensitivity are not met, the results will not be usable for determining whether the analyte concentrations are above or below the PALs. Best available common laboratory methods for analyses are being used.

The most sensitive commercially available analytical methods are being utilized for the analyses presented in this UFP-QAPP. However, there are circumstances where theoretically determined toxicity values are so low that commercially available analytical methods cannot achieve them. These have been highlighted in the following tables with shading. In the human health and ecological risk assessments, not detected analytes where risk screening values are lower than the

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[9] Screening values are identified in the Human Health and Ecological Risk Assessment Work Plans presented in Appendix D and Appendix E, respectively. The lowest ecological screening values are presented in Worksheet 15. A compilation of ecological screening values used to select the lowest values is presented in Attachment 4 of the Ecological Risk Assessment Work Plan (Appendix E).

LOD (to which the laboratory will report as not detected) will be addressed in the uncertainty sections of each risk assessment

PALs in red indicate where the laboratory LOD is higher than the screening value (N-Methyl-2,4,6-trinitrophenylnitramine). Shaded cells indicate where the laboratory LOQ is higher than the lowest screening values (mercury, thallium, n-methyl-2,4,6-trinitrophenylnitroamine, 2-nitrotoluene (2NT), 3-nitrotoluene (3NT), 4-nitrotoluene (4NT), and nitroglycerine). There is some uncertainty in the data for analytes with LOQs that are higher than the screening values. This will be addressed as an uncertainty associated with the project. Matrix effects or necessary dilutions may affect the laboratory limits reported for project samples.

Table 15-1 – Reference Limits and Evaluation Table for Metals - Soil

Matrix: Soil
Analytical Group: TAL Metals by EPA SW 846 Methods 6010C/6020A and Mercury by EPA SW Method 7471B
Concentration Level: Low

Analyte	CAS No.	EPA Screening Levels[1,2,3,4]			Achievable Laboratory Limits (mg/kg)		
		Residential Soil RSL (mg/kg)[1,2]	Industrial Soil RSL (mg/kg)[1]	EPA Region 4 Ecological Soil Screening Levels (mg/kg)[3]	MDL	LOD	LOQ
Aluminum	7429-90-5	7,700	110,000	NS	1.55	6	50
Antimony	7440-36-0	3.1	47	0.27	0.014	0.05	0.2
Arsenic	7440-38-2	0.68	3	6.8	0.0506	0.2	0.6
Barium	7440-39-3	1,500	22,000	110	0.0705	0.2	0.25
Beryllium	7440-41-7	16	230	2.5	0.0225	0.08	0.1
Cadmium	7440-43-9	7.1	98	0.36	0.00938	0.035	0.1
Calcium	7440-70-2	NS	NS	NS	14.1	50	100
Chromium, Total	7440-47-3	12,000	180,000	23	0.076	0.175	0.6
Cobalt	7440-48-4	2.3	35	13	0.00663	0.025	0.1
Copper	7440-50-8	310	4,700	28	0.0711	0.2	2.5
Iron	7439-89-6	5,500	82,000	NS	3.8	15	80
Lead	7439-92-1	400	800	11	0.0182	0.07	0.4
Magnesium	7439-95-4	NS	NS	NS	3.7	14	30
Manganese	7439-96-5	180	2,600	220	0.033	0.1	1
Mercury	7439-97-6	1.1	4.6	0.013	0.00553	0.0133	0.017
Nickel	7440-02-0	150	2,200	38	0.0253	0.1	0.35
Potassium	7440-09-7	NS	NS	NS	41	160	300
Selenium	7782-49-2	39	580	0.52	0.133	0.4	0.5
Silver	7440-22-4	39	580	4.2	0.0203	0.08	0.1
Sodium	7440-23-5	NS	NS	NS	59	100	500
Thallium	7440-28-0	0.078	1.2	0.05	0.00351	0.01	0.1
Vanadium	7440-62-2	39	580	7.8	0.0385	0.1	0.5
Zinc	7440-66-6	2,300	35,000	46	0.316	0.95	2.5

1) EPA Regional Screening Levels Table, EPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10-6.
2) A deed restriction is in place noting that there is to be no residential development at the site (USACE 1995); however, EPA residential soil RSLs are included to assess for children receptors including site visitation for nature walks and potential camping.
3) EPA Region 4 Ecological Risk Assessment Supplemental Guidance. Scientific Support Section Superfund Division EPA Region 4. March 2018. Screening values are further detailed in Appendix E, Ecological Risk Assessment Work Plan.
4) Shaded cells indicate where the laboratory LOQ is higher than the screening value. If these contaminants are not detected, they will be discussed in the uncertainty sections of the risk assessments.

NOTES:
CAS = Chemical abstract services
EPA = United States Environmental Protection Agency
HI = Hazard index
LOD = Limit of detection
LOQ = Limit of quantitation
MDL = Method detection limit
mg/kg = Milligram(s) per kilogram
NS = No standard
RSL = Regional screening level
TAL = Target analyte list

Table 15-2 – Reference Limits and Evaluation Table for Polycyclic Aromatic Hydrocarbons – Soil

Matrix: Soil
Analytical Group: PAHs EPA SW-846 Method 8270D SIM
Concentration Level: Trace

		EPA Screening Levels			Achievable Laboratory Limits (mg/kg)		
Analyte	**CAS No.**	**Residential Soil RSL (mg/kg)[1,2]**	**Industrial Soil RSL (mg/kg)[1]**	**EPA Region 4 Ecological Soil Screening Levels (mg/kg)[3]**	**MDL**	**LOD**	**LOQ**
1-Methylnaphthalene	90-12-0	18	73	29	0.00052	0.002	0.01
2-Methylnaphthalene	91-57-6	24	300	29	0.00052	0.002	0.01
Acenaphthene	83-32-9	360	4,500	29	0.00032	0.00107	0.01
Acenaphthylene	208-96-8	NS	NS	29	0.00034	0.00107	0.01
Anthracene	120-12-7	1,800	23,000	29	0.00144	0.00433	0.01
Benzo(a)anthracene	56-55-3	1.1	21	1.1	0.0018	0.00433	0.01
Benzo(a)pyrene	50-32-8	0.11	2.1	1.1	0.00148	0.00433	0.01
Benzo(b)fluoranthene	205-99-2	1.1	21	1.1	0.0024	0.00667	0.01
Benzo(g,h,i)perylene	191-24-2	NS	NS	1.1	0.0022	0.00667	0.01
Benzo(k)fluoranthene	207-08-9	11	210	1.1	0.002	0.00433	0.01
Chrysene	218-01-9	110	2,100	1.1	0.002	0.00433	0.01
Dibenz(a,h)anthracene	53-70-3	0.11	2.1	1.1	0.0026	0.00667	0.01
Fluoranthene	206-44-0	240	3,000	1.1	0.002	0.00433	0.01
Fluorene	86-73-7	240	3,000	29	0.00094	0.00267	0.01
Indeno(1,2,3-cd)pyrene	193-39-5	1.1	21	1.1	0.0022	0.00667	0.01
Naphthalene	91-20-3	3.8	17	29	0.000652	0.002	0.01
Phenanthrene	85-01-8	NS	NS	29	0.0022	0.00667	0.01
Pyrene	129-00-0	180	2,300	1.1	0.0022	0.00667	0.01

1) EPA Regional Screening Levels Table, EPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to $1\text{x}10^{-6}$.
2) A deed restriction is in place noting that there is to be no residential development at the site (USACE 1995); however, EPA residential soil RSLs are included to assess for children receptors including site visitation for nature walks and potential camping.
3) EPA Region 4 Ecological Risk Assessment Supplemental Guidance. Scientific Support Section Superfund Division EPA Region 4. March 2018. Screening values are further detailed in Appendix E, Ecological Risk Assessment Work Plan.

NOTES:
CAS = Chemical abstract services
EPA = United States Environmental Protection Agency
HI = Hazard index
LOD = Limit of detection
LOQ = Limit of quantitation
MDL = Method detection limit
mg/kg = Milligram(s) per kilogram
NS = No standard
PAH = Polycyclic aromatic hydrocarbon
RSL = Regional screening level

Table 15-3 – Reference Limits and Evaluation Table for Benzene, Toluene, Ethylbenzene, and Xylenes – Soil

Matrix: Soil
Analytical Group: Target Compound List Volatile Organic Compounds EPA SW-846 Method 8260B
Concentration Level: Low

Analyte	CAS No.	EPA Screening Criteria			Achievable Laboratory Limits (mg/kg)		
		Residential Soil RSL (mg/kg)^{1,2}	Industrial Soil RSL (mg/kg)^{1}	EPA Region 4 Ecological Soil Screening Levels (mg/kg)^{3}	MDL	LOD	LOQ
Benzene	71-43-2	1.2	5.1	NS	0.0451	0.16	0.25
Ethylbenzene	100-41-4	5.8	25	NS	0.034	0.08	0.25
m,p-Xylene	108-38-3	55	240	NS	0.078	0.16	0.25
o-Xylene	95-47-6	65	280	NS	0.035	0.08	0.125
Toluene	108-88-3	490	4,700	NS	0.039	0.08	0.25
Xylenes (total)	1330-20-7	58	250	NS	0.035	0.08	0.125

1) EPA Regional Screening Levels Table, EPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to $1x10^{-6}$.
2) A deed restriction is in place noting that there is to be no residential development at the site (USACE 1995); however, EPA residential soil RSLs are included to assess for children receptors including site visitation for nature walks and potential camping.
3) EPA Region 4 Ecological Risk Assessment Supplemental Guidance. Scientific Support Section Superfund Division EPA Region 4. March 2018. Screening values are further detailed in Appendix E, Ecological Risk Assessment Work Plan.

NOTES:
BTEX = Benzene, toluene, ethylbenzene, and xylenes
CAS = Chemical abstract services
EPA = United States Environmental Protection Agency
HI = Hazard index
LOD = Limit of detection
LOQ = Limit of quantitation
MDL = Method detection limit
mg/kg = Milligram(s) per kilogram
NS = No standard
RSL = Regional screening level

Table 15-4 – Reference Limits and Evaluation Table for Polychlorinated Biphenyls – Soil

Matrix: Soil
Analytical Group: PCBs EPA Method 8082A
Concentration Level: Low

Analyte	CAS No.	EPA Screening Levels			Achievable Laboratory Limits (mg/kg)		
		Residential Soil RSL (mg/kg)[1,2]	Industrial Soil RSL (mg/kg)[1]	EPA Region 4 Ecological Soil Screening Levels (mg/kg)[3]	MDL	LOD	LOQ
Aroclor 1016	12674-11-2	0.41	5.1	NS	0.0102	0.0307	0.066
Aroclor 1221	11104-28-2	0.2	0.83	NS	0.0312	0.08	0.094
Aroclor 1232	11141-16-5	0.17	0.72	NS	0.0102	0.0307	0.066
Aroclor 1242	53469-21-9	0.23	0.95	NS	0.0182	0.048	0.066
Aroclor 1248	12672-29-6	0.23	0.95	NS	0.0112	0.0333	0.066
Aroclor 1254	11097-69-1	0.12	0.97	NS	0.011	0.0333	0.066
Aroclor 1260	11096-82-5	0.24	0.99	NS	0.0053	0.016	0.066
Aroclor 1262	37324-23-5	NS	NS	NS	0.0232	0.06	0.066
Aroclor 1268	11100-14-4	NS	NS	NS	0.0079	0.024	0.066
Total PCBs	1336-36-3	0.23	0.94	0.041	NA	NA	NA

1) EPA Regional Screening Levels Table, EPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10^{-6}.
2) A deed restriction is in place noting that there is to be no residential development at the site (USACE 1995); however, EPA residential soil RSLs are included to assess for children receptors including site visitation for nature walks and potential camping.
3) EPA Region 4 Ecological Risk Assessment Supplemental Guidance. Scientific Support Section Superfund Division EPA Region 4. March 2018. Screening values are further detailed in Appendix E, Ecological Risk Assessment Work Plan.

NOTES:
CAS = Chemical abstract services
EPA = United States Environmental Protection Agency
HI = Hazard index
LOD = Limit of detection
LOQ = Limit of quantitation
MDL = Method detection limit
mg/kg = Milligram(s) per kilogram
PCB = Polychlorinated biphenyl
NA = Not applicable
NS = No standard
RSL = Regional screening level

Table 15-5 – Reference Limits and Evaluation Table for Explosives – Soil

Matrix: Soil
Analytical Group: Explosives by 8330B
Concentration Level: Low

		EPA Screening Levels[1,2,3,4]			Achievable Laboratory Limits (mg/kg)		
Analyte	**CAS No.**	**Residential Soil RSL (mg/kg)[1,2]**	**Industrial Soil RSL (mg/kg)[1]**	**EPA Region 4 Ecological Soil Screening Levels (mg/kg)[3]**	**MDL**	**LOD**	**LOQ**
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	390	5,700	16	0.0227	0.0400	0.100
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	8.3	38	2.3	0.0430	0.100	0.200
2,4,6-Trinitrotoluene (TNT)	118-96-7	3.6	51	7.5	0.0307	0.100	0.100
1,3,5-Trinitrobenzene (TNB)	99-35-4	220	3,200	0.3	0.0138	0.0400	0.100
1,3-Dinitrobenzene (DNB)	99-65-0	0.63	8.2	0.034	0.0166	0.0400	0.100
N-Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	479-45-8	0.16	230	0.018	0.0439	0.100	0.200
Nitrobenzene (NB)	98-95-3	5.1	22	2.2	0.0850	0.100	0.300
2-Amino-4,6-dinitrotoluene (2AMDNT)	35572-78-2	15	230	14	0.0329	0.100	0.100
4-Amino-2,6-dinitrotoluene (4AMDNT)	19406-51-0	NS	NS	12	0.0299	0.100	0.100
2,6-Dinitrotoluene (26DNT)	606-20-2	0.36	1.5	4	0.0191	0.0400	0.100
2,4-Dinitrotoluene (24DNT)	121-14-2	1.7	7.4	6	0.0147	0.0400	0.100
2-Nitrotoluene (2NT)	88-72-2	3.2	15	0.19	0.0472	0.100	0.200
3-Nitrotoluene (3NT)	99-08-1	0.63	8.2	0.13	0.0640	0.100	0.200
4-Nitrotoluene (4NT)	99-99-0	25	140	0.14	0.0365	0.100	0.200
Nitroglycerin (NG)	55-63-0	0.63	8.2	13	0.215	0.400	2.00
3,5-Dinitroaniline	618-87-1	NS	NS	NS	0.00900	0.0200	0.100
PETN	78-11-5	13	160	2.2	0.493	1.00	2.00

1) EPA Regional Screening Levels Table, EPA, May 2019. Value shown is equal to HI=0.1. Carcinogenic values equal to 1x10^{-6}.
2) A deed restriction is in place noting that there is to be no residential development at the site (USACE 1995); however, EPA residential soil RSLs are included to assess for children receptors including site visitation for nature walks and potential camping.
3) EPA Region 4 Ecological Risk Assessment Supplemental Guidance. Scientific Support Section Superfund Division EPA Region 4. March 2018. Screening values are further detailed in Appendix E, Ecological Risk Assessment Work Plan.
4) Shaded cells indicate where the laboratory LOQ is higher than the screening value. If these contaminants are not detected, they will be discussed in the uncertainty sections of the risk assessments.

NOTES:
CAS = Chemical abstract services
EPA = United States Environmental Protection Agency
HI = Hazard index
LOD = Limit of detection
LOQ = Limit of quantitation
MDL = Method detection limit
Mg/kg = Milligram(s) per kilogram
NS = No standard
RSL = Regional screening level

Table 15-6 – Reference Limits and Evaluation Table for Total Organic Carbon – Sediment

Matrix: Sediment
Analytical Group: Total Organic Carbon by Walkley-Black
Concentration Level: Low

Analyte	Achievable Laboratory Limits (% dry weight)		
	MDL	LOD	LOQ
Total Organic Carbon	0.01	0.04	0.1

QAPP Worksheet #17 –Sample Design and Rationale

This UFP-QAPP worksheet documents the overall process for the design and rationale of the sampling program for the HTRW project RI. This worksheet is used to develop and document the investigative approach, in terms of the types of activities/procedures to be conducted, investigative locations, field methodologies, matrices to be sampled, analytical groups to be analyzed and at what concentration levels (QC samples), the number of samples to be taken, and the sampling frequency (including seasonal considerations).

If the field conditions encountered during the HTRW RI warrant changes to the field tasks or sampling plans, the Field Team Leader will notify the EA PM immediately upon discovery. Field changes will be communicated as presented in Worksheet #6. Specifically, once notified, the EA PM will notify the USACE PM within 24 hours verbally or via email. Based on a review of the proposed change, and if required by the USACE, a field change request memorandum will be submitted within 1 week to the USACE PM for review and approval. It should be noted that unanticipated field changes may require a UFP-QAPP addendum, amendment, and/or revision. This requirement will be determined in consultation with the USACE PM following notification of the proposed change. Any UFP-QAPP addendum, amendment, and/or revision will be submitted to the USACE and regulators for review, comment, and approval.

Describe and provide a rationale for choosing the sampling approach

This HTRW RI is being conducted to characterize the nature and extent of impacts to environmental media (surface soil, subsurface soil, and other media as necessary [i.e., sediment, surface water, and groundwater]) associated with 19 AOCs identified as being eligible for further investigation under the FUDS HTRW project, and assess potential exposure pathways and risk to human receptors (e.g., park workers, researchers, trespassers, recreational visitors, and/or construction workers) and/or ecological receptors (e.g., terrestrial invertebrates, terrestrial plants, wildlife). As described in Worksheets #10 and #11, the primary COPCs for this investigation vary by AOC. A comprehensive list of COPCs identified for AOCs is presented in Table 10-5.

A multi-phased approach will be conducted during this HTRW project RI as presented in Worksheet #11 to facilitate information evaluation, communication, and discussion. Phase I will include a shoreline reconnaissance survey along the eastern and western sides of Iona Island and along the active River Subdivision (CSX Transportation) railroad tracks; comprehensive evaluations of COPCs in surface soil and shallow subsurface soil; a background investigation of TAL metals and PAHs in soil; a targeted investigation of BTEX (subsurface soil) and PAHs (surface and subsurface soil) at AOC #13 - Area A (one former fuel oil AST located near former Building 233), AOC 14 - Area B (one former fuel oil AST located near Dock 131), and AOC #15 - Area C (two former fuel oil ASTs located near former Building 417); a targeted investigation of PCBs at AOC #19 (three former transformers); and a targeted investigation of explosives and PCBs at AOC #16 – Area D (Dumping Area). Additional sampling for explosives residues will be conducted at the seven additional former buildings identified as having a significant potential for explosive hazard, pending direction of contracting officer.

The Phase I media to be investigated, sample locations, sample depth, and analyses have been selected to evaluate impacts to environmental media and define primary source contaminants of concern in each media for human and/or ecological receptors. The shoreline reconnaissance survey areas are presented in Figure 11-2. An ISM approach has been selected for surface and subsurface soil to reduce data variability and increase sample representativeness. Background sampling will be conducted at the locations presented on Figure 11-3 to establish regional background metal and PAH concentration ranges in surface and subsurface soil. Onsite DUs have been established as detailed in Worksheet #11 and presented on Figure 11-4 and 11-5. The Phase I sampling data needs and sampling rationale are presented in Tables 17-1 and 17-2. The list of analyses to be completed for each media during Phase I is presented below:

- TAL metals by EPA Method 6010C/6020A (surface and subsurface soil from each of the 19 approximately 1-acre [200 x 200 ft] sized DUs established to address HTRW AOCs and associated COPCs [DU-1 through DU-19] and surface and subsurface soil from each of the 8 offsite background approximately 1-acre [200 x 200 ft] sized DUs [BADU-1 through BADU-8])

- Mercury by EPA Method 7471B (surface and subsurface soil from 16 of the approximately 1-acre [200 x 200 ft] sized DUs established to address HTRW AOCs and associated COPCs [DU-1 through DU-5, DU-8 and DU-9, DU-11 through DU-19] and surface and subsurface soil from each of the 8 offsite background approximately 1-acre [200 x 200 ft] sized DUs [BADU-1 through BADU-8])

- PAHs by EPA Method 8270D SIM (surface and subsurface soil from 14 of the approximately 1-acre [200 x 200 ft] sized DUs established to address HTRW AOCs and associated COPCs [DU-1 through DU-5, DU-8 and DU-9, DU-11 through DU-13, and DU-16 through DU-19], surface and subsurface soil from each of the 8 offsite background approximately 1-acre [200 x 200 ft] sized DUs [BADU-1 through BADU-8], and surface and subsurface soil from 3 of the smaller 60 x 60 ft DUs established to address AOCs #13, #14, and #15 [locations/footprints of 4 former fuel oil ASTs DU-20, DU-21, and DU-22])

- PCBs by EPA Method 8082A (surface and subsurface soil from 3 of the approximately 1-acre [200 x 200 ft] sized DUs established to address AOC #16 – Area D [Dumping area; DU-17, DU-18, and DU-19] and surface and subsurface soil from 3 of the smaller 60 x 60 ft DUs established to address AOC #19 [three former transformer locations; DU-23, DU-24, and DU-25])

- Explosives residues by Method 8330B (surface and subsurface soil from 3 of the approximately 1-acre [200 x 200 ft] sized DUs established to address AOC #16 – Area D [Dumping area; DU-17, DU-18, and DU-19], and surface soil only from 7 additional approximately 1-acre [200 x 200 ft or 100 x 400 ft] sized DUs established at former buildings identified as having a significant potential for explosive hazard [pending direction of contracting offer; EXDU-1 through EXDU-7]).

- BTEX by EPA Method 8260B (subsurface soil only from 3 of the smaller 60 x 60 ft DUs established to address AOCs #13, #14, and #15 [locations/footprints of 4 former fuel oil ASTs DU-20, DU-21, and DU-22]).

- TOC by Walkley Black (sediment sampling locations)

- Grain size by ASTM D422 (sediment sampling locations).

Phase I data will be evaluated and presented in a Phase I data summary report. An HHRA and an ERA will be prepared using analytical data obtained from this investigation. Risk assessment work plans are presented in Appendix D (human health) and Appendix E (ecological receptors). If additional data are needed to fill data gaps, ensure that DQOs are met, fully delineate the nature and extent of COPCs, or support the risk assessments, then additional data will be collected during the subsequent Phase II investigation. The sampling design and rationale for subsequent investigations will be provided as addenda to this UFP-QAPP.

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Table 17-1 Phase I Data Needs (Phase I Investigation to be Conducted in Spring 2020)

Sample Matrix	Parameter	Analytical Method	Rationale for Analysis	Data Use
Surface and/or Shallow Subsurface Soil	TAL Metals	EPA Methods 6010C/6020A	Widespread metals detections reported in surface and/or subsurface soil during previous investigations. Additional data are needed to evaluate the nature and extent of impacts and to evaluate potential exposure pathways and risk to human and ecological receptors. The TAL metals list is being evaluated to fully characterize metals concentrations. Background sampling will be conducted.	Determine if metals are present in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) at concentrations above background and applicable screening criteria and if concentrations pose a risk to human and/or ecological receptors. Determine background concentrations of metals in surface soil (0-6 in. bgs) and shallow subsurface (6-36 in. bgs) soil outside the influence of the Iona Island Naval Ammunition Depot FUDS.
	Mercury	EPA Method 7471B	Widespread mercury detections reported in surface and/or subsurface soil during previous investigations. Additional data are needed to evaluate the nature and extent of impacts and to evaluate potential exposure pathways and risk to human and ecological receptors.	Determine if mercury is present in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) at concentrations above background and applicable screening criteria and if concentrations pose a risk to human and/or ecological receptors. Determine background concentrations of mercury in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) outside the influence of the Iona Island Naval Ammunition Depot FUDS.
	PAHs	EPA Method 8270D SIM	Widespread PAH detections reported in surface and/or subsurface soil during previous investigations. Additional data are needed to evaluate the nature and extent of impacts and to evaluate potential exposure pathways and risk to human and ecological receptors. SIM analysis is needed to meet screening values for PAHs.	Determine if PAHs are present in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) at concentrations above applicable screening criteria and if concentrations pose a risk to human and/or ecological receptors. Determine the presence/absence of PAHs in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) at AOC #13 - Area A (one former fuel oil AST located near former Building 233), AOC #14 - Area B (one former fuel oil AST located near Dock 131), and AOC #15 - Area C (two former fuel oil ASTs located near former Building 417) are present at elevated concentrations above background and applicable screening criteria and if concentrations pose a risk to human and/or ecological receptors. Determine background concentrations of PAHs in surface and shallow subsurface soil (6-36 in. bgs) outside the influence of the Iona Island Naval Ammunition Depot FUDS.
	BTEX	EPA Method 8260B	Primary COPCs associated with former fuel oil ASTs at AOC #13 - Area A (one former fuel oil AST located near former Building 233), AOC #14 - Area B (one former fuel oil AST located near Dock 131), and AOC #15 - Area C (two former fuel oil ASTs located near former Building 417). While VOCs were previously sampled at three of the former fuel oil ASTs, these locations were not closed out. Additional investigation is needed to evaluate the ASTs.	Determine the presence/absence of BTEX in shallow subsurface soil (6-36 in. bgs) at AOC #13 - Area A (one former fuel oil AST located near former Building 233), AOC #14 - Area B (one former fuel oil AST located near Dock 131), and AOC #15 - Area C (two former fuel oil ASTs located near former Building 417) at concentrations above applicable screening criteria and if concentrations pose a risk to human and/or ecological receptors.
	Aroclor PCBs	EPA Method 8082A	Primary COPCs associated with AOC #19 (three former transformers). Former transformer locations have not been previously investigated. Elevated concentrations of PCBs were reported in AOC #16 - Area D (Dumping Area) during the 1996 investigation.	Determine the presence/absence of PCBs in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) at AOC #19 (three former transformers). Determine if PCBs are present in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) at AOC #16 - Area D (Dumping Area) at concentrations above applicable screening criteria and if concentrations pose a risk to human and/or ecological receptors.
	Explosives	EPA Method 8330B	Elevated concentrations of explosives compounds (e.g., dinitrotoluene) were reported in AOC #16 - Area D (Dumping Area) during the 1996 investigation. Primary COPCs associated with seven additional former buildings identified as having a significant potential for explosive hazard based on limited information available in previous documents (including the ASR [USACE 1998] and HPA [USAGC 2018]) and input from USACE. These buildings have not been previously investigated.	Determine if explosives are present in surface soil (0-6 in. bgs) and shallow subsurface soil (6-36 in. bgs) at AOC #16 - Area D (Dumping Area) at concentrations above applicable screening criteria and if concentrations pose a risk to human and/or ecological receptors. Determine presence/absence of explosives in surface soil (0-6 in. bgs) at seven additional former buildings.
	pH	Field screening using a pH meter	Soil pH data were not collected during previous investigations.	Support development of the SLERA.

Sample Matrix	Parameter	Analytical Method	Rationale for Analysis	Data Use
Sediment	Total organic carbon	Walkley-Black	Evaluate the concentration of TOC in sediments to determine if sediments could be a potential "sink" for contaminants (i.e., higher TOC indicates potentially higher contaminant concentrations).	Determine whether sediments should be sampled for chemical contaminants during Phase II investigation. If sediments will be sampled for chemical contaminants during Phase II, physical characteristics of the sediment (e.g., TOC content, grain size) will be used to select an appropriate background sediment area.
Sediment	Grain size	ASTM D422	Evaluate the grain size of sediments to determine if sediments could be a potential "sink" for organic contaminants (i.e., fines, silts, and clays indicate potentially higher contaminant concentrations).	Determine whether sediments should be sampled for chemical contaminants during Phase II investigation. If sediments will be sampled for chemical contaminants during Phase II, physical characteristics of the sediment (e.g., TOC content, grain size) will be used to select an appropriate background sediment area.

NOTES:
AOC = Area of concern
AST = Above ground storage tank
Bgs = Below ground surface
BTEX = Benzene, toluene, ethylbenzene, and xylenes
COPC = Contaminant of potential concern
EPA = U.S. Environmental Protection Agency
ERA = Ecological risk assessment
FUDS = Formerly Used Defense Site
In. = inches
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
SIM = Selected ion monitoring
TAL = Target analyte list
TOC = Total organic carbon
VOC = Volatile organic compound

Table 17-2 Decision Unit and Sampling Rationale

Decision Unit # / Sample Location[1]	Decision Unit Size	Number of Surface Soil Increments (Collected at 0–6 inches)	Number of Soil Borings	Number of Subsurface Soil Increments (Collected at 6–36 inches)	Analysis	Rationale for Sampling	Primary AOC Investigated
DU-1	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #17 - Area E (Former Coal Trestle and Storage Area).and AOC #10 - Former Building 406 (Tin, Electrical and Annealing Shop Building). Soil pH data will be used to support development of the ecological risk assessment. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#17 and #10
DU-2	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #17 - Area E (Former Coal Trestle and Storage Area). Soil pH data will be used to support development of the ecological risk assessment. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#17
DU-3	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #11 – Former Building 410 (Power House) and AOC #11 - Former Building 407 (Paint Shop and Pipe Shop). Soil pH data will be used to support development of the ecological risk assessment. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#12 and #11
DU-4	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at previous sampling location II-EA-SD-02-01 with elevated concentrations of antimony, copper, lead, and mercury; and previous sampling location IX407-B1, with elevated concentrations of arsenic, lead, and fluoranthene. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	Previous investigation locations
DU-5	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at AOC #3 - Former Building 123 (Garage Building) and previous sampling location II-EA-SS-02-06 with elevated concentrations of antimony, copper, lead, mercury, and zinc. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#3
DU-6	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of II-EA-SS-02-09 with elevated concentration of copper and EA-SS-02-03 with elevated concentration of lead. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	Previous investigation locations
DU-7	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of previous sampling location II-EA-SS-02-08 with elevated concentrations of copper, lead, and zinc. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	Previous investigation locations

Table 17-2 Decision Unit and Sampling Rationale

Decision Unit # / Sample Location[1]	Decision Unit Size	Number of Surface Soil Increments (Collected at 0–6 inches)	Number of Soil Borings	Number of Subsurface Soil Increments (Collected at 6–36 inches)	Analysis	Rationale for Sampling	Primary AOC Investigated
DU-8	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #5 - Former building 207 (Marine Garage Building). COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#5
DU-9	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #8 – Former Building 219 (Garage Building) and AOC #9 – Former Building 220 (Garage Buildings). COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#8 and #9
DU-10	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity previous sampling location II-EA-SS-02-14 with elevated concentrations of copper, lead, mercury, and zinc. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	Previous sampling location
DU-11	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #18 - Area F (Former Coal Storage Area). COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#18
DU-12	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #6 – Former Building 213 (Paint Locker for Building 202) and AOC #7 - Former Building 215 (Garage Building). COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#6, and #7
DU-13	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #1 - Former Building 103 (Paint and Oil Storage) and previous sampling location IX 103-B1 with elevated concentrations of arsenic, cadmium, lead, fluoranthene, and pyrene. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#1 and previous sample location
DU-14	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of previous sampling location II-EA-SS-02-13 with elevated concentrations of lead and mercury. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	Previous investigation location
DU-15	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of previous sampling location II-EA-SS-02-15 with elevated concentrations of lead and mercury. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	Previous investigation location

Table 17-2 Decision Unit and Sampling Rationale

Decision Unit # / Sample Location[1]	Decision Unit Size	Number of Surface Soil Increments (Collected at 0–6 inches)	Number of Soil Borings	Number of Subsurface Soil Increments (Collected at 6–36 inches)	Analysis	Rationale for Sampling	Primary AOC Investigated
DU-16	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at and in the vicinity of AOC #4 - Former Buildings 124-128 (Sewage Disposal Plant). COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#4
DU-17	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, Aroclor PCBs by EPA Method 8082A, explosives by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil, subsurface soil, and shallow overburden groundwater at AOC #2 - Former Building 121 (Incinerator); AOC #16 - Area D (Dumping Area); in vicinity of previous sampling locations IX-121-B1 with elevated concentrations of arsenic, cadmium, lead, fluoranthene, and pyrene; and in vicinity of previous sampling location II-EA-SD-02-02 with elevated concentrations of antimony, copper, lead, nickel, and zinc. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#2 and #16
DU-18	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, Aroclor PCBs by EPA Method 8082A, explosives by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at AOC #16 - Area D (Dumping Area); at and in the vicinity of previous sampling location IX DMP-B22 with elevated concentrations of arsenic, cadmium, chromium, lead, silver, 2,4-DNT, 2,6-DNT, and Aroclor 1260; and at and in vicinity of previous sampling location IXDMP-B1 with elevated concentrations of lead and Aroclor 1260. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#16
DU-19	200 ft x 200 ft	50 per incremental sample (150 total)	5 per incremental sample (15 total)	10 per soil boring, 50 per incremental sample (150 total)	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, Aroclor PCBs by EPA Method 8082A, explosives by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate potential contamination in surface soil (0-6 in. bgs) subsurface soil (6-36 in. bgs) at AOC #16 - Area D (Dumping Area); at and in the vicinity of previous sampling location II-EA-SS-02-16 with elevated concentrations of antimony, copper, lead, mercury, and zinc. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	#16
DU-20	60 ft x 60 ft	30 per incremental sample (90 total)	3 per incremental sample (9 total)	10 per soil boring, 30 per incremental sample (90 total)	PAHs by EPA Method 8270 SIM, BTEX by EPA Method 8260B (subsurface soil only), and pH (screened in the field with pH meter)	To evaluate the presence/absence of potential contamination in surface soil (0-6 in. bgs) (PAHs only) and subsurface soil (6-36 in. bgs) (PAHs and BTEX) at former AST located near former Building 233 (AOC #13 – Area A).	#13
DU-21	60 ft x 60 ft	30 per incremental sample (90 total)	3 per incremental sample (9 total)	10 per soil boring, 30 per incremental sample (90 total)	PAHs by EPA Method 8270 SIM, BTEX by EPA Method 8260B (subsurface soil only), and pH (screened in the field with pH meter)	To evaluate the presence/absence of potential contamination in surface soil (0-6 in. bgs) (PAHs only) and subsurface soil (6-36 in. bgs) (PAHs and BTEX) at former AST near former Dock 131 (AOC #14 – Area B).	#14

Table 17-2 Decision Unit and Sampling Rationale

Decision Unit # / Sample Location[1]	Decision Unit Size	Number of Surface Soil Increments (Collected at 0–6 inches)	Number of Soil Borings	Number of Subsurface Soil Increments (Collected at 6–36 inches)	Analysis	Rationale for Sampling	Primary AOC Investigated
DU-22	60 ft x 60 ft	30 per incremental sample (90 total)	3 per incremental sample (9 total)	10 per soil boring, 30 per incremental sample (90 total)	PAHs by EPA Method 8270 SIM, BTEX by EPA Method 8260B (subsurface soil only), and pH (screened in the field with pH meter)	To evaluate the presence/absence of potential contamination in surface soil (0-6 in. bgs) (PAHs only) and subsurface soil (6-36 in. bgs) (PAHs and BTEX) at two former ASTs located near former Building 407 (AOC #15 – Area C).	#15
DU-23	60 ft x 60 ft	30 per incremental sample (90 total)	3 per incremental sample (9 total)	10 per soil boring, 30 per incremental sample (90 total)	Aroclor PCBs by EPA Method 8082A, and pH (screened in the field with pH meter)	To evaluate the presence/absence of potential contamination in surface soil (0-6 in. bgs) and subsurface soil (6-36 in. bgs) at former transformer T1 (AOC #19).	#19
DU-24	60 ft x 60 ft	30 per incremental sample (90 total)	3 per incremental sample (9 total)	10 per soil boring, 30 per incremental sample (90 total)	Aroclor PCBs by EPA Method 8082A, and pH (screened in the field with pH meter)	To evaluate the presence/absence of potential contamination in surface soil (0-6 in. bgs) and subsurface soil (6-36 in. bgs) at former transformer T2 (AOC #19).	#19
DU-25	60 ft x 60 ft	30 per incremental sample (90 total)	3 per incremental sample (9 total)	10 per soil boring, 30 per incremental sample (90 total)	Aroclor PCBs by EPA Method 8082A, and pH (screened in the field with pH meter)	To evaluate the presence/absence of potential contamination in surface soil (0-6 in. bgs) and subsurface soil (6-36 in. bgs) at former transformer T3 (AOC #19).	
Former Buildings Identified as Having Significant Potential for Explosive Hazard (EXDU; pending direction of contracting offer)							
EXDU-1	200 ft x 200 ft	50 per incremental sample (150 total)	NA	NA	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate the presence or absence of residual explosives contamination in surface soil from Building 609 – Mine Loading Plant. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	NA
EXDU-2	200 ft x 200 ft	50 per incremental sample (150 total)	NA	NA	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate the presence or absence of residual explosives contamination in surface soil from Building 506 – Filling House #3. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	NA
EXDU-3	200 ft x 200 ft	50 per incremental sample (150 total)	NA	NA	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate the presence or absence of residual explosives contamination in surface soil from Building 503 – Filling House #6. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	NA
EXDU-4	200 ft x 200 ft	50 per incremental sample (150 total)	NA	NA	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate the presence or absence of residual explosives contamination in surface soil from Building 404 – Filling House #1. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	NA
EXDU-5	200 ft x 200 ft	50 per incremental sample (150 total)	NA	NA	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate the presence or absence of residual explosives contamination in surface soil from Building 307 – Filling House #5. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	NA
EXDU-6	200 ft x 200 ft	50 per incremental sample (150 total)	NA	NA	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate the presence or absence of residual explosives contamination in surface soil from Building 306 – Filling House #2. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	NA

Table 17-2 Decision Unit and Sampling Rationale

Decision Unit # / Sample Location[1]	Decision Unit Size	Number of Surface Soil Increments (Collected at 0–6 inches)	Number of Soil Borings	Number of Subsurface Soil Increments (Collected at 6–36 inches)	Analysis	Rationale for Sampling	Primary AOC Investigated
EXDU-7	100 ft x 400 ft	50 per incremental sample (150 total)	NA	NA	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	To evaluate the presence or absence of residual explosives contamination in surface soil from Building 202 – Shell House #5 and D Plant. COPC analytical data will be used in risk assessments to evaluate risk to human and ecological receptors as presented in the Human Health Risk Assessment Work Plan (Appendix D) and Ecological Risk Assessment Work Plan (Appendix E).	NA
Background Area Decision Unit (BADU)							
BDU-1	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
BDU-2	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
BDU-3	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
BDU-4	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
BDU-5	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
BDU-6	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
BDU-7	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
BDU-8	200 ft x 200 ft	50	5	50 each	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	To determine background concentrations of metals and PAHs. Analytical data will be used in background comparison.	NA
Sediment Shoreline Grab Samples							
SD-01	NA	NA	NA	NA	TOC by Walkley-Black, grain size by ASTM D422	To screen physical characteristic of sediment, evaluate whether sediments could be a potential “sink” for site-related contaminants, and inform the design of the Phase II investigation (if needed).	NA
SD-02	NA	NA	NA	NA	TOC by Walkley-Black, grain size by ASTM D422	To screen physical characteristic of sediment, evaluate whether sediments could be a potential “sink” for site-related contaminants, and inform the design of the Phase II investigation (if needed).	NA

Table 17-2 Decision Unit and Sampling Rationale

Decision Unit # / Sample Location[1]	Decision Unit Size	Number of Surface Soil Increments (Collected at 0–6 inches)	Number of Soil Borings	Number of Subsurface Soil Increments (Collected at 6–36 inches)	Analysis	Rationale for Sampling	Primary AOC Investigated
SD-03	NA	NA	NA	NA	TOC by Walkley-Black, grain size by ASTM D422	To screen physical characteristic of sediment, evaluate whether sediments could be a potential “sink” for site-related contaminants, and inform the design of the Phase II investigation (if needed).	NA
SD-04	NA	NA	NA	NA	TOC by Walkley-Black, grain size by ASTM D422	To screen physical characteristic of sediment, evaluate whether sediments could be a potential “sink” for site-related contaminants, and inform the design of the Phase II investigation (if needed).	NA
SD-05	NA	NA	NA	NA	TOC by Walkley-Black, grain size by ASTM D422	To screen physical characteristic of sediment, evaluate whether sediments could be a potential “sink” for site-related contaminants, and inform the design of the Phase II investigation (if needed).	NA
SD-06	NA	NA	NA	NA	TOC by Walkley-Black, grain size by ASTM D422	To screen physical characteristic of sediment, evaluate whether sediments could be a potential “sink” for site-related contaminants, and inform the design of the Phase II investigation (if needed).	NA

1. Background sampling locations are presented on Figure 11-3. Surface and subsurface soil DUs are presented on Figures 11-4 and 11-5.

NOTES:
AOC = Area of concern
AST = Above ground storage tank
BDU – Background area decision unit
BTEX = Benzene, toluene, ethylbenzene, and xylenes
COPC = Contaminant of potential concern
DNT = Dinitrotoluene
DU = Decision unit
EXDU = Explosives area decision unit
ft = Foot (feet)
NA = Not applicable
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
SIM = Selected ion monitoring
TAL = Target analyte list
TBD = To be determined
TCL = Target compound list
TOC = Total organic compound
VOC = Volatile organic compound

QAPP Worksheet #18 – Sampling Locations and Methods

Decision Unit #	Northing[1]	Easting[1]	Sampling Standard Operating Procedure[2]	Analyses	Sample Identification Code[3]	Quality Assurance/Quality Control Samples
Phase I Investigation Area: Surface and Subsurface Soil, Groundwater						
DU-1	900665.83	636368.91	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-1A-SSIS-YYYYMMDD IINY-DU-1A-SBIS1-YYYYMMDD IINY-DU-1B-SSIS-YYYYMMDD IINY-DU-1B-SBIS1-YYYYMMDD IINY-DU-1C-SSIS-YYYYMMDD IINY-DU-1C-SBIS1-YYYYMMDD	ISM triplicate samples
	900850.75	636293.02				
	900926.67	636477.98				
	900741.72	636553.86				
DU-2	900437.96	636344.23	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-2A-SSIS-YYYYMMDD IINY-DU-2A-SBIS1-YYYYMMDD IINY-DU-2B-SSIS-YYYYMMDD IINY-DU-2B-SBIS1-YYYYMMDD IINY-DU-2C-SSIS-YYYYMMDD IINY-DU-2C-SBIS1-YYYYMMDD	ISM triplicate samples
	900622.83	636268.31				
	900698.76	636453.26				
	900513.81	636529.14				
DU-3	900513.77	636529.38	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-3A-SSIS-YYYYMMDD IINY-DU-3A-SBIS1-YYYYMMDD IINY-DU-3B-SSIS-YYYYMMDD IINY-DU-3B-SBIS1-YYYYMMDD IINY-DU-3C-SSIS-YYYYMMDD IINY-DU-3C-SBIS1-YYYYMMDD	ISM triplicate samples
	900698.72	636453.50				
	900774.60	636638.45				
	900589.65	636714.34				
DU-4	900589.41	636714.34	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-4A-SSIS-YYYYMMDD IINY-DU-4A-SBIS1-YYYYMMDD IINY-DU-4B-SSIS-YYYYMMDD IINY-DU-4B-SBIS1-YYYYMMDD IINY-DU-4C-SSIS-YYYYMMDD IINY-DU-4C-SBIS1-YYYYMMDD	ISM triplicate samples
	900774.36	636638.45				
	900850.25	636823.41				
	900665.29	636899.29				
DU-5	900311.71	636561.25	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-5A-SSIS-YYYYMMDD IINY-DU-5A-SBIS1-YYYYMMDD IINY-DU-5B-SSIS-YYYYMMDD IINY-DU-5B-SBIS1-YYYYMMDD IINY-DU-5C-SSIS-YYYYMMDD IINY-DU-5C-SBIS1-YYYYMMDD	ISM triplicate samples
	900496.66	636485.32				
	900572.54	636670.28				
	900387.59	636746.20				
DU-6	900291.02	635889.54	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, pH (screened in the field with pH meter)	IINY-DU-6A-SSIS-YYYYMMDD IINY-DU-6A-SBIS1-YYYYMMDD IINY-DU-6B-SSIS-YYYYMMDD IINY-DU-6B-SBIS1-YYYYMMDD IINY-DU-6C-SSIS-YYYYMMDD IINY-DU-6C-SBIS1-YYYYMMDD	ISM triplicate samples
	900439.03	635755.15				
	900575.81	635894.69				
	900429.03	636036.34				
DU-7	900088.86	636123.89	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, pH (screened in the field with pH meter)	IINY-DU-7A-SSIS-YYYYMMDD IINY-DU-7A-SBIS1-YYYYMMDD IINY-DU-7B-SSIS-YYYYMMDD IINY-DU-7B-SBIS1-YYYYMMDD IINY-DU-7C-SSIS-YYYYMMDD IINY-DU-7C-SBIS1-YYYYMMDD	ISM triplicate samples
	900273.81	636048.00				
	900349.73	636232.95				
	900164.78	636308.84				

Decision Unit #	Northing[1]	Easting[1]	Sampling Standard Operating Procedure[2]	Analyses	Sample Identification Code[3]	Quality Assurance/Quality Control Samples
DU-8	899586.58	636256.62	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-8A-SSIS-YYYYMMDD IINY-DU-8A-SBIS1-YYYYMMDD IINY-DU-8B-SSIS-YYYYMMDD IINY-DU-8B-SBIS1-YYYYMMDD IINY-DU-8C-SSIS-YYYYMMDD IINY-DU-8C-SBIS1-YYYYMMDD	ISM triplicate samples
	899669.80	636074.89				
	899851.58	636158.14				
	899768.33	636339.88				
DU-9	899429.97	636116.35	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-9A-SSIS-YYYYMMDD IINY-DU-9A-SBIS1-YYYYMMDD IINY-DU-9B-SSIS-YYYYMMDD IINY-DU-9B-SBIS1-YYYYMMDD IINY-DU-9C-SSIS-YYYYMMDD IINY-DU-9C-SBIS1-YYYYMMDD	ISM triplicate samples
	899613.40	636195.87				
	899533.88	636379.26				
	899350.53	636299.74				
DU-10	899410.89	636325.69	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, pH (screened in the field with pH meter)	IINY-DU-10A-SSIS-YYYYMMDD IINY-DU-10A-SBIS1-YYYYMMDD IINY-DU-10B-SSIS-YYYYMMDD IINY-DU-10B-SBIS1-YYYYMMDD IINY-DU-10C-SSIS-YYYYMMDD IINY-DU-10C-SBIS1-YYYYMMDD	ISM triplicate samples
	899594.32	636405.21				
	899514.80	636588.60				
	899331.45	636509.08				
DU-11	899853.62	636390.49	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-11A-SSIS-YYYYMMDD IINY-DU-11A-SBIS1-YYYYMMDD IINY-DU-11B-SSIS-YYYYMMDD IINY-DU-11B-SBIS1-YYYYMMDD IINY-DU-11C-SSIS-YYYYMMDD IINY-DU-11C-SBIS1-YYYYMMDD	ISM triplicate samples
	900038.57	636314.57				
	900114.45	636499.52				
	899929.50	636575.40				
DU-12	899685.26	636503.14	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-12A-SSIS-YYYYMMDD IINY-DU-12A-SBIS1-YYYYMMDD IINY-DU-12B-SSIS-YYYYMMDD IINY-DU-12B-SBIS1-YYYYMMDD IINY-DU-12C-SSIS-YYYYMMDD IINY-DU-12C-SBIS1-YYYYMMDD	ISM triplicate samples
	899870.21	636427.21				
	899946.09	636612.17				
	899761.18	636688.01				
DU-13	899540.99	636678.03	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-13A-SSIS-YYYYMMDD IINY-DU-13A-SBIS1-YYYYMMDD IINY-DU-13B-SSIS-YYYYMMDD IINY-DU-13B-SBIS1-YYYYMMDD IINY-DU-13C-SSIS-YYYYMMDD IINY-DU-13C-SBIS1-YYYYMMDD	ISM triplicate samples
	899725.64	636601.40				
	899802.30	636786.05				
	899617.66	636862.64				
DU-14	899985.44	636706.49	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, pH (screened in the field with pH meter)	IINY-DU-14A-SSIS-YYYYMMDD IINY-DU-14A-SBIS1-YYYYMMDD IINY-DU-14B-SSIS-YYYYMMDD IINY-DU-14B-SBIS1-YYYYMMDD IINY-DU-14C-SSIS-YYYYMMDD IINY-DU-14C-SBIS1-YYYYMMDD	ISM triplicate samples
	900170.39	636630.61				
	900246.24	636815.56				
	900061.28	636891.44				
DU-15	899610.00	636922.34	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, pH (screened in the field with pH meter)	IINY-DU-15A-SSIS-YYYYMMDD IINY-DU-15A-SBIS1-YYYYMMDD IINY-DU-15B-SSIS-YYYYMMDD IINY-DU-15B-SBIS1-YYYYMMDD IINY-DU-15C-SSIS-YYYYMMDD IINY-DU-15C-SBIS1-YYYYMMDD	ISM triplicate samples
	899801.45	636864.72				
	899858.99	637056.16				
	899667.62	637113.79				

Decision Unit #	Northing[1]	Easting[1]	Sampling Standard Operating Procedure[2]	Analyses	Sample Identification Code[3]	Quality Assurance/Quality Control Samples
DU-16	899448.93	636875.34	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, pH (screened in the field with pH meter)	IINY-DU-16A-SSIS-YYYYMMDD IINY-DU-16A-SBIS1-YYYYMMDD IINY-DU-16B-SSIS-YYYYMMDD IINY-DU-16B-SBIS1-YYYYMMDD IINY-DU-16C-SSIS-YYYYMMDD IINY-DU-16C-SBIS1-YYYYMMDD	ISM triplicate samples
	899612.29	636990.61				
	899497.02	637153.89				
	899333.70	637038.71				
DU-17	899548.69	637080.83	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, Aroclor PCBs by EPA Method 8082A, explosives by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-17A-SSIS-YYYYMMDD IINY-DU-17A-SBIS1-YYYYMMDD IINY-DU-17B-SSIS-YYYYMMDD IINY-DU-17B-SBIS1-YYYYMMDD IINY-DU-17C-SSIS-YYYYMMDD IINY-DU-17C-SBIS1-YYYYMMDD	ISM triplicate samples
	899712.05	637196.09				
	899596.78	637359.38				
	899433.46	637244.19				
DU-18	899433.16	637244.42	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, Aroclor PCBs by EPA Method 8082A, explosives by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-18A-SSIS-YYYYMMDD IINY-DU-18A-SBIS1-YYYYMMDD IINY-DU-18B-SSIS-YYYYMMDD IINY-DU-18B-SBIS1-YYYYMMDD IINY-DU-18C-SSIS-YYYYMMDD IINY-DU-18C-SBIS1-YYYYMMDD	ISM triplicate samples
	899596.52	637359.69				
	899481.26	637522.97				
	899317.93	637407.79				
DU-19	899333.22	637038.81	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM, Aroclor PCBs by EPA Method 8082A, explosives by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-19A-SSIS-YYYYMMDD IINY-DU-19A-SBIS1-YYYYMMDD IINY-DU-19B-SSIS-YYYYMMDD IINY-DU-19B-SBIS1-YYYYMMDD IINY-DU-19C-SSIS-YYYYMMDD IINY-DU-19C-SBIS1-YYYYMMDD	ISM triplicate samples
	899496.58	637154.07				
	899381.31	637317.35				
	899217.99	637202.17				
DU-20	899795.68	635898.01	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	PAHs by EPA Method 8270 SIM (surface and subsurface soil), BTEX by EPA Method 8260B (subsurface soil only), and pH (screened in the field with pH meter)	IINY-DU-20A-SSIS-YYYYMMDD IINY-DU-20A-SBIS1-YYYYMMDD IINY-DU-20B-SSIS-YYYYMMDD IINY-DU-20B-SBIS1-YYYYMMDD IINY-DU-20C-SSIS-YYYYMMDD IINY-DU-20C-SBIS1-YYYYMMDD	ISM triplicate samples
	899752.09	635855.53				
	899796.38	635813.22				
	899838.88	635855.97				
DU-21	900521.89	636886.29	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	PAHs by EPA Method 8270 SIM (surface and subsurface soil), BTEX by EPA Method 8260B (subsurface soil only), and pH (screened in the field with pH meter)	IINY-DU-21A-SSIS-YYYYMMDD IINY-DU-21A-SBIS1-YYYYMMDD IINY-DU-21B-SSIS-YYYYMMDD IINY-DU-21B-SBIS1-YYYYMMDD IINY-DU-21C-SSIS-YYYYMMDD IINY-DU-21C-SBIS1-YYYYMMDD	ISM triplicate samples
	900469.35	636917.04				
	900440.48	636863.01				
	900493.07	636833.54				
DU-22	900819.91	636626.47	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	PAHs by EPA Method 8270 SIM (surface and subsurface soil), BTEX by EPA Method 8260B (subsurface soil only), and pH (screened in the field with pH meter)	IINY-DU-22A-SSIS-YYYYMMDD IINY-DU-22A-SBIS1-YYYYMMDD IINY-DU-22B-SSIS-YYYYMMDD IINY-DU-22B-SBIS1-YYYYMMDD IINY-DU-22C-SSIS-YYYYMMDD IINY-DU-22C-SBIS1-YYYYMMDD	ISM triplicate samples
	900772.76	636588.83				
	900812.60	636542.30				
	900859.16	636580.59				
DU-23	901083.22	636455.56	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	Aroclor PCBs by EPA Method 8082A, and pH (screened in the field with pH meter)	IINY-DU-23A-SSIS-YYYYMMDD IINY-DU-23A-SBIS1-YYYYMMDD IINY-DU-23B-SSIS-YYYYMMDD IINY-DU-23B-SBIS1-YYYYMMDD IINY-DU-23C-SSIS-YYYYMMDD IINY-DU-23C-SBIS1-YYYYMMDD	ISM triplicate samples
	901022.37	636456.66				
	901023.35	636395.41				
	901083.63	636395.18				

Decision Unit #	Northing[1]	Easting[1]	Sampling Standard Operating Procedure[2]	Analyses	Sample Identification Code[3]	Quality Assurance/Quality Control Samples
DU-24	899500.08	637396.65	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	Aroclor PCBs by EPA Method 8082A, and pH (screened in the field with pH meter)	IINY-DU-24A-SSIS-YYYYMMDD IINY-DU-24A-SBIS1-YYYYMMDD IINY-DU-24B-SSIS-YYYYMMDD IINY-DU-24B-SBIS1-YYYYMMDD IINY-DU-24C-SSIS-YYYYMMDD IINY-DU-24C-SBIS1-YYYYMMDD	ISM triplicate samples
	899499.16	637456.63				
	899438.29	637457.31				
	899439.80	637396.08				
DU-25	899534.42	636280.32	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	Aroclor PCBs by EPA Method 8082A, and pH (screened in the field with pH meter)	IINY-DU-25A-SSIS-YYYYMMDD IINY-DU-25A-SBIS1-YYYYMMDD IINY-DU-25B-SSIS-YYYYMMDD IINY-DU-25B-SBIS1-YYYYMMDD IINY-DU-25C-SSIS-YYYYMMDD IINY-DU-25C-SBIS1-YYYYMMDD	ISM triplicate samples
	899533.69	636340.42				
	899472.82	636341.30				
	899474.13	636280.06				
Former Buildings Identified as Having Significant Potential for Explosive Hazard (EXDU; pending direction of contracting offer): Surface and Subsurface Soil						
EXDU-1	901434.18	636329.87	SOP 001, SOP 002, SOP 004, SOP 016, SOP 057	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-1A-SSIS-YYYYMMDD IINY-DU-1B-SSIS-YYYYMMDD IINY-DU-1C-SSIS-YYYYMMDD	ISM triplicate samples
	901249.58	636406.61				
	901173.69	636221.66				
	901358.61	636145.78				
EXDU-2	901362.70	635451.85	SOP 001, SOP 002, SOP 004, SOP 016, SOP 057	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-2A-SSIS-YYYYMMDD IINY-DU-2B-SSIS-YYYYMMDD IINY-DU-2C-SSIS-YYYYMMDD	ISM triplicate samples
	901276.43	635632.37				
	901099.59	635539.13				
	901192.80	635362.31				
EXDU-3	900929.34	635455.88	SOP 001, SOP 002, SOP 004, SOP 016, SOP 057	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-3A-SSIS-YYYYMMDD IINY-DU-3B-SSIS-YYYYMMDD IINY-DU-3C-SSIS-YYYYMMDD	ISM triplicate samples
	900746.09	635535.91				
	900670.21	635350.96				
	900855.12	635275.07				
EXDU-4	900896.53	636406.25	SOP 001, SOP 002, SOP 004, SOP 016, SOP 057	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-4A-SSIS-YYYYMMDD IINY-DU-4B-SSIS-YYYYMMDD IINY-DU-4C-SSIS-YYYYMMDD	ISM triplicate samples
	900713.76	636487.45				
	900637.88	636302.50				
	900822.79	636226.61				
EXDU-5	900432.79	635836.95	SOP 001, SOP 002, SOP 004, SOP 016, SOP 057	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-5A-SSIS-YYYYMMDD IINY-DU-5B-SSIS-YYYYMMDD IINY-DU-5C-SSIS-YYYYMMDD	ISM triplicate samples
	900249.54	635916.99				
	900173.65	635732.03				
	900358.57	635656.15				
EXDU-6	900321.93	635668.36	SOP 001, SOP 002, SOP 004, SOP 016, SOP 057	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-6A-SSIS-YYYYMMDD IINY-DU-6B-SSIS-YYYYMMDD IINY-DU-6C-SSIS-YYYYMMDD	ISM triplicate samples
	900138.68	635748.39				
	900062.80	635563.44				
	900247.71	635487.55				
EXDU-7	899624.58	636696.73	SOP 001, SOP 002, SOP 004, SOP 016, SOP 057	Explosives residues by EPA Method 8330B, and pH (screened in the field with pH meter)	IINY-DU-7A-SSIS-YYYYMMDD IINY-DU-7B-SSIS-YYYYMMDD IINY-DU-7C-SSIS-YYYYMMDD	ISM triplicate samples
	899549.44	636651.87				
	899737.18	636294.49				
	899823.18	636341.95				
Phase I Background: Surface and Subsurface Soil						
BDU-1	900519.56	627330.05	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-1-SSIS-YYYYMMDD IINY-BADU-1-SBIS1-YYYYMMDD	
	900318.77	627330.04				
	900318.87	627130.04				
	900519.71	627130.26				

Decision Unit #	Northing[1]	Easting[1]	Sampling Standard Operating Procedure[2]	Analyses	Sample Identification Code[3]	Quality Assurance/Quality Control Samples
BDU-2	900439.45	627719.24	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-2-SSIS-YYYYMMDD IINY-BADU-2-SBIS1-YYYYMMDD	
	900238.67	627719.23				
	900238.76	627519.23				
	900439.45	627518.91				
BDU-3	899803.78	627797.60	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-3-SSIS-YYYYMMDD IINY-BADU-3-SBIS1-YYYYMMDD	
	899602.99	627797.59				
	899602.90	627597.68				
	899804.13	627597.10				
BDU-4	899930.45	628180.57	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-4-SSIS-YYYYMMDD IINY-BADU-4-SBIS1-YYYYMMDD	
	899729.67	628180.56				
	899729.62	627980.60				
	899928.89	627980.65				
BDU-5	898483.25	630004.89	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-5-SSIS-YYYYMMDD IINY-BADU-5-SBIS1-YYYYMMDD	
	898282.34	630004.98				
	898282.44	629804.98				
	898483.10	629805.07				
BDU-6	898869.35	631593.58	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-6-SSIS-YYYYMMDD IINY-BADU-6-SBIS1-YYYYMMDD	
	898669.35	631593.48				
	898669.44	631393.48				
	898869.44	631393.58				
BDU-7	898119.29	631824.04	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-7-SSIS-YYYYMMDD IINY-BADU-7-SBIS1-YYYYMMDD	
	898119.29	632023.86				
	897918.95	632023.95				
	897919.04	631823.95				
BDU-8	897871.42	631624.01	SOP 001, SOP 002, SOP 004, SOP 016, SOP 025, SOP 057	TAL Metals by EPA Methods 6010C/6020A, Mercury by EPA Method 7471B, PAHs by EPA Method 8270 SIM	IINY-BADU-8-SSIS-YYYYMMDD IINY-BADU-8-SBIS1-YYYYMMDD	
	897670.64	631624.00				
	897670.86	631424.26				
	897871.14	631424.26				
Shoreline Reconnaissance Survey Sediment Sampling						
SD-01	TBD, eastern shoreline	TBD, eastern shoreline	SOP 001, SOP 002, SOP 004, SOP 021	TOC by Walkley-Black, grain size by ASTM D422	IINY-SD01-YYYYMMDD	
SD-02	TBD, eastern shoreline	TBD, eastern shoreline	SOP 001, SOP 002, SOP 004, SOP 021	TOC by Walkley-Black, grain size by ASTM D422	IINY-SD02-YYYYMMDD	
SD-03	TBD, eastern shoreline	TBD, eastern shoreline	SOP 001, SOP 002, SOP 004, SOP 021	TOC by Walkley-Black, grain size by ASTM D422	IINY-SD03-YYYYMMDD	
SD-04	TBD, western shoreline	TBD, western shoreline	SOP 001, SOP 002, SOP 004, SOP 021	TOC by Walkley-Black, grain size by ASTM D422	IINY-SD04-YYYYMMDD	
SD-05	TBD, western shoreline	TBD, western shoreline	SOP 001, SOP 002, SOP 004, SOP 021	TOC by Walkley-Black, grain size by ASTM D422	IINY-SD05-YYYYMMDD	
SD-06	TBD, western shoreline	TBD, western shoreline	SOP 001, SOP 002, SOP 004, SOP 021	TOC by Walkley-Black, grain size by ASTM D422	IINY-SD06-YYYYMMDD	

1) Northing and Easting coordinates are in New York State Plane Coordinate System, Eastern Zone, NAD 83 (CORS 96) Datum, Feet.
2) Field SOPs that will be used in support of field sampling activities are provided in Appendix H.
3) Sample Identification Code as presented in Worksheet #26 and #27.

NOTES:
BTEX = Benzene, toluene, ethylbenzene, and xylenes
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
SOP = Standard operating procedure
TAL = Target analyte list
TOC = Total organic carbon

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QAPP Worksheets #19 and #30 – Sample Containers, Preservation, and Hold Times

Laboratory: TestAmerica
Accreditations/Certifications: Provided in Appendix G
Sample Delivery Method: Overnight shipping
Data Package Turnaround: **Standard Turnaround Time:** 21 days for analysis and 21 days for data validation

Matrix	Analytical Group	Analytical/Preparation Method Standard Operating Procedures Reference[1]	Containers (number, size, and type)	Sample volume[2] (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[3] (preparation / analysis)
Soil	6010C Metals	DV-MT-0021/ DV-IP-0015	1 kilogram for multi-incremental sampling, glass or HDPE jar or double-bagged Ziploc bag or bucket	20 g	Cool ≤ 6 °C	180 days
	6020A Metals	DV-MT-0022/ DV-IP-0015		20 g		180 days
	7471B Mercury	DV-MT-0016		5 g		28 days
	8270 SIM PAHs	DV-MS-0012, DV-MS-0002 / DV-OP-0007, DV-OP-0015, DV-OP-0016		60 g		14 days to extract – 40 days from extract
	8082A GC PCBs	DV-GC-0021 / DV-OP-0015, DV-OP-0016 & DV-OP-0007		60 g		1 year to extract – 40 days from extract
	8330B HPLC Explosives	DV-LC-0002 / DV-OP-0018		20 g		14 days to extract – 40 days from extract
Soil	8260B MS BTEX	DV-MS-0010	Laboratory sample kit	15 g (three 5 g)	Methanol; Cool ≤ 6 °C	48 hours from sampling to preservation/freezing/ 14 days from sampling to analysis
Sediment	Walkley-Black TOC	CA-777	2-oz wide-mouth jar	0.5 g	Cool to ≤ 6 ° C	14 days to analysis
Sediment	ASTM D422 Grain Size	CA-551	8-oz wide-mouth jar	200 g	Cool to ≤ 6 ° C	None

1) Refer to the Analytical SOP References table (Worksheet #23).
2) The minimum sample size is based on analysis allowing for sufficient sample for reanalysis.
3) Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

NOTES:
°C = Degrees Celsius
GC = Gas chromatography
g = Grams
BTEX = Benzene, etehylbenzene, toluene, and xylenes
HCl = Hydrochloric acid
HDPE = High density polyethylene
HNO3 = Nitric acid
HPLC = High performance liquid chromatography
kg = Kilogram(s)
mL = Milliliter(s)
MS = Mass spectrometry
oz = Ounce
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
SIM = Selected ion monitoring

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QAPP Worksheet #20 – Field Quality Control

Table 20-1 Incremental Surface and Subsurface Soil Samples at DU-1 through DU-16

Matrix	Analytical Group	Number of DUs	Number of Samples per Decision Unit[1]	Maximum Total Number of Samples
Incremental Surface Soil	TAL Metals by EPA Methods 6010C/6020A	16	3	48
	Mercury by EPA Method 7471B	13	3	39
	PAHs by EPA Method 8270D by SIM	11	3	33
Incremental Subsurface Soil	TAL Metals by EPA Methods 6010C/6020A	16	3	48
	Mercury by EPA Method 7471B	13	3	39
	PAHs by EPA Method 8270D by SIM	11	3	33

1) Each onsite DU will be sampled in triplicate (3 samples per matrix per DU).

NOTES:
DU = Decision Unit
EPA = U.S. Environmental Protection Agency
PAH = Polycyclic aromatic hydrocarbon
SIM = Selected ion monitoring
TAL = Target analyte list

Table 20-2 Incremental Surface and Subsurface Samples at Soil DU-17, DU-18, and DU-19 (AOC #16 – Area D [Dumping Area])

Matrix	**Analytical Group**	**Number of DUs**	**Number of Samples per Decision Unit[1]**	**Maximum Total Number of Samples**
Incremental Surface Soil	TAL Metals by EPA Methods 6010C/6020A	3	3	9
	Mercury by EPA Method 7471B	3	3	9
	PAHs by EPA Method 8270D by SIM	3	3	9
	Aroclor PCBs by EPA Method 8082A	3	3	9
	Explosives residues by EPA Method 8330B	3	3	9
Incremental Subsurface Soil	TAL Metals by EPA Methods 6010C/6020A	3	3	9
	Mercury by EPA Method 7471B	3	3	9
	PAHs by EPA Method 8270D by SIM	3	3	9
	Aroclor PCBs by EPA Method 8082A	3	3	9
	Explosives residues by EPA Method 8330B	3	3	9

1) Each onsite DU will be sampled in triplicate (3 samples per matrix per DU).

NOTES:
DU = Decision Unit
EPA = U.S. Environmental Protection Agency
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
SIM = Selected ion monitoring
TAL = Target analyte list

Table 20-3 Incremental Surface and Subsurface Soil Samples DU-20, DU-21, and DU-22 (AOCs #13, 14, and 15: Locations/Footprints of 4 Former Fuel Oil ASTs)

Matrix	Analytical Group	Number of DUs	Number of Samples per Decision Unit[1]	Maximum Total Number of Field Samples	Number Methanol Field Blanks[2]	Number Methanol Trip Blanks[3]
Incremental Surface Soil	PAHs by EPA Method 8270D by SIM	3	3	9	0	0
Incremental Subsurface Soil	PAHs by EPA Method 8270D by SIM	3	3	9	0	0
	BTEX by EPA Method 8260B	3	3	9	TBD	TBD

1) Each onsite DU will be sampled in triplicate (3 samples per matrix per DU).
2) Methanol field blanks will be collected at a rate of one per day when BTEX samples are collected. The total number of samples submitted for analysis is dependent on the number of days required to sample each DU.
3) Trip blanks will be submitted at a rate of one per cooler containing BTEX samples. The total number of samples submitted for analysis is dependent on the number of coolers used to ship BTEX samples.

NOTES:
DU = Decision Unit
EPA = U.S. Environmental Protection Agency
BTEX = Benzene, toluene, ethylbenzene, and xylenes
PAH = Polycyclic aromatic hydrocarbon
SIM = Selected ion monitoring
TBD = To be determined

Table 20-4 Incremental Surface and Subsurface Soil Samples at DU-23, DU-24, and DU-25 (AOC #19 Three Former Transformer Locations)

Matrix	Analytical Group	Number of DUs	Number of Samples per Decision Unit[1]	Maximum Total Number of Samples
Incremental Surface Soil	Aroclor PCBs by EPA Method 8082A	3	3	9
Incremental Subsurface Soil	Aroclor PCBs by EPA Method 8082A	3	3	9

1) Each onsite DU will be sampled in triplicate (3 samples per matrix per DU).

NOTES:
DU = Decision Unit
EPA = U.S. Environmental Protection Agency
PCB = Polychlorinated biphenyl

Table 20-5 Incremental Surface Soil Samples at EXDU-1 Through EXDU-7 (Seven Former Buildings of Significant Potential for Explosive Hazard [Pending Direction of Contracting Offer])

Matrix	Analytical Group	Number of DUs	Number of Samples per Decision Unit[1]	Maximum Total Number of Samples
Incremental Surface Soil	Explosives residues by EPA Method 8330B	7	3	21

1) Each onsite DU will be sampled in triplicate (3 samples per matrix per DU).

NOTES:
DU = Decision Unit
EPA = U.S. Environmental Protection Agency

Table 20-6 Incremental Surface and Subsurface Soil at BADU-1 through BADU-8 (Background Area Decision Units)

Matrix	Analytical Group	Number of DUs	Number of Samples per Decision Unit[1]	Maximum Total Number of Samples
Incremental Surface Soil	TAL Metals by EPA Methods 6010C/6020A	8	1	8
	Mercury by EPA Method 7471B	8	1	8
	PAHs by EPA Method 8270D by SIM	8	1	8
Incremental Subsurface Soil	TAL Metals by EPA Methods 6010C/6020A	8	1	8
	Mercury by EPA Method 7471B	8	1	8
	PAHs by EPA Method 8270D by SIM	8	1	8

1) Background DUs will not be sampled in triplicate. Single samples will be collected from each background DUs.

NOTES:
DU = Decision Unit
EPA = U.S. Environmental Protection Agency
PAH = Polycyclic aromatic hydrocarbon
SIM = Selected ion monitoring
TAL = Target analyte list

Table 20-7 Discrete Sediment Samples

Matrix	Analytical Group	Maximum Number of Native Samples	Maximum Number of Field Replicates[1]	Maximum Number of MS/MSD Pairs[1]
Discrete Sediment	TOC	6	0	0
	Grain Size	6	0	0

1) Quality control samples will not be collected for sediment parameter samples.

NOTES:
TOC = Total organic carbon

QAPP Worksheet #21 – Field Standard Operating Procedures

SOP Reference Number	Responsible Organization	Title, Revision Date and/or Number	Equipment Type or Instrument	Comments
EA SOP-1	EA	SOP for Sample Labels, November 2018	Labels	Field SOPs that will be used in support of field sampling activities are provided in Appendix H.
EA SOP-2	EA	SOP for Chain-of-Custody Form, November 2018	Laboratory supplied chain-of-custody	
EA SOP-3	EA	SOP for Subsurface Utility Clearance, July 2018	None	
EA SOP-4	EA	SOP for Sampling Packing and Shipping, September 2018	Coolers and shipping materials (bags, tape)	
EA SOP-5	EA	SOP for Field Decontamination, September 2018	Potable water and cleaning agents	
EA SOP-15	EA	SOP for Document Control System, December 2014	None	
EA SOP-16	EA	SOP for Groundwater/Soil Field Logbooks, December 2014	Logbooks and appropriate field forms	
EA SOP-21	EA	SOP for Sediment Sampling	Scoops/spoons, logbooks and appropriate field forms	
EA SOP-25	EA	SOP for Soil Sampling	Soil boring advancement	
EA SOP-57	EA	SOP for Multi-Incremental Sampling, December 2014	Incremental sampling tool	
EA SOP-59	EA	SOP for Field Logbook, Revision 1, December 2014	Field logbook	

NOTES:
EA = EA Engineering, P.C. and Its Affiliate EA Science and Technology
SOP = Standard operating procedure

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Incremental Sampling tool	Set to collect at 0–6 inches below ground surface	Decontaminate between sample locations	Field checks	Inspect for external damage	Daily		Operator correction	Field personnel	EA-SOP-057
1) Field SOPs that will be used in support of field sampling activities are provided in Appendix H. NOTES: NA = Not applicable SOP = Standard operating procedure									

The Field Team Leader will be responsible for ensuring that these instruments are calibrated before each field-sampling event. Field equipment must be inspected and calibrated before use according to the criteria given in the referenced SOPs. If problems occur with field instruments or equipment that cannot be resolved by the field team personnel, the Field Team Leader should be contacted. If field equipment fails inspection, it is the Field Team Leader's responsibility to investigate and resolve the problem. The Equipment Facility Manager can also be contacted by the field crew or the Field Team Leader to help resolve problems with field equipment and supply or obtain any spare or replacement parts or equipment.

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QAPP Worksheet #23 – Analytical Standard Operating Procedures

Laboratory Standard Operating Procedure No.	Title and / or Method Number[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?[2] (Y/N)
Test America						
DV-GC-0021	Polychlorinated Biphenyls (PCBs) by GC/ECD (SW846 Method 8082 and 8082A)	Definitive	PCBs, Water and Soil	GC	TestAmerica Denver	N
DV-IP-0010	Acid Digestion of Aqueous Samples for Metals Analysis by ICP	Preparation	Metals, Water	NA	TestAmerica Denver	N
DV-IP-0014	Acid digestion of Aqueous Samples for Analysis by ICP-MS (SW-846 3005A, 3020A, and EPA 200.8)	Preparation	Metals, Water	NA	TestAmerica Denver	N
DV-IP-0015	Acid Digestion of Solids (EPA 3050B)	Preparation	Metals, Soil	NA	TestAmerica Denver	N
DV-LC-0002	Nitroaromatic and Nitramine Explosive Compounds by High Performance Liquid Chromatography (HPLC) (SW846 8330B & 8330B)	Definitive	Explosives, Water and Soil	HPLC	TestAmerica Denver	N
DV-MS-0002	Polycyclic Aromatic Hydrocarbons by GC/MS Selected Ion Monitoring (SIM) [SW 846 Method 8270C and 8270D]	Definitive	Semi-Volatiles, Water and Soil	GCMS	TestAmerica Denver	N
DV-MS-0010	Determination of Volatile Organics by GC/MS (SW846 8260B and EPA 624)	Definitive	Volatiles, Water and Soil	GCMS	TestAmerica Denver	N
DV-MS-0012	GC/MS Analysis Based on Method 8270D	Definitive	Semi-Volatiles, Water and Soil	GCMS	TestAmerica Denver	N
DV-MT-0016	Mercury in Solids by Cold Vapor Atomic Absorption (SW-846 7471A and 7471B)	Definitive	Metals (Mercury), Soil	CVAA	TestAmerica Denver	N
DV-MT-0021	ICP Analysis for Trace Elements by SW-846 Method 6010C	Definitive	Metals, Water and Soil	ICP	TestAmerica Denver	N
DV-MT-0022	Inductively Coupled Plasma Mass Spectrometry for Trace Element Analysis by SW-846 Method 6020A	Definitive	Metals, Water and Soil	ICPMS	TestAmerica Denver	N
DV-OP-0006	Extraction of Aqueous Samples by Separatory Funnel, SW-846 3510C and EPA 600 Series	Preparation	Organic Preparation, Water	NA	TestAmerica Denver	N
DV-OP-0007	Concentration and Clean-up of Organic Extracts (SW-846 3510C, 3520C, 3540C, 3546, 3550B, 3550C, 3620C, 3660B, 3665A, and EPA 600 series)	Preparation	Organic Preparation, Water and Soil	NA	TestAmerica Denver	N
DV-OP-0008	Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C and Method 625	Preparation	Organic Preparation, Water	NA	TestAmerica Denver	N
DV-OP-0013	Multi-incremental Sub-sampling from Soils and Sediments (ASTM D 6323)	Preparation	Organic Preparation, Soil	NA	TestAmerica Denver	N
DV-OP-0015	Microwave Extraction of Solid Samples by Method [SW 3546]	Preparation	Organic Preparation, Soil	NA	TestAmerica Denver	N
DV-OP-0016	Ultrasonic Extraction of Solid Samples by Method SW-846 3550C	Preparation	Organic Preparation, Soil	NA	TestAmerica Denver	N
DV-OP-0017	Solid Phase Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Water Samples (SW-846 3535A)	Preparation	Organic Preparation, Water	NA	TestAmerica Denver	N
DV-OP-0018	Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples (SW-846 8330B & 8330B)	Preparation	Organic Preparation, Soil	NA	TestAmerica Denver	N
Katahdin Analytical Services, LLC						
CA-551	Grain Size Analysis, 04/19, Revision 2.	Definitive	Solid / Grain Size	Sieves	Katahdin Analytical Services, LLC	N
CA-777	Titrimetric Determination of Organic Carbon Using the Walkley-Black Method, 05/13, Revision 0. (Reviewed 02/19)	Definitive	Solid / Total Organic Carbon	Total Organic Carbon Analyzer	No Variance	N
CA-551	Sample Receipt and Internal Control, 01/19, Revision 13.	NA	NA	NA	Katahdin Analytical Services, LLC	N
CA-741	Sample Disposal, 09/17, Revision 6. (Reviewed 01/19)	NA	NA	NA	Katahdin Analytical Services, LLC	N

1) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.
2) If yes, then specify the modification that has been made. Note that any analytical SOP modification made relative to project specific needs must be reviewed and approved by the Navy Quality Assurance Officer.

NOTES:
ASTM = American Society for Testing and Materials
CLLE = Continuous liquid/liquid Extraction
CVAA = Cold vapor atomic absorption
ECD = Electron capture detector
EPA = United States Environmental Protection Agency
GC = Gas chromatography
HPLC = High performance liquid chromatography
ICP = Inductively coupled plasma
NA = Not applicable
No. = Number
MS = Mass spectrometry
PCB = Polychlorinated biphenyls
SIM = Selected ion monitoring

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QAPP Worksheet #24 – Analytical Instrument Calibration

Table 24-1 Analytical Instrument Calibration Table: Target Analyte List Metals Method 6010C

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
ICP-AES	LDR or high-level check standard	At initial set up and checked every 6 months with a high standard at the upper limit of the range	Within ± 10% of true value	Dilute samples within the calibration range or re-establish/verify the LDR	Analyst/Section Supervisor	DV-MT-0021
ICP-AES	ICAL - Minimum of one high standard and a calibration blank	Prior to sample analysis.	If more than one calibration standard is used, r2 ≥ 0.99	Correct problem, then repeat ICAL	Analyst/Section Supervisor	DV-MT-0021
ICP-AES	ICV	Second source standard Immediately following ICAL	All reported analytes ± 10% of expected value.	Correct any problems and rerun ICV. If that fails, correct problem and repeat ICAL. No samples will be analyzed until the second-source calibration verification is successful.	Analyst/Section Supervisor	DV-MT-0021
ICP-AES	Low-Level Calibration Check Standard < LOQ (Low-level ICV)	Daily after one-point ICAL	All reported analytes must be within ± 20% of expected value.	Correct any problems, then reanalyze or repeat ICAL. Results cannot be reported without a valid low-level calibration check standard.	Analyst/Section Supervisor	DV-MT-0021
ICP-AES	ICS	After ICAL and prior to sample analysis	ICS-A: Absolute value of concentration for non-spiked project analytes < ½ LOQ (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within + 20% of true value. (Not needed if instrument can read negative responses.)	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze samples. If corrective action fails, apply Q-flag to results for specific analytes in samples associated with the failed ICS.	Analyst/Section Supervisor	DV-MT-0021
ICP-AES	CCV	After every 10 field samples and at the end of the sequence.	All reported analytes ± 10% of expected value.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze affected samples since the last acceptable CCV.	Analyst/Section Supervisor	DV-MT-0021
ICP-AES	ICB, CCB	Immediately after the ICV and immediately after every CCV.	The absolute values of analytes must be < ½ LOQ or < 1/10 the amount measured in any sample. Non-detects associated with positive blank infractions may be reported.	ICB: Correct any problems and repeat ICV/ICB. If that fails, rerun ICAL. CCBs cannot be reanalyzed without reanalysis of the associated samples and CCVs. Samples following the last acceptable calibration blank must be reanalyzed. CCB failures due to carryover may not require an ICAL.	Analyst/Section Supervisor	DV-MT-0021

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
AES = Atomic emission spectroscopy
CCB = Continuing calibration blank CCV = Continuing calibration verification
ICB = Initial calibration blank
ICP = Inductively coupled plasma
ICS = Interference check solutions
ICS = Interference check solutions
ICS-A = Interference check Solution A
ICV = Initial calibration verification
ICAL = Initial calibration
LDR = Linear dynamic range
LOQ = Limit of quantitation

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Table 24-2 Analytical Instrument Calibration Table: Target Analyte List Metals Method 6020A

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
ICP-MS	LDR or High-Level Check Standard	At initial set-up and checked every 6 months with a high standard at the upper limit of the range.	Within ± 10% of true value	Dilute samples within the calibration range or re-establish/verify the LDR	Analyst/Section Supervisor	DV-MT-0022
ICP-MS	Tuning	Prior to ICAL	Mass calibration < 0.1 amu from the true value. Resolution< 0.9 amu full width at 10% peak height.	Retune instrument and verify. No Samples will be analyzed without a valid tune.	Analyst/Section Supervisor	DV-MT-0022
ICP-MS	ICAL – Minimum of one high standard and a calibration blank	Daily, prior to sample analysis.	NA	NA	Analyst/Section Supervisor	DV-MT-0022
ICP-MS	ICV	Second source standard immediately following ICAL	All reported analytes ± 10% of expected value.	Correct any problems and rerun ICV. If that fails, correct problem and repeat ICAL. No samples will be analyzed until the second-source calibration verification is successful.	Analyst/Section Supervisor	DV-MT-0022
ICP-MS	Low-Level Calibration Check Standard < LOQ (Low-level ICV)	Daily after one-point ICAL	All reported analytes must be within ± 20% of expected value.	Correct any problems, then reanalyze or repeat ICAL. Results cannot be reported without a valid low-level calibration check standard.	Analyst/Section Supervisor	DV-MT-0022
ICP-MS	ICS	After ICAL and prior to sample analysis	ICS-A: Absolute value of concentration for non-spiked project analytes < ½ LOQ (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within + 20% of true value. (Not needed if instrument can read negative responses.)	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze samples.	Analyst/Section Supervisor	DV-MT-0022
ICP-MS	CCV	After every 10 field samples and at the end of the sequence.	All reported analytes ± 10% of expected value.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze affected samples since the last acceptable CCV.	Analyst/Section Supervisor	DV-MT-0022
ICP-MS	Initial and Continuing ICB, CCB	Immediately after the ICV and immediately after every CCV	Absolute values of analytes must be < ½ LOQ or <1/10 the amount measured in any sample. Non-detects associated with positive blank infractions may be reported. Sample results >10x LOQ associated with negative blanks may be reported.	Correct any problems and repeat ICV/ICB analysis. If that fails rerun ICAL. All samples following the last acceptable calibration blank must be reanalyzed. CCBs may not be reanalyzed without reanalysis of the associated samples and CCVs. CCB failures due to carryover may not require an ICAL.	Analyst/Section Supervisor	DV-MT-0022

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
ICP-MS	Internal Standard	Every field sample, standard and QC sample	IS intensity in the samples within 30-120% of intensity of the IS in the ICAL blank	Failures in samples with acceptable results in QC indicates matrix effect. Samples suffering from matrix effect should be diluted until criteria is met or alternate IS should be selected. Reanalyze samples at 5-fold dilution until criteria is met. For failed QC samples, correct problem and rerun associated failed field samples.	Analyst/Section Supervisor	DV-MT-0022

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
CCB = Continuing calibration bank
CCV = Continuing calibration verification
ICB = Initial calibration blank
ICP = Inductively coupled plasma
ICS = Interference check solutions
ICV = Initial calibration verification
ICAL = Initial calibration
LDR = Linear dynamic range
LOQ = Limit of quantitation
MS = Mass spectrometry
QC = Quality control

Table 24-3 Analytical Instrument Calibration Table: Mercury Method 7471

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	SOP Reference[2]
CVAA –7471B	ICAL (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis.	r2 ≥ 0.99	Correct problem then repeat initial calibration. If calibration fails again, re-digest the entire digestion batch.	Analyst/Laboratory Manager	DV-MT-0016, DV-MT-0017
	ICV	Run second-source standard once after each ICAL and prior to sample analysis.	Analytes within +10% of expected value	Correct problem then rerun ICV. If that fails, repeat initial calibration. If calibration fails again, re-digest the entire digestion batch.	Analyst/Laboratory Manager	DV-MT-0016, DV-MT-0017
	LLCCV	Daily If concentration of lowest calibration standard is less than or equal to the LOQ the lowest standard may be re-quantified against the calibration curve as a LLCCV.	Analytes within +20% of expected value	Correct problem and repeat ICAL	Analyst/Laboratory Manager	DV-MT-0016, DV-MT-0017
	CCV	After every 10 field samples, and at the end of the analysis sequence	All analytes within 10% of expected value	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze affected samples since the last acceptable CCV.	Analyst/Laboratory Manager	DV-MT-0016, DV-MT-0017
	ICB/CCB	Immediately after the ICV and immediately after every CCV	Absolute values of analyte < ½ LOQ or < 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. Non-detects associated with positive blank infractions may be reported. Sample results > 10x associated with negative blanks may be reported.	ICB: Correct problem and repeat ICV/ICB analysis. If that fails, rerun ICAL All samples following g the last acceptable Calibration Blank must be reanalyzed. CCBs may not be re-analyzed without re-analysis of the associated samples and CCV(s) CCB failures due to carryover may not require an ICAL.	Analyst/Laboratory Manager	DV-MT-0016, DV-MT-0017

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
CCB = Continuing calibration blank
CCV = Continuing calibration verification
CCVA = Cold vapor atomic absorption
ICB = Initial calibration blank
ICV = Initial calibration verification
ICAL = Initial calibration
LLCCV = Low-level calibration check standard
LOQ = Limit of quantitation

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Table 24-4 Analytical Instrument Calibration Table: Polycyclic Aromatic Hydrocarbons Method 8270D SIM

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
GC/MS	Tune Check - Check of mass assignments using PFTBA auto tune	Prior to ICAL and daily	Acceptable mass assignments using auto tune function	Retune instrument and verify.	Analyst/Section Supervisor	DV-MS-0002
GC/MS	Performance Checks	At the beginning of each 12-hour period, prior to analysis of samples.	Degradation ≤ 20% for DDT.	Correct problem, then repeat performance checks.	Analyst/Section Supervisor	DV-MS-0002
GC/MS	ICAL Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the reporting limit.	Initial calibration prior to sample analysis	Each analyte must meet one of these options below: Option 1: RSD for each analyte ≤ 20%. If pentachlorophenol is a target analyte, an RSD of ≤ 40% allowed. Option 2: linear least squares regression for each analyte: $r^2 \geq 0.99$;	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL.	Analyst/Section Supervisor	DV-MS-0002
GC/MS	ICV	Second source standard, once after each ICAL.	All reported analytes within ± 20% of true value. If pentachlorophenol is a target analyte, a %D from true value of ± 50% is allowed.	Correct problem and verify second source standard. Rerun verification. If still fails, repeat initial calibration.	Analyst/Section Supervisor	DV-MS-0002
GC/MS	Retention Time Window Position Establishment	Once per ICAL, and at the beginning of the analytical sequence for each analyte and surrogate.	Set position using the mid-point standard of the ICAL when ICAL is performed. On days when ICAL is not performed, use initial CCV.	NA	Analyst/Section Supervisor	DV-MS-0002
GC/MS	Evaluation of Relative Retention Time	With each sample	RRT of each reported analyte within 0.06 RRT units of the mean RRT of the calibration standards. RRT may be updated based on the daily CCV.	Correct problem and then rerun ICAL.	Analyst/Section Supervisor	DV-MS-0002
GC/MS	CCV	Daily, prior to sample analysis and after every 12 hours of analysis time; and at the end of the analytical batch.	All reported analytes and surrogates within ± 20% of true value. If analyte identified as a poor performer in Table 15, use criteria of ± 30% of true value. All reported analytes (except poor performers identified in Table 15) and surrogates within ± 50% for end of analytical batch CCV. If pentachlorophenol is a target analyte, a %D from true value of + 50% is allowed.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment. For closing CCVs, if compounds are not identified as critical compounds of concern report results with qualifiers. For closing CCVs, if the compound is identified as a critical compound of concern, then recalibrate, and reanalyze affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze affected samples since the last acceptable CCV.	Analyst/Section Supervisor	DV-MS-0002

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
GC/MS	Tune Check - Check of mass spectral ion intensities (tuning procedure) using DFTPP)	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method/SOP for specific ion criteria.	Retune instrument and verify.	Analyst/Section Supervisor	DV-MS-0012

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = Percent
CCV = Continuing Calibration Verification
D = Difference
DDT = Dichlorodiphenyltrichloroethane
DFTPP = Decafluorotriphenylphosphine
GC = Gas chromatography
ICV = Initial calibration verification
ICAL = Initial Calibration
MS = Mass spectrometry
NA = Not applicable
PFTBA = PerFluoroTriButylAmine
RRT = Relative retention time
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 24-5 Analytical Instrument Calibration Table: Benzene, Toluene, Ethylbenzene, and Xylenes Method 8260B

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
GC/MS	Check of mass spectral ion intensities (tuning procedure) using BFB	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method/SOP for specific ion criteria.	Retune instrument and verify.	Analyst/Section Supervisor	DV-MS-0010
GC/MS	Minimum five-point ICAL for target analytes for linear or six-point for quadratic; lowest concentration standard at or below the reporting limit,	Initial calibration prior to sample analysis	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 15% Option 2: linear least squares regression for each analyte: $r^2 \geq 0.99$; Option 3: non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$.	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL.	Analyst/Section Supervisor	DV-MS-0010
GC/MS	ICV	Second source standard, once after each ICAL.	All reported analytes within ± 20% of true value. If analyte is identified as a laboratory poor performer, use criteria of ± 30% of true value.	Correct problem and verify second source standard. Rerun verification. If still fails, repeat initial calibration.	Analyst/Section Supervisor	DV-MS-0010
GC/MS	Retention Time Window Position Establishment	Once per ICAL, and at the beginning of the analytical sequence for each analyte and surrogate.	Set position using the mid-point standard of the ICAL when ICAL is performed. On days when ICAL is not performed, use initial CCV.	NA	Analyst/Section Supervisor	DV-MS-0010
GC/MS	Daily calibration verification	Daily, prior to sample analysis and after every 12 hours of analysis time; and at the end of the analytical batch run.	All reported analytes and surrogates within ± 20% of true value. If analyte is identified as a laboratory poor performer, use criteria of ± 30% of true value. All reported analytes (except laboratory poor performers) and surrogates within ± 50% for end of analytical batch CCV.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment. For closing CCVs, if compounds are not identified as critical compounds of concern report results with qualifiers. For closing CCVs, if the compound is identified as a critical compound of concern, then recalibrate, and reanalyze affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze affected samples since the last acceptable CCV.	Analyst/Section Supervisor	DV-MS-0010

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
GC/MS	Internal Standards	During acquisition of calibration standard.	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL; EICP area within - 50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Analyst/Section Supervisor	DV-MS-0010

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = Percent
BFB = 4-bromofluorobenzene
CCB = Continuing calibration blank
CCV = Continuing calibration verification
EICP = Extracted ion current profile
GC = Gas chromatography
ICV = Initial calibration verification
ICAL = Initial calibration
MS = Mass spectrometry
NA = Not applicable
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 24-6 Analytical Instrument Calibration Table: Polychlorinated Biphenyls Method 8082A

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
GC-ECD	ICAL Minimum five-point initial calibration for target analytes	Initial calibration prior to sample analysis.	Acceptance Criteria options: 1. RSD for each analyte ≤ 20%. 2. Linear least squares regression: r2 ≥ 0.99 3. Non-linear regression: COD r2 ≥ 0.99.	Evaluate standards, chromatography, and detector response. If problem found with above, correct as appropriate, then repeat initial calibration An initial calibration using a minimum of 5 levels will be performed using Aroclors 1016 and 1260. Single point calibrations will be performed for the remaining Aroclors.	Analyst/Laboratory Manager	DV-GC-0021
	Retention Time Window Position Establishment	Once per ICAL and at the beginning of the analytical sequence, for each analyte and surrogate.	Set position using the mid-point standard of the ICAL when ICAL is performed. On days when ICAL is not performed, use initial CCV.	NA	Analyst/Laboratory Manager	DV-GC-0021
	ICV	Second source standard, immediately following ICAL	All project analytes within ± 20% of the expected value from the ICAL	Evaluate data. If problem (e.g., concentrated standard, plugged injector needle) found, correct, then repeat second source verification. If still fails, repeat initial calibration.	Analyst/Laboratory Manager	DV-GC-0021
	Daily CCV	Prior to sample analysis, after every 10 field samples, and at the end of the sequence with the exception of CCVs for Pesticides multi-component analytes (i.e., Toxaphene, Chlordane and Aroclors other than 1016 and 1260), which are only required before sample analysis.	All project analytes within ± 20% of the expected value from the ICAL	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze once affected samples since the last acceptable CCV. If CCV still fails, consult client before reporting.	Analyst/Laboratory Manager	DV-GC-0021

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = Percent
CCV = Continuing calibration verification
COD = Coefficient of determination
ECD = Electron capture detector
GC = Gas chromatography
ICV = Initial calibration verification
ICAL = Initial calibration
NA = Not applicable
RSD = Relative standard deviation
SOP = Standard operating procedure

Table 24-7 Analytical Instrument Calibration Table: Explosives Method 8330B

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
HPLC Method 8330B	ICAL – Minimum five-point initial calibration for target analytes	Initial calibration prior to sample analysis and after ICV or CCV failures. Perform instrument re-calibration once per year minimum.	Acceptance Criteria options: 1. RSD for each analyte ≤ 15%. 2. Linear least squares regression: r2 ≥ 0.99 3. Non-linear regression: COD: r2 ≥ 0.99	Correct problem then repeat initial calibration	Analyst/Laboratory Manager	DV-LC-0002
	ICV	Second source standard immediately following initial calibration.	All analytes within 20% of expected value	Correct problem. Repeat ICV. If that fails, repeat initial calibration	Analyst/Laboratory Manager	DV-LC-0002
	CCV	Before sample analysis, after every 10 field samples, and at the end of the analysis sequence	All analytes within + 20% of true value	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze affected samples since the last acceptable CCV. Only a single reanalysis is performed. If it is determined through reanalysis that project samples are the cause of CCV failures consult with client before reporting.	Analyst/Laboratory Manager	DV-LC-0002

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = Percent
CCV = Continuing Calibration Verification
COD = Coefficient of determination
HPLC = High Performance Liquid Chromatography
ICV = Initial calibration verification
ICAL = Initial Calibration
RSD = Relative standard deviation

Table 24-8 Analytical Instrument Calibration Table: Total Organic Carbon Method Walkley-Black

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
Buret / Total Organic Carbon	Standardization	Titrant must be standardized daily.	The titrated normality must be 0.500 +/- 0.05N	Remake the titrant and retitrate	Analyst	CA-777

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
CCV = Continuing calibration verification
ICAL = Initial calibration
ICV = Initial calibration verification
PQL = Project quantitation limit
%R = Percent recovery

Table 24-9 Analytical Instrument Calibration Table: Grain Size Method ASTM D422

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria[1]	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference[2]
Grain Size	Sieve – Visual inspection	Every use	No clogging or tears in mesh	Remove from service	Analyst, Department Manager	CA-551

1) This is a summary of the acceptance criteria; refer to the method SOP for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	Standard Operating Procedure Reference[1]
Test America								
GC	Change septum, clean injection port, change or clip column, install new liner, replace column, filters and seals	Detector signals and chromatogram review	Instrument performance and sensitivity	As needed	CCV passes criteria	Re-inspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Analyst	Quality Assurance Manual – Section 20
GC-MS	Clean sources, maintain vacuum pumps	Tuning	Instrument performance and sensitivity	Service vacuum pumps twice per year, other maintenance as needed	Tune and CCV pass criteria	Recalibrate instrument	Analyst	Quality Assurance Manual – Section 20
GC-MS	Change septum, clean injection port, change or clip column, install new liner, change trap	Response factors and chromatogram review	Instrument performance and sensitivity	As needed	Tune and CCV pass criteria	Re-inspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Analyst	Quality Assurance Manual – Section 20
ICP	Replace pump windings and gas tanks, check standard and sample flow	Monitor ISTD counts for variation	Instrument performance and sensitivity	As needed	Monitor ISTD counts for variation	Replace windings, recalibrate and reanalyze	Analyst	Quality Assurance Manual – Section 20
ICPMS	Replace disposables, clean/change nebulizer, torch, and cones	Tuning	Instrument performance and sensitivity	Daily or as needed	Tune and CCV pass criteria	Recalibrate	Analyst	Quality Assurance Manual – Section 20
CVAA	Replace disposables, flush lines, check lamp current and gas flow	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	Quality Assurance Manual – Section 20
HPLC	Replace columns, DAD flow cell windows and ball-valve cartridges as needed, clean/change filters, check eluent reservoirs	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	Quality Assurance Manual – Section 20
Katahdin Analytical Services, LLC								
Buret – Total Organic Carbon	N/A	TOC	Visual inspection for cracks or chips	Each use	N/A	Remove from service	Analyst, Department Manager	CA-777
Seives	Cleaning	Grain Size	Visual inspection for clogs or tears	Each use	N/A	Remove from service	Analyst, Department Manager	CA-551

1) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
CCV = Continuing calibration verification
CVAA = Cold vapor atomic absorption
GC = Gas chromatography
HPLC = High performance liquid chromatography
ICP = Inductively coupled plasma
ISTD = Internal standard gas chromatography
SOP = Standard operating procedure

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QAPP Worksheets #26 and #27 – Sample Handling, Custody, and Disposal

To ensure sample authenticity and data defensibility, a proper sample handing system will be followed from the time of sample collection to final sample disposal.

Sampling organization: EA Engineering, Science, and Technology, Inc., PBC

Laboratory: TestAmerica, Denver, Colorado; Katahdin Analytical Services, LLC, Scarborough, Maine

Method of sample delivery (shipper/carrier): Overnight Shipping (Federal Express or United Parcel Service).

Number of days from reporting until sample disposal: Per laboratory requirements.

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference[1]
Sample labeling	EA, field personnel	EA-SOP-1
Chain-of-custody form completion	EA, field personnel	EA-SOP-2
Packaging	EA, field personnel	EA-SOP-4
Shipping coordination	EA, field personnel	EA-SOP-4
Sample receipt, inspection, and log-in	Laboratory sample log-in staff and laboratory PM	TBD
Sample custody and storage	Laboratory PM	TBD
Sample disposal	Laboratory Waste Manager	TBD

1. Field SOPs that will be used in support of field sampling activities are included in Appendix H.

NOTES
EA = EA Engineering, P.C. and Its Affiliate EA Science and Technology
PM = Project manager
SOP = Standard operating procedure
TBD = To be determined

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory)

Sample Collection: Analytical samples will be collected using clean nitrile gloves and placed in laboratory supplied and/or approved bottle ware containing appropriate preservatives, as defined in Worksheet #19 and #30.

QA/QC samples (methanol trip blanks and field blanks) will be collected as detailed in Worksheet #20.

Sample Identification—Weatherproof sample labels with sample identification numbers will be affixed to each sample container. Each sample will be assigned a unique alpha-numeric code to assist in the tracking of samples and to facilitate retrieval of analytical results. The sampling code will be used on sample labels, sample tracking forms, chain of custody forms, field logs, and any other applicable documentation. The alpha-numeric code will be as follows:

- Site Name-Decision Unit Identifier-Sequential Decision Unit Number and Triplicate Sample Indicator-Sample Media-Date Code

  — Site Name = IINY for Iona Island, New York

  — Decision Unit Identifier= DU for onsite Decision Unit, BADU for Background Area Decision Unit, EXDU for Explosives area DU

  — Sequential Decision Unit Number=assigned DU number (1, 2, 3, 4, etc.) as presented on Figure X.

  — Triplicate sample indicator = A for initial sample, B for duplicate sample, or C for triplicate sample. Background DUs, which will not be sampled in triplicate, will not be assigned a triplicate sample indicator.

  — Sample Media = SSIS for Surface Soil Incremental Sample, SBIS1 for Subsurface Soil at 0-36 in.

  — Date Code = the six-digit date codes correspond to YYYYMMDD. For example, 20190708 corresponds to samples collected on 8 July 2019.

For example, surface soil and subsurface soil incremental samples collected from DU#6 on 8 July 2019 would be labeled as follows:

- Initial incremental surface soil sample: IINY-DU-6A-SSIS-20190708
- Initial incremental subsurface soil sample: IINY-DU-6A-SBIS1-20190708
- Duplicate incremental surface soil sample: IINY-DU-6B-SSIS-20190708
- Duplicate incremental subsurface soil sample: IINY-DU-6B-SBIS1-20190708
- Triplicate incremental surface soil sample: IINY-DU-6C-SSIS-20190708
- Triplicate incremental subsurface soil sample: IINY-DU-6C-SBIS1-20190708

Methanol trip blanks and field blanks will be named with the Site Name-Sample Prefix-Date. Sample prefixes are as follows:

- Methanol trip blanks will be labeled by using prefix "TB" in front of the date (mmddyy) (YYYYMMDD). For example, a methanol trip blank collected on 8 July 2019 would be labeled IINY-TB-20190708.

- Methanol field blanks will be labeled by using the prefix "FB" in front of the date (YYYYMMDD). For example, a methanol field blank collected on 8 July 2019 would be labeled IINY-FB-20190708.

Sample Tracking

Sample tracking will start at the point of collection with logbook entries. The log entries will be recorded legibly in blue or black waterproof ink in a bound field logbook updated daily and maintained at the site. Information to be recorded in the logbook will include the project name and number; a unique, sequential sample number for each sample taken; sampling date and time; method of sampling; preservation techniques; analyte classes of interest; significant observations made during the sampling process; results of any field measurements; and printed name and signature of the person performing the sampling.

Each sample will be labeled in waterproof ink with the following information:

- Sample identification
- Sampling date and time
- Name of sampler
- Analysis requested
- Preservation technique.

Sample Custody and Documentation

Each sample will be tracked by secure chain-of-custody protocol, until receipt at the laboratory. Chain-of-custody documentation is required for each sample to track collection, shipments, laboratory receipt, custody, and disposal. Each individual who has the samples in their possession will sign the chain-of-custody record. A sample is considered to be in custody under the following conditions:

- It is in actual possession or in view of the person who collected the sample
- It is locked in a secure area
- It is placed in an area restricted to authorized personnel.

Upon completion of sample collection, logging, and preservation, each sample identification number will be entered on the chain-of-custody record. The chain-of-custody records will identify sample-specific information (sample identification number, date/time collected, sampler, matrix, preservation, and turnaround time for analysis) and a listing of the analytical parameters required on each sample.

The chain-of-custody record will accompany the samples throughout the shipping and analytical process. When transferring possession of samples, the individual relinquishing and receiving the samples will sign, date, and note the time on the chain-of-custody record. This record will document transfer of custody of samples from the sampler to another person or to the laboratory.

Upon arrival at the laboratory, the samples in the cooler will be checked against the chain-of-custody record by laboratory personnel. If discrepancies are noted, the samples in question will be segregated and field personnel will be immediately notified. The person accepting the delivery will sign and date the chain-of-custody.

The original chain-of-custody record will accompany the sample shipment, and copies will be retained by the EA PM for the project file. Participating laboratories will follow their documented, internal chain-of-custody procedures.

Sample Packaging and Shipping

Onsite personnel will be responsible for ensuring that adequate sample containers are available for the work scheduled.

Samples will be placed on ice in sample coolers immediately after collection to ensure proper preservation. A temperature blank will be included with samples as required to document laboratory receipt temperature. Each cooler will be cleaned and lined with bubble wrap. Double-bagged ice will be packed around the samples. A completed chain-of-custody form will be placed in a sealed plastic bag and taped to the inside lid of one of the coolers for each shipment. Coolers will be sealed with tape and a custody seal will be attached to protect the integrity of the samples.

Environmental samples will be shipped to the laboratory via overnight delivery service. Samples will be packaged and shipped in a manner that will ensure the safety and accountability of each sample, and the procedures implemented will be in accordance with applicable federal and local requirements. The persons packing and shipping environmental samples should review and be aware of state, federal, New York State Department of Transportation, and International Air Transport Association regulations governing environmental and hazardous sample packaging. The person(s) shipping the samples is responsible to comply with applicable packaging, labeling, and shipping requirements.

QAPP Worksheet #28 – Analytical Quality Control and Corrective Action

Table 28-1 Quality Control Samples: Target Analyte List Metals Method 6010C

Matrix: Soil
Analytical Group: Metals
Analytical Method/SOP Reference[2]: EPA 6010C DV-MT-0021

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/ Preparatory Batch (20 samples)	No Target Compounds> ½ LOQ or greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Common lab contaminants: no analytes detected > LOQ.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >10x negative blanks or sample results ND.	Analyst/Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>1/2 LOQ
Laboratory Control Sample	1/Preparatory Batch (20 samples)	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published.	If acceptable, report. If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, evaluate and re-prep and reanalyze the LCS and samples in the associated prep batch for failed analytes, if sufficient sample material is available. Marginal exceedance allowed unless analyte is specified risk driver.	Analyst/Section Supervisor	Accuracy/Bias	DoD QSM 5.2 or Laboratory % Recovery / RPD Control Limits
MS/MSD	1 pair/Preparatory Batch (20 samples)	Recovery: DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published. RPD: RPD between MS and MSD < 20%	If MS fails, consult project specific DQOs and contact client to see if additional measures need to be taken. For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error. For Sample/Matrix Duplicate criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	DoD QSM 5.2 or Laboratory % Recovery/RPD Control Limits
Dilution test	One per preparatory batch if MS or MSD fails. Only applicable for samples with concentrations >50 x LOQ. Use along with MS/MSD and PDS data to confirm matrix effects	Five-fold dilution must agree within + 10% of the original determination	If dilution test fails analyze post digestion spike.	Analyst Section Supervisor	Accuracy/Bias/ Precision	N/A
Post digestion spike addition	When MS/MSD fails and analyte concentration < 50 x LOQ	Recovery within 80-120% of expected results	For specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst/Section Supervisor	Accuracy/Bias	N/A
Method of Standard Additions	When dilution test or PDS fails and if required by the project	NA	Document use of MSA in Case Narrative	Analyst/Section Supervisor	Accuracy/Bias	N/A
LOQ Check	Quarterly	Compound specific recovery limits included in Appendix G	Per DoD QSM requirements	Section Supervisor/QA Manager	Accuracy/Sensitivity	Compound Specific Recovery Limits

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = percent
DQO = Data quality objective
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSA = Measurement systems analysis
MSD = Matrix spike duplicate
NA = Not applicable
ND = Non-detect
PDS = Post digestion spike
QSM = Quality Systems Manual
RPD = Relative percent difference

Table 28-2 Quality Control Samples: Target Analyte List Metals Method 6020A

Matrix:	Soil
Analytical Group:	Metals
Analytical Method / SOP Reference[2]:	EPA 6020A DV-MT-0022

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedures Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/ Preparatory Batch (20 samples)	The absolute values of analytes must be < ½ LOQ or 1/10 the regulatory limit (whichever is greater). Common lab contaminants: no analytes detected > LOQ. Non-detects associated with positive blank infractions may be reported. Sample results >10x the LOQ associated with negative blanks may be reported.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst/Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>1/2 LOQ
Laboratory Control Sample	1/Preparatory Batch (20 samples)	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published.	If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, evaluate and re-prep and reanalyze the LCS and samples in the associated prep batch for failed analytes, if sufficient sample material is available. Marginal exceedances allowed unless analyte is specified risk driver.	Analyst/Section Supervisor	Accuracy/Bias	DoD QSM 5.2 or Laboratory % Recovery/RPD Control Limits
MS/MSD	1 pair/Preparatory Batch (20 samples)	Recovery: DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published. RPD: RPD between MS and MSD < 20% For Sample/MD: RPD criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	If MS fails, consult project specific DQOs and contact client to see if additional measures need to be taken. For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	DoD QSM 5.2 or Laboratory % Recovery/RPD Control Limits
Dilution test	One per preparatory batch if MS or MSD fails. Only applicable for samples with concentrations >50 x LOQ. Use along with MS/MSD or PDS data to confirm matrix effects.	Five-fold dilution must agree within + 10% of the original determination	If dilution test fails analyze post digestion spike.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	NA
Post digestion spike addition	When MS/MSD fails or analyte concentration of samples < 50 x LOQ.	Recovery within 80-120% of expected results	For specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst/Section Supervisor	Accuracy/Bias	NA
Method of Standard Additions	When dilution test or post digestion spike fails and if required by the project	NA	Document use of MSA in the Case Narrative	Analyst/Section Supervisor	Accuracy/Bias	NA
LOQ Check	Quarterly	Compound specific recovery limits included in Appendix G	Per DoD QSM requirements	Section Supervisor/QA Manager	Accuracy/Sensitivity	Compound Specific Recovery Limits

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:

% = percent
DQO = Data quality objective
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSA = Measurement systems analysis
MSD = Matrix spike duplicate
NA = Not applicable
ND = Non-detect
PDS = Post digestion spike
QSM = Quality Systems Manual
RPD = Relative percent difference

Table 28-3 Quality Control Samples: Mercury Methods 7471B

Matrix:	Soil
Analytical Group:	Mercury
Analytical Method/SOP Reference[2]**:**	EPA 7471B, DV-MT-0016, DV-MT-0017

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/Preparatory Batch (20 samples)	Absolute value of analyte must be < ½ LOQ or < 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater).	Correct problem then re-prep and analyze method blank and samples processed with the contaminated blank. Non-detects associated with positive blank results may be reported. Sample results > 10x the LOQ associated with negative blanks may be reported. If reanalysis is not possible, apply B-flag to results for the specific analyte(s) in samples processed with the contaminated blank. Must be explained in the case narrative.	Analyst/Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>1/2 RL
Laboratory Control Sample	1/Preparatory Batch (20 samples)	DoD QSM 5.2 limits	If the LCS recovery is above the project acceptance limits and there are no detections in the samples, report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project (3HR) Correct any problems, then re-prep and reanalyze LCS and associated samples for failed analytes in samples in the associated batch. If corrective action fails, apply Q-flag to specific analyte(s) in samples in associated batch.	Analyst/Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
MS/MSD	1/Preparatory Batch (20 samples)	DoD QSM 5.2 Limits RPD: < 20% For Sample/MD: % recovery and RPD criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	If MS fails, consult project specific DQOs and contact client to see if additional measures need to be taken. For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	Laboratory % Recovery / RPD Control Limits
LOQ Check	Quarterly	Compound specific recovery limits included in Appendix G	Per DoD QSM requirements	Section Supervisor/QA Manager	Accuracy/Sensitivity	Compound Specific Recovery Limits

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:

% = percent	LOQ = Limit of quantitation	ND = Non-detect	RPD = Relative percent difference
DQO = Data quality objective	MS = Matrix spike	QSM = Quality Systems Manual	RL = Reporting limit
LCS = Laboratory control sample	MSD = Matrix spike duplicate		

Table 28-4 Quality Control Samples: Polycyclic Aromatic Hydrocarbons Method 8270D SIM

Matrix:	Soil
Analytical Group:	Polycyclic Aromatic Hydrocarbons
Analytical Method/SOP Reference[2]:	EPA 8270C or 8270D SIM, DV-MS-0002

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Internal Standards	Each calibration standard, sample and QC sample	Retention time within ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard. On days when ICAL is not performed, the initial CCV is used.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning in accordance with DoD QSM 5.2 requirements. If field samples still outside criteria, qualify data and explain in case narrative.	Analyst/Section Supervisor	NA	EPA method requirements
Method Blank	One per preparatory batch (20 samples)	No Target Compounds > ½ LOQ or > 1/10 the amount in any sample or 1/10 the regulatory limit (whichever is greater)	If sufficient sample is available, re-prep and reanalyze samples. Qualify data as needed. Narrate if reanalysis cannot be performed.	Analyst/Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>1/2 LOQ; no common lab contaminants > LOQ.
Laboratory Control Sample	One per preparatory batch (20 samples)	DoD QSM 5.2 limits (if available) or current in-housel limits if no QSM limits published.	Reanalyze LCS once. If acceptable, report. Otherwise, if exceedance is not a critical chemical of concern as identified by the project team, evaluate for SME. If acceptable, report with case narrative comment. If not acceptable for SME, evaluate samples for detections, and LCS for high bias. If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, or if there are detections for critical chemicals of concern, evaluate and re-prep and reanalyze the LCS and samples in the associated prep batch for failed analytes, if sufficient sample material is available.	Analyst/Section Supervisor	Accuracy/Bias	DoD QSM 5.2 or Laboratory % Recovery Control Limits
MS/MSD	One MS/MSD per preparatory batch (20 samples)	Recovery: DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published. RPD: DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published RPD between MS and MSD ≤ 40% for analytes (between MS/MSD or sample and MD)	Determine root cause; J flag analytes in parent sample if acceptance criteria not met. Discuss in narrative.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	DoD QSM 5.2 or Laboratory % Recovery / RPD Control Limits
Surrogates	Every field and QC sample	PAH Analysis: DMC required for PAH target analytes: fluoranthene-d10 and 2-methylnaphthylene-d10 Minimum RRF for PAH DMCs is 0.40 DoD QSM 5.2 limits (if available) or current in-housel limits if no QSM limits published or 50-150% until limits can be established.	Evaluate data, if samples non-detect and surrogate recovery is above upper limits, report with case narrative comment. If obvious chromatographic interference is present, notify the client, report with narrative comment. Otherwise, re-extract and reanalyze.	Analyst/Section Supervisor	Accuracy/Bias	DoD QSM 5.2 or Laboratory % Recovery Control Limits
Characteristic ions for MS confirmation	Minimum 3 ions	The relative intensities of the characteristic ions of target analytes agree within 30% of the relative intensities in the reference spectrum and the relative intensities must be > 0. Confirmation requires S/N ratio of ≥ 3 for each quant and confirmation ion.	No data can be reported without MS confirmation.	Analyst/Section Supervisor	Accuracy	
LOQ Check	Quarterly	Compound specific recovery limits included in Appendix G	Per DoD QSM requirements	Section Supervisor/QA Manager	Accuracy/Sensitivity	Compound Specific Recovery Limits

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = percent
CCV = Continuing calibration verification
DMC = Deuterated Monitoring Compound
DoD = Department of Defense
GC = Gas chromatography
DQO = Data quality objective
EICP = Extracted ion current profile
EPA = United States Environmental Protection Agency
ICAL = Initial calibration
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
NA = Not applicable
PAH = Polyaromatic hydrocarbon
QSM = Quality Systems Manuel
QC = Quality control
SME = Sporadic marginal exceedance
RPD = Relative percent difference
RRF = Relative response factor

Table 28-5 Quality Control Samples: Benzene, Ethylbenzene, Toluene, and Xylenes Method 8260B

Matrix	Soil
Analytical Group	Benzene, Ethylbenzene, Toluene, and Xylenes
Analytical Method/SOP Reference[2]:	EPA 8260B, DV-MS-0010

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Internal Standards	Each calibration standard, sample and QC sample	Retention time within ± 10 seconds from retention time of the midpoint standard in the ICAL; EICP area within - 50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning in accordance with DoD QSM 5.2 requirements. If field samples still outside criteria, qualify data and explain in case narrative.	Analyst/Section Supervisor	NA	EPA method requirements
Method Blank	One per preparatory batch (20 samples)	No Target Compounds> ½ LOQ or > 1/10 the amount in any sample or 1/10 the regulatory limit (whichever is greater). No common lab contaminants >RL.	If sufficient sample is available, re-prep and reanalyze samples. Qualify data as needed.	Analyst/Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>1/2 LOQ; no common lab contaminants > LOQ.
Laboratory Control Sample	One per preparatory batch (20 samples)	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published.	Reanalyze LCS once. If acceptable, report. Otherwise, if exceedance is not a critical chemical of concern as identified by the project team, evaluate for SME. If acceptable, report with case narrative comment. If not acceptable for SME, evaluate samples for detections, and LCS for high bias. If LCS has high bias, and samples non-detect, report with case narrative comment. If LCS has low bias, or if there are detections for critical chemicals of concern, evaluate and re-prep and reanalyze the LCS and samples in the associated prep batch for failed analytes, if sufficient sample material is available.	Analyst/Section Supervisor	Accuracy/Bias	DoD QSM 5.2 or Laboratory % Recovery Control Limits
MS/MSD	One MS/MSD per preparatory batch (20 samples)	Recovery: DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published. RPD: RPD between MS and MSD < 20%	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	DoD QSM 5.2 or Laboratory % Recovery / RPD Control Limits
Surrogates	Every field and QC sample	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published.	Evaluate data, if samples non-detect and surrogate recovery is above upper limits, report with case narrative comment. If obvious chromatographic interference is present, report with narrative comment. Otherwise, re-extract and reanalyze.	Analyst/Section Supervisor	Accuracy/Bias	DoD QSM 5.2 or Laboratory % Recovery Control Limits
LOQ Check	Quarterly	Compound specific recovery limits included in Appendix G	Per DoD QSM requirements	Section Supervisor/QA Manager	Accuracy/Sensitivity	Compound Specific Recovery Limits

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = percent
DoD = Department of Defense
EICP = Extracted ion current profile
EPA = United States Environmental Protection Agency
ICAL = Initial calibration
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
QSM = Quality Systems Manuel
QC = Quality control
SME = Sporadic marginal exceedance
RL = Reporting limit
RPD = Relative percent difference

Table 28-6 Quality Control Samples: Polychlorinated Biphenyls Method 8082A

Matrix: Soil
Analytical Group: Polychlorinated Biphenyls
Analytical Method/SOP Reference[2]: EPA 8082/8082A/, DV-GC-0021

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds > ½ LOQ or > 1/10 the amount in any sample or 1/10 the regulatory limit (whichever is greater).	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >10x blank result or sample results ND.	Analyst/Section Supervisor	Accuracy/Bias Contamination	No Target Compounds>1/2 LOQ
Laboratory Control Sample	1/Batch (20 samples)	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published	If the LCS recovery is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project (3HR). Otherwise, correct any problems then re-prep and reanalyze the LCS and associated samples for failed analytes. If insufficient sample, then apply Q-flag to specific analyte(s) in samples in the associated prep batch. Flagging is only appropriate when samples cannot be reanalyzed unless 3HR is accepted by the client. Marginal exceedances will be applied unless analytes identified as critical chemicals of concern (risk drivers). (1SME)	Analyst/Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
MS/MSD	1/Batch (20 samples)	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published. RPD: < 30%	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. Explain in the case narrative. The MS is for matrix evaluation only. If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every field sample and QC samples	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published.	For QC and field samples, correct any problems, then re-prep and reanalyze failed samples for failed surrogates in the associated prep batch. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary, but the client must be notified prior to reporting data. If surrogate recoveries are above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project. For samples with ND results, a high bias as evidenced in these situations is typically not an issue (3HR). Apply Q-flag to associated analytes if acceptance criteria are not met. Explain in the case narrative. All surrogates analyzed must be reported.	Analyst/Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
LOQ Check	Quarterly	Compound specific recovery limits included in Appendix G	Per DoD QSM requirements	Section Supervisor/QA Manager	Accuracy/Sensitivity	Compound Specific Recovery Limits

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = percent
DL = Detection limit
LCS = Laboratory control sample
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
ND = Non-detect
QSM = Quality Systems Manuel
QC = Quality control
SME = Sporadic marginal exceedance
RPD = Relative percent difference

Table 28-7 Quality Control Samples: Explosives Method 8330B

Matrix: Soil
Analytical Group: Explosives
Analytical Method/SOP Reference[2]: EPA 8330B, DV-LC-0002

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1/Preparatory Batch (20 samples)	No Target Compounds> ½ LOQ or > 1/10 the amount in any sample or 1/10 the regulatory limit (whichever is greater).	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >10x blank result or sample results ND.	Analyst/Section Supervisor	Contamination	No Target Compounds>1/2 LOQ
Soil Grinding Blank (Soil Only)	One grinding blank (e.g., Ottawa sand) per batch of samples. The grinding blank must be processed; after the LCS (if ground) Or After a client identified sample with known contamination, Or At the end of the batch.	No reported analytes detected > ½ LOQ.	If any individual grinding blank is found to exceed the acceptance criteria, apply B-flag to the samples following that blank.	Analyst/Section Supervisor	Contamination	No Target Compounds>1/2 LOQ
Subsampling	Each Sample, LCS, and MS samples All samples must be subsampled, including those that were not initially dried, ground or sieved.	Entire sample mixed and spread out evenly on a large flat surface and 30 or more randomly located increments are removed from the entire depth and breadth to obtain the appropriate subsample size.				
Soil Sample Triplicate (Soil Only)	At the subsampling step, one sample per batch, randomly selected unless identified by the client (not on a designated blank)	Three subsamples are taken from a sample expected to contain the highest levels of explosives within the quantitation range of the method. The RSD for results above the LOQ must be < 30%.	Contact the client for action to be taken.	Analyst/Section Supervisor	Accuracy/Bias/Precision	RSD < 30% (for results >LOQ)
Laboratory Control Sample	1/Preparatory Batch (20 samples) (Does not go through grinding process; spiked with components of interest)	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published	If the LCS recovery is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project (3HR). Otherwise, correct any problems then re-prep and reanalyze the LCS and associated samples for failed analytes. If insufficient sample, then apply Q-flag to specific analyte(s) in samples in the associated prep batch. Flagging is only appropriate when samples cannot be reanalyzed unless 3HR is accepted by the client. Marginal exceedances will be applied unless analytes identified as critical chemicals of concern (risk drivers). (1SME)	Analyst/Section Supervisor	Accuracy/Bias	DoD QSM 5.2 or Laboratory % Recovery Control Limits
MS/MSD	1/Preparatory Batch (20 samples)	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published. RPD: < 20% For sample/MD: % recovery and RPD criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. Explain in the case narrative. The MS is for matrix evaluation only. If MS falls outside LCS limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst/Section Supervisor	Accuracy/Bias/ Precision	Laboratory % Recovery / RPD Control Limits

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Surrogates	Every field sample and QC samples	DoD QSM 5.2 limits (if available) or current in-house limits if no QSM limits published.	For QC and field samples, correct any problems, then re-prep and reanalyze failed samples for failed surrogates in the associated prep batch. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. For obvious chromatographic interference, client must be notified prior to reporting data and failures must be discussed in the case narrative. If surrogate recoveries are above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project. For samples with ND results, a high bias as evidenced in these situations is typically not an issue (3HR). Apply Q-flag to associated analytes if acceptance criteria are not met. Explain in the case narrative.	Analyst/Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Confirmation of positive results	All results > DL must be confirmed Confirmation not required if LCMS or >LCMS used for primary analysis.	Calibration and QC criteria are the same for the confirmation analysis as for initial or primary column analysis. Results between primary and second column RPD < 40%. Confirmation column must be able to resolve the analytes of interest and must have a different retention time order relative to the primary column. Report from primary column unless project directs otherwise.	Report from both columns. Apply J-flag if RPD > 40%; discuss in case narrative.	Analyst/Section Supervisor	Confirmation	RPD < 40%
LOQ Check	Quarterly	Compound specific recovery limits included in Appendix G	Per DoD QSM requirements	Section Supervisor/QA Manager	Accuracy/Sensitivity	Compound Specific Recovery Limits

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = percent
CRM =
LCS = Laboratory control sample
LCMS = Laboratory control Mass Spec
LOQ = Limit of quantitation
MS = Matrix spike
MSD = Matrix spike duplicate
ND = Non-detect
QSM = Quality Systems Manuel
QC = Quality control
SME = Sporadic marginal exceedance
RPD = Relative percent difference
RSD = Relative standard deviation

Table 28-8 Quality Control Samples: Total Organic Carbon Method Walkley-Black

Matrix:	Sediment
Analytical Group:	Total Organic Carbon
Analytical Method/SOP Reference[2]:	Walkley-Black / CA-741

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	One per prep batch of 20 or fewer samples	No analyte detected >PQL	(1) Investigate source of contamination (2) Report all sample results <PQL. (3) Report sample results >10X the blank result and flag results with a "B". (4) Reanalyze all other samples associated with the failing blank where possible or flag results with "B"	Analyst, Laboratory Department Manager and Data Validator	Bias/contamination	Same as Method/SOP QC Acceptance Limits.
LCS	One per prep batch of 20 or fewer samples	80% - 120% Recovery	(1) If the LCS fails repeat LCS determination Re-prepare affected reagent or standard and repeat LCS	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.
MS	One for every set of 20 or fewer samples	75% - 125% Recovery	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. Low recovery may be due to acid-insoluble organic carbons.	Analyst, Laboratory Department Manager, and Data Validator	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate	One sample duplicate per ten samples	(1) RPD ≤20 for sample results greater than 3 times the PQL For sample results less than three times the PQL, the RPD between sample and duplicate should be < 100%.	If RPD is outside criteria report original result with notation or narration.	Analyst, Laboratory Department Manager, and Data Validator	Precision	Same as Method/SOP QC Acceptance Limits.

1) This is a summary of the acceptance criteria; refer to Appendix G for specific or more information.
2) SOPs are reviewed/revised on an annual schedule. The current version will be followed at the time of sample receipt.

NOTES:
% = percent
LCS = Laboratory control sample
LOD = Limit of detection
PQL = Project quantitation limit
MS = Matrix spike
QC = Quality control
SOP = Standard operating procedure
RPD = Relative percent difference

Table 28-9 Quality Control Samples: Grain Size Method ASTM D422

Matrix:	Sediment
Analytical Group:	Grain Size
Analytical Method/SOP Reference[2]:	ASTM D422 / CA-551

Quality Control Sample	Frequency/Number	Method/Standard Operating Procedure Quality Control Acceptance Limits[1]	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
N/A: Laboratory QC samples are not planned for grain size analysis.						

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QAPP Worksheet #29 – Project Documents and Records

Planning Documents[1]	Sample Collection Documents and Records[1]	Onsite Analysis Documents and Records[1]	Offsite Analysis Documents and Records[1]	Data Assessment Documents and Records[1]	Other[1]
• Project Management Plan • Community Relations Plan • UFP-QAPP • Accident Prevention Plan • SOPs • eQAPP within FUDSChem	• Field logbook • Data collection documents and records • Field forms • Chain-of-custody records • Photographs	• Air bills • Chain-of-custody records • Communications regarding corrective action or deviation from methods • Calibration logs • Sampling notes • Field forms • Identification of QC samples • Quality Control Reports • Photographs	• Case narrative • Definitions of laboratory qualifiers • Documentation of corrective action results • Documentation of laboratory method deviations • Electronic data deliverables • Identification of QC samples • Subcontract Laboratory certifications • Subcontract Laboratory Quality Assurance Plans • SOPs • Laboratory sample identification numbers • Reporting forms, completed with actual results • Sample chronology (time of receipt, extraction, and analysis) • Tabulated data summary forms and raw data for field samples, standards, QC checks, and QC samples	• Chemical Data Interim Reports • Chemical Data Final Reports • Data Validation Reports • Chemical Quality Control Summary Report	• Health and Safety Sign-off Sheets • Daily field reports • Phase I Data Summary Report • Remedial Investigation Report

1) Documents will be verified by the Project Manager (Timothy Reese, P.E.) and stored in the project file.

NOTES:
QC = Quality control
SOP = Standard operating procedure
UFP-QAPP = Uniform Federal Policy Quality Assurance Project Plan

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QAPP Worksheets #31, #32, and #33 – Assessments and Corrective Action

Assessment Type	Responsible Party and Organization	Number/Frequency	Assessment Deliverable	Deliverable Due Date
Field Sampling Audit	QA/QC Manager or designee	As required by USACE	Audit Memorandum	7 days after assessment
Independent Technical Review	Senior Technical Experts	As needed, at critical points in development and performance	Independent Technical Review Report	7 days after assessment
Field Documentation Audit	QA/QC Manager or designee	TBD	Audit Memorandum	7 days after assessment
Deliverable Checks	Qualified individual from the appropriate discipline	Prior to document submission	Email or written documentation	Immediate correction
Interdisciplinary Checks	Project development team members	Daily, as needed	Email or written documentation; sign-off sheet	Immediate correction
Laboratory Technical Systems Audit (may be documentation review)	Laboratory QA; Project Chemist	As required by USACE	Audit Memorandum	Immediate correction – written documentation within 7 days
Performance Evaluation Sample	QCS	As required by USACE	Audit Memorandum	7 days after assessment
Data Review Technical Systems Audit	QCS	As necessary or requested	Data Evaluation Summary Report	30 days after review
Health and Safety Compliance Audit	SSHO	During each DFW, upon arrival of new crew, and as required by USACE	Project Review Summary Report	Immediate correction – written documentation due within 1 week
Management Systems Review	QCS	As necessary or requested	Project Review Summary Report	Immediate correction - written documentation due within 1 week
Subcontract Laboratory Technical Systems/ Performance Audits	Laboratory PM	Per Laboratory QA Manual	Audit Memorandum	

NOTES:
PM = Project Manager
QA = Quality assurance
QC = Quality control
QCS = Quality Control Supervisor
SSHO = Site Safety and Health Officer
TBD = To be determined
USACE = U.S. Army Corps of Engineers

Assessment Response and Corrective Action

Assessment Type	Responsibility for Responding to Assessment Findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for Monitoring Corrective Action Implementation
Field Sampling Audit	Field Task Leader	Corrective Action Response (email or memorandum)	Immediate correction - written documentation due within 1 week	Field Task Leader	PM, EA or designee
Independent Technical Review	Appropriate persons depending on the area of the findings, EA Project Chemist	Corrections to plans, documents as indicated	In accordance with project schedule	Appropriate persons depending on the area of the findings, EA Project Chemist	PM, EA or designee
Field Documentation Audit	Field Task Leader	Corrective Action Response (email or memorandum)	Immediate correction - written documentation due within 1 week	Field Task Leader	PM, EA or designee
Deliverable Checks	Appropriate persons depending on the area of the findings, EA Project Chemist	Corrections to deliverables as indicated	In accordance with project schedule	Appropriate persons depending on the area of the findings, EA Project Chemist	PM, EA or designee
Interdisciplinary Checks	Appropriate persons depending on the area of the findings, EA Project Chemist	Email to file	As necessary for progress of project	Appropriate persons depending on the area of the findings, EA Project Chemist	PM, EA or designee
Laboratory Technical Systems Audit (may be documentation review)	Laboratory QA Manager	Corrective Action Response (email or memorandum)	Immediate correction- written documentation within 7 days of receipt of memorandum	Laboratory Manager	Contractor Project Chemist
Performance Evaluation Sample	Laboratory QA Manager	Corrective Action Response	7 days from receipt of memorandum	Laboratory Technical Director	Contractor Project Chemist
Data Review Technical Systems Audit	Appropriate persons depending on the area of the findings, EA Project Chemist	Corrective Action Response (email or memorandum)	21 days for reissuance	Appropriate persons depending on the area of the findings, EA Project Chemist	Contractor QA/QC Manager or designee
Health and Safety Compliance Audit	SSHO	Corrective Action Response (email or memorandum)	Immediate correction- written documentation within 7 days of receipt of memorandum	SSHO	PM, EA or designee
Management Systems Review	PM, EA or designee	Corrective Action Response	7 days from receipt of memorandum	As assigned in response	Contractor QA/QC Manager or designee
Laboratory	Laboratory QA Manager	E-mail to file	Immediate correction - written documentation due within 1 week	Laboratory PM	Laboratory PM

NOTES:
DFW = Definable feature of work
EA = EA Engineering, P.C. and Its Affiliate EA Science and Technology
PM = Project Manager
QA = Quality assurance
QC = Quality control
SSHO = Site Safety and Health Officer

QAPP Worksheet #34 – Data Verification and Validation Inputs

This worksheet is used to list the inputs that will be used during data verification and validation. Inputs include planning documents, field records, and laboratory records.

Item	Record/Document	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records				
1	Approved planning documents	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	X	X
2	Contract		X	
4	Field SOPs		X	X
5	Laboratory SOPs		X	X
Field Records				
6	Tailgate safety meeting record	Tailgate safety meetings and associated health and safety forms will be completed by the designated health and safety officer and UXO specialist.	X	X
7	Field logbooks/Field Sheets	Field notes will be prepared daily by the Field Team and will be complete, appropriate to the project tasks, and legible. The Field Team Leader will review logbooks and records for accuracy and completeness. Upon completion of field work, logbooks and records will be placed in the project files. Field reports will be verified to ensure correct reporting of information. Review will be conducted prior to completion of each report.	X	X
8	Equipment calibration records		X	X
9	Chain-of-custody records	Sample Manager, Field Team Leader, or designee will review the COC forms against the samples packed in each cooler prior to shipment. COCs will be sent with the samples to the laboratory and copies retained for the project files. Analytical data will be reviewed upon completion of analytical activities and verified against the laboratory report.	X	X
10	Sampling drawings/surveys	Data user will review during evaluation and completion of data report.	X	X
11	Relevant correspondence	Relevant correspondence will be used to reconcile field records and data.	X	X
12	Change orders/deviations	Field changes will be communicated as presented in Worksheet #6. Unanticipated field changes may require a UFP-QAPP addendum, amendment, and/or revision. This requirement will be determined in consultation with the USACE PM and USACE Technical Manager following notification of the proposed change. If required, any UFP-QAPP addendum, amendment, and/or revision will be submitted to the USACE PM and USACE Technical Manager, and regulators /stakeholders (as applicable) for review, comment, and approval.	X	X
13	Field audit reports	The EA PM and/or QCS will evaluate whether field sampling procedures were followed with respect to equipment and proper sampling support and verify that planned audits were conducted and examine audit reports. For any deficiencies noted, the QCS will verify that corrective action was implemented according to plan. The audit reports will indicate whether samples were collected, field measurements performed, and field equipment calibrated according to the Work Plan. During verification, any necessary corrective actions will be reviewed.	X	X
14	Field corrective action reports		X	X

Item	Record/Document	Description	Verification (completeness)	Validation (conformance to specifications)
Analytical Data Package				
15	Cover sheet (laboratory identifying information)	Laboratory analyst and QA officer will review/verify internally the completeness and technical accuracy of data prior to submittal. Laboratory data will be verified by the project chemist who will review data packages for content and sample information upon receipt. Data packages will be evaluated for completeness and compliance. Relevant correspondence will be used to reconcile analytical data. Data will be validated using ADR, and the FUDSChem checklist. The data will be evaluated against project DQOs and measurement performance criteria, such as completeness.	X	X
16	Case narrative		X	X
17	Internal laboratory chain-of-custody		X	X
18	Sample receipt records		X	X
19	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)		X	X
20	Communication records		X	X
21	Project-specific proficiency testing/sample results (if applicable)		X	X
22	LOD/LOQ establishment and verification		X	X
23	Standards traceability		X	X
24	Instrument calibration records		X	X
25	Definition of laboratory qualifiers		X	X
26	Results reporting forms		X	X
27	QA/QC sample results		X	X
28	Corrective action reports		X	X
29	Raw data		X	
30	Electronic data deliverable		X	X

NOTES:
ADR = Automated data review
COC = chain of custody
DQO = Daily quality objectives
EA = EA Engineering P.C. and its affiliate EA Science and Technology
FUDSChem = Formerly Used Defense Site Online Chemical Database
QA = Quality assurance
QC = Quality control
QCS = Quality Control Supervisor
LOD = Limit of detection
LOQ = Limit of quantitation
SOP = Standard operating procedure
TBD = To be determined
USACE = U.S. Army Corps of Engineers
UFP-QAPP = Uniformed Federal Program Quality Assurance Project Plan
UXO = Unexploded ordnance

QAPP Worksheet #35 – Data Verification Procedures

This worksheet establishes the procedures that will be followed to verify project data. Data verification is a completeness check to confirm that the required activities were conducted, the specified records are present, and the contents of the records are complete.

Records Reviewed	Process Description	Responsible Person, Organization
Chain-of-custody records and shipping forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers that they represent to verify their completeness, accuracy, and consistency with the field logbook. The review will include verification of appropriate analytical methods, preservation, sufficient volume for analyses and necessary QC samples (i.e., MS/MSD), and required signatures and dates. A check for transcription errors will occur. A copy of the chain-of-custody will be retained in the project file, with the original and remaining copies taped inside the cooler for shipment.	Daily – Field team lead; at the conclusion of field activities – EA Project Chemist or designee.
Field notes/logbook/field forms	Field notes will be reviewed daily internally for completeness, accuracy, and comparability between sample locations and field samplers. The review will include verification that records are present and complete for each day of field activities, the planned samples including field QC samples were collected, sample collection locations are documented, and meteorological data were provided for each day of field activities. Review will also include verification that changes/exceptions are documented and were reported in accordance with requirements. If field data are collected, review will verify that results are documented. Any required corrective actions will be addressed with the field samplers prior to further site work.	Daily – Field team lead; at the conclusion of field activities – Project Chemist or designee.
Audit reports, Corrective Action Reports	The QCS will verify that planned audits were conducted and examine audit reports. For any deficiencies noted, the QCS will verify that corrective action was implemented according to plan. The audit reports will indicate whether samples were collected, field measurements performed, and field equipment calibrated according to the Work Plan. During verification, any necessary corrective actions will be reviewed.	QCS, EA PM or designee
Laboratory deliverables	The laboratory deliverable will be reviewed to verify that content contains the records specified in the planning documents. Verification will include check of sample receipt records to ensure sample condition upon receipt was noted, and that missing/broken sample containers were noted and reported according to planning documents. The data package will be compared to chain-of-custody records to verify that results were provided for the collected samples. The narrative will be reviewed to ensure that QC exceptions are described. The review will verify that necessary signatures and dates are present.	Before release of data package – Laboratory QA Manager; Upon receipt – EA Project Chemist or designee

NOTES:
EA = EA Engineering, P.C. and its affiliate EA Science and Technology
QCS = Quality Control Supervisor
MS = Matrix spike
MSD = Matrix spike duplicate
QC = Quality control

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QAPP Worksheet #36 – Data Validation Procedures

Data validation is an analyte and sample-specific process for evaluating compliance with contract requirements, methods/SOPs, and method performance criteria. The validation to be performed for each data type is summarized in this worksheet. Data validation will be performed by the EA Project Chemist.

Data Validation

Analytical Group/Method:	TAL metals by EPA Method 6010C/6020A, mercury by EPA Method 7471B, PAHs by EPA Method 8270D SIM, BTEX by EPA Method 8260B, Aroclor PCBs by EPA Method 8082A, explosives by 8330B, soil pH
Data deliverable requirements:	Level 4 PDF data package; SEDD format Stage 2A version 5.2
Analytical specifications:	Worksheet #28
Measurement performance criteria:	Worksheet #12
Percent of data packages to be validated:	100%
Percent of raw data reviewed:	0%
Percent of results to be recalculated:	0%
Validation procedure:	FUDSChem eQAPP; DoD-QSM, version 5.2; and EPA National Functional Guidelines
Validation code[1]	S2bVEM
Electronic validation program/version:	ADR in FUDSChem

1) Refer to Validation Code and Label Identifier Table

NOTES:
% = percent
ADR = Automatic Data Review
BTEX = Benzene, toluene, ethylbenzene, and xylenes
DoD = Department of Defense
EPA = United States Environmental Protection Agency
FUDSChem = Formerly Used Defense Sites Chemistry Database
SEDD = Staged electronic data deliverables
SIM = Selective ion monitoring
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
QSM = Quality Systems Manual
TAL = Target analyte list

Validation Code and Label Identifier Table

Validation Code	Validation Label	Description	Reference
S1VE	Stage 1 Validation Electronic	Stage 1 Validation - Verification and validation based only on completeness and compliance of sample receipt condition checks.	EPA 540-R-08-005
S1VM	Stage 1 Validation Manual		
S1VEM	Stage 1 Validation Electronic and Manual		
S2aVE	Stage 2a Validation Electronic	Stage 2A Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions and ONLY sample-related QC results.	
S2aVM	Stage 2a Validation Manual		
S2aVEM	Stage 2a Validation Electronic and Manual		
S2bVE	Stage 2b Validation Electronic	Stage 2B Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions and BOTH sample-related and instrument-related QC results.	
S2bVM	Stage 2b Validation Manual		
S2bVEM	Stage 2b Validation Electronic and Manual		
S3VE	Stage 3 Validation Electronic	Stage 3 Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, AND recalculation checks.	
S3VM	Stage 3 Validation Manual		
S3VEM	Stage 3 Validation Electronic and Manual		
S4VE	Stage 4 Validation Electronic	Stage 4 Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, recalculation checks, AND the review of actual instrument outputs.	
S4VM	Stage 4 Validation Manual		
S4VEM	Stage 4 Validation Electronic and Manual		
NV	Not Validated	Not applicable.	

EPA = United States Environmental Protection Agency
NV = Not validated
VE = Validation electronic
VEM = Validation electronic and manual

The following data qualifiers will be applied during data validation. Potential impacts on project specific DQOs will be discussed in the data validation report.

- NM – Measurement Performance Criteria contained in Worksheet #12 were not met.

- J – The result is an estimated value. The nature of the bias will be discussed in the data validation report.

- J- – The result is an estimated value with a potential low bias.

- J+ – The result is an estimated value with a potential high bias.

- X – The sample results were affected by serious deficiencies. The analyte may or may not be present in the sample. Exclusion of the data is recommended.

- R – The data are unusable and are rejected.

- U – The analyte was analyzed for but was not detected above the level of the associated value. The associated value is the limit of detection (LOD).

- UJ – The analyte was analyzed for but was not detected above the level of the associated value. The associated value is an estimate and may be inaccurate or imprecise.

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QAPP Worksheet #37 – Data Usability Assessment

This worksheet documents procedures that will be used to perform the data usability assessment. The data usability assessment is performed at the end of data collection activities, using the outputs from data verification and data validation. It is the data interpretation phase that involves a qualitative and quantitative evaluation of environmental data to evaluate whether the project data are of the right type, quality, and quantity to support the decisions that need to be made. It involves a retrospective evaluation of the systematic planning process, and like the systematic planning process, involves participation by key members of the project team. The data usability assessment evaluates whether underlying assumptions used during systematic planning are supported, sources of uncertainty have been accounted for and are acceptable, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence.

The usability assessment will consider whether data meet project quality objectives as they relate to the decisions to be made and evaluates whether data are suitable for making those decisions. The usability assessment is a data review and will be performed only on data of known and documented quality (i.e., verified and validated data).

To accomplish this step of data review, the project team will do the following:

- Summarize the usability assessment process and the usability assessment procedures, including interim steps and any statistics, equations, and computer algorithms that will be used to assess data.

- Describe the documentation that will be generated during usability assessment.

- Identify the personnel (by title and organizational affiliation) responsible for performing the usability assessment.

- Describe how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies.

- Describe the evaluation procedures used to assess overall measurement error associated with the project and include the data quality indicators.

The usability assessment process and procedures, including interim steps and any statistics, equations, and computer algorithms that will be used are as follows:

- **Step 1**: Review the project's objectives and sampling design:

  — The team conducting the usability assessment will review the objectives of the monitoring program as they relate to usability of data collected.

- **Step 2**: Review the data verification and data validation outputs:

- Data verification and validation outputs will be reviewed for deviations (in the field or laboratory), trends, and anomalies that may affect data usability, and the impacts of the findings on data usability will be assessed.

Summary of Data Quality Indicators

A data usability assessment will include a summary of whether the data achieved the project DQOs, as well as a data quality and usability statement. A description of each data quality indicator is found under each parameter heading below. Precision, accuracy/bias, representativeness, comparability, and completeness, as well as sensitivity, are the data quality indicators used to validate and assess the data produced during the project. Each data quality indicator is described below including a definition of the terminology, the referenced process for calculating the indicator, and the referenced measurement performance criteria for this project. Specific data quality indicators and their specific measurement performance criteria to be evaluated for data usability are presented on Worksheet #12 and Worksheet #28.

To measure and control the quality of analyses, certain QA parameters are defined and utilized in data analysis activities. These QA parameters are defined below. The assigned subcontract laboratory will generally follow the QA/QC criteria specified in the applicable EPA method.

Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, percent difference, or range, in either absolute or relative terms. QC measures for precision include field duplicates, laboratory duplicates, MSDs, and analytical replicates.

To meet the needs of the data users, project data must meet the measurement performance criteria for precision specified in UFP-QAPP Worksheets #12 and #28 and supporting worksheets. Precision may be the result of one or more of the following: field instrument variation, analytical measurement variation, poor sampling technique, sample transport problems, or spatial variation (heterogeneous sample matrices). To identify the cause of imprecision, the field sampling design rationale and sampling techniques will be evaluated by the reviewer, and both field and analytical duplicate/replicate sample results will be reviewed. The process for calculating precision will be in accordance with the UFP-QAPP Manual, Section 2.6.2.1 (EPA 2005a).

Duplicate precision is stated in terms of RPD or absolute difference between two measurements. Measurement of precision is dependent upon sampling technique and analytical method. Field duplicate and laboratory duplicate samples will be used to measure precision for project samples. Both sampling and analysis will be as consistent as possible. For a pair of measurements, RPD (or absolute difference) will be used, as presented below:

$$\text{RPD (\%)} = \frac{|D_1 - D_2|}{\frac{(D_1 + D_2)}{2}} \times 100$$

where: D_1 and D_2 = the two replicate values.

RPD will meet QA requirements listed in the applicable laboratory SOPs.

If poor precision is indicated in both the field and analytical duplicates/replicates, then the laboratory may be the source of error. If poor precision is limited to the field duplicate/replicate results, then the sampling technique, field instrument variation, sample transport, and/or spatial variability may be the source of error. If data validation reports indicate that analytical imprecision exists for a particular data set or sample delivery group, then the impact of that imprecision on usability will be considered prior to use.

Analytical Accuracy/Bias

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) that are due to sampling and analytical operations. Examples of QC measures for accuracy include MS, LCS, equipment blanks, and surrogates. In order to meet the needs of the data users, project data must meet the measurement performance criteria for accuracy/bias specified in UFP-QAPP Worksheets #12 and #28. The process for calculating accuracy/bias will be in accordance with the UFP-QAPP Manual, Section 2.6.2.2.

Sources of error include the sampling process, field contamination, preservation, handling, shipping, sample matrix, sample preparation, and analysis technique. Analytical accuracy will be assessed through surrogate spike, MS, laboratory control and/or quality check samples, where applicable. In general, accuracy is measured in terms of percent recovery (%R):

$$\%\text{R} = \frac{(\text{SSR} - \text{SR})}{\text{SA}} \times 100$$

where:
SSR = spike sample result
SR = sample result
SA = spike added to spiking matrix

Refer to the scope of work for the laboratory analytical method accuracy requirements for methods; percent recoveries for other analytical methods will meet the QA requirements listed in the applicable laboratory SOPs.

Representativeness

Representativeness is the measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that is dependent upon the proper design and implementation of the sampling program and proper laboratory protocol. In order to meet the needs of the data users, project data must meet the measurement performance criteria for sample representativeness specified in the UFP-QAPP Worksheets #12 and #28. The process for calculation representativeness will be in accordance with the UFP-QAPP Manual, Section 2.6.2.4.

The sampling protocol created for this project was designed to provide data representative of site conditions. During the development of the sampling protocol, consideration was given to the past history of the site, existing analytical data, physical setting, and processes. Representativeness will be satisfied by determining that the UFP-QAPP is followed, proper sampling techniques, preservation, and handling are used, proper analytical procedures are followed, and holding times for the samples are not exceeded in the laboratory.

This UFP-QAPP discusses how the QA/QC activities (review of sampling design and SOPs, field sampling technical systems audits, split sampling and analysis audits, etc.) and QC sample data will be reviewed to assess sample representativeness. For samples collected, if field duplicate precision checks indicate potential spatial variability, additional scoping meetings and subsequent sampling may be needed in order to collect data that are more representative of the site.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was planned to be obtained. In order to meet the needs of the data users, project data must meet the measurement performance criteria for data completeness specified in UFP-QAPP Worksheets #12 and #28.

A completeness check will be done on the data generated by the laboratory. The completeness criterion for this project is 100% for each DU/analyte/data use. Completeness will be calculated for each analyte as follows (UFP-QAPP Manual Section 2.6.2.6). For each analyte, completeness will be calculated as the number of valid (usable) data points for each analyte, divided by the total number of data points for each analyte.

Following the completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness (\%)} = \frac{\text{number of usable data}}{\text{number of samples collected for each parameter analyzed}} \times 100$$

The completeness acceptance criterion for samples collected in the field will be 90% of the quantity of samples planned for collection in the UFP-QAPP. Corrective action may be implemented to re-collect samples where necessary and possible (e.g., modifying a planned sample location, sample jars broken during shipment). Laboratory notification of sample receipt and conditions will be used to evaluate, as soon as possible, whether any problems during sample shipment would necessitate recollection of samples.

Comparability

Comparability is the degree to which different methods, data sets, and decisions agree or can be represented as similar. Comparability describes the confidence (expressed qualitatively or quantitatively) that two data sets can contribute to a common analysis and interpolation. In order to meet the needs of the data users, project data must meet the measurement performance criteria for comparability specified in UFP-QAPP Worksheets #12 and #28.

The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are expected to provide comparable data. The procedures used will be EPA methodologies or other standard test methods, which are well recognized and commonly used for environmental investigations.

Desired Method Sensitivity

Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. Examples of QC measures for determining sensitivity include laboratory fortified blanks, a method detection limit study, and calibration standards at the quantitation limit. To meet the needs of the data users, project data must meet the measurement performance criteria for sensitivity specified in Worksheet #12 and PALs specified in Worksheet #15 of this UFP-QAPP.

Depending upon the use of the data and the type of test parameter, specific QLs will be required. Worksheet #15 lists the required PALs for the chemical parameters of interest for this work. The analytical methods used for this project should have sensitivities below these criteria.

Usability Assessment

The project team will reconvene to perform the usability assessment, led by the Project Chemist, to ensure that the project quality objectives are understood, and the full scope is considered. Data usability will be discussed in any reports that are produced for this project.

As part of the data usability assessment, each of the project quality objectives previously described and presented on Worksheets #12 and #28 will be examined to determine if the objective was met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will first be evaluated separately in terms of the major impacts observed from the data validation, data quality indicators, and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be evaluated. Based on the quality determined, the usability of the data for each analysis will be determined. Based on the combined usability of the data from analyses for an objective, it will be determined if the project quality objective was met and whether PALs were exceeded. As part of the reconciliation of each objective, conclusions will be drawn and any limitations on the usability of any of the data will be described.

If measurement performance criteria are not achieved and it is determined that certain project data are not usable, such that the completeness criterion for the project is not met, then the Project Team will evaluate if it is necessary to take further action, such as resampling, to ensure that DQOs have been met.

The following items are examples of specific items that will be considered during the usability assessment:

- ***Data Deliverables and UFP-QAPP, Deviation***—Ensure that necessary information was provided including, but not limited to, validation results.
- ***Deviations***—Evaluate the impact of deviations on the usability of data.
- ***Sampling Locations***—Evaluate whether alterations to sample locations continue to satisfy the project objectives.
- ***Chain-of-Custody***—Establish that any problems with documentation or custody procedures do not prevent the data from being used for the intended purpose.
- ***Holding Times***—Evaluate the acceptability of data if holding times were exceeded.
- ***Damaged Samples***—Evaluate whether the data from damaged samples are usable. If the data cannot be used, determine whether resampling is necessary.
- ***SOPs and Methods***—Evaluate the impact of deviations from SOPs and specified methods on data.
- ***QC Samples***—Evaluate the implications of unacceptable QC sample results on the data usability for the associated samples. For example, consider the effects of observed blank contamination.
- ***Matrix***—Evaluate matrix effects (interference or bias).
- ***Meteorological Data and Site Conditions***—Evaluate the possible effects of meteorological (e.g., wind, rain, temperature) and site conditions on sample results. Review field reports to identify whether any unusual conditions were present and how the sampling plan was executed.

- ***Comparability*****—**Ensure that results from different data collection activities achieve an acceptable level of agreement.

- ***Completeness*****—**Evaluate the impact of missing information. Ensure that enough information was obtained for the data to be usable (completeness as defined in project quality objectives documented in the UFP-QAPP).

- ***Background*****—**Evaluate whether background levels have been adequately established.

- ***Critical Samples*****—**Establish that COPCs as defined in the UFP-QAPP, were collected and analyzed. Determine if the results meet criteria specified in the QAPP.

- ***Data Restrictions*****—**Describe the exact process for handling data that do not meet project quality objectives (i.e., when measurement performance criteria are not met). Depending on how those data will be used, specify the restrictions on use of those data for environmental decision-making.

- ***Usability Decision****—Determine if the data can be used to make a specific decision considering the implications of deviations and corrective actions.*

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Appendix A

Accident Prevention Plan

REVISION 1
ACCIDENT PREVENTION PLAN

MILITARY MUNITIONS RESPONSE PROGRAM AND HAZARDOUS TOXIC AND RADIOACTIVE WASTE SITES REMEDIAL INVESTIGATION THROUGH DECISION DOCUMENT AT THE IONA ISLAND NAVAL AMMUNITION DEPOT FORMERLY USED DEFENSE SITE, ROCKLAND COUNTY, NEW YORK

PREPARED BY:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

MAY 2019

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Revision Tracking

Date	Revision	Description and Sections Affected
12/2018	0	Baseline document
5/20/2019	1	Response to comments Text edits Appendix G Appendix H

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LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ABIH	American Board of Industrial Hygiene
ACGIH	American Conference of Governmental Industrial Hygienists
AED	Automatic external defibrillator
AEODS	American Explosive Ordnance Disposal Services
AGC	Advanced geophysical classification
AHA	Activity hazard analysis
ANJV	Acorn SI/NAEVA Joint Venture
AOC	Area of Concern
AOR	AOR International, LLC
APP	Accident prevention plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
COR	Contracting Officer's Representative
CPR	Cardiopulmonary resuscitation
CSP	Certified Safety Professional
CON/HTRW	Containerized Hazardous Toxic and Radioactive Waste
DAGCAP	Department of Defense Advanced Geophysical Classification Accreditation Program
dBA	Decibel(s)
DD	Decision document
DDESB	Department of Defense Explosives Safety Board
DGM	Digital geophysical mapping
DMM	Discarded military munitions
DPIC	Direct Person in Charge
DU	Decision Unit
EA	EA Engineering, Science, and Technology, Inc., PBC
EM	Engineering manual
ft	Foot (feet)
FUDS	Formerly Used Defense Site
GPS	Global Positioning System
GFCI	Ground fault circuit interrupter
HAZWOPER	Hazardous Waste Operations and Emergency Response
HTRW	Hazardous Toxic and Radioactive Waste
IDW	Investigation-derived wastes
in.	Inch(es)

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

KO	Contracting Officer
LEP	Licensed Environmental Professional
MD	Munitions debris
MDAS	Material documented as safe
MEC	Munitions and explosives of concern
MMRP	Military Munition Response Program
MPPEH	Munitions potentially presenting an explosive hazard
MR	Munitions response
MRS	Munition response site
NYSDEC	New York State Department of Environmental Conservation
OESS	Ordnance and Explosives Safety Specialist
OSHA	Occupational Safety and Health Administration
P.E.	Professional Engineer
P.G.	Professional Geologist
PhD	Doctor of Philosophy
PIPC	Palisades Interstate Park Commission
PMP	Project Management Professional
PPE	Personal protective equipment
PWS	Performance Work Statement
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QCS	Quality control specialist
RAC	Risk assessment code
RI	Remedial investigation
RTK	Real-time kinematic
SDS	Safety data sheet
SHM	Safety and Health Manager
SSHO	Site Safety and Health Officer
SSHP	Site safety and health plan
STR	Senior technical review
SUXOS	Senior Unexploded Ordnance Supervisor

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TBD	To be determined
TOI	Target(s) of interest
TLV	Threshold limit value
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USEPA	U.S Environmental Protection Agency
UXO	Unexploded Ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer

1. INTRODUCTION

This Accident Prevention Plan (APP) has been prepared by EA Engineering, Science, and Technology, Inc., PBC (EA) to support the Military Munition Response Program (MMRP) and Hazardous Toxic and Radioactive Waste (HTRW) Remedial Investigation (RI) through Decision Document (DD) for the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS), Rockland County, New York (**Figure 1-1**). The scope of the project includes conducting an RI through DD at MMRP Munitions Response Site (MRS)-01 1903 Explosion Area and at 19 HTRW Areas of Concern (AOCs) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Work conducted under this contract will be performed in accordance with applicable federal, state, and local safety and occupational health laws and regulations including: Occupational Safety and Health Administration (OSHA) Standards (including 29 Code of Federal Regulations [CFR] 1910 and 1926), the U.S. Army Corps of Engineers (USACE) Safety and Health Requirements Manual (Engineering Manual [EM] 385-1-1, 30 November 2014), and USACE EM 385-1-97. The contents of this APP are subject to review and revision as new or additional information becomes available.

1.1 SIGNATURE SHEET

Plan Preparer

This APP has been prepared by Qualified Persons.

Denise Wilt
20 May 2019
Name: Denise Wilt, Professional Geologist (P.G.) Date
Title: Senior Geologist
Company: EA Telephone: 410-584-7000

Plan Approvals

An officer of the company with the authority to obligate the company has approved this APP.

Gordon Porter
20 May 2019
Name: Gordon Porter Date
Title: Vice President, Site Characterization and Remediation Business Unit Director
Company: EA Telephone: 410-329-5113

An American Board of Industrial Hygiene (ABIH) – Certified Industrial Hygienist (CIH) and a Certified Safety Professional (CSP) has supervised the preparation, reviewed, and approved this APP:

Pete Garger
20 May 2019
Name: Peter Garger, CIH (ABIH No. 3118) Date:
CSP (Board of Certified Safety Professionals No. 20560)
Title: Director of Safety and Health/Safety and Health Manager (SHM)
Company: EA Telephone: 410-527-2425

Certification/Concurrence:

Project and Program Management has concurred with the elements of this APP. Site worker concurrence will be documented through signature on an APP/Site Safety and Health Plan (SSHP) review form.

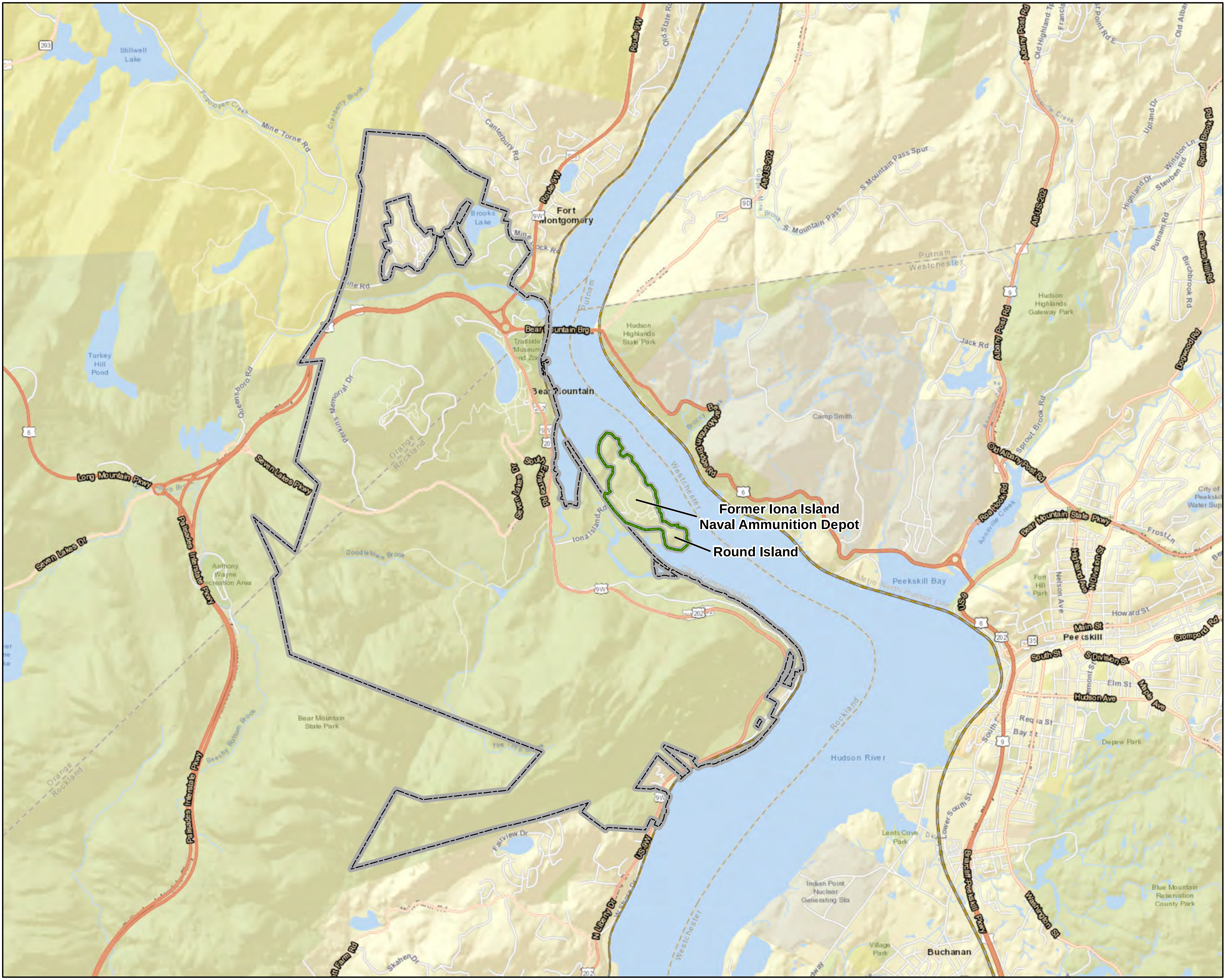
Brenda Herman
20 May 2019
Name: Brenda Herman, P.G. Date
Title: Senior Vice President, Army Programs, Delivery Order Program Manager
Company: EA Telephone: 410-527-2474

Barranco, Jr.
20 May 2019
Name: Frank Barranco, Jr., Doctor of Philosophy (PhD) Date
Professional Engineer (P.E.), P.G.
Title: Director of Quality Control (QC)
Company: EA Telephone: 410-329-5137

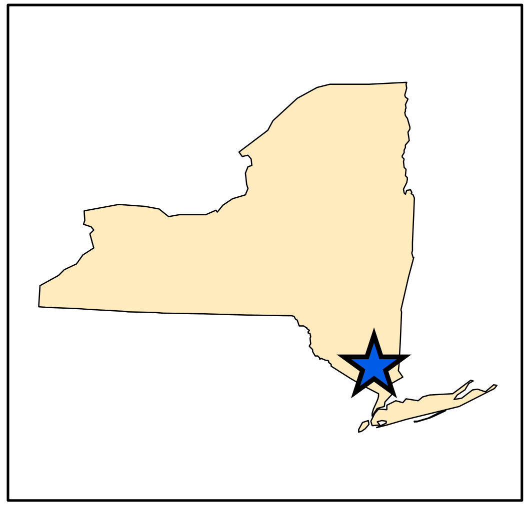
20 May 2019
Name: Timothy Reese, P.E. Date
Title: Project Manager
Company: EA Telephone: 410-671-6051

1.2 REVISIONS

Changes in the Performance Work Statement (PWS), field changes, or unanticipated site conditions may require APP modification and approval in order to retain field safety. Changes will be made by the Plan Preparer with input from other qualified personnel familiar with the types of work involved and current site safety issues. The revisions and/or APP addenda will also be submitted to USACE–Baltimore District for acceptance.



VICINITY MAP



Legend

- 🟩 FUDS Boundary
- ⬜ Bear Mountain State Park Boundary

0 0.5 1
Miles
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N

FIGURE 1-1
General Location of the Iona Island Naval Ammunition Depot FUDS

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 1/2/2019

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2. BACKGROUND INFORMATION

This section presents a brief description of the project including site description, PWS, and phases of work.

Contractor:	EA Engineering, Science, and Technology, Inc., PBC 225 Schilling Circle Suite 400 Hunt Valley, Maryland 21031
Contract Number:	W912DR-15-D-0014, Delivery Order W912DR18F0587
Project Name and Location:	MMRP and HRTW RI through DD for Iona Island Naval Ammunition Depot FUDS, Rockland County, New York (**Figures 2-1** and **2-2** Areas of Investigation Maps)

2.1 PROJECT DESCRIPTION

USACE has contracted EA to conduct an RI through DD at the Iona Island Naval Ammunition Depot FUDS, located in Stony Point, Rockland County, New York. The Iona Island FUDS is a bedrock island located on the Hudson River and consists of approximately 125 acres of land and inland water. Previous investigations have resulted in the discovery of munitions and explosives of concern (MEC) and inorganic compounds that exceed regulatory screening levels in site soil and sediment. The FUDS property is within Bear Mountain State Park which is part of the much larger Hudson River National Estuarine Research Reserve, a Significant Coastal Fish and Wildlife Habitat Area and National Natural Landmark and is owned by the Palisades Interstate Park Commission (PIPC). PIPC currently utilizes a portion of Iona Island as a storage facility; however, the property is closed to the public and use is restricted to park purposes only.

USACE is conducting work at the site under the Defense Environmental Restoration Program for FUDs using the processes under the Comprehensive Environmental Response, Compensation, and Liability Act. The FUDS program cleans up only DoD-generated eligible contamination, which occurred before the transfer of the property to private owners or federal, state or local governments. There are three FUDS projects at the former Iona Island Naval Ammunition Depot FUDS:

- C02NY074401 Containerized Hazardous Toxic and Radioactive Waste (CON/HTRW)
- C02NY074402 HTRW
- C02NY074403 Military MMRP.

This APP addresses the FUDS MMRP and HTRW project categories. The FUDS CON/HTRW was closed out in 2012. The FUDS MMRP includes one Munitions Response Site (MRS), MRS-01 1903 Explosion area (approximately 124.2 acres of land and inland water. MRS-01 extends beyond the FUDS boundary (**Figure 2-1**). The FUDS HTRW includes and 19 AOCs located in the footprints of former site facilities where various contaminants of potential concern resulting from historical site activities have been detected or may be present (**Figure 2-2**).

A MMRP RI will be conducted at MRS–01 (referred to as the 1903 Explosion) area and an HTRW RI will be conducted at 19 AOCs. The MMRP RI will characterize the occurrence of MEC and the HTRW RI will characterize contaminants of potential concern including metals, volatile organic compounds, and semi-volatile organic compounds that may be present in soil and groundwater from facilities or historic processes during the site's commission as an ammunition depot. Areas to be investigated under the MMRP RI are shown on **Figure 2-1** and areas to be investigated under the HTRW RI are shown on **Figure 2-2**. Field work will consist of multiple site mobilizations for RI field activities.

2.2 PHASES OF WORK

Brief descriptions of each phase of work associated with the RI are presented below. Detailed descriptions of the work are presented in the Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) (EA 2018). All phases of anticipated work are presented below; however, only a subset of phases require an activity with a dedicated Activity Hazard Analysis (AHA). Task-specific required equipment is listed on each AHA. Risk Assessment Codes (RACs) for the AHAs required to complete the PWS do not indicate high risk activities are to be completed. The site-specific AHAs are listed in **Table 2-1** and AHAs are presented in **Appendix A**. **Figure 2-1** shows the general site location, site features, and areas to be investigated related to MMRP RI. **Figure 2-2** shows the general site location, site features, and areas to be investigated related to HTRW RI. The general scope of planned MMRP and HTRW RI field activities is detailed below:

- Land-based and water geophysical surveys for MEC.

- Anomaly reacquisition and intrusive investigation activities will be conducted at targets of interest (TOIs) following digital geophysical mapping (DGM)/ Advanced Geophysical Classification (AGC) acquisition and processing at Magnetometer and Dig (Mag and Dig) locations for MEC investigation.

- Underwater intrusive investigations utilizing divers, to characterize the underwater area immediately surrounding three former loading docks locations for MEC.

- Direct-push technology sampling of soil and installation of piezometers.

- Bedrock well installation using air rotary drilling, development, and sampling, if necessary.

- Collection of soil, groundwater, and sediment samples for laboratory analysis.

- Material potentially presenting an explosive hazard (MPPEH) removal and disposal will be completed.

- Manage investigation-derived wastes (IDW) including soil and water.

2.2.1 Site Mobilization/Demobilization

For the MMRP RI, mobilization/demobilization will occur three times based on the proposed field schedule– during DGM, AGC, and during Mag and Dig and intrusive activities. For the HTRW RI, mobilization/demobilization will occur two times based on the proposed field schedule to accommodate a phased approach to the investigation. Mobilization for each phase will include setting up an equipment storage space (as needed), receiving and setting up equipment, locating dock facilities for the marine-based investigation (MMRP RI), safety meetings, and mobilizing staff to the site. This phase of work includes the delineation of equipment laydown and MEC support areas. An instrument verification strip will be established (MMRP RI). All equipment will be removed from the site upon completion of work.

2.2.2 Land Survey

A New York-licensed professional land surveyor will establish control points within the survey area to establish site control prior to starting fieldwork. The EA Team will conduct additional surveying of grid corners, MEC locations, and other significant items/positions using a Trimble R8 (or equivalent) real-time kinematic (RTK) Global Positioning System (GPS), which has centimeter accuracy. MEC anomaly avoidance will be conducted in support of the surveying activities.

2.2.3 Brush Clearing

Some cutting of grasses, brush, or branches interfering with geophysical surveys and land surveying activities will be conducted with hand tools, powered hand weed eaters, and/or brush hog as needed. No trees greater than 2 inches (in.) in diameter will be cut down and cut vegetation will remain onsite. MEC anomaly avoidance will be conducted in support of the brush clearing activities.

2.2.4 MMRP RI Land-Based and Shallow Water Geophysical Surveys

Land-based and water geophysical surveys will be performed to characterize the nature and extent of MEC using DGM. These activities will include land surveying; grid stakeout; and surface clearance prior to data acquisition. Acorn SI/NAEVA Joint Venture (ANJV), a Department of Defense Advanced Geophysical Classification Accreditation Program (DAGCAP)-accredited geophysical classification organization, will provide land and water DGM and land-based advanced geophysical classification services. MEC anomaly avoidance will be conducted in support of the geophysical surveying activities.

2.2.4.1 DGM Surveys

An EM61-MK2/RTK-GPS DGM survey will be performed over 100 percent of the coverage grids in MRS-01 to detect and locate anomalies that are representative of potential MEC. The survey will be performed by the field crew moving geophysical equipment over the ground surface. The goal of the DGM survey is to detect and locate anomalies above the approved target selection criteria, identify potential background locations for the cued AGC survey, and determine areas where cued AGC might not be applicable or provide value. Grids will be randomly placed, and may vary in size (e.g., 50 feet [ft] by 50 ft in High Density Areas, and 200 ft by 200 ft in Low Density Areas) depending on Project Delivery Team input. DGM will be collected in grids by a 2-person team comprised of a Field Geophysicist and a Geophysical Technician using Geonics EM61-MK2 electromagnetic induction sensors. The EM61-MK2 1.0- x 0.5-meter coil will be used to collect the DGM data over accessible portions of each grid, and the data will be positioned with RTK-GPS. It is anticipated that DGM detection survey data will need to be collected along parallel lines spaced 2 ft apart but will be confirmed during the technical project planning process. DGM transects will also be collected along the Hudson River shoreline near the former docks, and within areas suspected of buried discarded military munitions (DMM) such as "dump sites" and munitions storage areas. Transect spacing is anticipated to be 10 ft and will use the same equipment, personnel, and procedures as the grid-based data collection.

2.2.4.2 AGC Surveys

Cued AGC survey using an advanced geophysical sensor (e.g., Geometrics MetalMapper 2x2) will be conducted following the DGM detection survey. The survey will be performed by the field crew moving geophysical equipment over the grounds surface. The cued survey will provide high quality data to support classification decisions and generate a prioritized TOI Dig List to correctly classify TOI and non-TOI and reduce the intrusive effort associated with the MMRP RI, as well as provide a basis for using AGC as a remedial alternative going forward.

2.2.5 MMRP RI Land Intrusive Investigations

AGC TOIs identified for investigation will be reacquired in advance of intrusive investigation using RTK-GPS. EA will excavate anomalies to positively identify the item and will maintain a detailed record of the items, including amounts of MEC; proper identification nomenclature; and condition, location, depth, and disposition. In areas identified during the DGM survey that could potentially represent a potential DMM disposal area, EA will perform test pitting along its sides using a backhoe to determine the nature of the buried material. Based on the depth to bedrock it is not anticipated that excavations will be deeper than two feet. If after investigating enough to determine that the material is not munitions related and the team can be confident the area is not a DMM disposal area, a determination that further excavation is unnecessary will be made. At locations where test pitting results indicate munitions-related items are present, the excavation will continue to depth of the fill material (e.g., undisturbed soil) to characterize the vertical extent of munitions disposal.

Each intrusive investigation excavation will remain open until final quality assurance (QA)/QC is performed by the unexploded ordnance (UXO) Quality Control Specialist (UXOQCS) and Ordnance and Explosives Safety Specialist (OESS) (if present). Once the excavation has passed QA/QC, the excavation will be backfilled, and the flag removed. If disposal by detonation is necessary, post-detonation sampling for explosive residues may be required prior to restoration.

In areas where DGM and cued AGC are not practical in MRS-01, including heavily vegetated areas and other terrain that represent unsafe operating conditions for the equipment, geophysical survey (and intrusive investigation) may be accomplished using handheld all-metal detectors (i.e., Mag and Dig).

The majority of anomalies will be hand excavated; a mini excavator will be used as needed.

2.2.6 MMRP RI Underwater Intrusive Investigations

The area surrounding the three former loading docks will be investigated using UXO-qualified divers. In the 3 to 60-ft water depth, the investigation of these areas will be conducted by a UXO qualified dive team (AOR International, LLC [AOR]) using surface-supplied air and equipped with hand-held detection instruments (an Underwater Ebinger 725K analog detector fitted with a 230 mm coil (or similar detector). The Hudson River current is estimated to be 1 to 2 knots during ebb-and-flow tides, and a safety concern that could impede the investigation. It is for this reason that the underwater investigation will only be conducted during times that are determined acceptable by the Direct Person in Charge (DPIC) of diving. For efficiency and safety, divers will be employed in areas where they will be most efficient (i.e., shallow areas with less current where water depth allows longer bottom times, during slack tide in deeper water). In shallow, near-shore 0- to 3-ft water depth, intrusive investigations around the docks will be performed by wading rather than diving. UXO-qualified divers will be wading in the shallow water to complete the investigation tasks. The wading will be accomplished by walking through the water and reaching down when there is a magnetic anomaly. If needed, the UXO-qualified divers will be using diving masks to improve visibility.

For both the shallow and deeper underwater intrusive investigations, the UXO dive team, will employ a Shark Marine Navigation Tablet navigation. Transects of each loading dock area will be pre-loaded into the Shark Marine Navigation Tablet prior to diving operations. The tablet will be connected to a global navigation satellite system (GNSS) buoy for locating and tracking divers along transects. The GNSS GPS will be tested daily to ensure the positioning systems are functioning as designed and within the planned parameters for the project. The GNSS GPS will confirm the known monument location. If the coordinates are within the GPS tolerance of less than 2m (GNSS GPS) the control monument will be considered as satisfactory. After entering the water, the diver can view the underwater transects on the Shark Marine Navigation Tablet and navigate towards the outer edge of the pre-planned investigation area, as needed to begin investigation activities. Planned routes will be displayed on the Shark Marine Navigation Tablet, in one color for the diver to follow while actual diver’s routes are plotted in another color. Route plotting and contact information will be recorded and reviewed daily and provided to USACE. Positioning information (i.e., tracks) obtained through GNSS navigation will be recorded by the Shark Marine Tablet and will allow the diver to visually follow his transect. The geo-referenced digital path will undergo QC review for coverage.

2.2.7 MMRP RI Soil Sampling

No munitions constituent sampling is proposed based on the results of the site inspection; however, soil samples may be collected and analyzed for explosives where breached MEC are identified. Management of IDW including soil will be conducted as it is generated. MEC anomaly avoidance will be conducted in support of the soil sampling activities.

2.2.8 HTRW RI Direct Push and Piezometer Sampling

Surface and subsurface soil samples will be collected for analysis of metals and semivolatile organic compounds using incremental sampling methodology (ISM) within 26 decision units (DUs) covering the AOCs, and within and one offsite DU anticipated to be located in Bear Mountain State Park. Each DU will be approximately 1 acre in size, with 50 aliquot surface soil and 50 aliquot subsurface soil samples collected from each DU as follows:

- Surface soil samples will be collected from 0 to 6 in. below the vegetative cover

- Subsurface soil samples will be collected from 5 borings advanced in each DU. Borings will be advanced using direct-push methods (direct-push mechanical equipment) to bedrock or a maximum of 4 ft if bedrock is not encountered. A total of 10 aliquots will be collected per boring from the 6 in. to 48 in. depth interval.

In addition, soil at former above ground storage tank locations will be investigated for the presence of volatile organic compounds using discrete sampling methodology. Samples submitted for laboratory analysis will be field screened and selected based on field observations. Surface samples will be collected from 0 to 6 in. below the vegetative cover. At minimum, one subsurface soil sample will be collected from the 12 to 24 in. depth interval and one from the overburden/bedrock interface.

Groundwater samples will be collected from the overburden soil using piezometers installed within select subsurface boring locations using direct-push mechanical equipment. MEC avoidance procedures will be performed by UXO technicians during well installation activities. Management of IDW including soil and groundwater will be conducted as it is generated.

2.2.9 HTRW RI Bedrock Well Installation

Up to three bedrock monitoring wells will be installed if determined necessary. It is anticipated that they will be installed using air rotary drilling methods (air-rotary drilling equipment). Monitoring well development and sampling would follow U.S. Environmental Protection Agency (USEPA) low-flow guidelines. MEC avoidance procedures will be performed by UXO technicians during well installation activities. Management of IDW including rock cuttings and water will be conducted as it is generated. MEC anomaly avoidance will be conducted in support of the well installation activities.

2.2.10 HTRW RI Sediment Sampling

Sediment sampling will be completed at 6 discrete locations along the shore of Iona Island topographically downgradient from AOCs, and from and 5 discrete background locations upstream along the Hudson River (i.e. at or north of Bear Mountain Bridge). Sediment samples will be collected during periods of low tide at depths of from 0 to 4 in. Additional toxicity sediment sampling may be conducted as necessary. MEC avoidance procedures will be performed by UXO technicians during all sampling activities. MEC anomaly avoidance will be conducted in support of the sediment activities.

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Table 2-1 Phases of Work and Site-Specific Activity Hazard Analyses

	MMRP RI Tasks										HTRW RI Tasks					
Site-Specific Activity Hazard Analysis [(a)]	**Mobilization and Demobilization**	**Land Survey**	**Brush Clearing**	**DGM Surveys**	**AGC Survey**	**Mag and Dig**	**Soil Sampling**	**Land-Based Intrusive Investigation**	**Underwater Surface and Investigation**	**Sediment Sampling**	**Mob. And Demobilization**	**Direct Push Soil Boring**	**Piezometer Installation**	**Ground-water Sampling**	**Sediment Sampling**	**Bedrock Well Installation**
General	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Large Hand Tools Use	X		X													X
Small Hand Tools Use	X			X	X					X			X	X		X
Intrusive Investigation of Target Anomalies								X	X							
MEC Avoidance		X	X	X	X		X	X		X		X	X		X	X
MEC Detector-Aided Surface/Subsurface Clearance		X	X	X	X	X		X								
MPPEH Inspection			X	X	X	X		X	X							
MEC Disposal			X	X	X	X		X	X							
Munitions Debris Inspection and Disposition			X	X	X	X		X	X							
Soil Sampling							X	X								
Surface Water/Sediment Sampling										X					X	
Groundwater Sampling/Well Development														X		
Direct Push Soil Boring/ Well Installation												X				X
Boating Operations									X							
Diving*									X							

[(a)] Site-specific activity hazard analyses are presented in Appendix A.
* Included with the Dive Plan (Appendix H).

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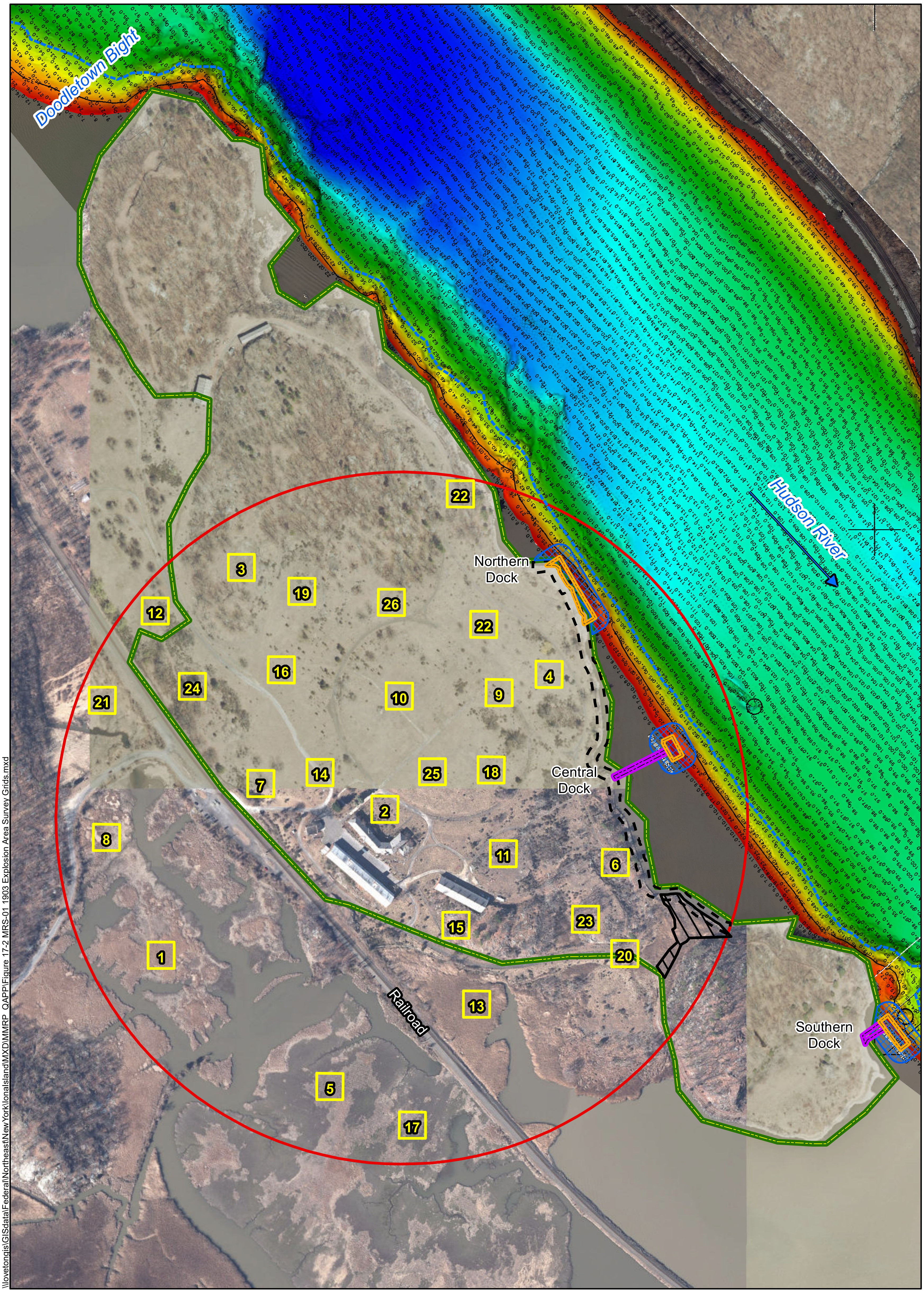
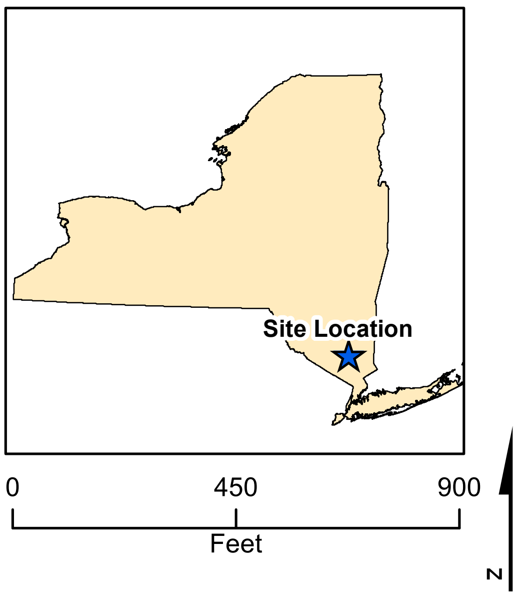


\\lovetongis\GISdata\Federal\Northeast\NewYork\IonaIsland\MXD\MMRP QAPP\Figure 17-2 MRS-01 1903 Explosion Area Survey Grids.mxd



Legend

- ▬ Approximate 60 Foot Depth Line
- ☐ DGM Grid (100ft x 100ft)
- ▨ Underwater Investigation Area (Former Docks)
- ⌜⌟ DGM Shoreline Area
- ⧄ Dump SIte
- ☐ Former Dock
- ☐ Former Causeway
- ☐ FUDS Boundary
- ☐ MRS-01 1903 Explosion Area

Note:
Dives will be limited to 3-60 ft or where the river bottom is less then 20 degree slope or determined acceptable by Direct Person in Charge.
Transects in water depth less then 3 ft will be walked.

FIGURE 2-1
MRS-01 1903 EXPLOSION AREA SURVEY GRIDS

IONA ISLAND NAVAL AMMUNITION DEPOT
FORMERLY USED DEFENSE SITE
ROCKLAND COUNTY, NY

Map Date: 11/22/2019
Dock Aerial - June 18 1948

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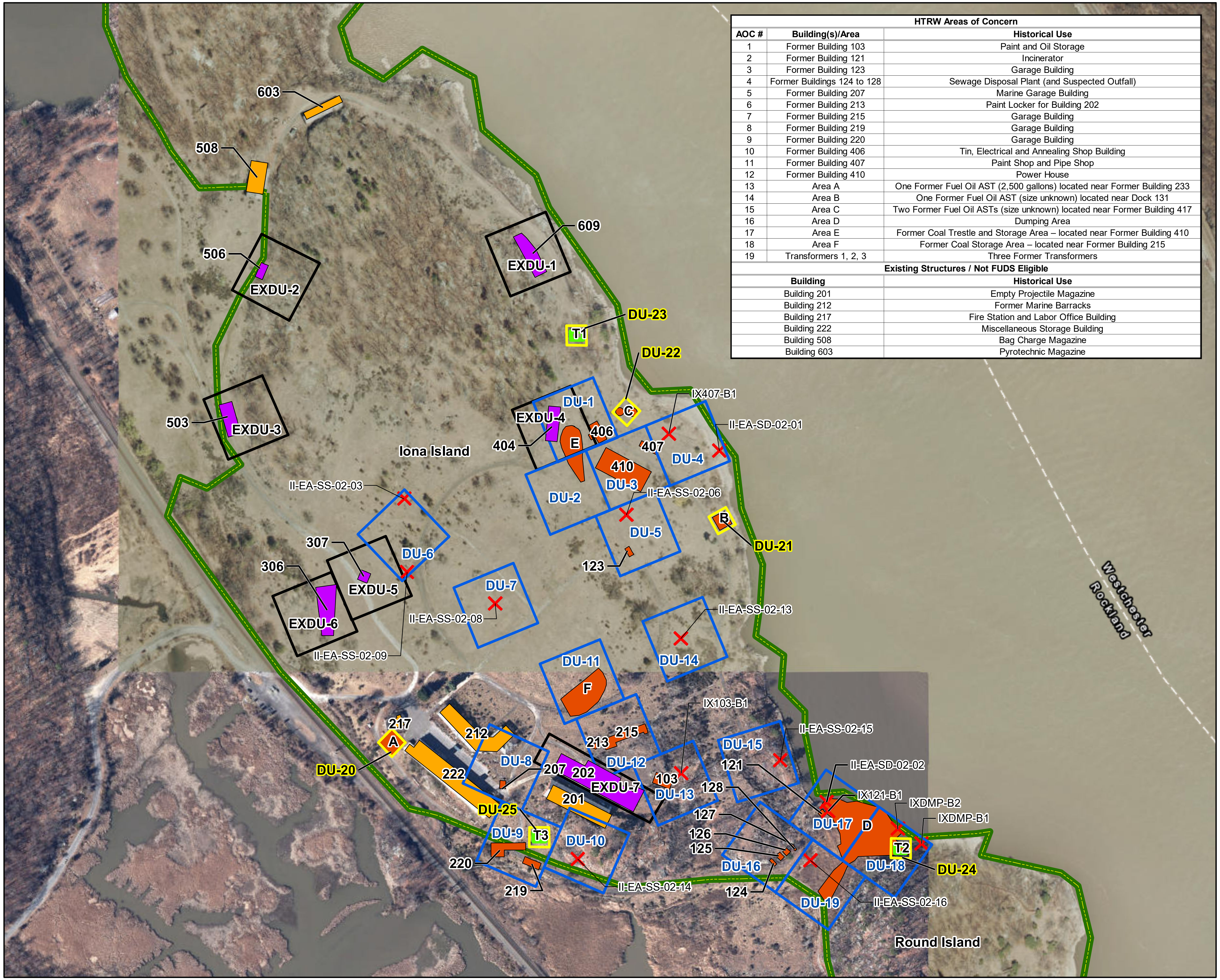
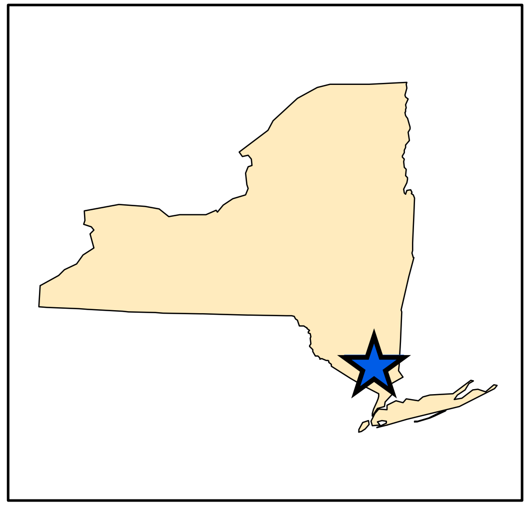


HTRW Areas of Concern		
AOC #	Building(s)/Area	Historical Use
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Existing Structures / Not FUDS Eligible	
Building	Historical Use
Building 201	Empty Projectile Magazine
Building 212	Former Marine Barracks
Building 217	Fire Station and Labor Office Building
Building 222	Miscellaneous Storage Building
Building 508	Bag Charge Magazine
Building 603	Pyrotechnic Magazine

VICINITY MAP



Legend

- 🟩 FUDS Boundary
- 🟥 HTRW Project Areas of Concern
- 🟩 FormerTransformers
- 🟧 Remaining Structure (Not FUDS Eligible)
- ✕ Previous Elevated Concentration of COPC
- ☐ 200 ft x 200 ft DU
- ☐ 60 ft x 60 ft DU
- 🟪 Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
- ☐ 1 Acre Explosives Building DU

0 300 600
Feet
1 in = 300 ft

N

FIGURE 2-2
HTRW Project AOC Incremental Sampling Decision Units

IONA ISLAND NAVAL AMMUNITION DEPOT
FORMERLY USED DEFENSE SITE
ROCKLAND COUNTY, NY

EA®

Aerial: ESRI ArcGIS Online Map Service

Map Date: 11/15/2019

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3. STATEMENT OF SAFETY AND HEALTH POLICY

EA's Corporate Safety and Health Policy is as follows:

EA considers the safety and health of its employees, clients, and visitors—as well as the prevention of work-related accidents and illnesses, property loss, and detrimental impact to the environment—to be of the highest priority. Proactively implemented, a comprehensive and systematic safety and health program will result in more efficient and profitable operations by improving employee health and morale, and by reducing Worker's Compensation costs, lost time, fire and liability insurance premiums, and property damage.

The objectives of EA's Safety and Health Program are to ensure:

- Sound safety and health practices and conditions necessary for the protection of the health and welfare of employees, subcontractors, clients, and visitors.
- Compliance with this APP, and federal and state safety and health regulations and standards.
- Effective safety, fire prevention, and work practices necessary for protection of company-owned or operated and site property.

EA is committed to the overall goal of having no workplace injuries or safety incidents at the Iona Island FUDS. A copy of EA's OSHA Form 300A – Summary of Work-Related Injuries and Illnesses for 2017 can be found in **Appendix B**.

EA's OSHA-recordable incident and lost-workday rates are comparable with the industry average. In addition, the insurance industry has developed an experience rating system as an equitable means of determining premiums for Workers' Compensation insurance (Experience Modification Rate). This rating is based on a comparison of firms doing similar types of work, with the employer rated against the average expected performance in each work classification. For the past 12 years, EA has been below the industry average. The last 5 years are provided in **Table 3-1**.

Table 3-1 Summary of EA Safety and Health Data

EA	2017	2016	2015	2014	2013
Experience Modification Rate	0.78	0.74	0.78	0.84	0.89
Number of Recordable Cases	7	5	4	4	1
Total Recordable Incident Rate	1.31	0.95	0.79	0.86	0.21
Total Hours Worked	1,072,638	1,055,170	1,008,144	924,925	952,444

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4. RESPONSIBILITIES AND LINES OF AUTHORITY

4.1 STATEMENT OF RESPONSIBILITY TO IMPLEMENT THE SAFETY AND HEALTH PROGRAM

EA is responsible for the implementation of a safety and occupational health program for protection of employees in the workplace and maintains full responsibility for the implementation of this APP. Site personnel are responsible for adherence to this APP and maintain stop-work authority at all times. The safety role of subcontractors is discussed in Section 5.2 and visitor safety is discussed in Section 6.

4.2 IDENTIFICATION AND ACCOUNTABILITY OF PERSONNEL

Personnel responsible for safety at corporate and project levels are listed below. Qualifications for onsite safety personnel shall include the OSHA 30-hour or equivalent course. Competency in performing several of the roles listed below is detailed on resumes and certifications provided in **Appendix C**.

4.2.1 Program Manager (Ms. Brenda Herman, P.G.)

The Program Manager will provide program management as the point-of-contact for the delivery order and will review safety plans, ensure client-specific safety and health requirements are followed, periodically monitor field operations, and communicate with safety personnel (listed below).

4.2.2 Business Unit Director (Mr. Gordy Porter)

The Business Unit Director is accountable for implementation of the safety and health program; may contractually obligate the company; ensures time and budget are applied to training; conducts periodic reviews of safety and health procedures; ensures employees follow safety and health procedures; and requires Project Managers to implement corrective actions, if necessary.

4.2.3 Project Manager (Mr. Timothy Reese, P.E.)

The Project Manager is accountable for allocating resources to the project to develop and implement this APP; direct corrective actions, if required; review/investigate work-related injuries and illnesses; and report accidents/incidents in accordance with requirements presented in Section 9. The Project Manager will assist in submission of safety-related documents for acceptance.

4.2.4 Director of Safety and Health and Safety and Health Manager (Mr. Peter Garger, CIH, CSP)

The SHM is accountable for development and enforcement of this APP/SSHP through oversight and implementation, audits and inspections, remaining available for project emergencies, modifications, evaluation of exposure monitoring, serving as a QC staff member, and approval of safety documents. The SHM is also accountable for providing expertise, opinion, and resolution to safety issues from employees; arranging and providing required safety and health training for workers within their region(s) of responsibility; assisting with investigation of accidents and near misses; ensuring medical surveillance program requirements are followed; ensuring monitoring programs are properly designed; and conducting hazard assessments documented through the generation of site-specific AHAs.

4.2.5 National Service Line Program Manager for Munitions Response (Mr. Richard Hanoski, Certified Quality Auditor)

The National Service Line Program Manager for Munitions Response (MR) will provide senior technical input on issues related to MR. He will also review the project plans and deliverables to identify any MR safety or QC concerns.

4.2.6 Site Safety and Health Officer (Eddie Meadows)

The Site Safety and Health Officer (SSHO) will be onsite in addition to the UXOSO/UXOQCS during air rotary drilling (otherwise the UXOSO/UXOQCS will serve as SSHO). They is accountable for ensuring onsite adherence to the APP/SSHP; mitigating unsafe work conditions; proper application of monitoring equipment; leading initial onsite investigations of accidents, near misses, and occupational illnesses; providing incident reports to project management; confirming qualifications and training of onsite personnel; performing onsite safety-related briefings and inspections; and investigating onsite hazardous conditions. The alternate SSHO is Jeff Smith.

4.2.7 Field Data Manager/Site Supervisor for HTRW RI (Mr. Joseph Von Uderitz, P.G.)

The Field Data Manager/Site Supervisor is accountable for reporting to project management; confirming adherence to sampling and analysis plans and/or work plans; coordinating activities with the Senior Unexploded Ordnance Supervisor (SUXOS), SSHO or the UXO Safety Officer (UXOSO)/QC Specialist (QCS); reviewing and comparing quality measurements against objectives; managing subcontractors; and providing documentation of daily safety inspections.

4.2.8 Munitions and Explosives of Concern Avoidance and Munitions and Explosives of Concern Investigation and Surface Clearance Personnel for Land-Based Activities

4.2.8.1 Senior Unexploded Ordnance Supervisor (Mr. John “JD” Marlowe)

The SUXOS is accountable for supervising MEC investigation; implementing all MR-related plans and field activities; providing work briefings when necessary; and recording daily MR-related activities.

4.2.8.2 Unexploded Ordnance Safety Officer and Quality Control Specialist (Mr. John Monk and Mr. Ward Stern [alternate])

The UXOSO/UXOQCS is accountable for reporting to the SHM for safety and to the Project QA/QC Manager and the Corporate QA/QC Manager for QC during MEC clearance activities. The UXOSO/UXOQCS will operate in conjunction with the SSHO during MEC activities and will execute the safety and QC requirements of the Explosives Site Plan (submitted under separate cover); implement MEC-related safety procedures; notify local public emergency agencies, including the fire department and/or police, of the onsite operations as required; update safety procedures; and recognize MPPEH.

4.2.8.3 Munitions and Explosives of Concern Support Personnel (TBD)

A UXO Technician III will lead each UXO team and is accountable for following safety and health rules and regulations; following procedures, controls, and safety devices including personal protective equipment (PPE); notifying the UXOSO, if encountering new hazards; and reporting any incidents to the UXOSO, as applicable. UXO Technician IIIs, UXO Technician IIs and/or UXO Technician Is will be used for intrusive investigation of anomalies, surface clearance of land-based geophysical areas and/or anomaly avoidance tasks in accordance with Department of Defense Explosives Safety Board (DDESB) Technical Paper 18.

4.2.9 Diving Personnel

The roles of diving personnel including the Direct Person in Charge (DPIC) (SUXOS Qualified) and UXOSO/UXOQCS will be included in the Dive Operations Plan (**Appendix H, to be submitted as a separate addendum**). Their resumes, qualifications, and certifications will be submitted via a separate addendum.

4.2.10 Supervisors and Employees

Supervisors are accountable for ensuring employees receive training in hazard recognition and safe work practices, periodically monitoring activities to ensure conformance with training, investigating/reporting incidents, investigating employee reports of hazardous conditions, and mitigating hazardous conditions. Employees, including subcontractors, are accountable for following the training, following safe work practices, notifying the SSHO and/or UXOSO, as applicable and Supervisors of new hazardous conditions, reporting incidents, and participating in pre-task/pre-entry/onsite training. Specific safety responsibilities of subcontractors are addressed in Section 5.

4.3 COMPETENT AND/OR QUALIFIED PERSONS

The following personnel are designated as Competent and/or Qualified Persons to complete the scope of services at the Iona Island FUDS. Proof of competency is provided using resumes and certifications presented in **Appendix C**. The designated competent/qualified persons are included in the AHAs presented in **Appendix A**. Alternates are presented in Section 4.2. The list of training and certifications of personnel required to complete this work, and documentation requirements, are presented in Table 6-1. The SSHO and/or UXOSO are responsible for maintaining current copies of certifications and training of onsite personnel.

The personnel, roles, and their competencies are presented below:

- ***Mr. Peter Garger, CIH, CSP (SHM)***—Review and approve the APP and SSHP, hazard identification, resolution of unanticipated safety issues, and forwarding safety documents and/or resolutions to USACE–Baltimore for acceptance.

- ***Mr. Michael McGuire***—Qualified person as the Senior Geophysicist.

- ***Ms. Denise Wilt***—Qualified person as the Plan Preparer.

- ***Mr. Eddie Meadows or Mr. Jeff Smith (SSHO for HTRW RI Intrusive Activities)***—Onsite for intrusive (drilling) and non-intrusive HTRW RI activities. The SSHO has a minimum of 5 years experiencing implementing Safety and Occupational Health procedures, OSHA 30-hour Construction Safety class, 40-hour initial and 8-hour Supervisor training and maintains 8-hour refresher training.

- ***Mr. Joe Von Uderitz (Site Supervisor for geophysics/non-UXO activities)***—Onsite for geophysics, target acquisition and non-UXO related activities (i.e., geophysics in areas with surface clearance completed).

- ***Mr. John "JD" Marlowe (SUXOS for land-based operations)***—Qualified SUXOS for land based MEC-related activities. Mr. Marlowe meets the requirements of DDESB Technical Paper 18 for a SUXOS and will ensure all MEC-related personnel meet the appropriate DDESB Technical Paper 18 requirements for their role.

- ***Mr. John Monk and Mr. Ward Stern (UXOSO/UXOQCS)***—Qualified Person for safety and QC for surface clearance and intrusive investigation activities. Mr. Monk meets the requirements of DDESB Technical Paper 18 (**Table 4-1**) for UXO Qualified Personnel. Mr. Monk will function as the UXOSO/UXOQCS for land-based activities.

- ***Direct Person In charge (SUXOS qualified) (TBD)***—Qualified Person for diving supervisor. Qualified Personnel for MEC-related diving activities. The DPIC diving supervisor will meet the requirements of DDESB Technical Paper 18 for UXO Qualified Personnel for the SUXOS responsibility. The DPIC and will ensure all MEC-related personnel meet the appropriate DDESB Technical Paper 18 requirements for UXO Qualified Personnel and technicians. Qualifications will be submitted via addendum in conjunction with the dive plan.

- ***UXOQCS/UXOSO (TBD)***—Qualified Person for the DPIC position. Qualified Personnel for MEC-related diving activities. The DPIC will have the qualifications and certifications for the UXOQCS/UXOSO position as per DDESB Technical Paper 18 for UXO Qualified Personnel. Qualifications will be submitted via addendum in conjunction with the dive plan.

Additional competent or qualified persons identified or provided by subcontractors will be identified prior to the initiation of that task and will be presented in the AHAs and/or subsequent addenda. All personnel will need to satisfy the training, certification, and inspection requirements highlighted in Sections 5, 6, and 7, respectively.

4.4 REQUIREMENT FOR WORK STOPPAGE WITHOUT COMPETENT PERSON

No work requiring an OSHA-defined competent person shall be performed unless the designated and accepted competent person or their approved alternate is present on the job site for the task being conducted. All site personnel have stop-work authority. Competent persons are listed on each AHA.

4.5 REQUIREMENTS FOR PRE-TASK SAFETY AND HEALTH ANAYLSIS

The SHM has evaluated the activities associated with implementation of the site work and have determined potential hazards associated with the activities. The results of the hazard analysis and associated controls are documented using AHAs (**Appendix A**). As part of the three-phase control process, AHAs will be submitted and accepted at the pre-mobilization preparatory meeting. In addition, site personnel will be required to review this APP and associated supplemental plans and will be given a pre-entry/pre-construction briefing on the contents of the APP and associated supplemental plans. The SSHO and/or UXOSO/UXOQCS will provide the pre-entry/pre-construction briefing, which will include discussion of the following items:

- Site description
- Site control measures
- Emergency response plan and procedures
- General and task-specific hazards and hazard controls including AHAs
- Task-specific PPE requirements
- Task-specific environmental monitoring requirements and action levels
- Lines-of-authority and communication
- Stop work authority in cases of safety non-compliance
- Hazard Communication Program
- Location of hazardous materials
- Identification and recognition of hazardous materials
- Physical and health hazards of hazardous materials
- Protective measures when working with hazardous materials.

General MEC safety briefings will be given by the UXOSO to inform the MEC clearance project team of the site-specific MEC hazards. When there are activities requiring only anomaly avoidance (no MEC investigation or construction support), the most senior UXO Technician (Technician III or II) will give the MEC safety briefing. For other activities, such as mobilization, demobilization, surveying, or brush cutting/removal, the SSHO and/or UXOSO, as applicable may perform the briefing.

4.6 LINES-OF-AUTHORITY

EA maintains separate lines of reporting for technical task management and safety in order to limit conflicts of interest between the need to maintain safety and maintain project deliverables, budget, and schedule. Safety personnel have the authority to require and implement changes with regard to site safety and all site personnel maintain stop-work authority. Depending on the phase of work, the UXOSO/UXOQCS and/or SSHO will report safety issues to the SHM. The SHM, in addition to the SSHO and UXOSO/UXOQCS, can request changes to the APP. The SHM will inform the Program Manager and Project Manager of the required changes.

If there is disagreement between safety and management at the SSHO/UXOSO and Project Management level, the disagreement will be elevated to the Director of Safety and Health and the Program Manager for resolution. The Director of Safety and Health and the Program Manager have the ability to elevate safety issues to EA's President/Chief Executive Officer, if required, for resolution. Work related to the identified safety issue or hazard will not resume until a safe resolution is agreed upon. The USACE Project Manager will be notified by the Project Manager of safety issues that result in a work stoppage or required change to the APP.

Table 4-1 and **Figure 4-1** present project personnel, their involvement on the project, the organization these individuals represent, and contact information. **Figure 4-2** presents the telephone notification process if MEC are found.

4.7 NON-COMPLIANCE WITH SAFETY REQUIREMENTS

EA expects and requires that employees and subcontractors will adhere to this APP and associated supplemental plans. Progressive disciplinary action is used to deal with non-compliance issues. For EA employees, this includes the following:

- First offense will warrant a verbal warning, explanation of why the activity was non-compliant, and reference the section of the APP where the activity lacking compliance was presented.
- A second offense, if it is of the same nature, will warrant a written warning and may lead to removal from the job site. If the second offense is not the same non-compliance issue as the first, additional explanation of why the activity was non-compliant will be discussed and the employee will be required to re-review the APP.
- A third offense will lead to removal from the job site.
- If additional offenses are perpetrated on other project sites, the employee may be suspended or terminated.

If subcontractors are non-compliant with safety requirements, they will be given verbal and written warnings for the first two offenses. If additional offenses occur, the subcontractor may be removed from the project site.

4.8 COMPANY PROCEDURES FOR MANAGER AND SUPERVISOR ACCOUNTABILITY FOR SAFETY

EA's commitment to safety and health is documented, and requirements addressed, from the time an offer of employment is made to a job applicant. Managers and supervisors are made responsible for enforcing safety and health as part of their job descriptions. They are ultimately responsible for protecting the health and welfare of the employees, as well as minimizing the potential liability associated with on the job or work-related accidents.

A manager or supervisor has the authority to assign and direct personnel on project tasks. As such, the Project Manager, Field Data Manager/Site Supervisor, SUXOS, UXOSO/UXOQCS, and SSHO will possess knowledge of the correct safe procedures for tasks that will be performed under their supervision. If there is question as to the appropriate safety measures, the SSHO, UXOSO/UXOQCS, Field Data Manager/Site Supervisor, SUXOS, or Project Manager will seek assistance from the SHM. If any task cannot be accomplished safely, it will not be attempted.

In addition, at a minimum of once per year, each employee's performance is formally evaluated in the following areas: personal commitment to safe work practices, adherence to established health and safety plans and programs, ability to recognize safety hazards, communication skills, acquisition and proper use of PPE and monitoring equipment, and proper budgeting for safety and health aspects in projects.

Unsatisfactory performance in any of the above areas by supervisors or managers is addressed through implementation of performance improvement plans; mandatory additional training; lower overall compensation; and, if appropriate, termination.

Table 4-1 Contact Information of Key Personnel

Project Personnel	Role	Phone Number	Email Address
Kathryn Brown	USACE KO	410-962-2585	Kathryn.E.Brown@usace.army.mil
Sesh Lal	USACE COR	410-962-2778	Sesh.P.Lal@usace.army.mil
Erin Kirby, P.G., LEP	USACE Project Manager	978-318-8147	Erin.Kirby@usace.army.mil
Todd Beckwith	USACE Technical Manager	410-962-6784	Todd.T.Beckwith@usace.army.mil
Marty Holmes	USACE Chief, Environmental and Explosives Safety Section	315-525-1195	Marty.a.holmes@usace.army.mil
Steven M. Scharf, P.E.	NYSDEC	845-786-2701	steven.scharf@dec.ny.gov
Edwin McGowan	PIPC Science Director	845-786-2701	edwin.mcgowen@parks.ny.gov
Brenda Herman, P.G.	EA Program Manager	410-527-2474	bherman@eaest.com
Richard Hanoski	EA STR, Deputy EA Program Manager	443-632-4887	rhanoski@eaest.com
Timothy Reese, P.E.	EA Project Manager	410-935-3887	treese@eaest.com
Amanda Kohn	EA Deputy Project Manager	315-565-6548/ 315-506-2556	akohn@eaest.com
Michael O'Neill	EA STR	410-329-5142	moneill@eaest.com
Michael McGuire	EA Geophysics Program Lead	443-986-2488	mmcguire@eaest.com
Peter Garger, CIH, CSP	EA Certified Industrial Hygienist	410-527-2425 / 410-790-6338	pgarger@eaest.com
Frank DeSantis, Jr.	EA Regulatory Specialist	315-565-6554	fdesantis@eaest.com
Mark Howard	ANJV AGC Project Manager	434-978-3187	mhoward@naevageophysics.com
Ben Dameron	ANJV QC Geophysicist	434-978-3187	bdameron@naevageophysics.com
Dean Keiswetter	ANJV QA Manager Geophysicist	919-454-4774	dkeiswetter@acornsi.com
Alex Kostera	ANJV Senior Geophysicist	434-825-0934	akostera@naevageophysics.com
Brandon Puttroff, P.E.	AOR Project Manager	619-203-7325	Brandon.Puttroff@aorintl.com
Steve Mulholland	AOR DPIC (Waterborne SUXOS)	619-559-5888	Steve.mulholland@aorintl.com
John "JD" Marlowe	EA SUXOS	443-752-1775	jmarlowe@eaest.com
John Monk	EA UXOSO/UXOQCS	717-887-5582	jmonk@eaest.com
Ward Stern	EA UXOSO/UXOQCS Alternate	256-731-9151	wrstern@tecoptic.com
Eddie Meadows	EA SSHO	410-671-6051	emeadows@eaest.com
Jeff Smith	EA SSHO Alternate	410-671-6051	jsmith@eaest.com
Joseph Von Uderitz, P.G.	EA HTRW Field Team Leader	315-565-6567 / 315-382-9534	jvonuderitz@eaest.com

NOTES:
COR = Contracting Officer's Representative
KO = Contracting Officer
LEP = Licensed Environmental Professional
PMP = Project Management Professional
NYSDEC = New York State Department of Environmental Protection
STR = Senior Technical Review
DPIC=Direct Person in Charge

Figure 4-1 Lines of Authority for EA Corporate and Site Activities (Safety)

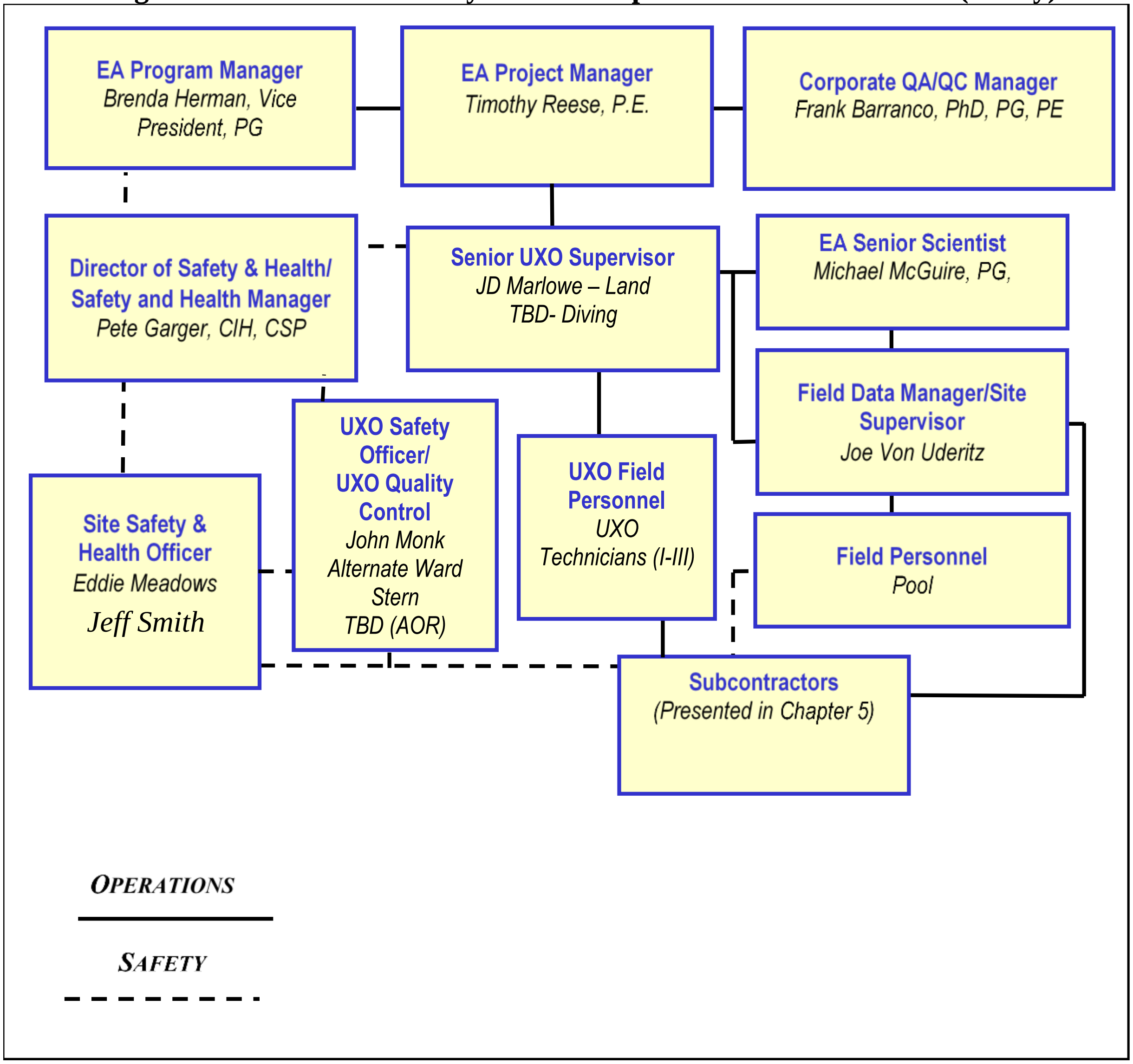
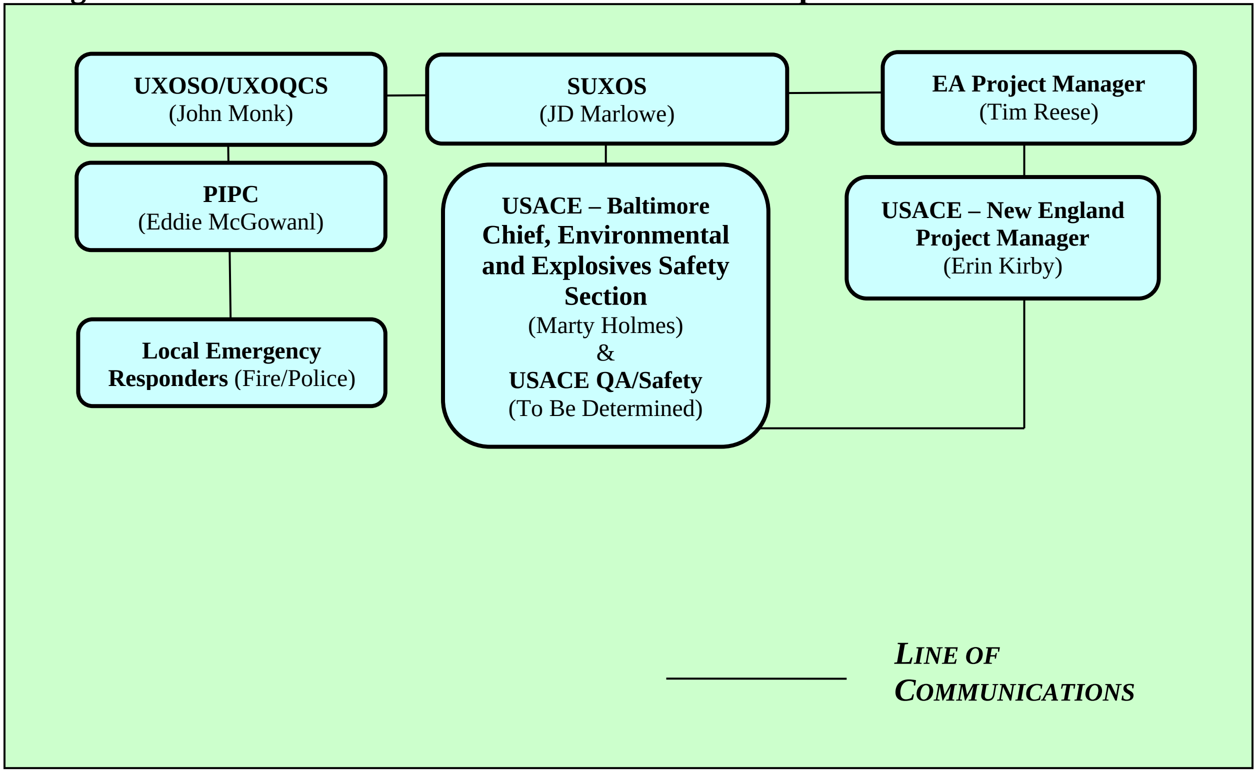


Figure 4-2 Phone Tree Notification if Munitions and Explosives of Concern are Found



5. SUBCONTRACTORS AND SUPPLIERS

5.1 IDENTIFICATION OF SUBCONTRACTORS AND SUPPLIERS

Subcontractors and suppliers currently identified to assist in onsite implementation of the project include:

- Water Based MEC Intrusive Investigation: AOR
- Geophysical Support (DGM and AGC): ANJV
- Professional Land Surveyor: Morris Associates, PLLC
- Drilling: Cascade Technical Services
- Material Documented as Safe (MDAS): American Explosive Ordnance Disposal Services (AEODS)
- Donor Explosives Provider: Tripwire
- Analytical Laboratory: TestAmerica Laboratories, Inc. (recently acquired by Eurofins)
- Data Validation: Environmental Data Services, LTD.

Competent/qualified persons will follow the requirements of this document. Coordination and safety responsibilities of subcontractors are presented below. Offsite work conducted by subcontractors is not covered by this APP. The subcontractor for the surveying task is not known at this time, but additional information will be submitted to the APP for acceptance prior to the start of any activities listed.

5.2 SAFETY RESPONSIBILITIES OF SUBCONTRACTORS AND SUPPLIERS

Subcontractors and suppliers providing onsite services will be required to review and abide by this APP. Subcontractors report to the SUXOS or Field Data Manager/Site Supervisor Specific responsibilities of subcontractors include:

- Complying with the requirements of their scope of work
- Maintaining a safe and healthy work environment
- Reporting of any unsafe conditions
- Reporting of any accidents

- Complying with contract flow down requirements, laws, regulations, and USACE safety guidance documents

- Reviewing this APP to ensure that the safety and health requirements of their specific tasks are satisfied
- Performing work in accordance with the APP requirements

- Providing trained and experienced workers for the specific work activities (e.g., diving).

- Providing documentation of training to EA

- Participating in the pre-entry site briefing and daily safety tailgate meetings

- Identifying additional training needs for unique tasks

- Participating in, and documenting, routine equipment and site inspection activities

- Providing documentation to the SUXOS/Field Data Manager/Site Supervisor/SSHO/UXOSO that materials and equipment brought to the site are in good condition, routinely inspected, maintained in safe working order and meets, or exceeds, required project specifications.

6. TRAINING

EA will ensure site personnel and supervisors have received the required training to complete the pertinent phases of work in a manner that is consistent with the Safety and Health Policy goals and objectives highlighted in Section 3 and state and federal standards. All employees and supervisors working on the Iona Island RI project receive safety and occupational health training upon hire and annually thereafter.

The SSHO and/or the UXOSO/UXOQCS will ensure that all employees engaged in site operations are informed regarding the nature and degree of exposure to chemical, physical, and biological hazards likely to result from participation in site operations. EA will accomplish this by ensuring that all personnel entering the site have received the appropriate training required to safely complete site-specific work prior to participation in site activities. OSHA-required training will be conducted prior to site mobilization and is documented through the resumes and certifications presented in **Appendix C**.

EA will conduct daily safety briefings summarizing site-specific activities and the training required to complete the onsite work. Site workers will have received the required training prior to the start of involvement in site activities and are required to attend daily safety briefings. Documentation of training, update frequency of training, time of initial training, training types, and personnel receiving the training are presented in **Table 6-1**. Training requirements for diving activities are included in Section 5.1 of the Dive Safety Plan (**Appendix H, to be submitted as an addendum**).

The SSHO and/or UXOSO, as applicable will brief all visitors to the site on the site hazards and controls. All visitors will be required to sign a visitor log and will be escorted at all times by the Field Data Manager/Site Supervisor, SSHO, SUXOS, or UXOSO/UXOQCS as appropriate depending on the ongoing activity.

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Table 6-1 Mandatory Training and Certifications

Personnel	Training	When	Update Frequency[(a)]	Documentation
APP Preparer/Project Manager/APP Reviewer	EA APP Training	Initially	Annually	Corporate Files
Personnel	Safety and Occupational Health Training (29 CFR 1910.120 (e)-compliant 40-Hour HAZWOPER)	Upon hire	Refer to 8-hour Refresher below	Corporate Files
HAZWOPER-Trained Personnel	Medical Clearance (Medical Monitoring)	Upon hire	Annually	Corporate Files
HAZWOPER-Trained Personnel	Annual Health and Safety Refresher (29 CFR 1910.120 (e)-compliant 8-hour HAZWOPER Refresher training)	One year after initial training	Annually after 40-hour HAZWOPER	Corporate Files
At least two onsite employees	First Aid/Cardiopulmonary Resuscitation (CPR) including automatic external defibrillator training (AED) (in person, not online)	Initially	Biannually	Corporate Files
First Aid/CPR Providers	OSHA 1910.1030-compliant bloodborne pathogens	Prior to onsite work	Annually	Corporate Files
SSHO	At least 24 hours of formal safety and health training every 4 years	Aggregate training requirement	4-year total	Corporate Files
SSHO	8-Hour Supervisor Training (includes 8-hour HAZWOPER Supervisor Training)	Prior to mobilization	Does not expire	Corporate Files Appendix C
SSHO	OSHA 30-hour Construction Safety Course and as per DDESB TP-18	Prior to mobilization	Does not expire	Corporate Files
Personnel	Emergency Response Training (Requirements in Section 9.2)	Prior to onsite work	Prior to onsite work; if retraining required	APP Review Form
Personnel	Use of Fire Extinguishers	Annually and prior to onsite work	Annually	Corporate Files
Personnel	Use of PPE	Annual and prior to onsite work	Annually; prior to onsite work; if retraining required[(b)]	PPE Training Form
Personnel	Pre-Entry Site Briefing	Prior to onsite work	Not applicable	APP Review Form
Personnel	Daily Tailgate Safety Meeting (Topics Exceed Monthly/Weekly Meeting)	Daily	Not applicable	Daily Tailgate Safety Form
Personnel	Hot/Cold (as applicable) Environments Training	Prior to onsite work	Not applicable	Daily Tailgate Safety Form
Mobile Construction Equipment	Valid Driver’s License	NA	Varies by Individual (On License)	Driver’s License
All Employees	MEC-Awareness (by UXOSO)	Initial	Not applicable	Daily Tailgate Form; Daily Operational Journal
EA and USACE	Safety Pre-Work Conference	Prior to onsite work	Not applicable	Meeting Minutes
Supervisors	Monthly Safety and Health Training and Planning Meeting [(c)]	Monthly	Not applicable	Annotation on Daily Tailgate Safety Form

Table 6-1 Mandatory Training and Certifications

Personnel	Training	When	Update Frequency[(a)]	Documentation
Visitors and Authorized Entrants	Visitor Briefing (by SSHO and/or UXOSO, as applicable) (escort by Field Data Manager/Site Supervisor, SSHO, SUXOS, or UXOSO/ UXOQCS)	Prior to observing onsite work	Once per visit	Visitor's Log
Vehicle Operators	Valid Driver's License	Prior to work onsite	Based on State Issuing License	Driver's License
Boat Operators	National Association of State Boating Law Administrators Small Boat Certification	Prior to work onsite	Not applicable	Corporate Files
UXO Technicians	In accordance with Department of Defense Explosive Safety Board Technical Paper-18	Prior to work onsite	Not applicable	Resumes in Corporate files

(a) Currently, EA uses an automated system to notify the Director of Safety and Health/Safety and Health Manager and the employee when a training or certification is about to expire. Employees are required to communicate their plan to update the training/certification with the Director of Safety and Health and will be provided with resources to meet training/certification requirements.

(b) Retraining requirements are at the discretion of health and safety personnel.

(c) In the event that any field events last longer than 1 month.

NOTES:
CPR = Cardiopulmonary resuscitation

7. SAFETY AND HEALTH INSPECTIONS

Periodic safety and health-related inspections are required at the Iona Island FUDS. **Table 7-1** summarizes inspectors, frequency of the inspections, and documentation. The qualifications of the inspectors stated in **Table 7-1** are presented in **Appendix C**. If a deficiency is found during the inspection process, the SSHO or UXOSO will note the date the deficiency was identified, a description of the deficiency, name of the person responsible for correcting the deficiency, the projected date of correction, and, once corrected, the date the deficiency is actually resolved. This information will also be recorded in chronological order on a deficiency log kept with the APP onsite. Deficiency logs and documentation of daily safety inspections and briefings will also be submitted to USACE Project Manager, Ms. Erin Kirby and to USACE Technical Manager, Mr. Todd Beckwith. The SSHO or UXOSO will perform a follow-up inspection and note the corrective measures taken and the date the correction was completed. The deficiency, follow-up actions, and statuses will be noted on the Daily Safety Inspection Checklist and the deficiency will be discussed during subsequent Daily Tailgate Safety Briefings. No external inspections or certifications are required to complete the work in this PWS.

A summary of inspections is presented in **Table 7-1**, and the forms to document the inspections are presented in **Appendix D**. Diving related inspection are included in the Dive Safety Plan (**Appendix H**).

Table 7-1 General Safety and Health Inspection Requirements

Personnel[a]	Inspection	Timing/ Frequency	Documentation[c]
SSHO/UXOSO	General Site Conditions (e.g., vehicles, documents, etc.)	Initial and Daily	Initial Safety and Health Inspection Checklist Daily Safety and Health Inspection Checklist Health and Safety Activity Report
	PPE	Initial and Daily	Initial Safety and Health Inspection Checklist Daily Safety and Health Inspection Checklist Dispose of PPE, if faulty
	Emergency Equipment: • Fire Extinguisher • First Aid Kit	Initial and Monthly	Initial Safety and Health Inspection Checklist Monthly Safety and Health Inspection Checklist
	Exposure Hours	Daily (Monthly)	Site Entry and Exit Log (Logged daily and reported monthly)
	Physiological Monitoring (Heat Stress Prevention)	Hourly[b]	Daily Environmental Monitoring Record
	Physiological Monitoring (Heat Stress Prevention) (Employees in Level C)	Hourly[b]	Daily Environmental Monitoring Record
	Air Temperature and Wind Speed (Cold Stress Prevention)	Hourly[b]	Daily Environmental Monitoring Record
All Employees	PPE	Before Use	None. Dispose of PPE if faulty
Operator	Boat	Daily	Inspection Form
UXO Technicians	Magnetometer	Before Use	Daily Operations Journal. Tag defective items "out of service." Replace with new unit.
SHM	Fire Prevention Plan Survey	Annual	Fire Prevention Plan Audit
SHM	Safety and Health Audits	Random	EA Corporate Audit Forms
Operators	Mobile Construction Equipment	Daily	Daily Equipment Inspection Form
Drillers	Drill Rigs	Daily	Cascade Inspection Form or USACE Drill Inspection Form
All Employees	Tools and Equipment	Before Use	None. Dispose/replace faulty equipment/supplies.
SSHO/UXOSO	General Safety and Health	Daily	Daily Safety and Health Inspection Checklist

(a) Personnel associated with titles are presented in Section 4.
(b) Monitoring frequency is weather-dependent and presented in the SSHP (**Appendix E**).
(c) Any deficiencies and related information will also be recorded in chronological order on a deficiency log posted in the site trailer in accordance with Section 7.

8. MISHAP REPORTING AND INVESTIGATION

EA will track exposure hours, mishap notifications and reporting, and accident investigations at the Iona Island FUDS.

8.1 FIELD EXPOSURE DATA REPORTING

EA will monitor employee exposure hours using the Site Entry and Exit Log (**Appendix D**). Site personnel are required to sign-in and sign-out each time they enter and exit the site. These hours will be tallied monthly and will be provided to the EA Project Manager. EA will report contractor field exposure hours (total hours onsite including unpaid hours and individual subcontractor hours) monthly to USACE. Reporting will be completed by the EA Project Manager or their designee. The EA Project Manager will provide these data to the USACE Safety Manager (copying the USACE Project Manager and USACE Technical Manager) by the 10th day of the subsequent month.

8.2 MISHAP REPORTING AND INVESTIGATION

A mishap is defined as any unplanned, undesired event that occurs during the course of work being performed. Mishaps include accidents, incidents, and near misses. Employees will immediately report all mishaps to the SSHO/UXOSO and Field Data Manager/Site Supervisor who will report the accident to the Project Manager, Supervisors, Director of Safety and Health/SHM, Program Manager and Human Resources. The SSHO/UXOSO will complete the EA Accident/Loss Report and submit it immediately to the Director of Safety and Health, Program Manager and the Project Manager. The Project Manager will report to the USACE Project Manager/COR. All recordable mishaps must be communicated to the USACE Project Manager/COR as soon as possible and within 24 hours of the accident with the exception of the following events, which must be reported immediately: fatality, permanent partial or total disability, hospitalization of one or more people from a single incident, or property damage of $500,000 or more.

EA is also responsible for reporting property damage (exceeding $5,000 is recordable), days away injuries, days away illnesses, and restricted/transfer injuries to USACE. In addition, EA is responsible for reporting any fatality to the New York State Department of Health within 8 hours and any inpatient hospitalization, amputation, or eye loss within 24 hours.

Any mishap occurring in any of the following high hazard areas will be immediately reported to the USACE Project Manager/Contracting Officer’s Representative:

- Electrical (e.g., arc flash, electrical shock, etc.)
- Uncontrolled release of hazardous energy (electrical and non-electrical)
- Load handing equipment or rigging
- Fall-from-height (any level than the same surface)
- Unintentional detonation of UXO
- Diving accidents.

The above mishaps will be investigated in depth to identify all causes and to recommend hazard control measures.

An accident investigation will be conducted for all mishaps. Reportable accidents will be investigated by the SHM including: occupational injuries and illnesses; accidents resulting in significant loss or damage to property; accidents involving vehicles whether or not they result in damage to property or personnel; and accidents in which there may have been no injury or property damage, but which have a high probability of recurring with at least a moderate risk to personnel or property ("near miss"). Minor accidents will be investigated by the SSHO/UXOSO. An accident investigation will be used to determine and implement corrective actions, identify the causal factors contributing to the accident, identify deficiencies to the APP, provide information to identify trends or problem areas, and follow requirements for Workers' Compensation and/or OSHA recordkeeping and reporting. Results of the accident investigation along with the appropriate corrective actions will be sent to the USACE Project Manager as soon as possible and within 5 working days using the USACE Accident Investigation Form (ENG3394)[1].

The SSHO/UXOSO will provide the Director of Safety and Health/SHM and the Project Manager with an update once the corrective action has been implemented. The EA Project Manager will notify the USACE Project Manager of the status of the corrective action. Contact information for individuals involved in accident reporting procedures is presented in Section 9.2.2.

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[1] http://www.swg.usace.army.mil/Portals/26/docs/Safety/ENGForm3394AccidentInvestigationForm.pdf

9. SUPPLEMENTAL PLANS

The tasks listed in **Table 2-1** have been evaluated to determine the applicability of plans required by Appendix A of EM 385-1-1 (USACE 2014). **Table 9-1** summarizes the findings of this evaluation and indicates the location of required plans.

Table 9-1 Summary of EM 385-1-1 Plan Evaluation

Plans Per Appendix A of EM 385-1-1 (November 2014)	Rationale for Inclusion or Exclusion	Location if Included
Fatigue Management Plan	Included in the event that triggers for plan occur during the course of work.	9.1
Emergency Plans	Applicable to all operations.	
• Procedures and Tests		9.2.1
• Spill Plans		9.2.3
• Fire Fighting Plan		9.2.4
• Posting of Emergency Telephone Numbers		9.2.2
• Man overboard/abandon ship		Refer to Appendix G
Plan for Prevention of Alcohol and Drug Abuse	Applicable to all operations.	9.3
Site Sanitation/Housekeeping Plan	Applicable to all operations.	9.4
Medical Support Agreement	Applicable to all operations	9.5
Site-Specific Bloodborne Pathogen Plan	Applicable to all operations.	9.6
Exposure Control Plan	Applicable to all operations.	9.6
AED Program	An AED will be on board the boat during diving activities.	9.7
Site Layout Plan	Completion of this PWS requires the placement of restroom facilities and a temporary storage container.	9.8
Access and Haul Road Plan	Access to the site project site is via existing roads within the National Park. No haul roads are necessary for the completion of the PWS.	Not applicable
Hearing Conservation Program	Applicable to potentially loud operations.	9.9
Respiratory Protection Plan	Respirators will not be utilized for the PWS.	9.10
Health Hazard Control Program	Applicable to all operations.	9.11
Hazard Communication Program	Applicable to operations with hazardous chemicals.	9.12
Process Safety Management Plan	Not required under the current scope of work because it does not include the use or storage of any highly hazardous chemicals.	Not applicable
Lead Compliance Plan	Not required under the PWS because it does not include lead hazard control activities.	Not applicable
Asbestos Abatement Plan	Not required under the PWS because it does not include asbestos abatement activities.	Not applicable

Table 9-1 Summary of EM 385-1-1 Plan Evaluation

Plans Per Appendix A of EM 385-1-1 (November 2014)	Rationale for Inclusion or Exclusion	Location if Included
Radiation Safety Program	Not required under the current PWS because it does not include the handling of radioactive material or the use of radiation generating devices.	Not applicable
Abrasive Blasting Plan	Not required under the PWS because it does not include the abrasive blasting.	Not applicable
Heat Stress Monitoring Plan	Applicable.	Section 8.1 of the SSHP (Appendix E)
Cold Stress Monitoring Plan	Applicable.	Section 8.2 of the SSHP (Appendix E)
Indoor Air Quality Management Plan	Not applicable, no indoor spaces.	Not applicable
Mold Remediation Plan	Not required, no remediation of mold.	Not applicable
Chromium (VI) Exposure Evaluation	A Chromium (VI) Evaluation is not required under the current scope of work because it does not include the cutting or breaking up of cement surfaces made from Portland cement with a high chromium content, painting or paint removal operations, welding using rods or wire with a chromium coating, heading or welding on stainless steel, and handing or applying anti-corrosive substances or coatings.	Not applicable
Crystalline Silica Assessment	No activities that could potentially generate crystalline silica (e.g. drilling/sawing concrete, mixing concrete) will be done under the PWS.	Not applicable
Light Plan for Night Operations	Not required under the current scope of work because all work will be scheduled during daylight hours.	Not applicable
Traffic Control Plan	Not required under the current scope of work because work is being conducted in areas away from vehicular traffic.	Not applicable
Fire Prevention Plan	Applicable.	9.13
Wild Land Fire Management Plan	Iona Island is not prone to wild land fire.	Not applicable
Arc Flash Hazard Analysis	An arc flash is a type of electrical explosion that results from a low-impedance connection to ground or another voltage phase in an electrical system. Whenever work on or near energized parts greater than 50 volts is necessary, a hazard analysis/arc flash hazard analysis is to be conducted in accordance with National Fire Protection Association 70E. No work on or near energized parts greater than 50 volts is anticipated under the PWS; therefore, a plan is not required.	Not applicable
Assured Equipment Grounding Control Program	All 120-volt, single phase, 15- and 20-ampere receptacle outlets on the job site, which are not part of the permanent wiring of a building or structure and which are in use by EA employees, shall have approved GFCIs for personnel protection; therefore, an assured equipment ground control plan is not required.	Not applicable

Table 9-1 Summary of EM 385-1-1 Plan Evaluation

Plans Per Appendix A of EM 385-1-1 (November 2014)	Rationale for Inclusion or Exclusion	Location if Included
Hazardous Energy Control Program and Procedures (Lock-Out/Tag-Out)	Tasks under the PWS do not require lock-out/tag-out.	Not applicable
Standard Pre-Lift Plan	Not required, no critical lifts are anticipated to complete the PWS.	Not applicable
Critical Lift Plan	Not required, no critical lifts are anticipated to complete the PWS.	Not applicable
Naval Architecture Analysis – Load Handling Equipment (Floating)	Not required, no load handling equipment on barges, pontoons, or vessels is required to complete the PWS.	Not applicable
Floating Plant Inspection and Certification	Applicable	Appendix G
Severe Weather Plan for Marine Activities	Applicable	Appendix G – Float Plan[1]
Emergency Plan for Marine Activities	Applicable	Appendix G
Man Overboard/Abandon Ship Procedures	Applicable	Appendix G
Float Plan for Launches, Motorboats, and Skiffs	Applicable	Appendix G – Float Plan
Fall Protection and Prevention Plan	Not applicable, no elevated work will be performed under the PWS.	Not applicable
Demolition/Renovation Plan	Not applicable, no demolition or renovation work will be performed under the PWS.	Not applicable
Rope Access Work Plan	Not required, no climbing activities are anticipated.	Not applicable
Excavation and Trenching Plan	The scope of work will involve the removal of less than 5 feet of soil from the surface for proposed test excavations based on the anticipated depth to bedrock. Based on the requirements stated in EM 385-1-1 25.A.01.a[1] an Activity Hazard Analysis (Appendix A) is required and an Excavation and Trenching Plan is not required. No excavation and trenching plan will be submitted for this PWS.	Not applicable
Fire Prevention and Protection Plan for Underground Construction Compressed Air Work Plan for Underground Construction	Not required, no underground construction activities are anticipated	Not applicable
Erection and Removal Plan for Formwork and Shoring	Not required, no use of formwork or shoring required for this PWS.	Not applicable
Precast Concrete Plan	Not required, no use of precast concrete.	Not applicable
Lift Slab Plan	Not required, no slab lifting activities are required for this PWS.	Not applicable
Masonry Bracing Plan	Not required, no masonry activities are required for this PWS.	Not applicable
Steel Erection Plan	Not required, no steel erection activities are required for this PWS.	Not applicable

Table 9-1 Summary of EM 385-1-1 Plan Evaluation

Plans Per Appendix A of EM 385-1-1 (November 2014)	Rationale for Inclusion or Exclusion	Location if Included
Explosives Site Plan	Per Section 01.G.C of EM 385-1-1, work performed with operations dealing with military munitions will be completed in accordance with USACE EM 385-1-97.	Explosives Site Plan, Appendix G of the UFP QAPP
Blasting Plan	No rock blasting is required for this PWS.	Not applicable
Diving Operations Plan	Applicable	Appendix H
Safe Practices Manual for Diving Activities	Applicable	Appendix H
Emergency Management for Diving	Applicable	Appendix H
Tree Felling/Maintenance Program	No trees greater than 2 inches in diameter will be removed during brush clearing activities.	Not applicable
Aircraft/Airfield Construction and Phasing Plan Aircraft/Airfield Safety Plan Compliance Document	No aircraft/or airfield construction is being completed.	Not applicable
Site Safety and Health Plan	Applicable	Appendix E
Confined Space Entry Procedures Confined Space Program	Confined spaces are locations that, by design, satisfy the following definition: • Are large enough and so configured that an employee can bodily enter and perform work • Limited or restricted means for entry or exit; (limited entry by means of configuration, location, size, number, etc.) • Are not designed for continuous worker occupancy. No work will be conducted in any areas that satisfy the above definition.	Not applicable

1 - 25.A.01.a. Conditions: For excavations/trenches less than 5 feet (1.5 meters) in depth, an AHA is required; plan is optional. For excavations or trenches greater than 5 feet (1.5 meters) in depth, an AHA and plan are required.
NOTES:
GFCI = Ground fault circuit interrupter

9.1 FATIGUE MANAGEMENT PLAN

A Fatigue Management Plan has been completed for the Iona Island FUDS site because it is anticipated that during the life of the project the following triggers for a Fatigue Management Plan may be met:

- Exceed 10 hours a day for more than 4 consecutive days
- Exceed 50 hours in a 7-day work week
- Exceed 12 hours a day for more than 3 consecutive days
- Exceed 58 hours a week for sedentary (to include office) work.

Fatigue can be defined as a state of impairment that can include physical and/or mental elements. This is associated with lower alertness and ultimately reduced performance. Fatigue is the result of insufficient rest and sleep between activities and symptoms are not easily recognized. Rest is defined as a period of time during which the person concerned is off duty; is not performing work, including administrative tasks; and is afforded the opportunity for uninterrupted sleep. This does not include time for breaks, meals, or travel time to/from work.

Due to the inherent risks associated with munitions response activities, personnel performing munitions response activities that present an explosive risk shall be limited to a 50-hour workweek, with no individual workday exceeding 10 hours total, unless specifically authorized by the USACE COR.

9.1.1 Scope

Primary work tasks have been noted that would require fatigue management control include:

- Mobilization/demobilization
- Brush clearing
- Geophysical surveys
- Intrusive investigations
- Drilling
- Soil, groundwater, and sediment sampling.

9.1.2 Application

All employees are subject to fatigue; however, equipment operators and motor vehicle operators are the primary focus because of the use of equipment or vehicles that can put others in harm’s way. A minimum of 8 consecutive hours of rest between shifts in a 24-hour period is required for equipment and motor vehicle operators. Equipment operators are defined as operators of equipment, including but not limited to the following, which may be found onsite: hosting equipment and draglines, mobile construction equipment, electrical power systems, and hydraulically operated equipment. These operators are not permitted to exceed 12 hours of duty time in any 24-hour period, including time worked at another occupation.

Motor vehicle operators are defined as operators of motor vehicles, while on duty. These operators shall not operate vehicles for a continuous period of more than 10 hours in any 24-hour period; no employee, while on duty, may operate a motor vehicle after being in a duty status for more than 12 hours during any 24-hour period.

9.1.3 Evaluation of Risk

There are several activities associated with the RI tasks (**Table 2-1**). Field crews tend to work long days and the work associated with the geophysical investigation process and the mobilization and demobilization process is physically and mentally demanding. Days associated with field activities are potentially anticipated to exceed the hour limitations described above.

9.1.4 Controls

Controls for fatigue may include work scheduling (limit number of consecutive shifts), rotating jobs to prevent repetitive work, breaks at critical times in the work cycle, control of environmental factors (heat, cold, and use of PPE), buddy check-in for individuals working alone, and alternate transportation for long commutes.

Two types of fatigue controls can be used: administrative controls and workplace controls.

Administrative Controls

- Alternate work tasks
- Allow for more frequent or longer breaks
- Alternative commutes
- Healthy food (lower sugar)
- Administrative employees take a walk
- Alternating, limit, or eliminating night shifts
- Schedule high risk tasks when most alert.

Workplace Controls

- Lifting devices
- Work assistance in lifting and holding
- Good ventilation
- Ability to move around every hour or so
- Use of PPE
- Alarms or monitors.

9.1.5 Training

Training shall include symptoms of fatigue, habits, and actions the worker may take to avoid fatigue, actions workers should take if they observe fatigue in a co-worker, and controls in place to prevent fatigue. This training will be integrated into the safety kickoff and periodically throughout the life of the project in daily tailgate safety meetings.

9.1.6 Procedures

The following procedures will be utilized for work tasks identified as having a risk of fatigue:

- Work tasks will be planned to eliminate or minimize fatigue, including utilizing the controls discussed in Section 9.1.4.

- Workers will be provided with adequate breaks.

- Workers will be encouraged to arrive to work in a rested state (ideally 8 hours of sleep, at least 5 hours of uninterrupted sleep).

- Symptoms of fatigue and work hours for equipment and vehicle operators will be monitored by employees and the SSHO/UXOSO. Symptoms include excessive yawning, reduced alertness, and reduced reaction time.

If a fatigued employee is identified, their task will be re-assigned to a non-fatigued employee. The fatigued employee will be safely transported (vehicle operated by other) to an area for rest.

9.2 EMERGENCY PLANS

An emergency is defined as a situation that requires calling outside help onto a job site. Depending on the phase of work, field personnel will immediately stop work and report to the Field Manager, SSHO, SUXOS, or UXOSO under the following situations: medical emergency, fire emergency, spill emergency, discovery of unanticipated hazards (e.g., drums, heavily contaminated materials), heavy equipment accident, overexposure of personnel to onsite contaminants requiring Emergency Medical Services, or heat/cold-related injury or stress requiring Emergency Medical Services support and diving accidents requiring hypobaric chamber treatment.

9.2.1 Procedures and Tests

Prior to work startup, personnel will be familiar with this Emergency Response Plan. A test of cellular phone coverage will be made across the entire work area and will be conducted prior to mobilization to ensure that emergency services can be alerted in the event of an emergency. For marine operations, radios will be tested prior to mobilization.

Prior to the start of work on land at the site, field personnel will conduct a drill to mobilize to a rally point designated by the SSHO/UXOSO for each work area. Alternate rally point locations will be communicated to field personnel. Additionally, the SSHO/UXOSO will review the provisions of this plan during the pre-entry site briefing. The Field Manager and/or the SSHO/UXOSO will make this plan available for review and photocopying. Emergency contact numbers are provided in **Table 9-2**. Directions to the nearest hospital (**Figure 9-1**) will be kept in vehicles onsite. If a diving emergency requires a hyperbaric chamber, 911 will route the appropriate transport to the site for transport. The closest emergency hyperbaric treatment center is the Jacobi Medical Center Hyperbarics located in the Bronx, New York.

In the event of an emergency, the information available at that time will be properly evaluated and the appropriate steps taken to implement the Emergency Response Procedures. The SSHO (or Field Data Manager/Site Supervisor if the SSHO/UXOSO is part of the emergency) will assume command of the situation, will call the appropriate emergency services, and will evacuate personnel to the rally point. Onsite emergencies will ultimately be handled by offsite emergency support personnel (i.e., the local fire department, ambulance squad, or police, depending on the nature of the emergency), who will have authority once they arrive. Information garnered onsite will not be released to parties other than those listed in this section and emergency responders.

After emergency response agencies have been notified, the Project Manager will then be notified immediately.

9.2.2 Posting of Emergency Telephone Numbers

Emergency telephone numbers will be kept in support vehicles. Additional copies will be distributed to site personnel by the SSHO/UXOSO. The SSHO/UXOSO will have the phone numbers readily available on his/her person or in their vehicle. Emergency contact information is presented in **Table 9-2**.

9.2.3 Spill Emergency Response Plan

Small incidental spills of non-hazardous materials less than reportable quantities (e.g., fuel in equipment) that do not cause injury to personnel or the environment are possible and will be cleaned up as quickly as possible. Waste will be containerized and disposed of properly and labeled accordingly. Spill kits will be present onsite in the event of spillage of fluids from site vehicles or during refueling of site vehicles during daily operations. Safety data sheets (SDSs) (**Appendix F**) will be reviewed prior to addressing the spill. This written plan applies to all employees. No testing of the recovered materials will be required based on the lack of a hazard. No escape routes or procedures will be required nor will critical plant operations (and the related emergency evacuation) be required. No rescue or medical duties are required beyond first aid/CPR training (and associated bloodborne pathogen training) that is already required for other site tasks.

Based on a review of the proposed phases of work at the Iona Island FUDS by the SHM, emergency response for spills will be conducted by outside emergency responders. No emergency response for spills will be handled by site personnel and emergency response for spills is not part of this PWS. No large quantities of materials will be handled.

9.2.4 Firefighting Plan/Fire Emergency Response Plan

Site personnel will not attempt to handle a fire/explosion emergency. The SSHO/UXOSO will take measures to reduce injury and illness, primarily by evacuating personnel as quickly as possible. The Field Manager may assist in this role. The Field Manager will then notify the Project Manager. Site personnel will evacuate the area and gather/meet at the rally point. The SSHO/UXOSO will be responsible for identifying if any site personnel did not gather at the rally point.

The Firefighting Plan will be presented by the SSHO/UXOSO and reviewed by site workers as part of the pre-entry site briefing (Section 6). In addition, the Director of Safety and Health, EA's designated authority for fire prevention and emergency response, prepares the fire hazard evaluation program that is reviewed by EA employees during annual employee safety and occupational health training.

As part of the Firefighting Plan/Fire Emergency Response Plan, the SHM will evaluate the operations and type(s) of equipment/materials to determine potential fire or explosion hazards and will convey this information to site personnel through the SSHO/UXOSO. Training requirements are listed in **Table 6-1**. A fire and/or explosion will be immediately recognized as an emergency. Emergency services (fire, police, and ambulance) will immediately be notified by the SSHO/UXOSO (emergency numbers are included in **Table 9-2**). A copy of the emergency numbers will be included in the site support vehicle.

Cleanup after such events may require specialized services and are not covered by this APP/SSHP. The Project Manager will establish proper cleanup actions through coordination with the Field Manager, emergency services personnel, with input from the USACE Project Manager. Emergency contact information is presented in **Table 9-2**.

9.3 PLAN FOR PREVENTION OF ALCOHOL AND DRUG ABUSE

Employees are strictly prohibited from any activity related to using, possessing, manufacturing, selling, transporting, distributing, storing, concealing, and/or dispensing any controlled or illegal substances, as defined by federal or state law, on the premises of EA, while conducting EA business (including travel), during EA-sponsored activities, or in off-the-job activities. This includes places of public accommodation or recreation, restaurants, and common carriers. Violation of this policy will result in immediate removal from the site and appropriate disciplinary action, up to and including termination of employment. If the employee is observed by another employee as not “fit-for-work” for any reason, contact the employee’s immediate Supervisor or Corporate Human Resources as the situation will be managed as any other performance problem. EA may drug test/screen employees at any time. Drug testing procedures are part of corporate policy and are not covered within this plan. Additionally, EA employees are to have no expectation of privacy with respect to any property brought onto site premises or carried during travel, including air travel. Specific information can be obtained from Corporate Human Resources. No part of this plan grants employees contract rights or changes their status as “at-will” employees.

9.4 SITE SANITATION/HOUSEKEEPING PLAN

Housekeeping**—**Work areas will be kept clear of debris, tools, or other potential tripping hazards.

Drinking Water**—**Adequate bottled drinking water will be provided to all site workers and will be stored in coolers within dedicated site vehicles; it will be cooled as necessary depending on weather conditions.

Non-Potable Water**—**Water for decontamination activities will be obtained offsite.

Toilets**—**Portable restroom facilities will be staged onsite.

Washing Facilities**—**Employees will use handwashing in portable restroom facilities. Each vehicle will also be furnished with a bottle of hand sanitizer and an eyewash container.

Showers and Food Service**—**Shower facilities, changing rooms, and clothes drying facilities are not necessary for this PWS. No food service will be provided at the Iona Island FUDS.

Waste Disposal**—**All municipal wastes (trash, dunnage, etc.) will be removed from the site in a timely manner from adequately located waste receptacles to prevent a health hazard.

9.5 MEDICAL SUPPORT AGREEMENT

Less than 100 personnel will be required onsite to complete this job; therefore, onsite medical support is not required for this project. At least two people currently trained in first aid/CPR will be present onsite. Training requirements are presented in Section 6. Offsite medical support will be provided by professional medical services presented in **Table 9-2**. The nearest hospital is New York Presbyterian Hudson Valley Hospital for emergency treatment.

Medical facilities identified in **Table 9-2** have been contacted to confirm that injured employees will be able to receive prompt treatment. No work tasks with a high or extremely high RAC on the AHAs have been identified; therefore, arrangements do not need to be confirmed in writing.

9.6 SITE-SPECIFIC BLOODBORNE PATHOGEN AND EXPOSURE CONTROL PLAN

This site-specific plan will be applied in conjunction with the EA Corporate Bloodborne Pathogen Exposure Control Plan and OSHA 29 CFR 1910.1030, which will be available for consultation by site employees when necessary. This plan applies to personnel who will potentially be providing first aid/CPR, as the completion of the work required in the PWS will not expose site personnel to bloodborne pathogens. OSHA definitions relating to bloodborne pathogens are covered during training.

Based on a review of the work required in the PWS for the Iona Island FUDS, only site personnel providing first aid/CPR will potentially be exposed to bloodborne pathogens. Universal precautions and PPE will be used by providers of first aid/CPR to prevent contact with blood or other potentially infectious materials when working with employees who have an injury or in areas where the injury may have contaminated surfaces. PPE required for the program is presented in Section 5 of the SSHP (**Appendix E**). No decontamination of PPE will occur; all PPE will be disposed of. Work areas will be kept clean and sanitary and will be decontaminated after contact with blood or potentially infectious materials with a dilute bleach solution. Information pertaining to the Hepatitis B Vaccination series; post-exposure reporting, evaluation, and follow-up procedures; and recordkeeping practices and requirements are presented in the EA Corporate Bloodborne Pathogen Exposure Control Plan, which is present online. Training requirements are presented in Section 6.

9.7 AUTOMATIC EXTERNAL DEFIBRILATOR PROGRAM

An AED will be located on board the boat during diving activities. It will be maintained onsite by the SSHO/UXOSO and will reside on the vessel. At least two onsite personnel will be trained in AED use. Trained personnel will familiarize themselves with the specific AED model and instructions prior to mobilization to the site. The SSHO/UXOSO shall conduct a weekly battery and functionality check and document the findings in that days' daily report. The Standard Operating Procedure for the AED is included in **Appendix D**.

9.8 SITE LAYOUT PLANS

No temporary construction ramps, trestles, scaffolds, or platforms will be placed onsite. Fencing is referenced in Section 9.8.3. **Figure 9-2** shows the location of the laydown area that is to include the placement of elements included below. Placement of these structures will occur during the mobilization phase of work. A site layout map will be used by the SSHO/UXOSO during the Tailgate Safety Briefing to inform the workers of the location of hazardous areas on the site, restroom facilities (including hand wash facility), assembly areas to be used in the event of site evacuation, and any other information relevant to the day's activities.

9.8.1 Temporary Construction Buildings

A temporary storage box or storage trailer may likely be placed at the site. The location of the storage will be coordinated with PIPC. The location will need to be approved by the PIPC at the time of site mobilization.

9.8.2 Facilities

Portable restroom facilities and a storage container will be placed onsite.

9.8.3 Fencing

No temporary fencing will be required.

9.8.4 Access Routes

Access to the land portions of the Iona Island FUDS project site will be via an unnamed road accessed from Route 9W. Access during emergency situations is identical to the access described above. When personnel are required to cross active railroad tracks located in the project area (it should be noted that there is no physical barriers or warning for approaching trains), personnel will stop, listen, look both ways, and if clear then pull across. The SSHO will include discussion the protocol for crossing active railroad tracks at the initial site briefing and as needed in daily briefings.

9.8.5 Anchor Systems for Temporary Structures

No temporary structures will be utilized.

9.8.6 Temporary Facility Spacing

No other temporary facilities other than the storage container and temporary restrooms will be placed with approval of PIPC; therefore, no spacing considerations are required.

9.8.7 Temporary Power Distribution Approval

No temporary power will be required.

9.8.8 Temporary Ramp, Trestle, Scaffold, and Platform Approval

No ramps, trestles, scaffolds, or platforms will be used to complete this scope of work.

9.9 HEARING CONSERVATION PROGRAM

EA will evaluate the workplace for noise hazards initially and regularly during the course of work. The hearing conservation program applies to all employees who are exposed to hazardous noise or ototoxic chemicals during work tasks described in Table 2-1. No ototoxic chemicals (including arsenic, carbon disulfide, carbon monoxide, cyanide, lead and derivatives, manganese, mercury and derivatives, n-hexane, Stoddard solvent, styrene, trichloroethylene, toluene, and xylenes) will be encountered during work tasks.

Workers will be made aware of potential noise hazards prior to the start of tasks with noise hazards. Medical surveillance (Section 6 of the SSHP [Appendix E]) includes pre-employment and end-of-employment testing.

9.9.1 Noise Hazard Identification

Noise measurements shall be made whenever there is difficulty in communicating at distances greater than 2 ft (0.6 meters) without site personnel raising voice levels, upon worker complaint of excessive noise, or whenever hazardous noise levels are suspected. Noise assessments and/or measurements shall be performed and documented when any new facility or new equipment is placed in service and when areas that in the past were not noise hazardous become noise hazardous for any reason.

9.9.2 Assessment of Noise Hazards

Workplaces known or suspected to include hazardous noise will be surveyed initially, annually, and whenever site conditions change impacting noise generation.

The following will be utilized for the assessment of noise hazards:

- For continuous (steady state) noise and impact (impulse) noise, the instrument settings shall be in accordance with **Table 9-3**.

- Dosimeters shall measure the entire employee’s work shift to be considered full-shift sampling.

- Calibration of noise measuring equipment shall be in accordance with manufacturer’s instructions (USACE refer to Engineer Regulation 385-1-89).

9.9.3 Exposure Standards

Work using heavy equipment often creates excessive noise. Noise can cause workers to be startled, annoyed, or distracted; it can cause physical damage to the ear, pain, and temporary and/or permanent hearing loss; and it can interfere with communication. For impact (impulse) noise, personnel exposures may not exceed 140 dBA (unweighted) without effective hearing protection devices.

If workers are subjected to noise exceeding an 8-hour time-weighted average sound level of 85 dBA (decibels on the A-weighted scale), hearing protection will be provided with an appropriate noise reduction rating to comply with 29 CFR 1910.95 and reduce noise levels to or below 85 dBA. Workers involved in drilling or heavy machinery operation activities are likely to be subjected to noise exceeding sound levels of 85 dBA peak sound pressure. At this level, hearing protection will be selected by the SSHO with an appropriate Noise Reduction Rating to reduce noise levels to or below these values (**Table 9-4**).

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, the combined effects must be considered.

Exposure to different levels for various periods of time shall be computed according to the following formula:

$$Cn = T1 / L1 + T2 / L2 + . . . + Tx / Lx$$

Where:

Cn = Combined noise exposure factor.
T = Total time of exposure at a specified sound-pressure level (in hours).
L = Total time of exposure permitted at that level (in hours), from **Tables 9-3** or **9-4**, as appropriate If the sum exceeds 1, the mixture of exposure periods exceeds the threshold limit value (TLV).

9.9.4 Noise Controls

Hearing protection will be worn when working within 25 ft of heavy equipment that is in operation.

9.10 RESPIRATORY PROTECTION PLAN

The SHM is the Respiratory Program Administrator and has reviewed project tasks to prepare the respiratory protection plan for the site. This plan applies to EA employees and subcontractors who wear respirators on the job at the site.

Improper use of respirators can be hazardous to the employee's safety and health. Selection of the wrong equipment may result in the employee being unknowingly exposed to the hazard and thus inhaling harmful concentrations. Respirators that are not properly maintained, inspected, and cleaned can reduce the protection afforded, as well as cause skin irritation and place a greater strain on the respiratory system. An improper respiratory protection program may give the employee a false sense of security that could lead to harmful exposures. The purpose of this plan is to ensure that employees who must wear respirators are adequately protected and that respirator usage complies with the requirements of the OSHA Respiratory Protection Standard (29 CFR 1910.134).

EA will ensure appropriate respiratory protection of site workers. This plan describes the anticipated respiratory hazard, the feasible engineering, and work practice controls to reduce the hazard, the monitoring to measure the hazard, the correct respirator for each job, action levels for upgrading or downgrading respiratory protection, and personnel authorized to perform each task requiring respiratory protection.

9.10.1 Methods Used to Identify and Evaluate Workplace Respiratory Hazards

Respiratory hazards have been identified by reviewing site history to identify potential contaminants and their transport mechanisms and the proposed work tasks to be conducted. Individual potential volatile organic compound contaminants of concern have not been identified.

Based on the potential for site contaminants, respiratory protection may be required for volatiles. Prior to requiring upgrades in PPE, engineering controls (i.e., ventilation) will be employed to reduce exposure below the action levels presented in the SSHP (Appendix E). If engineering controls do not suffice, upgrades in PPE to include respiratory protection will be made. The environmental monitoring requirements, action levels, and potential PPE upgrades are presented in the SSHP (Appendix E).

9.10.2 Selection and Assignment

Based on the contaminants at the project site and reasonably expected potential concentrations in site media, a full-face air purifying respirator (APR) (North or MSA models) with combination high efficiency particulate air **(**HEPA)/organic vapor cartridges will provide adequate protection, if respirators are necessary. If an employee/subcontractor cannot be successfully fit tested with these respirator models, an alternate respirator model will be selected that provides a proper fit. Only respirators that are certified by the National Institute for Occupational Safety and Health will be utilized. Components of a respirator system will not be mixed or replaced with parts from different manufacturers. Alternate respirator models will be approved, prior to use in the field, by the SHM.

Oxygen deficient atmospheres will not be entered under this plan. Full-face APRs will not be permitted when atmospheric contaminants exceed the TLV (or in the absence of a TLV, the OSHA permissible exposure limit) (the more stringent value) by a factor of 10 if qualitative fit testing has been performed or 50 if quantitative fit testing has been performed (the protective factor for a full facepiece APR).

APRs will not be selected for protection against substances that lack adequate warning properties, unless the service life of the cartridge is specified, and field concentrations do not exceed specified amounts or the cartridge/canister has an end-of-service life indicator.

No site worker will be assigned a respirator unless the SSHO has determined that the employee is authorized to wear a respirator by virtue of current training and medical certificates.
Supplied air respirators are not included in the respiratory protection.

9.10.3 Fit Testing

At a minimum, qualitative fit testing using irritant smoke must be conducted annually on all individuals who will wear an APR. Such qualitative fit tests must follow the procedures outlined in Appendix A to 29 CFR 1910.134: Fit Testing Procedures (Mandatory) published in the *Federal Register* 8 January 1998. These procedures are provided in Appendix D and will be posted in the project trailer/office. Fit testing will be conducted by the SSHO or SHM. A fit test certificate will be issued upon successful completion and will include the respirator size and type, manufacturer name, and the signatures of the person performing the fit test and the person fit tested. Personnel are authorized to wear only those respirators for which they have been successfully fit tested.

9.10.4 Proper Use

Field personnel will wear only the respirator makes and models for which they have received hands-on respirator training or retraining (for APRs), within 12 months prior to use. In addition, for APR usage, a fit test with the specific make and model must have been successfully completed and documented within 12 months prior to use. Respirators will not be worn when conditions prevent a good face-to-facepiece seal. Such conditions may include but are not limited to:

- Growth of beard or sideburns, or a skull cap, hat, or other headgear that projects under the facepiece

- Absence of one or both dentures, or facial scars/deformities that affect the fit of the facepiece

- Corrective glasses or temple bars extend through the sealing edge of full facepiece.

As part of the donning procedure, the wearer will perform positive and negative pressure checks on the face-to-facepiece seal. If these fit checks indicate a possible leak, the user will re-adjust the facepiece and re-check. If the re-adjustment fails to correct the fit problem, the wearer will report this problem to the SSHO, who will either issue another respirator or perform fit testing using the qualitative fit test procedure, until a satisfactory fit is obtained.

If ambient temperatures are at or below freezing, a nose cup will be worn when full-face respirators are used.

Employees will return to a safe area to replace APR cartridges whenever breathing resistance increases or chemical breakthrough is detected or to wash their faces and respirators as necessary in order to prevent skin irritation. At the end of the workday, respirators will be cleaned, as specified in Section 9.9.5.

Basic rules for respirator usage are listed below:

- Facial hair that interferes with a satisfactory fit of the mask-to-face seal is not allowed on personnel required to wear respirators.

- Respirator cartridges should be replaced prior to reaching the service life, or after a full shift of continuous or intermittent usage, whichever is sooner. Cartridges should also be replaced if they become damaged, after the expiration date is exceeded, if vapor odor breakthrough occurs, or if filters become clogged causing resistance to breathing.

- Contact lenses may be worn when respiratory protection is required.

- Prior to donning, respirators will be inspected for worn or deteriorated parts.

- After donning, personnel will perform positive and negative pressure fit checks to determine if a good seal has been achieved.

- Site workers will be familiar with all sections of this Plan.

Used respirator cartridges will be managed and disposed as IDW, in accordance with the protocols specified in the Work Plan.

9.10.5 Maintenance, Inspection, Cleaning, and Storage of Respirators

Respiratory protection equipment will be properly inspected, cleaned, maintained, and stored to retain its original effectiveness. All persons who are assigned a respirator will be personally responsible for regularly cleaning, disinfecting, inspecting, and storing their assigned respirators as required by this section. The SSHO will be responsible for inspecting, storing, and distributing the respirators kept in the office supply.

Inspection by Wearer—Respirator wearers will inspect their respirators for defects **before and after each use** as delineated in the written inspection procedures that accompanied their respirator upon assignment. Defective or ill-fitting respirators will not be used and will be returned to the

SSHO immediately for replacement or repair. Personnel who cannot obtain an adequate fit check will inform the SSHO and be fit tested. Respirators that are not adequately clean will be returned to the most recent wearer who is responsible for cleaning and disinfecting the respirator according to the manufacturer's instructions.

Inspection by SSHO—On a daily basis, the SSHO will inspect the inventory of cartridges to ensure an adequate supply. On a weekly basis, the SSHO will inspect individually assigned respirators according to the inspection procedures provided by the respective respirator manufacturer. The SSHO will keep records of these inspections and note findings. The SSHO will also check the cleanliness of the respirators. Personnel whose respirators have not been maintained in good working order will be reported to their supervisor, who will issue appropriate disciplinary action.

Repair—Replacement or repair of respirators will be conducted only by the manufacturer's representative or SSHO with parts designed for the respirator according to the manufacturer's instructions. No attempt will be made to replace components or to make adjustment or repairs beyond the manufacturer's recommendations. All replacement parts must be identical to the original parts in order to maintain the National Institute for Occupational Safety and Health certification.

Cleaning and Disinfecting—After each use, respirators will be cleaned by the wearer according to these minimum cleaning requirements:

Wash with soap and water or respirator wipes or wipe with materials recommended by the respirator manufacturer. Place the facepiece (when dry) in a plastic bag and seal it.

Respirators will not be transferred from one employee to another until the most recent wearer has cleaned and disinfected it according to the manufacturer's instructions.

Storage—After inspection, cleaning, and necessary repair, the wearer(s) will store respirators in labeled plastic bags and protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. Cleaned respirators will be stored at the onsite project trailer/office. Prior to storage in lockers, cabinets, desks, or other location, the wearer must place the bagged respirator in a clean storage carton, packing it so that the facepiece rests in a normal position and is not distorted. APRs will not be stored for prolonged periods with cartridges attached. If cartridges are reused, then the used cartridges will be placed in a separate sealable bag (labeled with the user's name) and stored with the user's bagged respirator.

APR Cartridges—Cartridges with marred, torn, or missing labels will be crushed and discarded without using. Transfer of used cartridges between personnel is not permitted. After use, APR cartridges will be discarded by the wearer.

9.10.6 Training

Personnel must be trained in proper use and limitations of respirators according to the requirements of this section. Prior to wearing respirators, field personnel will receive training from the SSHO that will include at a minimum:

- Overview of the requirements in the Respiratory Protection Plan
- Responsibilities of individuals involved in the plan
- Nature, extent, and effects of respiratory hazards to which the employee may be exposed
- Operation, limitations, and capabilities of the respirators selected
- Proper inspection, maintenance, care, and storage of respirators
- Procedures for respiratory failure or emergency situations
- Demonstrations and hands-on training in how to wear, fit, and adjust respirators and how to test the face-to-facepiece seal to determine proper fit
- Fit testing.

Pre-Use Briefing—If more than 12 months have passed since the employees received training or have worn respirators, or upon request of the employee, a “hands-on” pre-use briefing will be provided by the SSHO. This briefing will cover the safe and proper use of respirators.

9.10.7 Medical Requirements

Personnel will not be assigned to tasks requiring the use of respirators unless it has first been medically determined that they are physically able to perform the work and use the equipment. The medical exam will be performed by a licensed physician, and will include, at a minimum, completion of the OSHA Respiratory Medical Evaluation Questionnaire (Appendix C of 29 CFR 1910.134). Upon receipt of a satisfactory assessment signed by the examining physician, an EA employee or subcontractor may participate in respirator fit testing. No EA employee or subcontractor will wear a respirator in a hazardous atmosphere until the SSHO has received a final assessment signed by the licensed physician. Any limitations or restrictions noted by the physician will be observed. Respirator users must renew their medical certification annually.

Voluntary use of respirators, when respirators are not required, will meet the requirements of 29 CFR 1910.134, Appendix D.

9.10.8 Recordkeeping and Program Evaluation

Training certificates, as well as respirator fit test records will be stored by the SSHO for the duration of employment, plus 1 year in project files. Medical certificates and records for all project personnel must be stored for the duration of employment plus 30 years in project specific files.

Monitoring results will be permanently recorded. Monitoring results are posted or distributed to affected employees within 5 working days of receipt. Respirator inspection records will be kept by the SSHO on the job site and for 1 year (for APRs) in project files.

The SSHO will monitor the effectiveness of this respirator program by maintaining frequent communications with respirator wearers and conducting periodic inspections of the respirators. Problems identified will be resolved by the SSHO with assistance from the SHM, as needed.

9.10.9 Responsibilities

Project Manager

- Provide adequate resources for respiratory protection.

Safety and Health Manager

- Inform the Site Manager, UXOSO, and SSHO of those operations for which respiratory protection will be required, including emergency situations.
- In conjunction with the SSHO, and/or UXOSO, determine whether engineering controls or administrative controls can be used to limit the hazard to workers involved.
- Implement this respiratory plan whenever site workers may be exposed to a respiratory hazard.

SSHO/UXOSO

- Provide onsite training for this respiratory protection plan.
- Maintain, distribute, and store respiratory protection equipment, including cartridges for air purifying respirators.
- Ensure that authorized personnel appropriately wear the assigned respiratory protection.
- Inform potentially affected employees about this plan.
- Conduct periodic inspections of respiratory protection equipment.

- Issue respirators and associated equipment to authorized site workers.

- Perform respirator fit tests, as needed.

- Ensure that subcontractors to EA who must wear respiratory protection submit evidence of medical approval for respirator usage and training in respirator usage including a fit test, within the prior 12 months, and are apprised of the respiratory protection requirements outlined in this plan.

- Conduct frequent, random inspections of workers' respiratory protection during work operations.

EA and Subcontractor Personnel

- Only authorized EA and subcontractor personnel will wear respirators. Authorized personnel have successfully completed an initial training course in respirator usage, are annually re-trained, and are medically certified for respirator usage annually. All personnel who wear respirators will be fit tested annually.

- Non-authorized EA and subcontractor employees will not wear respirators and will not be exposed to potentially hazardous atmospheres. If a non-authorized employee suspects that an atmosphere is unsafe, the employee will leave the area and immediately report to his/her supervisor.

- Properly inspect, use, maintain, clean, and store assigned respiratory protection equipment in compliance with the requirements of this plan.

- Notify Supervisor immediately of any suspected safety/health hazards associated with the use of respiratory protection.

- Use respirators in accordance with manufacturer's instructions.

- Personnel must be clean-shaven wherever the respirator facepiece seals to the wearer's skin. Personnel may not have facial hair that impairs the function of the respirator.

- If glasses are required, personnel will wear a respirator spectacle kit whenever they wear a full-face respirator.

- Personnel will not alter or modify respirators in any way.

- Read the site-specific safety and health plan prior to undertaking any tasks which may require respiratory protection.

9.11 HEALTH HAZARD CONTROL PROGRAM

The presence of hazards will be assessed through identifying work phases and potential physical, chemical, biological, and radiological hazards associated with those work phases. Work phases for this site are listed in Section 2. The hazards and related controls, including engineering controls and PPE, for activities performed during these work phases were assessed by the SHM during development of this APP and are described in AHAs included in **Appendix A** and the SSHP (**Appendix E**). To understand potential hazards associated with each required activity, AHAs are reviewed with onsite personnel prior to performing site tasks.

9.12 HAZARD COMMUNICATION PROGRAM

The purpose of this Hazard Communication Program is to ensure that important information regarding hazardous chemicals used, handled, or stored during the conduct of business is transmitted to employees and other affected persons as appropriate. A hazardous chemical, as defined by OSHA, is any chemical that is either a physical hazard or health hazard and includes hazardous chemicals generated during work operations. Chemical hazard information will be made available to employees and other affected persons, as appropriate, through the implementation of this comprehensive program, which includes container labeling and other forms of warning, collection, and compilation of material safety data sheets (SDSs, and training. A summary of the hazard communication program, as it pertains to this PWS, is presented below.

9.12.1 Chemicals Included in the Hazard Communication Program

The program applies to hazardous chemicals that are known to be present in the workplace and used or stored in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency. It is the responsibility of the SHM with support of the SSHO/UXOSO to ensure that chemical materials meet the provisions of this Hazard Communication Program. If there are any questions regarding the applicability of these program requirements to a particular material or situation, the SHM will be consulted.

The following materials are exempt from requirements of the program:

- Hazardous waste as defined by Resource Conservation and Recovery Act when subject to regulations issued under the U.S. Environmental Protection Agency (USEPA)
- Hazardous substances as defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) when subject to regulations issued under CERCLA by USEPA
- Tobacco or tobacco products
- Wood or wood products which will not be processed; wood treated with a hazardous chemical and wood which may be sawed or cut, generating dust, are covered

- Articles which are a manufactured item other than a fluid or particle; formed to a specific shape or design during manufacture; which have end use functions dependent in whole or in part upon their shape or design during end use; and which, under normal conditions or use, do not release more than minute or trace amounts of a hazardous chemical and do not pose a physical hazard or health risk to employees

- Any drug when it is in solid, final form for direct administration such as over-the-counter drugs and first aid supplies

- Cosmetics

- Any consumer product or hazardous substance, where it can be demonstrated that it is used in the workplace for the purpose intended by the chemical manufacturer or importer of the product, and the use results in a duration and frequency of exposure which is not greater than the range of exposures that could reasonably be experienced by consumers when used for the purpose intended

- Nuisance particulate where the chemical manufacturer or importer can establish that they do not pose any physical or health hazard

- Ionizing and non-ionizing radiation

- Biological hazards.

9.12.2 Lists of Hazardous Chemicals

The SHM has reviewed the list of chemicals required to complete the PWS at the Iona Island FUDS and determined that no hazardous chemicals will be used, brought onsite, or manufactured. Non-hazardous chemicals brought onsite are presented by the SDSs in **Appendix F**. The list of chemicals required to complete the PWS includes the name of each chemical, type of compound (e.g., flammable, corrosive, poison), the date of the inventory, and the location of the compound. The UXOSO/SSHO will maintain the list for the duration of the project, update the list appropriately, notify site personnel and the SHM of the addition of new compounds, and inform the site personnel of the associated hazards of those compounds. Small amounts of chemicals will be required for sample preservation. SDSs for all onsite chemicals, even non-hazardous chemicals, will be updated in a manner consistent with the above paragraph as new chemicals are brought onsite.

9.12.3 Labels and Other Forms of Warning

Site personnel will rely upon the original product labels to the extent practical. When labels must be applied to a temporary container, they will be printed in English and contain the following information:

- Identity of the hazardous chemical(s)

- Appropriate hazard warnings (i.e., any words, pictures, symbols, or combination thereof), which provide employees with specific information regarding the physical or health hazard(s) including primary target organ effect(s)

- Name of the chemical manufacturer, importer, or other responsible party, if appropriate.

Labels and other forms of warning will be legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. If existing labels already contain the required information, new labels are not required.

9.12.4 Alternatives to Labeling, Tagging, or Marking Requirements

Alternatives to the above-referenced labeling, tagging, or marking requirements are described below:

- Signs, placards, process sheets, batch tickets, operating procedures, or other such written materials may be used in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the marking information required above. The written materials will be readily accessible to employees in their work area throughout each work shift. If this alternative system is utilized, it will be done only with approval of the SHM or the UXOSO/SSHO.

- Portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer, are not required to be labeled (e.g., fueling vehicles with gasoline).

9.12.5 Shipping Hazardous Chemicals

No shipping of hazardous chemicals is required for completion of this PWS. Decontamination methods (presented in Appendix E of the SSHP) will not generate hazardous chemicals.

9.12.6 Safety Data Sheets

The UXOSO/SSHO will maintain a copy of the SDS for each new chemical brought onsite and will ensure that they are readily accessible during each work shift to employees when they are in their work area(s). While conducting site-specific field operations, the list of chemicals and the SDSs must be readily available onsite. SDSs for insect repellant (DEET and Permethrin), diesel fuel, fire extinguisher, sunscreen, and gasoline are presented in **Appendix F** and will be maintained with the UXOSO/SSHO.

9.12.7 Employee Information and Training

At a minimum, training will be conducted at the pre-entry briefing and whenever a new physical or health hazard (e.g., new material brought onsite) the employees have not previously been trained in is introduced into their work scope.

9.13 FIRE PREVENTION AND PROTECTION PLAN

Fire hazards at the Iona Island FUDS associated exhaust from vehicles creating enough heat to ignite combustibles (grass) will be considered. Detonation of MEC can also cause fires. No fixed water supply is present at the Iona Island FUDS. Therefore, fire suppression equipment will consist of portable fire extinguishers. Site work has been conveyed to the local fire and police departments to brief responders prior to an emergency response. Based on a review of the hazards associated with this PWS, no unusual fire hazards exist other than MEC detonation for completion of this RI. Smoking is prohibited within 50 ft of sampling locations or vegetated areas and there are no areas with underground fire hazards. No compressed gas cylinders or Department of Transportation-identified incompatible materials are required for this RI. No brush-control, steel-cabinets, insulating materials, disposal of combustible materials, burning operations, use of low-density fiberboard, temporary enclosures, temporary building spacing requirements, or fire lanes are required. There are no hazardous locations onsite with respect to a fire prevention plan. No additional combustible materials are required to complete this RI; therefore, safety issues regarding lighting, flames of torches to cut/sweat pipe, use of formwork and scaffolding, and fire protection in the construction process are invalid (reference training [Section 6] and inspection [Section 7] requirements[2]).

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[2] The inspection presented in Section 7 covers annual survey, suitability, and effectiveness requirements of this plan and the associated documentation.

Table 9-2 Emergency Contact Numbers

Contacts	Name	Office/Work	Mobile
Ambulance, Fire, and/or Police	Fort Montgomery Fire District	911/845-446-7116	Not applicable
Hospital (24 Hours)	New York Presbyterian Hudson Valley Hospital	914-737-9000	Not applicable
Hyperbaric Chamber	Jacobi Medical Center Hyperbarics	718-918-5800	Not applicable
USACE Project Manager	Erin Kirby, P.G., LEP	978-318-8147	Not applicable
USACE Technical Manager	Todd Beckwith	410-962-6784	Not applicable
USACE Ordnance and Explosives Safety Specialist	Marty Holmes	Not applicable	315-525-1195
EA Program Manager	Brenda Herman, P.G.	410-527-2474	410-913-1681
EA Corporate Safety and Health Director	Peter Garger, CIH, CSP	410-527-2425	410-790-6338
EA National Service Line Program Manager Munitions Response	Richard Hanoski	443-632-4887	443-632-4887
EA Project Manager	Timothy Reese, P.E.	410-329-5198	410-935-3887
EA Senior Geophysicist/Quality Control Geophysicist	Michael McGuire, P.G.	Not applicable	443-986-2488
EA SSHO	Eddie Meadows	410-671-6051	410-961-4028
SSHO Alternate	Jeff Smith	410-671-6051	410-627-4195
EA UXOSO	John Monk	410-584-7000	717-887-5582
EA UXOSO Alternate	Ward Stern	To Be Determined	256-731-9151
EA SUXOS	John “JD” Marlowe	443-752-1775	443-752-1775
AOR Project Manager	Brandon Puttroff	Not applicable	619-203-7325
AOR DPIC / Diving Supervisor	Steve Mulholland	Not applicable	619-559-5888
ANJV Senior Geophysicist	Alex Kostera	434-559-5888	434-559-5888
ANJV AGC Project Manager	Mark Howard	434-978-3187	434-978-3187
PIPC Executive Director	James Hall	845-786-2701	Not applicable
Poison Control	Not applicable	800-222-1222	Not applicable
U.S. Environmental Protection Agency National Response Center	Not applicable	800-424-8802	Not applicable
EA Medical Services (Physician)	All One Health Resources	800-350-4511	Not applicable
New York State Department of Health	Bureau of Occupational Health and Injury Prevention	(518) 402-7900	Not applicable
Federal OSHA Hotline	Not applicable	800-321-6742	Not applicable

Table 9-3 Settings for Noise Measuring Equipment

Feature	Dosimeter (ACGIH)	Dosimeter (Department of Defense and USACE)*	Type 2 (or better) Sound Level Meter for Continuous Noise (USACE)*	Type 1 Sound Level Meter for Impulse Noise (USACE)*
Criterion Time	8 hours	8 hours	8 hours	8 hours
Criterion Level	85 dBA	85 dBA	85 dBA	85 dBA
Weighting	A	A	A	Unweighted, linear, or Z
Peak Weighting	Unweighted	Unweighted, linear, or Z	Unweighted, linear, or Z	Unweighted, linear, or Z
Threshold Level	80 dBA	80 dBA	80 dBA	140 dBA
Upper bound on integration	130 dBA	None	None	None
Time Weighting	Slow	Slow	Slow	Impulse
Exchange Rate	5 dBA	3 dBA	3 dBA	3 dBA

* When used for the purposes of delineating noise hazardous areas or evaluating noise exposures to personnel.
NOTES:
ACGIH = American Conference of Governmental Industrial Hygienists

Table 9-4 Non-Department of Defense Continuous Noise Exposures

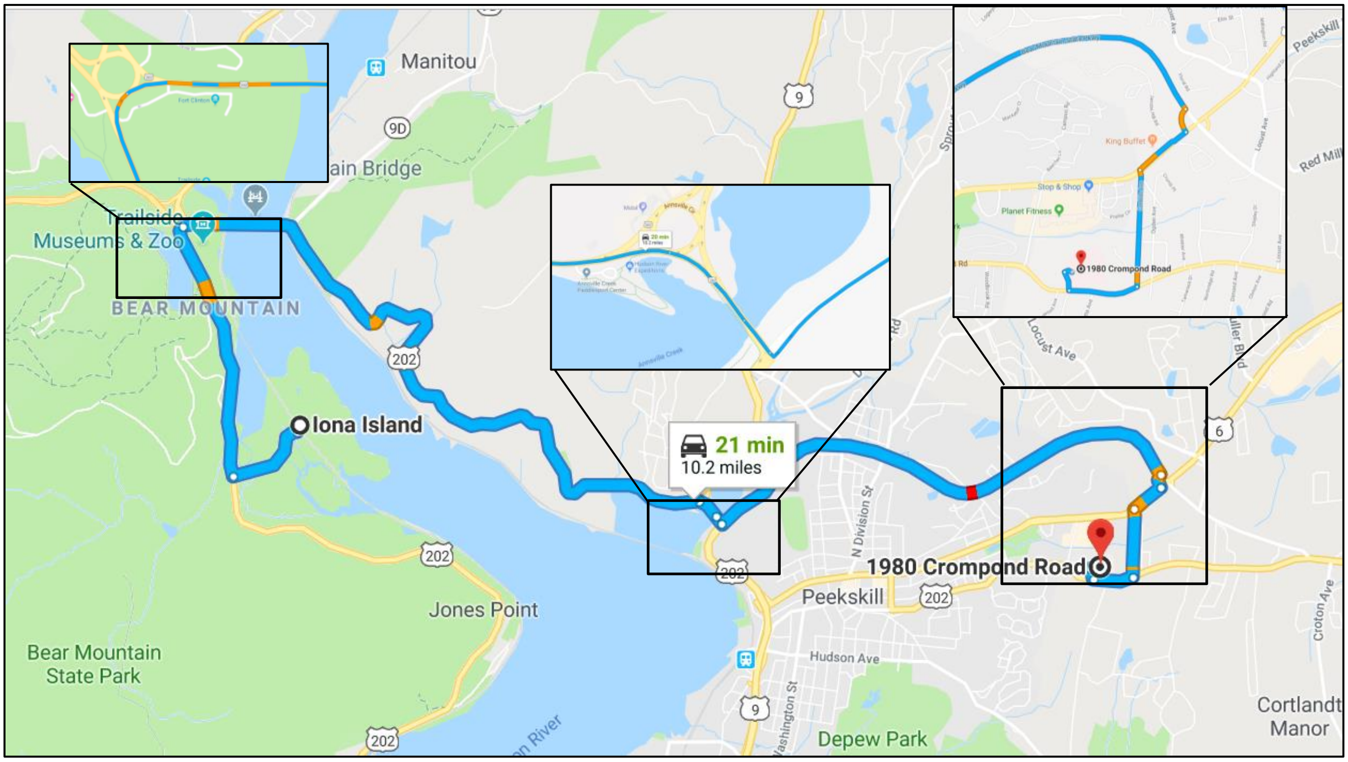
OSHA Standard Duration per day (hours)	Permissible Sound Pressure Level (dBA)
8	85
4	88
2	91
1	94
0.5 = 30 minutes	97
0.25 = 15 minutes	100

Figure 9-1 Hospital Map and Directions

Directions to the New York Presbyterian Hudson Valley Hospital from the Iona Island FUDS

- Distance to Nearest Hospital (with emergency room): 10.2 miles and 21 minutes
- Hospital Name: New York Presbyterian Hudson Valley Hospital (24 hours)
- Hospital Phone: (914) 737-9000
- Hospital Address: 1980 Crompond Road, Cortlandt, New York 10567
- Route to Hospital: Directions and map to hospital below:

  - Head west towards US 202/US 9W on the unnamed road (0.5 miles)
  - Turn RIGHT onto US-202 E, follow to Bear Mountain State Parkway/New York State Reference Route 987H in Peekskill (5.8 miles).
  - At the traffic circle, take the 1st exit onto US-202 E/US-6 E (4.2 miles).
  - At Annsville Circle, take the 1st exit onto US-202 E/US-6 E/U.S. 9 S/Jans Peeck Bridge (0.1 miles).
  - Keep LEFT to continue on Jans Peeck Bridge (272 feet).
  - Turn LEFT onto Bear Mountain State Parkway/New York State Reference Route 87H (signs for Bear Mountain Parkway/Taconic State Parkway) (2.9 miles).
  - Turn RIGHT onto US-6 W (0.2 miles).
  - Turn LEFT onto Conklin Avenue (0.8 miles)
  - Turn RIGHT onto Crompond Road/US 202 W (0.2 miles)
  - New York Presbyterian Hudson Valley Hospital is at 1980 Crompond Road on the RIGHT.



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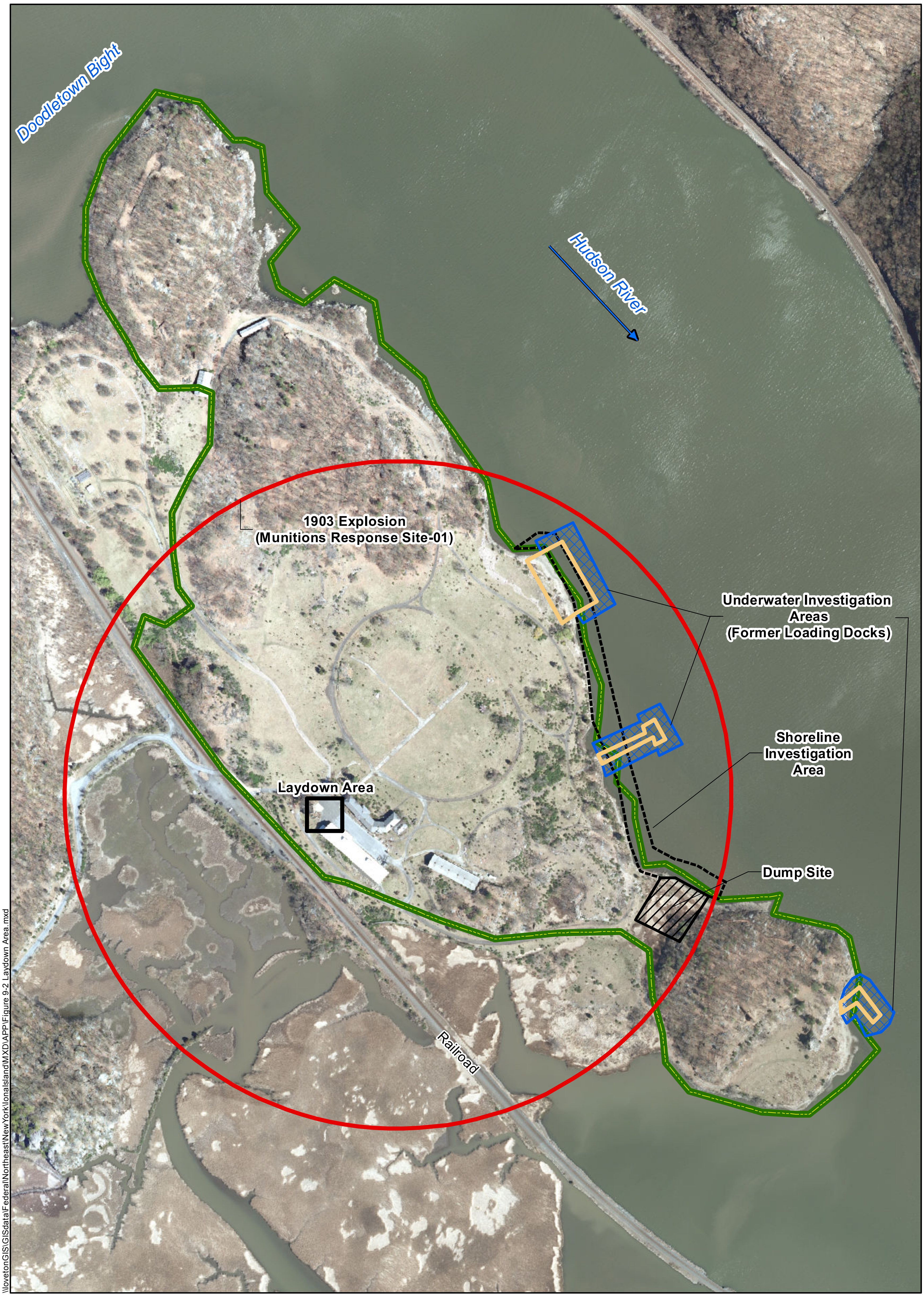
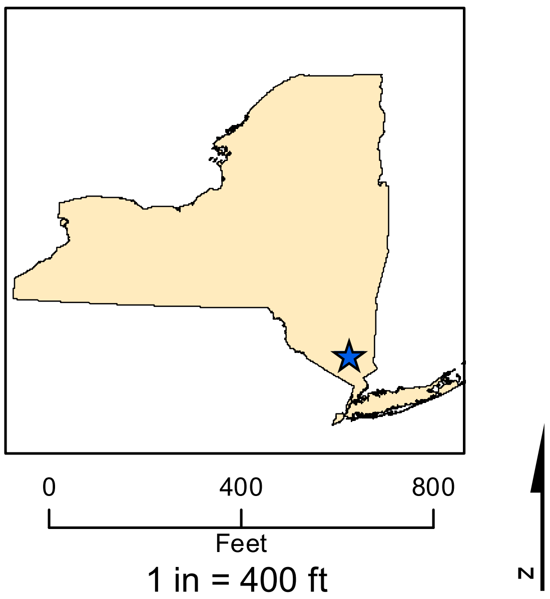


\\lovetonGIS\GISdata\Federal\Northeast\NewYork\IonaIsland\MXD\APP\Figure 9-2 Laydown Area.mxd



Legend

- ★ Site Location
- 🟩 FUDS Boundary
- 🟥 Approximate Area of 1903 Explosion
- 🟧 Former Loading Docks
- ▨ Land Investigation Area
- ▦ Underwater Investigation area (Former Docks)
- ⬚ Shoreline Investigation Area
- ☐ Laydown Area

FIGURE 9-2
LAYDOWN AREA

ACCIDENT PREVENTION PLAN
MMRP AND HTRW - RI THROUGH DD
IONA ISLAND NAVAL
AMMUNITION DEPOT FUDS
ROCKLAND COUNTY, NY

Map Date: 09/21/2018
Projection: NAD 1883 State Plane
New York East FIPS 3101 (US Feet)

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10. RISK MANAGEMENT PROCESSES

An assessment of the hazards, training, and equipment required to perform the tasks were completed as part of a risk analysis by corporate health and safety management with input from personnel who have previously performed the tasks. In accordance with EM 385-1-1 01.A.14, major activities and phases of work to be performed will be covered in an AHA. AHAs will be reviewed with all personnel involved in a task prior to each work activity or phase presenting hazards not experienced in previous project operations.

Upon commencement and throughout the activity, the AHA will be used to verify compliance with the prescribed hazard controls and to note any potential changes in process. The AHAs provide detailed project-specific hazards and controls for each major phase/activity of work. The primary activities and phases of work required to complete the PWS for the Iona Island FUDS are presented in Section 2. AHAs are included in **Appendix A**.

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11. PERSONAL PROTECTIVE EQUIPMENT

Information pertaining to PPE is presented in the SSHP (**Appendix E**).

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12. REFERENCES

EA Engineering, Science, and Technology, Inc., PBC (EA). 2018. *Draft Uniform Federal Policy Quality Assurance Project Plan, Military Munitions Response Program Remedial Investigation at the Iona Island Naval Ammunition Depot Formerly Used Defense Site, Rockland County, New York*. October.

U.S. Army Corps of Engineers (USACE). 2014. *Engineering Manual 385-1-1 Safety and Health Requirements Manual*. 30 November.

USACE. 2008. *Engineering Manual 385-1-97 Explosives Safety and Health Requirements Manual*. 17 May.

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Appendix A

Activity Hazard Analyses

ACTIVITY HAZARD ANALYSES

This appendix contains U.S. Army Corps of Engineers Activity Hazard Analysis (AHA) forms for the Military Munition Response Program (MMRP) and Hazardous Toxic and Radioactive Waste (HTRW) Remedial Investigation (RI) through Decision Document (DD) for the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS), Rockland County, New York Accident Prevention Plan (APP). Table 1 presents the phases of work listed in Section 2 of the APP and each corresponding AHA. Each AHA is presented in the order it will occur and will apply to all subsequent phases of work.

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Phases of Work and Site-Specific Activity Hazard Analyses

	MMRP RI Tasks										**HTRW RI Tasks**					
Site-Specific Activity Hazard Analysis [(a)]	**Mobilization and Demobilization**	**Land Survey**	**Brush Clearing**	**DGM Surveys**	**AGC Survey**	**Mag and Dig**	**Soil Sampling**	**Land-Based Intrusive Investigation**	**Underwater Surface and Investigation**	**Sediment Sampling**	**Mob. And Demobilization**	**Direct Push Soil Boring**	**Piezometer Installation**	**Ground-water Sampling**	**Sediment Sampling**	**Bedrock Well Installation**
General	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Large Hand Tools Use	X		X													X
Small Hand Tools Use	X			X	X					X			X	X		X
Intrusive Investigation of Target Anomalies								X	X							
MEC Avoidance		X	X	X	X		X	X		X		X	X		X	X
MEC Detector-Aided Surface/Subsurface Clearance		X	X	X	X	X		X								
MPPEH Inspection			X	X	X	X		X	X							
MEC Disposal			X	X	X	X		X	X							
Munitions Debris Inspection and Disposition			X	X	X	X		X	X							
Soil Sampling							X	X								
Surface Water/Sediment Sampling										X					X	
Groundwater Sampling/Well Development														X		
Direct Push Soil Boring/ Well Installation												X				X
Boating Operations									X							
Diving[(a)]									X							

[(a)] Included with the Dive Plan (Appendix H)

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ACTIVITY HAZARD ANALYSIS – GENERAL

Activity/Activities:	**General**	**Phases:** All	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**	**M**
Project Location:	Iona Island, New York			
Project Number:	63029587			
Date Prepared:	12 October 2018			
Prepared By:	D. Wilt			
Reviewed By:	P. Garger, CIH, CSP			
Competent and/or Qualified Person(s):	SSHO, UXOSO, or Subcontractor(s)			

Risk Assessment Code (RAC) Matrix

	Probability				
Severity	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
1 Catastrophic	E	E	H	H	M
2 Critical	E	H	H	M	L
3 Marginal	H	M	M	L	L
4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
General	Biological Hazards: Bites and stings from insects and spiders; contact with poisonous plants, snakes	Inspect work areas when arriving to identify biological hazard(s). Use insect repellant. Insect repellant containing DEET may be used on exposed skin and/or clothing. Insect repellant containing Permethrin may only be applied to clothing. Stay alert and a safe distance away from biological hazards. Use barrier cream and appropriate PPE, which includes steel or composite toe ankle length boots, safety glasses, hardhat, ANSI Class 2 vest and work pants that will prevent injury from biological hazards as discussed in Section 2.10 of the SSHP. Workers with allergies should carry antidote kits, if necessary. Antidote kits (e.g., epi-pens) will be declared to the SSHO and site personnel regarding where the pen is kept and instructions on how to use the pen. Workers will use snake chaps as appropriate in overgrown areas.	3/3/M
General	Physical Hazard: Slips, trips, and falls	When working throughout the site, keep work area free of excess material and debris. Keep non-essential personnel away from equipment and tools. Work at an appropriate pace and do not run. Remove all trip hazards by keeping materials/objects organized and out of walkways. Be aware of uneven surfaces while walking. Stay aware of footing and do not run.	3/3/M
General	Physical Hazard: Noise	Hearing protection shall be worn by personnel when working around (within 25 feet of) heavy equipment.	2/4/M
General	Physical Hazard: Back strain and other muscle injuries from manual lifting	Follow proper lifting techniques for all objects at the site including, but not limited to, equipment, erosion and sediment control materials, soil samples, hand tools, small hand tools, shovels, and/or digging equipment. Use caution and do not twist the back when carrying heavy objects. Do not attempt to lift bulky items or items assessed at over 50 pounds without assistance. If an item's exact weight is unknown, consult the SSHO and consider a team lift. Use mechanical devices to move loads when possible (i.e., a skid steer to move clearing equipment or debris versus carrying items). Work gloves must be worn when personnel are handling materials.	3/3/M
General	Physical Hazard: Heat and cold stress	Conduct temperature monitoring when temperatures fall below 45°F and are above 75°F. Appropriate cold-weather clothing will be worn when temperatures fall below the range stated above and shelter will be provided (vehicles/boat). Potable water will be made available and workers are required to drink small amounts frequently. Work/rest regiments will be adjusted in hot and cold weather in accordance with Tables 8-1 and 8-2 in the SSHP. Use the buddy system when working.	3/4/L

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
General	Physical Hazard: Striking an object or person while driving a support vehicle or operating heavy equipment	Obey all traffic laws, including no cell phone usage while driving. 15 miles per hour is the maximum speed allowed in the work area and seat belts must be worn. Maintain eye contact with site personnel walking around or in the vicinity of the vehicles. Do not operate vehicles in unsafe conditions (e.g., on steep slopes, in deep mud). Back into parking locations (or pull through) wherever possible; use spotters when backing up in congested areas. Be aware of obstacles to avoid or clear. Be aware of surrounding vehicles. Do not park or generally navigate in the blind spot of other vehicles or the brush-clearing equipment. If you are uncertain of the blind spot, maintain a distance of 25 feet from heavy equipment and coordinate with the operator. Use a spotter when working in the vicinity of personnel and equipment. Be aware of pinch points with machinery and vehicles, and keep body parts clear of pinch points.	3/3/M
General	Physical Hazard: Falling objects	Be aware of overhead hazards, including tree branches. Employees will wear Level D PPE.	3/3/M
General	Physical Hazard: Weather/extreme weather	Monitor weather conditions. Discontinue work during lightning and severe weather events and wait 30 minutes in project vehicles or trailer after last occurrence of lightning within 6 miles as based on a lightning detector/NOAA radio application/Lightning Strike Map. The SSHO is responsible for alerting the “all-clear” to resume work. If unfavorable weather conditions arise, the SSHO will evaluate the safety hazards and activities will be halted at the discretion of the SSHO.	3/3/M
General	Physical Hazard: Visibility	Personnel must wear a high-visibility traffic vest at all times.	3/3/M
General	Physical Hazard: MEC	Ensure exclusion zones are established to authorized minimum safe distances for non-project personnel and team separation distances for project personnel. Use the minimum number of personnel (not less than two) to conduct the operation and minimize their exposure time to MEC. Ensure all personnel are under the direction of DDESB-qualified UXO Technicians. Do not conduct operations within site-specific minimum safe distances of other MEC intrusive operations. Observe general MEC hazards and precautions. Ensure compliance with relevant SOPs and the MEC Explosives Site Plan.	2/3/M
Refueling	Physical Hazard: Fire	Wear Level D PPE and ensure emergency equipment (fire extinguishers) are appropriately placed. Eliminate ignition sources; keep all potential ignition sources at least 20 feet from the work area. Practice vapor awareness (e.g., gasoline flash point is -40°F; diesel fuel flash point is 135°F). Ensure nozzle is in contact with tank to eliminate potential static discharge. Avoiding static discharge when fueling. To minimize the chance of static discharge at the pump, you must ensure metal-to-metal “bonding” by using a metal bonding cable or keeping the nozzle in contact with the tank being filled. Avoid spilling fuel, and cleanup spills following the instructions on the spill kit. Practice good housekeeping and keep obstacles, debris, and refuse away from your work area.	2/3/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Insect repellant and/or barrier cream • Level D PPE (steel/composite toed boots, safety glasses, hardhat [when overhead hazards are present], work pants, blaze orange/yellow clothing and/or reflective safety vests, and work gloves) • Antidote kits (if applicable) • Emergency equipment including first aid kit and fire extinguishers • Lightning detector, NOAA application, or use of lightning strike map • Excavation equipment (during intrusive activities) • Support vehicles	• Inspect PPE prior to each use • Inspect emergency equipment/supplies monthly (first aid, fire extinguisher)	• Use and limitations of PPE • Valid driver’s license (if driving) • APP and AHA review

ACTIVITY HAZARD ANALYSIS – LARGE HAND TOOLS

Activity/Activities:	**Large Hand Tools**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**	**M**	

Project Location:	Iona Island, New York
Project Number:	63029587
Date Prepared:	12 October 2018
Prepared By:	M. McGuire
Reviewed By:	P. Garger, CIH, CSP
Competent and/or Qualified Person(s):	Site Safety and Health Officer (Doug Thompson) SSHO, UXO Safety Officer (UXOSO)/UXO Quality Control Specialist (UXOQCS), UXOTIII, UXOTII, Field Technician

Risk Assessment Code (RAC) Matrix

	Probability				
Severity	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
1 Catastrophic	E	E	H	H	M
2 Critical	E	H	H	M	L
3 Marginal	H	M	M	L	L
4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
Use of large hand tools with saw or blade	Physical Hazard: Laceration	Cover saw or blades with guard when not in use and during transport. Wear Level D PPE as described below. Never saw or cut alone; implement the buddy system. Hold shaft with one hand approximately 8-12 inches from head and other hand approximately 6 inches from top. Check the clearance in the area in which you are to swing with respect to the location of objects and personnel. Set feet in a balanced position with terrain. Set the tool on the object to be struck before beginning swing. Lift the tool in a controlled manner and swing toward object.	3/3/M
Use of large hand tools to remove small diameter trees	Physical Hazard: Injuries from falling trees and limbs	Notch all trees when possible/practical. Always cut trees from the uphill side. Tree area should be cleared of extra personnel once the tree has been notched. Maintain good communication with partners; be sure who will remove saw when felling. Use warning shouts when felling and maintain proper spacing. Watch for felled material rolling downhill.	3/3/M
Use of large hand tools	Physical Hazard: Back injuries or muscle strain	Hold shaft with one hand approximately 8-12 inches from head and other hand approximately 6 inches from top. Check the clearance in the area in which you are to swing with respect to the location of objects and personnel. Set feet in a balanced position with terrain. Set the tool on the object to be struck before beginning swing. Lift the tool in a controlled manner and swing toward object.	3/3/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Large hand tools • Level D PPE within the exclusion zone (steel/composite toed boots, safety glasses, hardhat, work pants, blaze orange/yellow clothing and/or reflective safety vests, work gloves)	• Inspect PPE prior to each use • Inspect large hand tools prior to use	• Use and limitations of PPE • APP and General AHA review

ACTIVITY HAZARD ANALYSIS – SMALL HAND TOOLS

Activity/Activities:	**Small Hand Tools**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**				**M**	
Project Location:	Iona Island, New York		**Risk Assessment Code (RAC) Matrix**					
Project Number:	63029587		**Severity**	**Probability**				
Date Prepared:	12 October 2018			**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
Prepared By:	M. McGuire		1 Catastrophic	E	E	H	H	M
			2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP		3 Marginal	H	M	M	L	L
			4 Negligible	M	L	L	L	L
Competent and/or Qualified Person(s):	Site Safety and Health Officer (Doug Thompson) SSHO, UXO Safety Officer (UXOSO)/UXO Quality Control Specialist (UXOQCS), UXOTIII, UXOTII, Field Technician							

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
Use of small hand tools with sharp edges	Physical Hazard: Laceration	Cover saw or blades with guard when not in use and during transport. Wear Level D PPE as described below. Never saw or cut alone; implement the buddy system. Hold shaft with one hand approximately 8-12 inches from head and other hand approximately 6 inches from top. Check the clearance in the area in which you are to swing with respect to the location of objects and personnel. Set feet in a balanced position with terrain. Set the tool on the object to be struck before beginning swing. Lift the tool in a controlled manner and swing toward object.	3/3/M
Using hammer and screwdrivers	Physical Hazard: pinching, smashing	Wear eye protection Wear proper fitting gloves Clear area of other people	3/3/M
Tool Selection	Wrong Tool for the Job	Ask for help and advice Wear eye and hearing protection Wear proper fitting gloves Make sure safety devices on saws are operating Clear area of other people	3/3/M
Use of small hand tools	Physical Hazard: Back injuries or muscle strain	Hold shaft with one hand approximately 8-12 inches from head and other hand approximately 6 inches from top. Check the clearance in the area in which you are to swing with respect to the location of objects and personnel. Set feet in a balanced position with terrain. Set the tool on the object to be struck before beginning swing. Lift the tool in a controlled manner and swing toward object.	3/3/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Large hand tools • Level D PPE within the exclusion zone (steel/composite toed boots, safety glasses, hardhat, work pants, blaze orange/yellow clothing and/or reflective safety vests, work gloves)	• Inspect PPE prior to each use • Inspect large hand tools prior to use	• Use and limitations of PPE • APP and General AHA review

ACTIVITY HAZARD ANALYSIS – INTRUSIVE INVESTIGATION OF TARGET ANOMALIES

Activity/Activities:	**Intrusive Investigation of Target Anomalies**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**		**M**	
Project Location:	Iona Island, New York		**Risk Assessment Code (RAC) Matrix**			
Project Number:	63029587		**Severity**	**Probability**		
Date Prepared:	12 October 2018			**1 Frequent**	**2 Likely**	**3 Occasional** / **4 Seldom** / **5 Unlikely**
Prepared By:	M. McGuire		1 Catastrophic	E	E	H / H / M
			2 Critical	E	H	H / M / L
Reviewed By:	P. Garger, CIH, CSP		3 Marginal	H	M	M / L / L
			4 Negligible	M	L	L / L / L
Competent and/or Qualified Person(s):	UXOSO/UXOQCS, SUXOS and UXO Technician III					

Severity	1 Frequent	2 Likely	3 Occasional	4 Seldom	5 Unlikely
1 Catastrophic	E	E	H	H	M
2 Critical	E	H	H	M	L
3 Marginal	H	M	M	L	L
4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
Intrusive Investigation of Target Anomalies	Physical Hazard: MEC	Ensure Exclusion Zones (EZs) are established to authorized minimum safe distances (MSDs) for non-project personnel and team separation distances for project personnel. Use the minimum number of personnel (not less than two) to conduct the operation and minimize their exposure time to MEC. Ensure all personnel are under the direction of DDESB-qualified UXO Technicians. Do not conduct operations within site-specific MSDs of other MEC intrusive operations. Observe general MEC hazards and precautions. Ensure compliance with relevant SOPs and the MEC ESP.	2/4/M
	Physical Hazard: Hand-Digging Anomalies	Always use a two-man dig team Dig on the side of the anomaly so as not to strike the anomaly. Only excavate the anomaly to the extent needed to confirm the identity and hazard associated with the item.	2/4/M
	Physical Hazard: Manual Lifting	Follow proper lifting techniques. Use caution and do not twist the back when carrying a load. Do not attempt to lift bulky items or items assessed at over 50lbs. without assistance. Use mechanical devices to move loads when possible. Wear leather gloves for materials handling.	3/3/M
	Physical Hazard: Hand Tools	Inspect tools prior to use. Use tools for their intended use only. Don’t use damaged tools. Push, don’t pull wrenches.	3/3/M
	Physical Hazard: Underground Utilities	Complete utility locates and/or coordinate with site personnel. Mark any utility locations in white. Field verify utility locations. Document all utility locations. Observe the area for indication of utilities.	2/4/M

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
Intrusive Investigation of	Physical Hazard: Injury from heavy equipment	Be aware of the location of equipment, wear high visibility vest, and establish eye contact with operator. Be aware of pinch points, swinging chains, buckets, etc. Wear appropriate PPE (hard hat) when working in proximity to equipment and overhead hazards.	2/4/M
	Physical Hazard: Faulty or Inappropriate Equipment	Operator must inspect equipment prior to use, if faulty or inappropriate, do not proceed until repaired or replaced. Inspect all hand tools prior to use, if faulty or inappropriate, do not proceed until repaired or replaced.	2/4/M
	Physical Hazard: Moving Equipment	Clear area of obstructions and communicate with all workers involved that excavation is beginning. Secure loose clothing. Do not walk under suspended loads. When possible, remove overhead hazards promptly. Wear appropriate PPE including hard hat and steel-toed boots. Use spotters when moving in/out of nominal clearance areas. Backup alarms are required when equipment is backing up.	3/4/L
	Falls	The number of personnel on the ground in the vicinity of excavation activities shall be limited to those necessary for the job. Workers shall maintain eye contact with equipment operators. Select and implement the appropriate excavation perimeter protection as specified in US Army Corps of Engineers Safety and Health Requirements Manual EM 385-1-1, Section 25 B and Appendix Q). All excavations will be backfilled at the end of the workday if possible; otherwise, suitable barriers must be used to prevent unauthorized entry. Any excavation four feet and deeper will be provided with ladders, ramps or other means of egress in such a way as to require no more than 25 feet of lateral travel. They will also be used for ingress.	3/3/M
	Caught –In (excavation collapse)	Obtain Excavation/Trenching Permit as required by client, State, or municipality prior to any excavation activities. NO ENTRY is permitted into excavations/trenches without approval from the Competent Person. Authorization for entry shall only occur when a proper protective system is in place If a person must enter an excavation, protective systems such as trench boxes, shoring, sloping, or benching, will be effected in excavations greater than five feet in depth, or if deemed necessary by a Competent Person. The designated Competent Person shall be present during all excavation activities. Excavations are not anticipated to exceed 5 ft in depth. The Competent Person will perform daily excavation inspections and document such on the Daily Excavation Inspection Checklist. The Competent Person will perform a soils analysis and document such on the Soils Analysis Checklist. Excavated spoils will be staged a minimum of two feet back from the edge of the excavation. Personnel will keep back a minimum of two feet from the edge of all excavations/trenches – the area will be constantly observed for cracks, fissures, or subsidence, and the minimum approach distance increased accordingly.	3/3/M
	Physical Hazard: Collapse	Do not enter excavation unless all hazards have been evaluated and a safe entry plan is in place. If it is necessary to enter excavation that is more than 5 feet, proper sloping is to be utilized.	2/4/M
	Physical Hazard: Vibrations (Potential Cause of Collapse)	Locate the vibratory equipment as far away from the excavation as possible. Divert traffic away from the excavation	2/4/M
	Physical Hazard: Water (Potential Cause of Collapse)	Construct diversion ditches and/or dikes if necessary to prevent water from accumulating in an excavation or trench. Pumps should be used to keep rain and/or ground water from collecting at the bottom of an excavation or trench.	2/4/M
	Physical Hazard: Weight (Potential Cause of Collapse)	Spoils piles shall be stored at least two (2) feet or more from the edge of the excavation or trench.	2/4/M
	Physical Hazard: Noise	Wear hearing protection when an excavator is being used and when working near the excavator.	3/3/M
	Physical Hazard: Falls	Make sure to have good, solid footing. Make sure that walking/working surfaces are as clean and dry as possible.	3/3/M

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
Target Anomalies *(continued)*	Physical Hazard: Equipment Energization	Lockout and tagout is required if accidental energizing of the excavator could cause injury.	3/3/M
	Chemical Hazards	Review material safety data sheets. Follow manufacturer’s instruction for use, handling and storage. Use recommended protective equipment. Label all containers.	3/3/M 3/3/M

REQUIRED EQUIPMENT, INSPECTION AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Level D PPE within the exclusion zone (steel/composite toed boots, work pants, blaze orange/yellow clothing and/or reflective safety vests, and work gloves as appropriate) • Magnetometer • Support vehicle • Hand tools (shovel, etc.) • Mini Excavator (if needed) • Emergency equipment including fire extinguisher	• Inspect tools prior to each use • Inspect vehicle daily • Inspect excavator • Inspect emergency equipment/supplies	• Use and limitations of PPE • Valid driver's license • APP and AHA review • Hazardous waste sites require 40 hour HAZWOPER training, annual updates for any intrusive activities. • UXOSO, and all other supervisors, will require HAZWOPER Supervisor's Training and 30-hour OSHA Construction Safety Course.

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ACTIVITY HAZARD ANALYSIS – MUNITIONS AND EXPLOSIVES OF CONCERN AVOIDANCE

Activity/Activities:	**Munitions and Explosives of Concern Avoidance**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**				**M**	
Project Location:	Iona Island, New York		**Risk Assessment Code (RAC) Matrix**					
Project Number:	63029587			**Probability**				
Date Prepared:	12 October 2018		**Severity**	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
Prepared By:	M. McGuire		1 Catastrophic	E	E	H	H	M
			2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP		3 Marginal	H	M	M	L	L
			4 Negligible	M	L	L	L	L
Competent and/or Qualified Person(s):	UXOSO/UXOQCS, SUXOS or UXO Technician III							

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
Instrument-Aided Visual Inspection (MEC Avoidance)	Physical Hazard: Direct contact with MEC	Non-essential employees will obey any posted signage when entering a designated exclusion zone that UXO may be present. Smoking is prohibited. In areas that have not received surface clearance, UXO-qualified personnel will escort all non-UXO qualified staff, and non-UXO qualified staff will receive site-specific UXO awareness training. Do not use cell phones or radios within 50 feet of potential MEC, do not disturb the ground in potential MEC areas without consulting UXO-qualified staff, and do not move UXO or MEC. If suspect MEC is observed, evacuate area and notify UXOSO/UXOQCS. Ensure compliance with relevant SOPs and the approved Department of Defense Explosives Safety Board (DDESB) Explosives Site Plan (ESP).	1/5/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Level D PPE within the exclusion zone (steel/composite toed boots, blaze orange/yellow clothing and/or reflective safety vests,) • Magnetometer	• Inspect PPE prior to each use • Inspect magnetometer prior to each use	• Use and limitations of PPE • APP and General AHA review • UXO personnel: qualifications and training per DDESB TP-18 • Non-UXO qualified personnel: project-specific training conducted by UXOSO/UXOQCS to ensure that all onsite personnel fully understand the potential MEC/UXO onsite and MEC avoidance procedures

ACTIVITY HAZARD ANALYSIS – MUNITIONS AND EXPLOSIVES OF CONCERN DETECTOR-AIDED SURFACE/SUBSURFACE CLEARANCE

Activity/Activities:	**Munitions and Explosives of Concern Detector-Aided Surface/Subsurface Clearance**	**Phases:** MEC Clearance	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**			**M**	
Project Location:	Iona Island, New York		**Risk Assessment Code (RAC) Matrix**				
Project Number:	63029587			**Probability**			
Date Prepared:	12 October 2018	**Severity**	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
Prepared By:	M. McGuire	1 Catastrophic	E	E	H	H	M
		2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L
Competent and/or Qualified Person(s):	UXOSO/UXOQCS, UXOTIII or SUXOS						

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS: MONTHLY INSPECTION AND MAINTENANCE

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
Surface/Subsurface Clearance	Physical Hazard: Direct contact with MEC	Ensure Exclusion Zones are established to authorized minimum safe distances for non-project personnel and team separation distances for project personnel. Use the minimum number of personnel (not less than two) to conduct the clearance activities in order to minimize unnecessary exposure to MEC/UXO and ensure all personnel are under the direction of qualified UXO Technicians qualified as per DDESB TP-18. Do not conduct operations within site-specific minimum safe distances of other MEC intrusive operations and observe general MEC hazards and precautions. compliance with relevant standard operating procedures and the DDESB approved ESS.	1/5/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Level D PPE within the exclusion zone (steel/composite toed boots, safety glasses, hard hat [when overhead hazards are present], work pants, blaze orange/yellow clothing and/or reflective safety vests, work gloves) • Magnetometer	• Inspect PPE prior to each use • Inspect magnetometer	• Use and limitations of PPE • APP and General AHA review • UXO Personnel: Qualifications and training per DDESB TP-18

ACTIVITY HAZARD ANALYSIS – MUNITIONS POTENTIALLY PRESENTING IN AN EXPLOSIVE HAZARD INSPECTION

Activity/Activities:	**Munitions Potentially Presenting in an Explosive Hazard Inspection**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**			**M**	
Project Location:	Iona Island, New York		**Risk Assessment Code (RAC) Matrix**				
Project Number:	63029587			**Probability**			
Date Prepared:	12 October 2018		**Severity**	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom** / **5 Unlikely**
Prepared By:	M. McGuire		1 Catastrophic	E	E	H	H / M
			2 Critical	E	H	H	M / L
Reviewed By:	P. Garger, CIH, CSP		3 Marginal	H	M	M	L / L
			4 Negligible	M	L	L	L / L
Competent and/or Qualified Person(s):	SUXOS or UXOSO/UXOQCS						

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
MPPEH Inspection	Physical Hazard: Exploding ordnance	Specific requirements for MPPEH inspection are detailed in SOP #10 in Appendix C of the UFP-QAPP and the ESP. Assess items to determine if they can be safely moved. If the item cannot be safely moved, it will be blown in place. Inspected and certified MD, range related debris, and materials deemed as safe will be certified.	1/5/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Level D PPE in the exclusion zone (steel/composite toed boots, work pants, blaze orange/yellow clothing and/or reflective safety vests, and work gloves [if necessary]) • Magnetometer • Type II storage magazine • 55-gallon drums (materials deemed as safe, MD)	• Inspect PPE prior to each use • Inspect magnetometer • Inspect magazine, as necessary • Inspect any MD, range related debris, and materials deemed as safe, and associated containers, prior to shipment.	• Use and limitations of PPE • APP and General AHA review • UXO personnel: qualifications and training per DDESB TP-18

ACTIVITY HAZARD ANALYSIS – MUNITIONS AND EXPLOSIVES OF CONCERN DISPOSAL

Activity/Activities:	**Munitions and Explosives of Concern Disposal**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**			**M**	
Project Location:	Iona Island, New York		**Risk Assessment Code (RAC) Matrix**				
Project Number:	63029587			**Probability**			
Date Prepared:	12 October 2018		**Severity**	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
Prepared By:	M. McGuire		1 Catastrophic	E	E	H	H	M
			2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP		3 Marginal	H	M	M	L	L
			4 Negligible	M	L	L	L	L
Competent and/or Qualified Person(s):	SUXOS or UXOSO/UXOQCS							

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
MEC Disposal	Physical Hazard: Exploding ordnance	If the item cannot be safely moved, it will be blown in place. Items that are not fused and are acceptable to move will be marked for collection and storage in accordance with the ESP. Demolition operations must be conducted in accordance with the demolition and SOP #8 in Appendix C of the UFP-QAPP and the ESP.	1/5/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Level D PPE within the exclusion zone (steel/composite toed boots, work pants, blaze orange/yellow clothing and/or reflective safety vests, and work gloves [if appropriate]) • Magnetometer • On-call donor explosives • Type II storage magazine • 55-gallon drums	• Inspect PPE prior to each use • Inspect magazine • Inspect magnetometer	• Use and limitations of PPE • APP and General AHA review • UXO personnel: qualifications and training per DDESB TP-18

ACTIVITY HAZARD ANALYSIS – MUNITIONS DEBRIS INSPECTION AND DISPOSITION

Activity/Activities:	**Munitions and Explosives of Concern Inspection and Disposal**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**	**M**

Project Location:	Iona Island, New York	**Risk Assessment Code (RAC) Matrix**					
Project Number:	63029587		**Probability**				
Date Prepared:	12 October 2018	**Severity**	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
Prepared By:	M. McGuire	1 Catastrophic	E	E	H	H	M
		2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L
Competent and/or Qualified Person(s):	SUXOS or UXOSO/UXOQCS						

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
MD Inspection and Disposition	Physical Hazard: MEC	Specific requirements for MD disposal are detailed in the UFP QAPP and Appendix C SOP #10 of the UFP-QAPP. Assess items to determine if MD, if MD proceed. If MPPEH refer to MPPEH AHA or if MEC refer to MEC Disposal AHA.	2/4/M
MD Inspection and Disposition	Physical Hazard: Manual lifting	Follow proper lifting techniques. Use caution and do not twist the back when carrying a load. Do not attempt to lift bulky items or items assessed at over 50 pounds without assistance. Use mechanical devices to move loads when possible. Wear leather gloves for materials handling.	3/3/M
MD Inspection and Disposition	Physical Hazard: Hand tools	Inspect tools prior to use. Use tools for their intended use only. Do not use damaged tools. Push, don't pull, wrenches.	3/3/M

REQUIRED EQUIPMENT, INSPECTION AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • Magnetometer • Level D PPE within the exclusion zone (steel/composite toed boots, work pants, blaze orange/yellow clothing and/or Reflective safety vests, and work gloves [if appropriate]) Emergency equipment including fire extinguishers	• Inspect PPE prior to each use • Inspect vehicle daily • Use appropriate PPE • Inspect emergency equipment/supplies	• Use and limitations of PPE • Valid driver's license • APP and General AHA review • Hazardous waste sites require 40-hour HAZWOPER training; annual updates for any intrusive activities. • UXOSO, and all other supervisors, will require HAZWOPER Supervisor's Training.

ACTIVITY HAZARD ANALYSIS – SOIL SAMPLING

Activity/Activities:	**Soil Sampling**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**	**M**	
Project Location:	Iona Island, New York				
Project Number:	63029587				
Date Prepared:	12 October 2018				
Prepared By:	D. Wilt				
Reviewed By:	P. Garger, CIH, CSP				
Competent and/or Qualified Person(s):	Field Sampling Technician, Field Manager, or SSHO				

Risk Assessment Code (RAC) Matrix

	Probability				
Severity	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
1 Catastrophic	E	E	H	H	M
2 Critical	E	H	H	M	L
3 Marginal	H	M	M	L	L
4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability/RAC
Soil Sampling	Chemical Hazard: Dermal exposure to contaminants of concern	Modified Level D PPE when handling soil directly. Sampling tools will be dedicated; dispose of properly. Observe proper hygiene after sampling events and leaving exclusion zone. Wash hands after departing the work zone and conduct a dry decontamination (brushing off) when departing the exclusion zone. Note: exclusion zone boundaries may change based on screening/analytical results.	3/4/L

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Modified Level D PPE (Level D PPE plus nitrile gloves instead of work gloves when handling soil) • Sampling equipment (i.e., bags, jars, scoops)	• Inspect PPE prior to each use	• Use and limitations of PPE • APP and General AHA review

ACTIVITY HAZARD ANALYSIS – SURFACE WATER AND SEDIMENT SAMPLING

Activity/Activities:	**Surface Water and Sediment Sampling**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**	**M**	

Project Location:	Iona Island, New York
Project Number:	63029587
Date Prepared:	12 October 2018
Prepared By:	D. Wilt
Reviewed By:	P. Garger, CIH, CSP
Competent and/or Qualified Person(s):	SSHO

Risk Assessment Code (RAC) Matrix

	Probability				
Severity	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
1 Catastrophic	E	E	H	H	M
2 Critical	E	H	H	M	L
3 Marginal	H	M	M	L	L
4 Negligible	M	L	L	L	L

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
Surface Water and Sediment Sampling	Chemical Hazard: Dermal exposure to contaminants of concern	Modified Level D PPE when handling soil directly. Sampling tools will be dedicated; dispose of properly. Observe proper hygiene after sampling events and leaving exclusion zone. Wash hands after departing the work zone and conduct a dry decontamination (brushing off) when departing the exclusion zone. Note: exclusion zone boundaries may change based on screening/analytical results.	3/4/L
Wading with Chest Waders	Physical Hazard: Slips, trips and falls	Wear an adjustable wading belt or drawstring. The belt should have a quick release feature and be constructed of non-stretch material. The adjustable belt creates a watertight environment from foot to waist and will compartmentalize water that does enter the waders. Wear wading shoes or boots with soles that grip the type of bottom present. Rubber cleat soles are best for sand, fine gravel, soft silt or mud. Felt soles are best for irregular-sized rocks and algae-covered bedrock. Cleated or studded felt soles work well in swift water with a slight rock bottom.	3/3/M
	Physical Hazard: Slips, trips and falls (continued)	Carry a large walking stick or wading staff to provide balance while wading and to check for holes, drop-offs and rocks. Use a pair of metal cramp-ons or cleats that fit over the boot portion of waders to improve traction when wading across slippery rocks and other debris. If you fall, do not panic or try to remove the waders while still in the water. In calm water, wade or swim to shore. In fast moving water, ride the current; pull your feet in front of you and point your toes down current. When you reach calmer water, swim back to shore and empty the waders.	

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• PFDs • Waders • Gloves • Emergency equipment including fire extinguishers	• Inspect PPE prior to each use • Inspect boat daily • Use appropriate PPE • Inspect emergency equipment/supplies	• Use and limitations of PPE • Valid driver's license • APP and AHA review • Hazardous waste sites require 40-hour HAZWOPER training; annual updates for any intrusive activities. • UXOSO, and all other supervisors, will require HAZWOPER Supervisor's Training and 30-hour OSHA Construction Safety Course.

ACTIVITY HAZARD ANALYSIS – GROUNDWATER SAMPLING AND WELL DEVELOPMENT/MULTIPLE

Activity/Activities:	**Groundwater Sampling and Well Development**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**				**M**	
Project Location:	Iona Island, New York		**Risk Assessment Code (RAC) Matrix**					
Project Number:	63029587			**Probability**				
Date Prepared:	12 October 2018		**Severity**	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
Prepared By:	D. Wilt		1 Catastrophic	E	E	H	H	M
			2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP		3 Marginal	H	M	M	L	L
			4 Negligible	M	L	L	L	L
Competent and/or Qualified Person(s):	SSHO							

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS AND CONTROLS: GROUNDWATER MONITORING/SAMPLING/WELL DEVELOPMENT

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
Groundwater Depth Sounding and Well Purging	Chemical Hazards – Exposure to Organic Vapors from Well, Contaminants in Groundwater	Perform environmental monitoring as required in APP. Wear appropriate PPE (including nitrile gloves). Ensure personnel using have been trained on instrument use and site specific action levels/upgrades. Calibrate instrument(s) prior to use. Position personnel and equipment up wind of well.	2/4/M
Well Purging	Physical Hazard: Compressed Air/Air Compressor Incident	Properly secure all compressed air cylinders. Do not allow air/gas to flow freely from gas lines (potentially creating a whip out of the line). Wear PPE (hard hat) when working in proximity compressor/cylinders. Sampler must inspect compressors, well head gas fittings, and regulators prior to use, if faulty or inappropriate, do not proceed until repaired or replaced.	2/5/L
	Physical Hazard: Hearing loss.	Wear PPE (ear plugs) when working in proximity to air compressor.	3/4/L
	Chemical Hazard: Uncontrolled Release of Groundwater	Ensure tubing discharge pressure is controlled and contained in bucket or drum.	2/4/M
	Physical Hazard: Deployment of pump system	Be aware of pinch points, moving equipment	2/4/M
Equipment Decontamination	Chemical Hazard: Decontamination Material Handling and Contaminated Media Residue Exposure	Only those personnel with HAZWOPER training will be allowed to perform equipment decontamination. Material safety data sheets will be maintained on site for decontamination materials/fluids (e.g., detergents, isopropyl alcohol, and/or nitric acid, etc.). Proper PPE will be required, including nitrile gloves and safety glasses. If vigorous scrubbing is required (creating a splash hazard) a face shield and/or disposable coverall may be required at the discretion of the SSHO.	3/4/L

REQUIRED EQUIPMENT, INSPECTION AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • Monitoring equipment per Table 7-1 of SSHP • Level D PPE (steel/composite toed boots, safety glasses, hard hat when overhead hazards are present, work pants, blaze orange/yellow clothing and/or reflective safety vests) • Compressed air cylinder brackets • Power tools/hand tools • Air compressor and air lines • Emergency equipment including first aid kit, eye wash, fire extinguishers • Bennett sampling pump system	• Inspect PPE prior to each use • Inspect vehicle daily • Calibrate environmental monitoring equipment daily prior to use. • Use appropriate PPE • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher) • Inspect air compressor • Inspect gas cylinders	• Use and limitations of PPE • Valid driver's license • Use of monitoring equipment • Lifting • APP and AHA review • Handling of compressed gas cylinders • Use of air compressor • First aid/CPR—at least 2 people on site • Hazardous waste sites require 40 hour HAZWOPER training, annual updates for any intrusive activities. • SSHO will require HAZWOPER 40 hour Worker Training and 30-hour OSHA Construction Safety Course.

ACTIVITY HAZARD ANALYSIS – WELL INSTALLATION (DRILLING)

<table>
<tr><td>Activity/Activities:</td><td>Drilling (Well installation and direct push boring)</td><td>Phases:</td><td colspan="4">Overall Risk Assessment Code (RAC) (highest code from subtasks):</td><td><u>M</u></td><td></td></tr>
<tr><td>Project Location:</td><td colspan="2">Iona Island, New York</td><td colspan="6">Risk Assessment Code (RAC) Matrix</td></tr>
<tr><td>Project Number:</td><td colspan="2">63029587</td><td rowspan="2">Severity</td><td colspan="5">Probability</td></tr>
<tr><td>Date Prepared:</td><td colspan="2">12 October 2018</td><td>1
Frequent</td><td>2
Likely</td><td>3
Occasional</td><td>4
Seldom</td><td>5
Unlikely</td></tr>
<tr><td rowspan="2">Prepared By:</td><td colspan="2" rowspan="2">D. Wilt</td><td>1 Catastrophic</td><td>E</td><td>E</td><td>H</td><td>H</td><td>M</td></tr>
<tr><td>2 Critical</td><td>E</td><td>H</td><td>H</td><td>M</td><td>L</td></tr>
<tr><td rowspan="2">Reviewed By:</td><td colspan="2" rowspan="2">P. Garger, CIH, CSP</td><td>3 Marginal</td><td>H</td><td>M</td><td>M</td><td>L</td><td>L</td></tr>
<tr><td>4 Negligible</td><td>M</td><td>L</td><td>L</td><td>L</td><td>L</td></tr>
<tr><td>Competent and/or Qualified Person(s):</td><td colspan="2">SSHO</td><td colspan="6"></td></tr>
<tr><td colspan="7">Step 1: Review each "hazard" and determine RAC.</td><td colspan="2">RAC Chart</td></tr>
<tr><td colspan="7">Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.</td><td colspan="2">E = Extremely High Risk</td></tr>
<tr><td colspan="7">Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.</td><td colspan="2">H = High Risk</td></tr>
<tr><td colspan="7">Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.</td><td colspan="2">M = Moderate Risk</td></tr>
<tr><td colspan="7"></td><td colspan="2">L = Low Risk</td></tr>
</table>

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
Drilling	Physical Hazard: Injury from heavy equipment (drill rig and support vehicles).	Be aware of the location of equipment, where high visibility safety colors, establish eye contact with operator. Be aware of pinch points, swinging chains, augers, etc. PPE (hard hat) when working within 25 ft of rig.	2/4/M
	Physical Hazard: Faulty or Inappropriate Equipment	Qualified driller must inspect drill rig prior to use, if faulty or inappropriate, do not proceed until repaired or replaced.	2/4/M
	Physical Hazard: Faulty or Inappropriate Equipment	Inspect all hand tools prior to use, if faulty or inappropriate, do not proceed until repaired or replaced. Also follow manufacturers' recommendations regarding hearing and eye protection during operation of all hand tools. Evaluate each operation to determine if safety glasses are adequate for the work being performed and have face shields available as necessary.	2/4/M
	Physical Hazard: Moving Equipment/Rotary and Sonic Drilling	Clear area of obstructions and communicate with all workers involved that drilling is beginning. Do not exceed manufacturer's recommended speed, force, torque, etc. and penetrate the ground slowly with hands on the controls for at least the first foot of soil to minimize chance of auger kick-out. Stay clear of rotating auger and compressed air lines/equipment. Use long-handled shovel to clear away cuttings when auger has stopped. Secure loose clothing. Do not walk under suspended loads. When possible, remove overhead hazards promptly. Wear appropriate PPE including hard hat and steel-toed boots.	3/4/L
	Physical Hazard: Hearing loss.	Where appropriate PPE (plugs) when working in proximity to drill rig.	3/4/L
	Physical Hazard: Material Handling, Moving, Lifting	Observe proper lifting techniques. Use two or more persons for heavy bulk lifting. Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads. Obey sensible lifting limits (50-pound maximum per person manual lifting).	3/4/L
	Physical Hazard: Heat/Cold Stress	Take breaks as needed. Be aware of weather conditions and dress appropriately. Consume adequate food/beverages. If possible, adjust work schedule to avoid heat/cold stresses.	3/4/L
	Physical Hazard: Fire/Explosion	Ensure type ABC, fully charged fire extinguisher on-site. Perform utility clearance (One Call) to avoid possible gas lines. Interview property owner for location of possible private gas/utility lines. Stop work if hazardous conditions are identified.	1/5/M
	Physical Hazard: Electrical	Inspect work areas for spark sources, maintain safe distances, properly illuminate work areas, and provide barriers to prevent inadvertent contact.	1/5/M
	Physical Hazard: Electrical	Maintain minimum clearance distances for overhead energized electrical lines. Use a spotter to confirm clearance of overhead lines and other obstructions. Perform utility clearance (One Call) to avoid possible buried electrical lines. Interview property owners on location of possible private utilities.	1/5/M
Ambient Air Monitoring	Chemical/Physical Hazard: Elevated Organic Vapors and/or Combustible Gases	Approach and stay upwind of potential sources of vapors. Ensure personnel using have been trained on instrument use and site specific action levels/upgrades. Calibrate instrument prior to use.	3/3/M
Drill Rig/Direct Push Relocation /Set-Up	Physical Hazard: Rig Roll Over	Do not move rig with mast raised. Cross all hills and obstructions head on. Set riggers prior to raising mast	2/5/L
	Physical Hazard: Collision with property or personnel	Heavy equipment should be equipped with back-up alarm or use horn when backing. Use spotters when moving in/out of nominal clearance areas.	2/5/L

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
Equipment Decontamination	Chemical Hazard: Decontamination Material Handling and Contaminated Media Residue Exposure	Only those personnel with HAZWOPER training will be allowed to perform equipment decontamination. Material safety data sheets will be maintained onsite for decontamination materials/fluids (e.g., detergents, isopropyl alcohol, etc.). Proper PPE will be required, including nitrile gloves and safety glasses. If vigorous scrubbing is required (creating a splash hazard) a face shield and/or disposable coverall may be required at the discretion of the SSHO.	3/4/L

REQUIRED EQUIPMENT, INSPECTION AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Support vehicle • Monitoring equipment per Table 7-1 of the SSHP • Level D PPE (steel/composite toed boots, safety glasses, hard hat, work pants, blaze orange/yellow clothing and/or reflective safety vests, nitrile gloves, face shield and coveralls [decontamination of equipment, splash hazards]) • Heavy equipment • Power tools/hand tools • Emergency equipment including first aid kit, eye wash, fire extinguishers • Drill rig • Decontamination equipment • Respiratory protection if Level C PPE utilized (respirator and appropriate cartridges)	• Inspect PPE prior to each use • Inspect vehicle daily • Calibrate environmental monitoring equipment daily prior to use. • Underground and overhead hazards require clearance • Inspect emergency equipment/supplies daily (first aid kit, eye wash, fire extinguisher) • Inspect and document inspection of drill rig.	• Use and limitations of PPE • Valid driver's license • Use of monitoring equipment • Drill rig operator (and any other large equipment operator) will be trained in equipment use and maintenance (licensed) • Lifting • APP and AHA review • First aid/CPR—at least 2 people on site • Hazardous waste sites require 40 hour HAZWOPER training, annual updates for any intrusive activities. • SSHO will require HAZWOPER Training and 30-hour OSHA Construction Safety Course. • Fit Test for respirator

ACTIVITY HAZARD ANALYSIS – BOATING OPERATIONS

Activity/Activities:	**Boating Operations**	**Phases:** Refer to Table 1	**Overall Risk Assessment Code (RAC) (highest code from subtasks):**			**M**	
Project Location:	Iona Island, New York	**Risk Assessment Code (RAC) Matrix**					
Project Number:	63029587		**Probability**				
Date Prepared:	12 October 2018	**Severity**	**1 Frequent**	**2 Likely**	**3 Occasional**	**4 Seldom**	**5 Unlikely**
Prepared By:	D. Wilt	1 Catastrophic	E	E	H	H	M
		2 Critical	E	H	H	M	L
Reviewed By:	P. Garger, CIH, CSP	3 Marginal	H	M	M	L	L
		4 Negligible	M	L	L	L	L
Competent and/or Qualified Person(s):	Boat Captain						

Step 1: Review each "hazard" and determine RAC.	RAC Chart
Probability = The likelihood to cause an incident, near miss, or accident. Identified as frequent, likely, occasional, seldom, or unlikely.	E = Extremely High Risk
Severity = The outcome/degree if an incident, near miss, or accident did occur. Identified as catastrophic, critical, marginal, or negligible.	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each hazard on AHA. Select the highest RAC and note at the top of the form.	M = Moderate Risk
	L = Low Risk

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
General Health and Safety	General boat operation	Conduct a daily health and safety tailgate meeting to review potential hazards and necessary precautions. Use the buddy system—two people must be present at all times. Boat operator will inspect the boat prior to operation. The operator will ensure the number of PFDs is equal to or greater than the number of passengers onboard. No personnel will embark or disembark the vessel without the direction of the vessel operator. Vessel operator will ensure passengers are wearing PFDs while on deck. At the request of the operator, personnel will be seated. When traveling to and from work areas, passengers will remain seated until the boat is docked or in working data collection mode. Ensure three-point contact whenever possible. A Type IV throwable device will be readily available onboard.	3/3/M
	General boat operation	Swimming is prohibited, with the following exceptions: (1) certified divers performing their duties, (2) personnel adjusting DGM sensors, and (3) personnel entering water to prevent injury or loss of life.	2/4/L
		Each boat measuring less than 26 feet in length will carry one 1A-10 BC fire extinguisher; motored boats measuring greater than 26 feet will carry two 1A-10 BC fire extinguishers.	2/4/M
Boating Operations	Physical Hazard: Slips, trips and falls (including falls overboard)	Keep work area free of excess material and debris Make sure you have good solid footing and that walking/working surfaces are as clean and dry as possible. Inspect areas daily and record findings on daily inspection report. Wear appropriate PPE including non-slip rubber boots. Stay aware of footing and do not run.	3/3/M
Boating Operations	Physical Hazard: Cold stress	Wear cold weather clothing and provide shelter as needed based on site conditions. Conduct temperature monitoring when temperatures fall below 45˚F.	3/3/M
Boating Operations	Physical Hazard: Heat stress	Make drinking water available to all workers and encourage workers to drink small amounts of water frequently. Adjust work/rest regimens during hot weather.	3/3/M
Boating Operations	Physical Hazard: Extreme weather	Monitor radio for up-to-date severe weather forecasts. Discontinue work and disembark during thunderstorms, high winds and other severe weather events.	2/4/M

TASK BREAKDOWN, HAZARDS, AND CONTROLS

Work Task Steps	Hazards	Controls	Severity/ Probability /RAC
Boating Operations	Physical Hazard: Water hazards	Wear PFD/life jackets. Identify unsafe conditions, obstructions, or objects that could cause a slip, trip or fall. Carry a first aid kit, a cell phone, two-way radios, and extra food and water in case of emergency.	3/3/M
Boating Operations	Biological Hazards: Insects	Use repellents and proper clothing for protection against insects including ticks and mosquitoes.	4/3/L
Boating Operations	Physical Hazard: Manual lifting	Follow proper lifting techniques. Use caution and do not twist the back when carrying a load. Do not attempt to lift bulky items or items assessed at over 50 pounds without assistance. Use mechanical devices to move loads when possible. Wear leather gloves for materials handling.	3/3/M
Mobilization/Demobilization	Physical Hazard: Driving	Drivers to, from, or at the site must possess a valid state driver's license. Drivers shall observe all traffic laws and practice safe driving skills while traveling to, from, and onsite. Drivers should not use cell phones while driving. Follow posted speed limits and obey traffic/roadway signs. Follow the "Rules of the Road." Review/make yourself familiar with maps and driving directions before beginning the drive to the site. Pull over to a safe place if you experience any signs of fatigue or drowsiness. In inclement weather, drive as road conditions allow and at least 5-10 miles per hour below the speed limit. Check the mirrors on a regular basis to be aware of vehicles around you.	3/3/M
Mobilization/Demobilization	Physical Hazard: Manual lifting	Follow proper lifting techniques. Use caution and do not twist the back when carrying a load. Do not attempt to lift bulky items or items assessed at over 50 pounds without assistance. Use mechanical devices to move loads when possible. Wear leather gloves for materials handling.	3/3/M
Wading with Chest Waders	Physical Hazard: Slips, trips and falls	Wear an adjustable wading belt or drawstring. The belt should have a quick release feature and be constructed of non-stretch material. The adjustable belt creates a watertight environment from foot to waist and will compartmentalize water that does enter the waders. Wear wading shoes or boots with soles that grip the type of bottom present. Rubber cleat soles are best for sand, fine gravel, soft silt or mud. Felt soles are best for irregular-sized rocks and algae-covered bedrock. Cleated or studded felt soles work well in swift water with a slight rock bottom. Carry a large walking stick or wading staff to provide balance while wading and to check for holes, drop-offs and rocks. Use a pair of metal cramp-ons or cleats that fit over the boot portion of waders to improve traction when wading across slippery rocks and other debris. If you fall, do not panic or try to remove the waders while still in the water. In calm water, wade or swim to shore. In fast moving water, ride the current; pull your feet in front of you and point your toes down current. When you reach calmer water, swim back to shore and empty the waders. When tethered, support personnel will extract you from the water.	3/3/M

REQUIRED EQUIPMENT, INSPECTION, AND TRAINING

Equipment	Inspection Requirements	Training Requirements (including Competent Person and Qualified Personnel, if applicable)
• Boat • PFDs • Waders • Gloves • Emergency equipment including fire extinguisher	• Inspect PPE prior to each use • Inspect boat daily • Use appropriate PPE • Inspect emergency equipment/supplies	• Use and limitations of PPE • Valid driver's license • APP and AHA review • Boat operator will be trained in equipment use and maintenance • USCG training and certificates (for boat operators) • Hazardous waste sites require 40-hour HAZWOPER training; annual updates for any intrusive activities. • UXOSO, and all other supervisors, will require HAZWOPER Supervisor's Training and 30-hour OSHA Construction Safety Course.

Appendix B

Occupational Safety and Health Administration
300 Form

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OSHA's Form 300 (Rev. 01/2004)

Log of Work-Related Injuries and Illnesses

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for

Year 2017

U.S. Department of Labor
Occupational Safety and Health Administration

You must record information about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid. You must also record significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional. You must also record work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR 1904.8 through 1904.12. Feel free to use two lines for a single case if you need to. You must complete an injury and illness incident report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.

Form approved OMB no. 1218-0176

Establishment name EA Engineering, Science, and Technology, Inc., PBC

City Hunt Valley State Maryland

Identify the person				Describe the case		Classify the case											
						CHECK ONLY ONE box for each case based on the most serious outcome for that case:				Enter the number of days the injured or ill worker was:		Check the "injury" column or choose one type of illness:					
								Remained at work				(M)					
(A) Case No.	(B) Employee's Name	(C) Job Title (e.g., Welder)	(D) Date of injury or onset of illness (mo./day)	(E) Where the event occurred (e.g. Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g. Second degree burns on right forearm from acetylene torch)	Death (G)	Days away from work (H)	Job transfer or (I)	Other record- able (J)	Away From Work (days) (K)	On job transfer or restrictio n (days) (L)	Injury (1)	Skin Disorder (2)	Respiratory Condition (3)	Poisoning (4)	Hearing Loss (5)	All other illnes (6)
1		geologist 1	5/3	Kirtland AFB project , parking lot north of Bullhead park	broken nose from collision with service dog			x			7	x					
2		scientist 1	6/30	Howard County Recs and Parks, Columbia MD	bee sting with allergic reaction and prescription meds				x			x					
3		technician 2	7/10	on the Missouri River near Brownville, NE	employee wiped eye with formalin solution on hands				x			x					
4		project mgr	8/12	FCC, Louisiana - Camp Clairborne	laceration to right ring finger requiring stitches				x			x					
5		technician 3	8/14	Sprague Road Project, Odessa , Texas	sulfuric acid burn to back from faulty pipe connection				x			x					
6		uxo tech	8/24	Joint Base Cape Cod , old K range	pulled shoulder muscle going through thick vegetation				x			x					
7		geologist	8/14	Waugh Chapel Town Center, Maryland	tick bite with bullseye rash - rash not noted until 8/28				x			x					
					Page totals	*0*	*0*	*1*	*6*	*0*	*7*	*7*	*0*	*0*	*0*	*0*	*0*
												Injury (1)	Skin Disorder (2)	Respiratory Condition (3)	Poisoning (4)	Hearing Loss (5)	All other illnesses (6)

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2017

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the log. If you had no cases write "0."

Employees former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR 1904.35, in OSHA's Recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	1	6
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	7
(K)	(L)

Injury and Illness Types

Total number of...
(M)

(1) Injury	7	(4) Poisoning	0
(2) Skin Disorder	0	(5) Hearing Loss	0
(3) Respiratory Condition	0	(6) All Other Illnesses	0

Post this Summary page from February 1 to April 30 of the year following the year covered by the form

Public reporting burden for this collection of information is estimated to average 50 minutes per response, including time to review the instruction, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistics, Room N-3644, 200 Constitution Ave, NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name EA Engineering, Science, and Technology Inc., PBC

Street 225 Schilling Circle

City Hunt Valley State Maryland Zip 21031

Industry description (e.g., Manufacture of motor truck trailers)
Environmental Remediation and Consulting

Standard Industrial Classification (SIC), if known (e.g., SIC 3715)

OR North American Industrial Classification (NAICS), if known (e.g., 336212)
5 6 2 9 1 0

Employment information

Annual average number of employees 514

Total hours worked by all employees last year 1,072,638

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

Company executive	President and CEO Title
410 584-7000 Phone	8-Jan-18 Date

Appendix C

Resumes and Certifications of Key Personnel

(Any certification that is set to expire prior to, or during, field activities will be renewed before said expiration date. Onsite files will be amended with current certifications as appropriate.)

Peter Garger, CIH, CSP

Director of Safety and Health/Safety and Health Manager

Mr. Garger has more than 34 years of experience managing and conducting industrial hygiene services including hazardous materials surveys and assessments, health and safety inspections and oversight on both environmental remediation projects as well as industrial operations.

During his career, he has performed sampling and evaluation of numerous occupational environments for airborne contaminants and made recommendations for their control. In addition, Mr. Garger has been involved in Occupational Safety and Health Program development in both the private sector and in the federal government arena. He has extensive experience in technical report preparation, regulatory interpretation and technical briefing to all levels within an organization.

Qualifications

Education

ScM; Johns Hopkins University School of Hygiene and Public Health; 1981
B.A.; Hofstra University; Chemistry; 1978

Registrations/Certifications

Certified Safety Professional—2008 (No. 20560)
Certified Industrial Hygienist—ABIH No. 3118; 1985

Specialized Training

OSHA Construction Outreach Trainer for 10- and 30-Hour Construction Safety Training
OSHA Hazardous Waste Supervisor, 1989 – Present
Investigating and Mitigating Microbial Contamination in Buildings; 1995
U.S. Army Corps of Engineers – Unexploded Ordnance Training; 1994
Department of Transportation Hazmat Training; 1994
National Institute for Occupational Safety and Health 582 Microscopic Evaluation of Fibers; 1993
Asbestos Building Inspector/Management Planner; 1993
X-Ray Fluorescence Testing Operator – Lead Paint Analysis; 1992

Professional Affiliations/Appointments

American Board of Industrial Hygiene
American Industrial Hygiene Association
Board of Certified Safety Professionals

Experience

Years with EA: 8 Total Years: 34

Professional Experience

Occupational Safety and Health Program Development—Held the position of Corporate Health and Safety Director for several private firms over the last 17 years. In addition, held the position of Chief of the Industrial Hygiene and Chemistry Section at the U.S. Army Corps of Engineers–Baltimore District. These positions involved the coordination of training activities, development and maintenance of the medical surveillance programs including the drug testing programs, providing overall coordination of all safety and health related project activities, as well as providing health and safety auditing of field activities during project execution. These field activities typically included soil sampling, groundwater monitoring and well installation, contaminated soil remediation and removal and hazardous waste disposal.

Industrial Hygiene/Asbestos/Lead Evaluation**—**Project experience has involved providing comprehensive industrial hygiene services to a 350-man chromium chemicals manufacturing plant that was followed by assignment as a regional Industrial Hygiene Manager for a complete business unit of a major chemical manufacturer. Held positions within the federal government and the private sector that involved the development and implementation of comprehensive testing programs for both asbestos-containing materials and lead-based paint. Was involved in the development of operations and maintenance plans for these materials as well as in the design of asbestos and lead abatement projects

Munitions and Explosives of Concern/Chemical Warfare Materials—Project experience has included providing safety and health services for the evaluation, decontamination, and demolition of several moth-balled Army Ammunition Plants. The contaminants of concern included trinitrotoluene, cyclotrimethylenetrinitraniine, nitrocellulose, and nitroglycerin as well as ordnance-related items and scrap associated with these plants. Was involved in the preparation and execution of an Open Burn Permit in the State of Illinois to allow for the controlled thermal degradation of numerous process buildings at an old Army site. Project experience also included work for the U.S. Army Corps of Engineers at the Chemical Agent cleanup project in the Spring Valley section of Washington, D.C.

Selected Publications and Presentations

Garger, P. 2007. Construction Site Safety Issues. Presented at the Design Law for Maryland Architects and Engineers, Columbia, Maryland. 27 September.

EA Project Experience

U.S. Environmental Protection Agency 316(b) Sampling at Kewaunee Nuclear Power Plant, Wisconsin—Performed safety and health audit of field work being conducted.
Project Date: 2006

U.S. Environmental Protection Agency Region 6 Sol Lynn Superfund Site, Houston, Texas—Performed safety and health audit of groundwater monitoring being performed and an additional safety audit during injection of emulsified vegetable oil solution for remediation of groundwater contaminants.
Project Date: 2007-2010

U.S. Environmental Protection Agency Region 6 Sprague Road Superfund Site, Odessa, Texas—Performed safety and health review along with assisting in a process review at the project site.
Project Date: 2007

U.S. Environmental Protection Agency Region 6 Garland Road Superfund Site, Longview, Texas—Performed two safety and health reviews during the duration of this contaminated soil excavation and landfill capping project.
Project Date: 2009-2010

U.S. Environmental Protection Agency Region 6 Texarkana Wood Preserving, Texarkana, Texas—Assisted in the development of the project health and safety plan including air monitoring requirements.
Project Date: 2010

Boomsnub/Airco Superfund Site, Vancouver, Washington; BOC Gases—Reviewed project Health and Safety Plan and performed safety and health audit during quarterly groundwater sampling event.
Project Date: 2007

Lake Ontario Ordnance Works, Buffalo, New York; U.S. Army Corps of Engineers–Baltimore District—Performed site safety and health audit during excavation of sewer lines for sampling.
Project Date: 2006

Fort Drum Gasoline Alley, Watertown, New York; U.S. Army Corps of Engineers–Baltimore District—Performed site safety and health audit at various project locations at Fort Drum.
Project Date: 2006

Fort Drum Surfactant Enhanced Aquifer Remediation, Watertown, New York; U.S. Army Corps of Engineers–Baltimore District—Performed site safety and health audit during pilot test phase of this project.
Project Date: 2010

U.S. Environmental Protection Agency Region 6; Many Diversified Industries Superfund Site, Houston, Texas—Performed site safety and health audit at this project location which involved lead testing of residential community adjacent to site.
Project Date: 2008

U.S. Army Corps of Engineers–Omaha District, Atlas (Former Lincoln Air Force Base) Superfund Site, York, Nebraska—Performed site safety and health audit at this project location that involved several pumping stations at the site.
Project Date: 2010

***U.S. Environmental Protection Agency Region 6; State Road 114 Superfund Site, Levelland, Texas*—**Performed two site safety and health audits at this project location which involved installation of a soil vapor extraction system and installation of residential water wells.
Project Date: 2009

***U.S. Environmental Protection Agency Region 6; Iron King Mine Superfund Site, Prescott, Arizona*—**Performed site safety and health audit at this project location that involved installation of a groundwater monitoring wells at this arsenic and lead contaminated site.
Project Date: 2008

***U.S. Environmental Protection Agency Region 6; Bandera Road Superfund Site, San Antonio, Texas*—**Performed site safety and health audit at this project location which involved installation of a groundwater monitoring wells and under slab evaluation for vapor intrusion of volatile organic compounds.
Project Date: 2008

***U.S. Environmental Protection Agency Region 3; Atlantic Wood Industries Superfund Site, Norfolk, Virginia*—**Provided senior technical review of the site-specific safety and health plan for this project that involved both onshore and offshore sampling of contaminants. In addition, performed a health and safety audit during Elm Avenue storm drain relocation work on this project site.
Project Date: 2008 – Present

***U.S. Environmental Protection Agency Region 3; Greenwood Chemical Superfund Site, Greenwood, Virginia*—**Performed senior technical review of site safety and health plan for this project which involved operations and maintenance of an onsite treatment system.
Project Date: 2008

***New York State Department of Environmental Conservation, Empire Electric Site, Brooklyn, New York*—**Performed site safety and health audit for this project that involved sampling and characterization of a polychlorinated biphenyl contaminated site.
Project Date: 2008

***Harper-Thiel Electroplating Site, Newark, Delaware; Delaware Department of Natural Resources and Environmental Control*—**Performed site safety and health audit for this project which involved decontamination and demolition of an old electroplating facility contaminated with various heavy metals including hexavalent chromium.
Project Date: 2008

***Cabrera Services, Aberdeen Pulse Radiation Facility*—**Served as one of the site safety and health officers for this project which involved decontamination and demolition of an old army pulse radiation test facility.
Project Date: 2009

***National Oceanic and Atmospheric Administration, National Marine Fisheries Service, St. Paul Island, Alaska*—**Performed site safety and health review of catwalks and related structures at the Northern Fur Seal Rookery.
Project Date: 2009

***National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland*—**Performed Operational Risk Management review of fish inspection services performed by National Oceanic and Atmospheric Administration personnel.
Project Date: 2010

***Aberdeen Proving Ground, Known Distance Range Site 30b, A; Aberdeen Proving Ground, Maryland*—**Conducted site safety and health audit for this project that involved clearing and grubbing and excavation of small arms waste from a former earthen backstop.
Project Date: 2008

New Mexico Formerly Used Defense Sites Health and Safety Plan—Assisted Bristol Environmental with the development of the Site Safety and Health Plan for the evaluation of numerous Formerly Used Defense Sites in New Mexico.
Project Date: 2010

Layon Landfill Groundwater Monitoring Sites Health and Safety Plan—Assisted Gershman, Brickner and Bratton in the development of the requirements for the Site Safety and Health Plan for the construction of the Layon Landfill, Inarajan, Guam.
Project Date: 2010

Washington Suburban Sanitary Commission, Montgomery County, Maryland—Performed site safety and health audit at this project location that involved installation of a 4-mile underground water tunnel to supply Washington, D.C.
Project Date: 2011

Former Monaca Air Force Base Petroleum, Oil, and Lubricant Facility, Monaca, Pennsylvania—Assisted in the development and implementation of the Accident Prevention Plan/Site Safety and Health Plan for this project which involved confined space entry into larger underground storage tanks.
Project Date: 2011

Hill Air Force Base Basewide Operations and Maintenance, Ogden, Utah; Air Force Center for Engineering and the Environment—Performed site safety and health audit at this project location which was performed completely by subcontract American Environmental and Engineering Consultants, LLC. Visited a majority of the working project sites during the review.
Project Date: 2011

Puchack Well Field Superfund Site, Pennsauken, New Jersey—Assisted in the development of the Accident Prevention Plan/Site Safety and Health Plan for this project involving *in situ* chemical fixation of hexavalent chromium contaminated groundwater. Also performed several site safety and health audits during the course of the project.
Project Date: 2012

Former Monaca Air Force Base Petroleum, Oil, and Lubricant Facility, Monaca, Pennsylvania—Assisted in the development and implementation of the Accident Prevention Plan/Site Safety and Health Plan for this project which involved the removal and disposal of large underground storage tank and asbestos covered piping at this site.
Project Date: 2012

U.S. Army Corps of Engineers–Omaha District, Offutt Air Force Base Military Munitions Response Program Site, Nebraska—Performed site safety and health audit at this project location that involved the location and excavation of potential unexploded ordnance items.
Project Date: 2012

Air Force Center for Engineering and the Environment; Eielson Air Force Base Multi Sites, Eielson Air Force Base, Alaska—Performed site safety and health audit at this project location that involved low flow sampling of monitoring wells adjacent to an active runway at the base..
Project Date: 2012

Prince Georges County Government; Brown Station Road Landfill, Prince Georges County, Maryland—
Performed site safety and health audit at this project location which involved confined space entry adjacent to an active sanitary landfill to install new valves in the leachate collection system.
Project Date: 2012

U.S. Environmental Protection Agency Region 6; Donna Canal Remedial Investigation/Feasibility Study, Hidalgo, Texas—Performed site safety and health audit at this project location that involved sampling of sediments in the Donna Canal and the Rio Grande River.
Project Date: 2012

Starr Indemnity and Liability Insurance Company, Various Site Safety Audits—Performed onsite safety audits of Creamer Environmental project sites in New Jersey under this blanket work order EA has with Starr.
Project Date: 2012 and 2013

SECO Audits 2013-2014; National Oceanic and Atmospheric Administration—Performed onsite safety audits of Radar Operations Center, Norman, Oklahoma.
Project Date: 2013

Hill Air Force Base Performance-Based Remediation Contract; Air Force Civil Engineer Center—Involved in the preparation of health and safety plans for the first several task orders under this contract at Hill Air Force Base, Utah.
Project Date: 2013

U.S. Army Corps of Engineers–Omaha District, Offutt Air Force Base, Omaha, Nebraska—Performed site safety and health audit at this project location that involved soil excavation and munitions evaluation
Project Date: 2012

Air Force Civil Engineering Center, Massachusetts Military Reservation—Performed site safety and health audit of EA operations and maintenance project at the site.
Project Date: 2012

U.S. Army Corps of Engineers–Omaha District, Arnold Air Force Base, Tullahoma, Tennessee—Performed site safety and health audit at this project location that involved soil excavation and munitions evaluation.
Project Date: 2013

U.S. Army Corps of Engineers–Omaha District, Langley Air Force Base, Langley, Virginia—Performed site safety and health audit at this project location that involved soil excavation and munitions evaluation.
Project Date: 2013

U.S. Army Corps of Engineers–Omaha District, Andrews Air Force Base, Maryland—Performed several site safety and health audits at this project location that involved soil excavation and munitions evaluation.
Project Date: 2014

Delaware Department of Natural Resources and Environmental Control Hamilton Park Site, New Castle, Delaware—Performed site safety and health audit at this project location that involved soil excavation in a residential community setting.
Project Date: 2014

Other Project Experience

Joliet Army Ammunition Plant, Joliet, Illinois; Volunteer Army Ammunition Plant, Chattanooga, Tennessee; Twin Cities Army Ammunition Plant, Arden Hills, Minnesota; Badger Army Ammunition Plant, Baraboo, Wisconsin; Project Safety and Health Officer; 1999-2003—Provided site safety and health oversight during the evaluation, decontamination, and demolition of numerous explosives manufacturing buildings on the sites listed above. This work often involved both pre-demolition asbestos and lead abatement as well as removal of other hazardous materials such as mercury and polychlorinated biphenyls prior to building demolition. In several instances, open burning was the technique used for decontamination of the explosives residue.

Time-Critical Removal Action, Former Backstop Area Formerly Used Defense Site; Harley-Davidson Plant, York, Pennsylvania; 2004—Served as the project manager on this time-critical removal action involving the removal of potential unexploded ordnance from two former backstop areas located on the Harley-Davidson property. Project involved removal and sifting of the sand in two former backstop areas and inspection of the sifting operation by unexploded ordnance trained personnel. Remote opening by drilling was used on the first several items removed from the sand to determine if they contained any explosive materials or were only practice rounds containing sand.

In addition to the unexploded ordnance inspection, the residual sand materials was tested for lead content and segregated into separate piles according to the analytical results to reduce the volume of hazardous waste to be shipped offsite.

Fort Meade Landfill Gas Extraction System, Fort Meade, Maryland; 2003-2004—Provided site health and safety oversight during the installation and startup of a landfill gas extraction/flare system at the Fort Meade Sanitary Landfill. Work involved extensive trenching work as well as continuous monitoring for explosive gases. Coordinated training in safe trenching and shoring techniques for site employees.

Marsh Run Dual Vapor Extraction System, New Cumberland, Pennsylvania; 2003-2004—Provided site health and safety oversight during the installation of extraction wells and air stripping units at this former landfill site. Coordinated with U.S. Army Corps of Engineers representatives during both project planning and execution stages.

Fort Meade Lake Allen Spillway Demolition, Fort Meade, Maryland; 2003—This project involved the demolition and removal of the spillway at the Lake Allen area of Fort Meade. Health and safety challenges during this project included not only routine construction/demolition hazards and working around water, but also included the possible presence of unexploded ordnance in the footprint of the project. Coordinated all aspects of project health and safety and worked with the unexploded ordnance subcontractor to coordinate all excavation work. Project was conducted on a Sunday to Wednesday schedule to accommodate the needs of the nearby firing range.

District of Columbia Public Schools, Washington, D.C.; 1997-1999—Project experience included initial coordination meetings between the DC Public Schools and the U.S. Army Corps of Engineers–Baltimore District in providing comprehensive safety and health oversight for the asbestos and lead abatement programs. Involved with numerous government entities as well as subcontractors in providing these services over a several year period.

Spring Valley, Chemical Warfare Materials Cleanup Program, Washington, D.C.; 1995-1998—This project involved the evaluation and removal of chemical warfare materials form the Spring Valley section of Washington, D.C. Project experience included work for a private environmental contractor during the initial phases of the project that included health and safety oversight during the waste removal effort. Subsequent project experience while at the U.S. Army Corps of Engineers–Baltimore District included health and safety program development and execution for follow-on phases of the Spring Valley Project.

Housing Authority of Baltimore City, Baltimore, Maryland; 1992-1994—Project experience included managing the comprehensive industrial hygiene services provided to support large asbestos and lead abatement contract with the Housing Authority of Baltimore City. Responsible for the preparation of contract specifications for numerous asbestos and lead abatement projects during the course of this contract. This position also involved the coordination of the laboratory's participation in the National Institute for Occupational Safety and Health Proficiency Analytical Testing Program.

Allied Signal Chrome Chemicals Remediation Project, Baltimore, Maryland; 1989-1992—Project experience included providing all safety, health, and environmental control at the job site. Coordinated all aspects of onsite training for demolition employees and was also responsible for conducting pilot testing for decontamination of chrome and asbestos-contaminated building materials.

Employment History

Employer—EA Engineering, Science, and Technology, Inc.
Dates of Employment—2006 – Present
Title—Corporate Health and Safety Director

Employer—Plexus Scientific/Explosive Technologies and Services Corporation
Dates of Employment—1999–2005
Title—Corporate Health and Safety Director

Employer—U.S. Army Corps of Engineers–Baltimore District, Hazardous, Toxic, and Radioactive Waste Branch
Dates of Employment—1996–1999

Title—Chief, Industrial Hygiene and Chemistry Section

Employer—Dow Environmental
Dates of Employment—1994–1996
Title—Eastern Region Health and Safety Manager

Employer—Martel Labs
Dates of Employment—1992–1994
Title—Industrial Hygiene Services Manager

Employer—International Dismantling and Machinery Corporation
Dates of Employment—1989–1992
Title—Site Health and Safety Manager, Chromium Chemicals Remediation Project

Employer—U.S. Army, Aberdeen Proving Ground
Dates of Employment—1987–1989
Title—Industrial Hygiene Team Leader, Edgewood Area, Aberdeen Proving Ground

Employer—Allied Chemical Corporation
Dates of Employment—1984–1987
Title—Eastern Region Industrial Hygiene Manager

Employer—Allied Chemical Corporation
Dates of Employment—1980–1984
Title—Plant Industrial Hygienist, Baltimore Chrome Works

List of Technical Skills and Specializations

- Certified Industrial Hygienist
- Certified OSHA 30-Hour Construction Safety Trainer
- Certified Safety Professional

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Denise E. Wilt, P.G.

Plan Preparer

Ms. Wilt is a geologist with EA's Site Characterization Group with over 17 years of experience working for federal and state government agencies as well as private sector clients. She is a registered Professional Geologist in the Commonwealth of Pennsylvania. Ms. Wilt's technical expertise includes site assessments; site investigations; groundwater, soil, and air sampling; geophysical surveys; laboratory data interpretation; technical writing; soil and groundwater remedial system designs; feasibility studies; and Phase I environmental site assessments. She has a working knowledge of federal, state, and local government environmental regulations.

Qualifications

Education

M.A.; Binghamton University; Geology; Binghamton, New York; 1999
B.A.; Bucknell University; Geology; Lewisburg, Pennsylvania; 1994

Registrations/Certifications

Professional Geologist—PA (No. PG004575); 2005

Specialized Training

OSHA 40-Hour Hazardous Waste Site Worker Safety Training; 1999
OSHA 8-Hour Hazardous Waste Site Worker Refresher; Current
OSHA 30-Hour Construction Safety Training; 2009
CPR and First Aid Training; Current
OSHA 8-Hour Hazardous Waste Operations Supervisor Training; 2008
X-Ray Fluorescence Spectrum Analyzer Training
EA Project Manager Training; 2009
Construction Quality Management for Contractors; U.S. Army Corps of Engineers Learning Center; 2011
Accident Prevention Plans for Contractors, Maryland AGC, 2015

Professional Affiliations/Appointments

Pennsylvania Council of Professional Geologists
Society of Women Environmental Professionals

Experience

Years with EA: 14.5 Total Years: 17

Professional Experience

Health and Safety—Aided in the preparation of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1. Acted as an U.S. Army Corps of Engineers-approved Site Health and Safety Officer on several projects and is also responsible for submitting field exposure hour reporting to the U.S. Army Corps of Engineers.

Relevant Project Experience

Former Frankford Arsenal, Philadelphia, Pennsylvania; U.S. Army Corps of Engineers–Baltimore District; Task Manger/Project Geologist—Prepared and presented project status update to stakeholders throughout all stages of the investigation, file review of existing documents, and preparation of conceptual site model and planning documents including the Accident Prevention Plan (APP). Site characterization and remedial investigation activities included the installation of over 130 soil borings, collection of over 300 surface and subsurface soil samples, installation and sampling of 27 temporary wells, and installation and sampling of 11 monitoring wells in a complex urban environment.
Project Date: January 2011 – January 2017

Performance-Based Remediation, Kirtland Air Force Base, New Mexico; U.S. Army Corps of Engineers, Albuquerque District, Geologist—Preparation and revision of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1 for a project that requires implementation of a Resource Conservation and Recovery Act Interim Measure for expanding the groundwater treatment system at Solid Waste Management Unit ST-106/SS-111 at Kirtland Air Force Base, New Mexico. Evaluation of project tasks to determine applicable plans, activity hazard analyses, monitoring requirements, and personal protective equipment needs. Revision of the APP as needed based on additionally awarded tasks, currently on Revision 4. Performance-Based Remediation, Kirtland Air Force Base, New Mexico; U.S. Army Corps of Engineers–Albuquerque District, Project Manager—Project requires implementation of a Resource Conservation and Recovery Act Interim Measure for expanding the groundwater treatment system at Solid Waste Management Unit ST-106/SS-111 at Kirtland Air Force Base, New Mexico for containment of the dissolved-phase ethylene dibromide off-base plume associated with the Bulk Fuel Facility and historical releases of JP-4, JP-8, and Avgas. The project included installation of a large diameter groundwater extraction well into the regional aquifer that occurs at a depth of approximately 460 ft below ground surface. Additional nested groundwater monitoring wells were installed at multiple depths for collection of data supporting

the vertical profile of the dissolved-phase ethylene dibromide plume. Dual-walled conveyance lines will be installed from the off-base extraction well to the groundwater treatment system building on Kirtland Air Force Base. The groundwater treatment system expansion included the construction of a second 400 gallons per minute granular activated carbon filter treatment system and the design of sand filters for both treatment trains with total capacity of 800 gpm. EA is responsible for the operation and maintenance of the groundwater treatment system, maintenance and operation of the groundwater monitoring network comprised of 140 deep, regional aquifer wells. Additional task associated with the groundwater treatment system include hazardous and nonhazardous waste management, performing line locates for the off-base extraction system, community relations support, and preparing all reporting plans and documents required to implement the Interim Measure. Future discharge options for the treated groundwater will be implemented through installation of additional regional aquifer injection wells and/or injection well galleries and conveyance lines to discharge treated water from the groundwater treatment system building to the injection area.
Project Date: 2015 – Present

Performance-Based Remediation, White Sands Missile Range, New Mexico; U.S. Army Environmental Command, Geologist—Preparation and revision of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1 for a project that includes environmental remediation services for 82 sites located at the White Sands Missile Range, New Mexico under the installation's Resource Conservation and Recovery Act Permit. White Sands Missile Range is an active installation serving as the U.S. Army's largest rocket and missile development and testing facility and is the largest land area military installation in the United States, comprised of 3,200 square miles of land. Project tasks include Release Assessments, Accelerated Corrective Action, Resource Conservation and Recovery Act Facility Investigations, Interim Measures, Corrective Measures, and Closure Plans/Post-Closure Care Plans, periodic groundwater monitoring. Evaluation of project tasks to determine applicable plans, activity hazard analyses, monitoring requirements, and personal protective equipment needs.
Project Date: 2015

Fort Lee Environmental Remediation, Fort Lee, Virginia; U.S. Army Environmental Command; Task Manger/Project Geologist—Prepared planning documents including the field sampling plan and aided in preparation of the Accident Prevention Plan. Coordinated the team conducting investigation report including coordination with management of data generated during the investigation. Conducts field audits during sampling events.
Project Date: January 2014 – Present

Fort Meyer; Arlington, Virginia; Project Geologist—Aided in the preparation of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1for a remedial investigation.
Project Date: September 2014

Long-Term Response Action; DeRewal Chemical Company Superfund Site; U.S. Army Corps of Engineers; Site Health and Safety Officer—Preparation and implementation of an Accident Prevention Plan. Responsible health and safety during ongoing operation and maintenance of a groundwater extraction system in Frenchtown, New Jersey. The groundwater extraction system consists of four extraction wells connected to a 20,000-gallon underground storage tank that holds groundwater until tanker trucks can visit the site to remove the water. Duties also included ensuring proper personal protective equipment was utilized and health and safety practices are followed during operation and maintenance of system.
Project Date: 2012 – November 2014

Monaca, Pittsburgh, Pennsylvania; U.S. Army Corps of Engineers–Baltimore District; Project Geologist/Site Health and Safety Officer—Aided in the preparation of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1for cleaning of five 1.74-million-gal underground storage tanks and associated pipeline. U.S. Army Corps of Engineers-approved Site Health and Safety Officer, monitoring of environmental parameters, enforcing proper use of personal protective equipment, and associated reporting for pipeline cleaning task. Provided technical input in relation to analytical data and Pennsylvania Department of Environmental Protection Land Recycling Program.
Project Date: January 2011 – 2013

Project Value – $2,877,757; Contract Type – LS; EA Project No. – 6220211; EA Project Manager – Michael O'Neil

Fort Meade System Demo; Fort Meade, Maryland; Project Geologist—Aided in the preparation of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1for the demolition of a remediation system.
Project Date: December 2012

Puchack Well Field Superfund Site, Pennsauken, New Jersey; U.S. Army Corps of Engineers–Kansas City District; Project Geologist—Aided in the preparation of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1 for the remediation of hexavalent chromium in groundwater via in-situ treatment. Sampling of monitoring wells and redevelopment of existing wells to recondition them for use as injection wells. Conducted pumping tests and well development of newly installed wells.
Project Date: June–September 2011, April 2013, and June to November 2014

Removal of 33 Underground Storage Tanks, Joint Base McGuire-Dix-Lakehurst, New Jersey; U.S. Army Corps of Engineers–Baltimore City District; Site Health and Safety Officer/Project Geologist—Aided in the preparation of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1 for the removal of 33 underground storage tanks. U.S. Army Corps of Engineers-approved Site Safety and Health Officer responsible for proper use of personal protective equipment, environmental monitoring, and daily health and safety briefings. Responsible for monthly submission of field exposure hours to U.S. Army Corps of Engineers. Provides technical input for planning stages of field activities. Additional delineation sampling to determine remediation required in tank excavations. Oversight of geotechnical sampling.
Project Date: May 2011 – January 2014

Marsh Run Park, Fairview Township, York County, Pennsylvania; U.S. Army Corps of Engineers–Baltimore District; Task Manager/Project Geologist/Site Health and Safety Officer—Additional site characterization of a chlorinated solvent plume associated with a former landfill with the end goal of site closure via the Pennsylvania Department of Environmental Protection Land Recycling Program. Prepared and presented project status update to stakeholders, file review of existing documents, and preparation of conceptual site model, planning documents, and five-year review. Installation of two additional monitoring wells, including oversight of geophysical well logging and installation of a multi-level sampling system, conducted straddle packer and pumping testing and associated groundwater sampling, and sampling of soil. Acted as Site Health and Safety Officer for several field events. Responsible for monthly submission of field exposure hours to U.S. Army Corps of Engineers. Provided ongoing historical knowledge of site in support of site closure and restoration tasks.
Project Date: July 2009 – September 2014

Atlantic Wood Industries Superfund Site, Portsmouth, Virginia; U.S. Environmental Protection Agency; Project Geologist—Pre-remedial design investigation at a 48-acre Superfund site. Prepared planning documents including a Health and Safety Plan, responsible for site management of land based field investigation, additional characterization and delineation of previously identified contamination, and preparation of technical memorandums summarizing investigation findings. Provides continuing site support as needed, including relief as Site Manager. Conducted delineation of dense non-aqueous phase liquid in the subsurface in support of remedial design efforts. Design of pumping test to determine flow conditions around a groundwater interceptor trench and evaluation of sheet pile wall on adjacent property.
Project Date: June 2008 – Present

Foster Wheeler Energy Site, Mountain Top, Pennsylvania; U.S. Environmental Protection Agency; Task Manager—Prepared an Oversight Technical Plan, Health and Safety Plan, and Quality Assurance Project Plan to support oversight of a remedial investigation and feasibility study at the Foster Wheeler trichloroethene site on behalf of the U.S. Environmental Protection Agency. Remediation activities include oversight to Geoprobe operations, vapor intrusion, geologic and hydrogeologic investigations, geophysical surveys, soil and rock boring and coring, well installations, exploratory boring installation, aquifer tests, and Human health and ecological risk assessments. Main objectives of this project included file review of available background documents and historical data regarding the Site, participation in Community meetings, overseeing the Potentially Responsible Party Remedial Investigation activities on behalf of the U.S. Environmental Protection Agency, coordination with the

U.S. Environmental Protection Agency Contract Laboratory Program, and collection and evaluation of split samples to evaluate Potentially Responsible Party laboratory analytical data.
Project Date: 2010–2014

Compliance Cleanup at 13 Sites, Aberdeen Proving Ground, Maryland; Aberdeen Proving Ground; Project Geologist—Aided in the preparation of the Accident Prevention Plan in accordance with Engineer Manual 385-1-1 for the removal of a remediation system and operations and maintenance activities.
Project Date: December 2013 – January 2014

Maryland Sand, Gravel, and Stone Remedial Construction Oversight Services; Clean Sites Environmental Services; Project Geologist—Project Geologist assisting with excavation oversight, the collection of perimeter air samples and analysis with a gas chromatograph, as well as data entry of analytical results to provide direction to the excavation crews.
Project Date: April-May 2010

Eddie M. Meadows

Site Health and Safety Officer

During his 22 years of experience, Mr. Meadows has been involved in the successful completion of numerous projects and field efforts or phases of those projects, which include management; field oversight; health and safety officer; sample collection and sample custody of soil, water, sediment, and air matrixes; mobile laboratory testing; field screening; report writing, and data reduction/management; basic surveying; and remedial injection activities. His expertise as a field scientist, site manager, and task manager includes field experience, strong understanding of standard operating procedures, and exceptional team oriented people and leadership skills of not only coworkers, but also clients, regulators, and subcontractors.

Education

B.S./Environmental Sciences/1995 (Virginia Tech)

Specialized Training

OSHA 40-Hour Hazardous Waste Operations and Emergency Response Training
OSHA 8-Hour Hazardous Waste Operations Supervisory Training
OSHA 30-Hour Construction Safety and Health Certification
Excavation Safety for Competent Person Training
Confined Space Training
U.S. Army Corps of Engineers Construction Quality Management for Contractors
OSHA 24-Hour Fall Protection for Competent Person Training
Immunoassay Training for field screening of Polycyclic Aromatic Hydrocarbons, Polychlorinated Biphenyls, and TNT
X-Ray Fluorescence Spectrum Analyzer Training
Basic Radiation Worker and Fundamentals of Radiation Training.
Respirator Fit Test
CPR and First Aid Training

Experience

Years with EA: 20 Total Years: 22

Professional Experience

Site Safety and Health Officer—Served as Site Safety and Health Officer for several investigations, removal actions, groundwater monitoring well installations, and construction projects. Duties have included leading tailgate meetings, documenting safety training and monitoring, directing the use of appropriate personal protective equipment, and supervising the implementation of proper decontamination procedures. Has an excellent safety record, including no recordable incidents on those projects where he has served as Site Safety and Health Officer.

SSHO Field Experience Summary (project details below)

- Aberdeen Proving Ground Long-Term Monitoring: April 2017 to Present, intermittent field work, 9 months total
- CLP Hybrid Project; Edgewood, Maryland: July to September 2017, 3 months
- White Swan-Sun Cleaners’ Source Area Superfund Site in Wall Township, New Jersey: January to June 2016, intermittent field work, 6 months total
- Fort Meade Base Realignment and Closure Range 17; Fort Meade, Maryland: January to June 2016, 3 months total
- Hamilton Park, Miscellaneous Sites, New Castle, Delaware: July 2014 – October 2015 and August–September 2017, 3 Months total
- Ground Vapor Intrusion; Aberdeen Proving Ground, Aberdeen, Maryland: December 2013 – March 2015, 6 months total
- Andrews Air Force Base Military Munitions Response Program; Andrews Air Force Base Camp Springs, Maryland: April–August 2014, 3 months total
- Ommelanden Huunter Education Training Center; New Castle, Delaware: March 2013 – January 2016, intermittent field work, 4 months total
- Fort Meade System Demolition; Fort Meade, Maryland: February 2013, 1 month total
- Hernwood Sanitary Landfill; Baltimore County; On-call Engineering Services: August 2011 – October 2015, intermittent field work, 4 months total
- Baltimore Gas and Electric Spring Gardens Quarterly Work: March 2015 and September 2015 – December 2016 and January 2017 – present, intermittent field work, 1 months total

- G Street Rad Remedial Investigation at Aberdeen Proving Ground-Other Edgewood Areas: April–August 2011, 5 months total
- Christina Landing Health and Safety Monitoring and Remediation: April 2004 – July 2005, 7 months total
- Maryland State Highway Administration Facility Methyl Tertiary-Butyl Ether Assessment: April–December 2005, 8 months total
- Fort Dix, New Jersey; Numerous Projects: April 1997 – October 2006; intermittent field work, 10 months total

SSHO Project Experience

Aberdeen Proving Ground Long-Term Monitoring; Aberdeen, Maryland; U.S. Army Environmental Command; Site Manager and Site Safety and Health Officer—Responsible for oversight of all aspects of the field effort including both technical and Health and Safety. Scheduled daily activities; coordinated with subcontractors, clients, and EA Project Management. Approximately 110 groundwater, surface water, and sediment samples were collected base-wide and relinquished for laboratory analysis specific to each site and with strict adherence to sample custody standard operating procedures. Regulations and quality control specifications were followed and implemented as required. Daily and weekly paperwork was completed in a timely fashion, and the field work effort was completed efficiently and effectively. Health and safety duties include ensuring proper use of PPE, conducing environmental monitoring, and completing H&S documentation as required.
Project Date: April 2017 – Present

CLP Hybrid Project; Edgewood, Maryland; City, Light, and Power, Inc.; Site Manager and Site Safety and Health Officer—Responsible for oversight of all aspects of the field effort including both technical and Health and Safety. Scheduled daily activities; coordinated with subcontractors, clients, unexploded ordnance support, and EA Project Management. Approximately 150 soil samples were collected via hand auger base-wide and relinquished for laboratory analysis specific to each site and with strict adherence to sample custody standard operating procedures. Regulations and quality control specifications were followed and implemented as required. Daily and weekly paperwork was completed in a timely fashion, and the field work effort was completed efficiently and effectively. Health and safety duties included ensuring proper use of PPE and conducted environmental monitoring.
Project Date: July–September 2017

Site Safety and Health Officer and Competent Person (Alternate); White Swan-Sun Cleaners' Source Area Superfund Site in Wall Township, New Jersey—Alternate Site Safety and Health Officer for site activities including asbestos assessment and abatement, respiratory protection and monitoring, tree and vegetation removal, excavation of surface soils with heavy equipment, asphalt removal, vegetation clearance and tree felling, traffic protection, well installation and development with heavy equipment, investigation-derived waste management and assessment, air monitoring, fall protection, ladder use, permanent fence installation, contaminated media sampling, heat and cold stress monitoring, exchange of granular activated carbon, and high pressure air sparge and soil vapor extraction system installation and monitoring for a chlorinated solvent-contaminated site. Responsibilities included:

- Perform SOH oversight during above activities as specified in Engineer Manual 385-1-1 including heavy equipment use, inspections, and corrective actions
- Perform SOH oversight during Rotosonic well installation activities, heavy equipment usage, high-pressure well development activities, and sampling groundwater
- Perform SOH oversight during oversized load equipment delivery and site operations trailer delivery and exchange of granular activated carbon (used and unused)
- Performed SOH oversight of the Fall Protection and Prevention Program during carbon-change out and usage of the aerial lift by qualified persons (JLG Model 260 MRT; Harness Model 19F395)
- Assisted with onsite quality control operations following quality control specifications
- Completion of audit process and near miss investigations
- Perform daily safety briefings consistent with the Accident Prevention Plan and Site Safety and Health Plan for site physical/chemical/biological/ and radiological hazards
- Ensure site workers abided by Respiratory Protection Program and followed respirator-use procedures
- Conduct daily site safety and health inspections for job zones
- Prepare safety and health compliance memoranda

- Develop, implement, and ensure compliance with the Accident Prevention Plan
- Calibrate and document calibration of monitoring and/or screening equipment prior to use
- Direct, distribute, and inspect appropriate personal protective equipment to site personnel (Level D, Mod Level D, and Level C)

Project Date: January–June 2016

***Fort Meade Base Realignment and Closure Range 17; Fort Meade, Maryland; U.S. Army Corps of Engineers–Baltimore Corps; Health and Safety Officer*—**Responsible for oversight of all onsite health and safety oversight. Implemented the Accident Prevention Plan and Site Safety and Health Plan, and conducted daily tailgate meetings. Reviewed applicable activity hazard analyses as project requirements dictated; wrote new activity hazard analyses onsite and submitted them as an addendum for proposed work that were not addressed in previously submitted activity hazard analyses; completed Accident and Near Miss forms as required; and all other daily health and safety paperwork including but not limited to health and safety tailgate meeting log, Site Entry and Exit log, Visitors Log, Exposure Hours log, Environmental Monitoring Record, Health and Safety Activity reports, and Daily Heavy Equipment Vehicle, Hand and Power Tool, First Aid, Eyewash, and Fire Extinguisher checklists.
Project Date: July 2015 – January 2016

***Hamilton Park, Miscellaneous Sites, New Castle, Delaware; Delaware Department of Natural Resources and Environmental Conservation; Laborer, Site Manager, Health and Safety Officer*—**Worked in various roles on several properties as the project required. All roles lead to being responsible for contributing to the safe and successful soil excavation and removal of contaminated soil at the individual properties site-wide.
Project Date: July 2014 – October 2015 and August–September 2017

Ground Vapor Intrusion; Aberdeen Proving Ground, Aberdeen, Maryland; U.S. Army Environmental Command; Task Manager, Site Manager, Health and Safety Officer—Responsible for oversight of all aspects of the field effort. Scheduled daily activities; coordinated with subcontractors, clients, and EA Project Management. Approximately 400 subsurface soil vapor samples were collected via 8-hour summa canisters in approximately 90 buildings base-wide; was responsible for this coordination effort with building tenants and/or custodians while keeping Aberdeen Proving Ground's chain of command intact. Daily activities included but were not limited to the following: scheduling, sampling that included preparation work, and drilling. Tracer testing (leak tests), recording pressure readings, and surface completion of tile, carpet, or concrete where holes were drilled inside the individual buildings, sample custody, and scheduling retests where applicable, completed daily paperwork as required, and also acted as the Site Safety and Health Officer.
Project Date: December 2013 – March 2015

Andrews Air Force Base Military Munitions Response Program; Andrews Air Force Base Camp Springs, Maryland; U.S. Army Corps of Engineers–Omaha District; Field Scientist and Site Safety and Health Officer—Filled in as the project required for either the full-time sampler, the Site Safety and Health Officer, and quality assurance/quality control analysis on sample locations; collected soil samples; analyzed sampled for metals via x-ray fluorescence; downloaded field screening results; performed sample custody for analytical samples via laboratory; managed progress of sampling grids; used Global Positioning System on sample grids; informed subcontractors where to dig and/or re-dig; acted as Site Safety and Health Officer as needed, including the completion of all daily U.S. Army Corps of Engineers required paperwork; and performed quality assurance/quality control analysis on grid work for samples collected by cross referencing the samples collected spreadsheet versus the completed figures for the individual grids.
Project Date: April–August 2014

Ommelanden Huunter Education Training Center; New Castle, Delaware; Delaware Department of Natural Resources and Environmental Control; Task Manager/Site Manager/Health and Safety Officer—Responsible for oversight of all aspects of the field effort. Scheduled daily activities; coordinated with subcontractors, clients, and EA's Project Manager; utilized Global Positioning on grids including approximately 400 sample locations; completed sample collection of surface soil, subsurface soil, surface water, and sediment samples; performed sample custody; executed field screening on samples, determined delineation requirements, reduced data, determined locations for laboratory confirmation samples; completed daily paperwork for sampling effort and Health and Safety requirements. Through challenging conditions such as wetland soil and subsurface soil samples, surface water

samples, and sediment samples that were heavily tidally influenced, outperformed the scope of work required while still completing the field effort on time and under budget. Assisted in the writing portions of the final report.
Project Date: March 2013 – January 2016

Fort Meade System Demolition; Fort Meade, Maryland; Health and Safety Officer—Performed duties as needed for the project requirements while acting as the Site Safety and Health Officer for the project. Completed daily paperwork, held tailgate meetings addressing possible hazards specific for the expectations of individual day's planned activities, coordinated with EA project management, subcontractors and clients, and ensured all site worker's certifications and training was current.
Project Date: February 2013

Hernwood Sanitary Landfill; Baltimore County; On-call Engineering Services; Field Scientist/EA Team Leader/Site Manager/Health and Safety Officer—Performed duties as needed including but not limited to the following: injection well installation, coordinating with subcontractors and clients as necessary, acted as a liaison between EA project management and subcontractors/clients, health and safety officer, sample collection and custody of groundwater, surface water, sediment, and air matrixes, pilot study in support of the full-scale groundwater remediation effort, and active amendment injections during and for the full-scale groundwater remediation effort.
Project Date: August 2011 – October 2015

Baltimore Gas and Electric Spring Gardens Quarterly Work; Task Manager/Project Geologist/Site Safety and Health Officer—Performed dense and light non-aqueous phase liquid recovery, collected offsite groundwater samples, managed data, wrote quarterly reports, updated the database, and interacted with subcontractors and client throughout the entire process.
Project Date: May 2003 – March 2015 and September 2015 – December 2016 and January 2017 – present

G Street Rad Remedial Investigation at Aberdeen Proving Ground-Other Edgewood Areas; Field Team Leader and Health and Safety Officer—Performed daily oversight of subcontractors and coworkers for Rad contamination investigation and performed all health and safety monitoring not within the radiological or unexploded ordnance concerns. Determined where to collect soil and/or water samples, performed sample custody, interacted with client, and acted as liaison between field crew and the Project Manager.
Project Date: April–August 2011

Christina Landing Health and Safety Monitoring and Remediation; Health and Safety Officer— Conducted health and safety oversight, oversaw remediation and excavation of petroleum-impacted soils, collected soil, groundwater, and air samples to confirm remaining areas were below human health risk criteria for future development of the area.
Project Date: April 2004 – July 2005

Maryland State Highway Administration Facility Methyl Tertiary-Butyl Ether Assessment; Site Manager and Health and Safety Officer —Performed oversight for monitor well installation, collected groundwater and soil samples to characterize contamination at the site as a result of possible leaking underground storage tanks. Performed health and safety monitoring throughout the duration of the project.
Project Date: April–December 2005

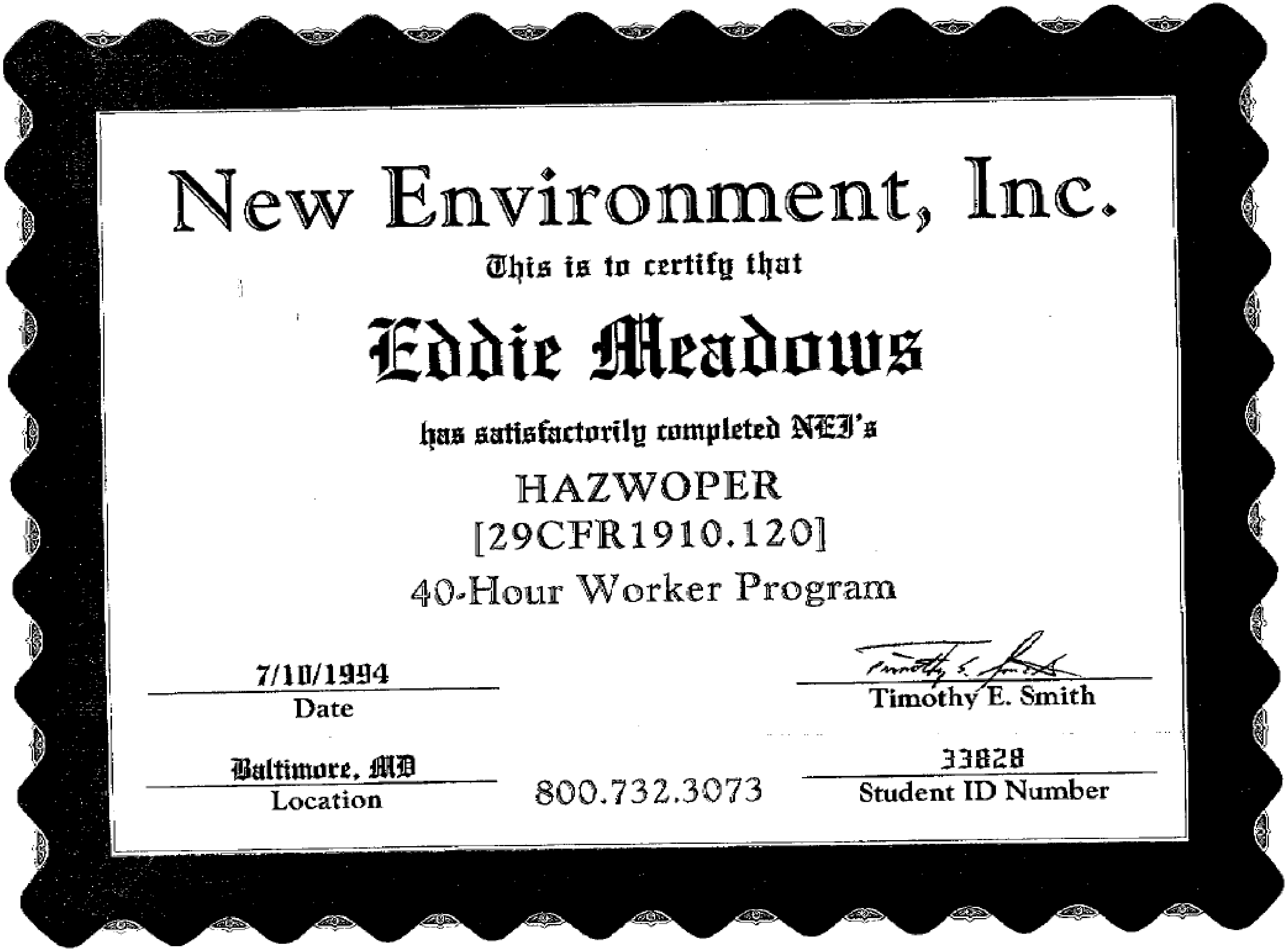
Fort Dix, New Jersey; Numerous Projects; Field Scientist/Site Manager/Scientist/Health and Safety Officer —
Coordinated the quarterly field sampling efforts with the client and subcontractors; collected groundwater, surface water, and sediment samples; oversaw sample custody preparation; and preformed report writing.
Project Date: April 1997 – October 2006

Meadows Safety and Health Certifications

1.	Cover Page and Resume		
2.	40-Hour HAZWOPER Original	(No Expiration)	(07/10/1994)
3.	8-HR Supervisor	(No Expiration)	(04/25/2008)
4.	30-HR Construction	(No Expiration)	(05/14/2009)
5.	8-HR Refresher for 40hrHAZWOPER and Bloodborne Pathogens	(Annual)	(03/23/2019)
6.	First Aid/CPR	(Biannual)	(12/08/2019)
7.	Bloodborne Pathogens Workplace	(Annual)	(12/08/2018)
8.	Medical Surveillance	(Annual)	(01/09/2019)
9.	Certification for Respirator Use	(Annual)	(01/09/2019)
10.	Respirator Fit Test Documentation	(Annual)	(01/09/2019)

Original 40-Hour HAZWOPER

(Does Not Expire)



New Environment, Inc.

This is to certify that

Eddie Meadows

has satisfactorily completed NEI's

HAZWOPER

[29CFR1910.120]

40-Hour Worker Program

7/10/1994

Date

Timothy E. Smith

Baltimore, MD

Location

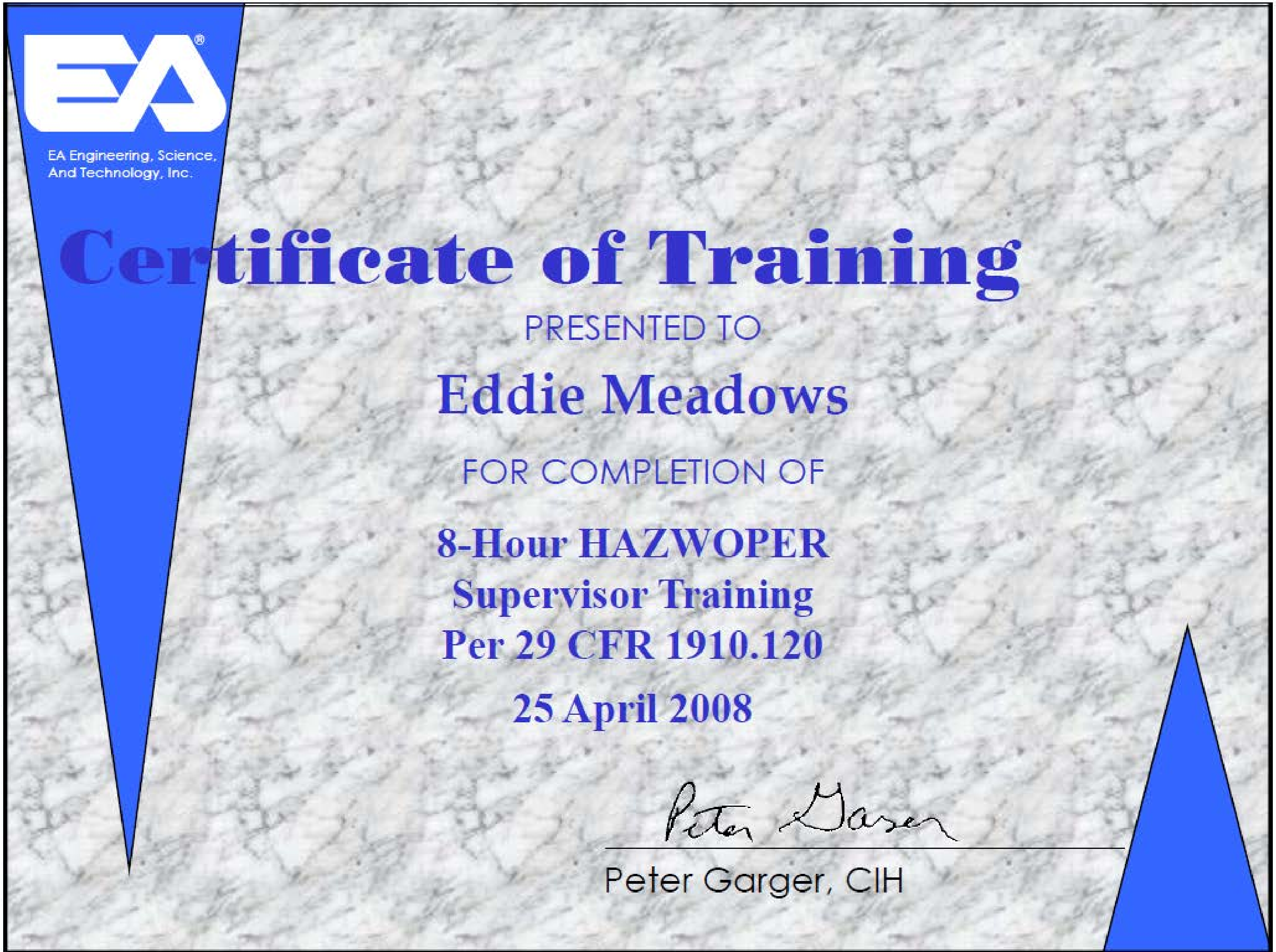
800.732.3073

33828

Student ID Number

8-Hour Supervisor Training

(Does Not Expire)



EA Engineering, Science,
And Technology, Inc.

Certificate of Training

PRESENTED TO

Eddie Meadows

FOR COMPLETION OF

8-Hour HAZWOPER
Supervisor Training
Per 29 CFR 1910.120

25 April 2008

Peter Garger

Peter Garger, CIH

30-Hour Construction
(Does Not Expire)

OSHA 600324600

U.S. Department of Labor
Occupational Safety and Health Administration

Eddie Meadows
has successfully completed a 30-hour Occupational Safety and Health Training Course in

Construction Safety & Health

M. Barton #278 5/14/2009
(Trainer) (Date)

8-Hour HAZWOPER Refresher
(Expires 03/23/2019)

EA Engineering, Science,
and Technology, Inc., PBC

Certificate of Training

Presented to

Eddie Meadows

For Completion of

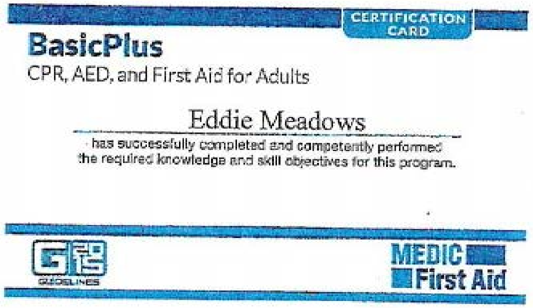
8 Hour HAZWOPER Refresher Training IAW 29 CFR 1910.120 and Blood-Borne Pathogen Training IAW 29 CFR 1910.130

March 23, 2018

Peter Garger

Peter Garger, CIH, CSP

First Aid and Cardiopulmonary Resuscitation (Expires 12/08/2019)



CERTIFICATION CARD

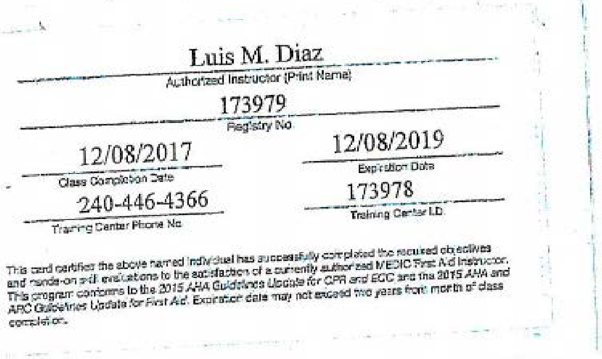
BasicPlus

CPR, AED, and First Aid for Adults

Eddie Meadows

has successfully completed and competently performed the required knowledge and skill objectives for this program.

MEDIC First Aid



Luis M. Diaz
Authorized Instructor (Print Name)

173979
Registry No.

12/08/2017
Class Completion Date

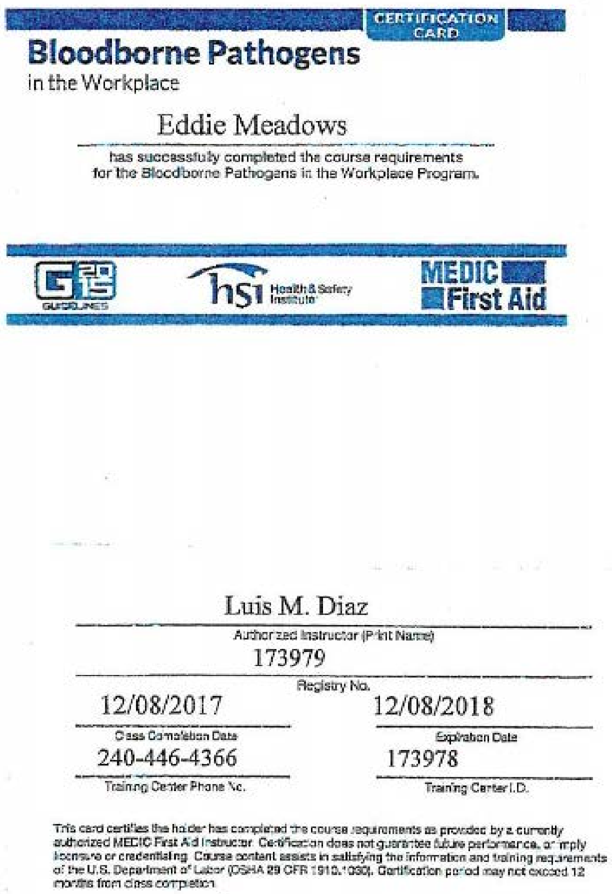
12/08/2019
Expiration Date

240-446-4366
Training Center Phone No.

173978
Training Center I.D.

This card certifies the above named individual has successfully completed the required objectives and hands-on skill evaluations to the satisfaction of a currently authorized MEDIC First Aid Instructor. This program conforms to the 2015 AHA *Guidelines Update for CPR and ECC* and the 2015 AHA and ARC *Guidelines Update for First Aid*. Expiration date may not exceed two years from month of class completion.

Bloodborne Pathogens in the Workplace (Expires 12/08/2018)



CERTIFICATION CARD

Bloodborne Pathogens
in the Workplace

Eddie Meadows

has successfully completed the course requirements for the Bloodborne Pathogens in the Workplace Program.

Luis M. Diaz
Authorized Instructor (Print Name)

173979
Registry No.

12/08/2017
Class Completion Date

12/08/2018
Expiration Date

240-446-4366
Training Center Phone No.

173978
Training Center I.D.

This card certifies the holder has completed the course requirements as provided by a currently authorized MEDIC First Aid Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content assists in satisfying the information and training requirements of the U.S. Department of Labor (OSHA 29 CFR 1910.1030). Certification period may not exceed 12 months from class completion.

Medical Surveillance
(Expires 01/09/2019)

ALLONE HEALTH

Medical Release for Medical Surveillance

Employee's Name:	Meadows, Eddie
Employee Number:	65911
Birth Date:	1/6/1972 12:00:00 AM
Company:	EA Engineering Science & Technology, Inc
Company Location:	Edgewood, MD
Date of Exam:	12/21/2017 12:00:00 AM
Exam Location:	Occupational Medical Services - Belcamp Belcamp, MD
Medical Surveillance:	Medical Surveillance - Periodic Exam

I have reviewed the services performed on the above named individual per OSHA regulations and in my opinion,

I have not detected any medical condition which would place the employee at increased risk of health impairment from work.

Other Comment: CERTIFICATION FOR RESPIRATOR USE EXPIRES 12/21/2017

I have informed the employee of the results of the examination and any medical conditions which require further examination or treatment.

For asbestos examinations: The above employee has been informed of the health risks associated with smoking and asbestos exposure.

Dr. Fred Kohanna MD	Fred Kohanna, MD	1/9/2018 10:47:55 AM
Authorized Physician	Authorized signature	Date

CVID: 2096661

Med ResultID: 58728855

Certification for Respirator Use
(Expires 01/09/2019)

ALLONE HEALTH

Certification for Respirator Use
29 CFR 1910.134

Employee's Name:	Meadows, Eddie
Employee Number:	65911
Birth Date:	01/06/1972
Company:	EA Engineering Science & Technology, Inc
Company Location:	Edgewood, MD
Date of Exam:	12/21/2017
Exam Location:	Occupational Medical Services - Belcamp Belcamp, MD

I have reviewed the examination of the above named individual and I certify that this employee is physically capable of using all types of respiratory protection.

Prescription eyeglasses and beards cannot be worn with all types of respirators. Any interference with a mask seal is not acceptable. Contact lenses should not be worn while working with acrylonitrile, 1, 2 dibromo-3-chloropropane, ethylene oxide, methylene chloride, and 4,4' - methylene dianiline.

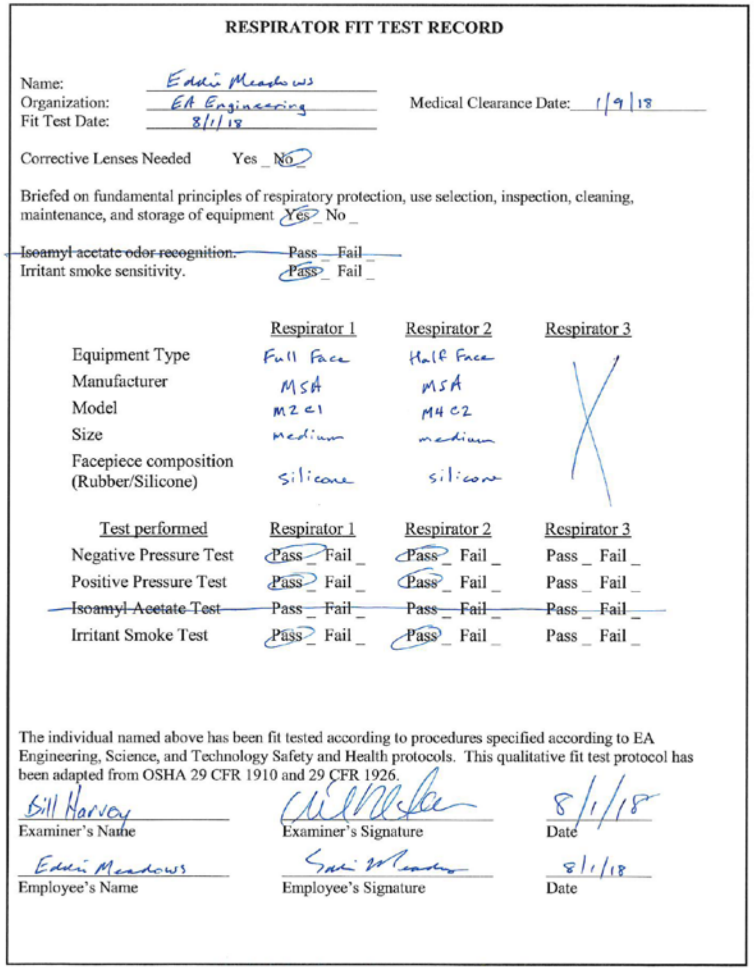
Dr Fred Kohanna	Fred Kohanna, MD	1/9/2018 10:48:30 AM
Authorized signature	Authorized signature	Date

The above employee has been notified of this determination

CVID: 2096661

Medical ResultID: 58728865

Respirator Fit Test Documentation
(Expires 1/09/2019)



RESPIRATOR FIT TEST RECORD

Name: Eddie Meadows
Organization: EA Engineering
Fit Test Date: 8/1/18
Medical Clearance Date: 1/9/18

Corrective Lenses Needed Yes _ [✓ No] _

Briefed on fundamental principles of respiratory protection, use selection, inspection, cleaning, maintenance, and storage of equipment [✓ Yes] _ No _

~~Isoamyl acetate odor recognition. Pass _ Fail _~~
Irritant smoke sensitivity. [✓ Pass] _ Fail _

	Respirator 1	Respirator 2	Respirator 3
Equipment Type	Full Face	Half Face	
Manufacturer	MSA	MSA	
Model	M2 C1	M4 C2	
Size	medium	medium	
Facepiece composition (Rubber/Silicone)	silicone	silicone	

Test performed	Respirator 1	Respirator 2	Respirator 3
Negative Pressure Test	[✓ Pass] _ Fail _	[✓ Pass] _ Fail _	Pass _ Fail _
Positive Pressure Test	[✓ Pass] _ Fail _	[✓ Pass] _ Fail _	Pass _ Fail _
~~Isoamyl Acetate Test~~	~~Pass _ Fail _~~	~~Pass _ Fail _~~	~~Pass _ Fail _~~
Irritant Smoke Test	[✓ Pass] _ Fail _	[✓ Pass] _ Fail _	Pass _ Fail _

The individual named above has been fit tested according to procedures specified according to EA Engineering, Science, and Technology Safety and Health protocols. This qualitative fit test protocol has been adapted from OSHA 29 CFR 1910 and 29 CFR 1926.

Bill Harvey
Examiner's Name

Examiner's Signature

8/1/18
Date

Eddie Meadows
Employee's Name

Employee's Signature

8/1/18
Date

Respirator Fit Test Record.

Jeffrey Smith

Site Safety and Health Officer (SSHO)

Qualifications

Education
B.S., Towson State University; Physics; 1990

Specialized Training
OSHA 40-Hour Hazardous Waste Operations Training
OSHA 8-Hour Supervisor
OSHA 30-hour Construction Safety Training
Confined Space Training
Competent Person Trenching/Construction

Experience
Years with EA: 21 Total Years: 24

With over 5 years of experience as an SSHO on construction and environmental sites and 24 years of experience overall, Mr. Smith provides health and safety responsibilities on sites involving excavations, heavy equipment operations, remediation system installation and environmental sampling. He is responsible for conducting daily health and safety meetings, ensuring Accident Prevention Plan (APP) compliance, and compiling daily quality control reports. Mr. Smith is trained and experienced in performing and demonstrating calibration of monitoring equipment; providing health and safety oversight during excavations, and/or environmental sampling activities; providing on-site training relating to project safety; applying Site Safety and Health Plans; implementation of emergency procedures; performing air monitoring; and selecting, wearing, and training others regarding personal protective equipment (PPE). Mr. Smith has also conducted site inspections to evaluate work conditions for potential job site hazards, investigating and reporting accidents injuries, and occupational illnesses, documentation via standard form 3394, daily safety tailgate meetings, investigating reports of hazardous conditions and taking actions as appropriate to remedy the situation. He has substantial experience in ensuring proper use, calibration, and maintenance of safety and monitoring equipment, ensuring air sampling/monitoring was properly performed, and monitoring/oversight of subcontractors. Responsible for implementing health and safety rules and regulations as dictated by U.S. Army Corps of Engineers 385-1-1Safety Manual as well as other state and federal regulations.

SSHO; Puchack Well Field Superfund Site in Pennsauken, NJ (35+ months; November 2011 – Present; Excavation and Trenching 12 Months; November 2012-November 2013):
SSHO for site activities including sampling of impacted groundwater, **excavation and trenching, heavy equipment operation**, and operations and maintenance of an injection system. Implemented APP and provided health and safety oversight for 20-30 subcontractors and 10- 20 EA employees simultaneously.

Responsibilities included:

- Performed environmental and **construction health and safety oversight** during all site activities including **excavation and trenching**
- Presented **daily safety briefings** that included awareness training for site physical/chemical/ biological hazards
- Calibrated and document calibration of monitoring and/or screening equipment prior to use (PID/YSI)
- Performed **air monitoring** for confined space entry
- Developed, implemented, and ensured compliance with the APP
- Develop new **activity hazard analyses (AHAs)** when conditions changed and new work activities were required
- Conducted site inspections to evaluate work conditions for job zones
- Prepared health and safety compliance memoranda
- Directed, distributed, and inspected appropriate PPE to site personnel
- Conducted **daily heavy equipment inspections** (excavator, loader, skid steer and dozer)
- Provided **accident and near miss investigation** and reporting via SF3394
- Maintained and enforced appropriate PPE use
- No lost time incidents were recorded over **46,000+ man-hours of exposure**.

SSHO; Aberdeen Proving Ground in Aberdeen, MD (10 months; January 2011-October 2011):
SSHO for **construction activities** including the construction and disposal of a soil stockpile approximating 100,000 cubic yards under BRAC (Base Realignment and Closure). Health and safety oversight included implementation of health & safety plan site inspections to evaluate work conditions for potential job site hazards, conducting daily safety tailgate meetings, and ensuring use of proper personal protective equipment PPE.

Responsibilities included:

- Performed **construction health and safety oversight** during heavy equipment operations including excavators and loaders
- Presented **daily safety briefings** that included awareness training for site physical/chemical/ biological hazards
- Calibrated and documented calibration of dust monitoring and/or screening equipment prior to use
- Developed, implemented, and ensured compliance with the APP
- Conducted site inspections to evaluate work conditions for job zones
- Conducted **daily heavy equipment inspections**
- Directed, distributed, and inspected appropriate PPE to site personnel
- Maintained and enforced appropriate PPE use

SSHO; Atlantic Woods Industries Superfund Site in Portsmouth, Virginia (12 Months; January 2010-December 2010):

SSHO for site **construction activities** including the construction of two soil containment berms for the disposal of locally dredged hazardous materials.

Responsibilities included:

- Performed **construction health and safety oversight** during all site activities including excavation, loading and dumping
- Presented **daily safety briefings** that included awareness training for site physical/chemical/ biological hazards
- Calibrated and document calibration of monitoring and/or screening equipment
- Developed, implemented, and ensured compliance with the APP
- Conducted **site inspections** to evaluate work conditions for job zones
- Conducted **daily heavy equipment inspections**
- Conducted **accident investigation** and reporting
- Directed, distributed, and inspected appropriate PPE to site personnel
- Maintained and enforced appropriate PPE use

SSHO; Remedial Action, Old Dump on Woodrest Creek, Aberdeen Proving Ground, Aberdeen Areas, Maryland (12 Months; January 2009-December 2009):

SSHO site **construction activities** involving the construction of a 4-acre soil cap. Responsible for the overall health and safety of multiple contractors and EA employees during the installation of a soil cap, and stabilization of over 1,000–ft of shoreline. Performed continuous air monitoring and advised of dust suppression during construction activities.

Responsibilities included:

- Performed **construction health and safety oversight** during all site activities including soil dumping, loading and dozing
- Presented **daily safety briefings** that included awareness training for site physical/chemical/ biological hazards
- Calibrated and used **dust monitoring equipment**
- Developed, implemented, and ensured compliance with the APP
- Conducted **site inspections** to evaluate work conditions for job zones
- Conducted **daily heavy equipment inspections**
- Conducted **accident investigation** and reporting
- Directed, distributed, and inspected appropriate PPE to site personnel
- Maintained and enforced appropriate PPE use

SSHO; Remedial Design and Soil Removal Action, Known Distance Range Site 30B, Aberdeen Proving Ground, Aberdeen, Maryland (12 Months; January 2008-December 2008):

SSHO for site **construction and investigation activities** including lead contamination delineation, heavy equipment excavation of lead impacted soil, soil screening, sample collection, soil stabilization, loading contaminated soil for offsite disposal and site restoration/grading The project included removal, stabilization, and offsite disposal of 16,000 tons of soil. Soil was screened prior to stabilization, recovering/recycling 13 tons of bullets/fragments. Soil was stabilized for offsite use as daily landfill cover. Site activities also involved identification and inspection of debris, certification of items as munitions debris or cultural debris, and shipping for final disposal (i.e., landfill, recycling).

Responsibilities included:

- Performed **construction health and safety oversight** during all site construction activities including excavation, loading, screening, stabilization, and hauling.
- Presented **daily safety briefings** that included awareness training for site hazards
- Implemented, and ensured compliance with the APP/SSHP
- Conducted **site inspections and accident investigation** to evaluate work conditions and accident causes
- Performed **initial and daily heavy equipment inspections**
- Directed, distributed, and inspected appropriate PPE to site personnel
- Maintained and enforced appropriate PPE use

SSHO; Riverfront Development Corporation, Wilmington, Delaware, Christina Landing Voluntary Cleanup Program; (12 Months, May 2006 – May 2007)

Provided **health and safety oversight during a construction activities** conducted under the voluntary cleanup program at a former brownfield site in Wilmington, Delaware. The remedial actions included soil excavation and hot spot removal (30,000 yd$_3$), onsite containment, soil sampling and the installation of vapor barriers and venting systems.

Responsibilities included:

- Performed **construction health and safety oversight** during all site construction activities including excavation, loading, screening, stabilization, and installation of vapor controls.
- Calibrated and documented calibration of monitoring and/or screening equipment
- Performed **air monitoring** for confined space entry and trenching activities
- Presented **daily safety briefings** that included awareness training for site hazards
- Implemented, and ensured compliance with the APP/SSHP
- Conducted **site inspections and accident investigation** to evaluate work conditions for job zones
- Directed, distributed, and inspected appropriate PPE to site personnel
- Maintained and enforced appropriate PPE use

SSHO; Soil Remediation, St. Georges Bridge, Delaware; U.S. Army Corps of Engineers, Baltimore, Maryland (12 Months; March 2000-March 2001):

SSHO for **site construction activities** including sampling of lead-based paint impacted soil and the excavation and disposal of 1,000+ yd3 of lead contaminated soil.

Responsibilities included:

- Performed **construction health and safety oversight** during all site construction activities including excavation, loading and site restoration
- Presented **daily safety briefings** that included awareness training for site hazards
- Implemented, and ensured compliance with the APP/SSHP
- Conducted **site inspections and accident investigations** to evaluate work conditions and accident causes
- Performed **initial and daily heavy equipment inspections**
- Conducted **air monitoring** for dust and ensure dust suppression measures were used
- Directed, distributed, and inspectd appropriate PPE to site personnel
- Maintained and enforced appropriate PPE use

Other Health and Safety Related Activities

Field Scientist; Remedial Action Mold Abatement, State Highway Administration, Maryland; (1 Week; September 2005)

Field scientist for remedial actions including removal of mold impacted drywall.

- Performed drywall removal and disposal in **Level C**
- Supervised personnel in **Level C**
- Performed **fit test** for personnel in Level C
- Performed **weekly inspections** of individual respirators and respirator storage

- Performed **daily respirator and respirator cartridge inventory inspections**

Field Scientist; Phase I and II Environmental Site Assessments, Former Lake Ontario Ordnance Works, Niagara County, New York;
(8 Months; Field Scientist June-September 1998 and June-September 2000)

Field scientist during the site investigation of process areas and underground utility lines of the former trinitrotoluene (TNT) plant and subsequent Department of Defense (DoD) facility. Site activities included soil and groundwater sampling.

- Performed soil and groundwater sampling in **Level C**
- Performed **weekly inspection** of individual respirators and respirator storage
- Performed **daily respirator and respirator cartridge inventory inspections** Performed initial and daily site health and safety inspections

Field Scientist; Environmental Sampling, Ellsworth Air Force Base, South Dakota;
(2 Weeks; May 1994)

- Performed soil sampling in **Level C**
- Performed **inspection** of individual respirators and respirator storage

Performed **daily respirator and respirator cartridge inventory inspections**

Field Scientist; Confined Space Tank Cleaning/Sampling, Prince George's County, Maryland;
(1 Week; June 1998)

- Performed soil sampling in **Level C** in confined space
- Performed **inspections** of individual respirators and respirator storage
- Performed **daily respirator and respirator cartridge inventory inspections**

General Project Experience

Environmental Remediation—Served as site construction manager, health and safety officer, and quality control officer for landfill capping operation on Aberdeen Proving Ground. Duties included wetlands creation and the planting of 1,200+ native trees and shrubs.

Field Management—Served as field manager and health and safety officer for installation of wildlife protection measures at all downrange areas of Aberdeen Proving Ground. Interacted with Aberdeen Proving Ground Safety Department during the movement of high voltage bucket trucks in swampy conditions in an effort to reach high voltage lines and install bird diverter cards, and worked with high voltage crews to obtain electrical outages on 35-kV lines.

Environmental Impact/Risk Assessment—Served as field manager and health and safety office for five Aberdeen Proving Ground sites for the removal of several hundred cubic yards of contaminated soil. Coordinated and worked with bomb disposal technicians during all excavation activities to remove all soils in a safe manner.

Petroleum Hydrocarbon Investigation and Remediation—Extensive experience in the installation and operation of various remedial technologies for the remediation of petroleum hydrocarbons. Has performed operation and maintenance at more than 75 remediation sites to utilize groundwater pump-and-treat, skimming, air sparging, soil vapor extraction, bioventing, and dual-phase extraction remediation systems for the recovery of petroleum hydrocarbons. Extensive experience in the troubleshooting and maximizing performance of these remedial systems.

Various Projects at Aberdeen Proving Ground; Aberdeen Proving Ground, Maryland—Involved in numerous tasks, serving as a site manager, and health and safety officer. Many of the projects at the 70,000-acre Aberdeen Proving Ground installation have involved explosive and/unexploded ordnance avoidance and removal. Health and safety duties included oversight, implementation of health & safety plan, site inspections to evaluate work conditions for potential job site hazards, daily safety tailgate meetings, ensuring proper use/calibration and maintenance of safety and monitoring equipment, and ensuring air sampling/monitoring was properly performed. ***(1994 – Present)***

Level D Field Support – Site Characterization in Other Edgewood Areas; Aberdeen Proving Ground, Maryland; Field Scientist—Activities completed include collection of surface soil samples and removal of potential sources of contamination from the ground surface within several study areas within the Other Edgewood Areas. Potential sources included various types of munitions and miscellaneous items (such as deteriorated drums and metallic items);

including a former munitions disposal pit where more than 6,500 rounds were recovered, resulting in a Time Critical Removal Action. ***Project Dates: 2007 – 2008***

1400 Lancaster Street, LLC, Baltimore City, Maryland - Hexavalent Chromium Remediation —Served as health and safety officer for the redevelopment of Brownfields along the Baltimore City waterfront. The property was located adjacent to the former Allied Signal plant, which processed chrome-plating materials from chromium ore. Duties included monitoring construction workers in the breathing zone and site perimeter during the removal of hazardous hexavalent chromium impacted soil. ***Project Dates: 2002-2004***

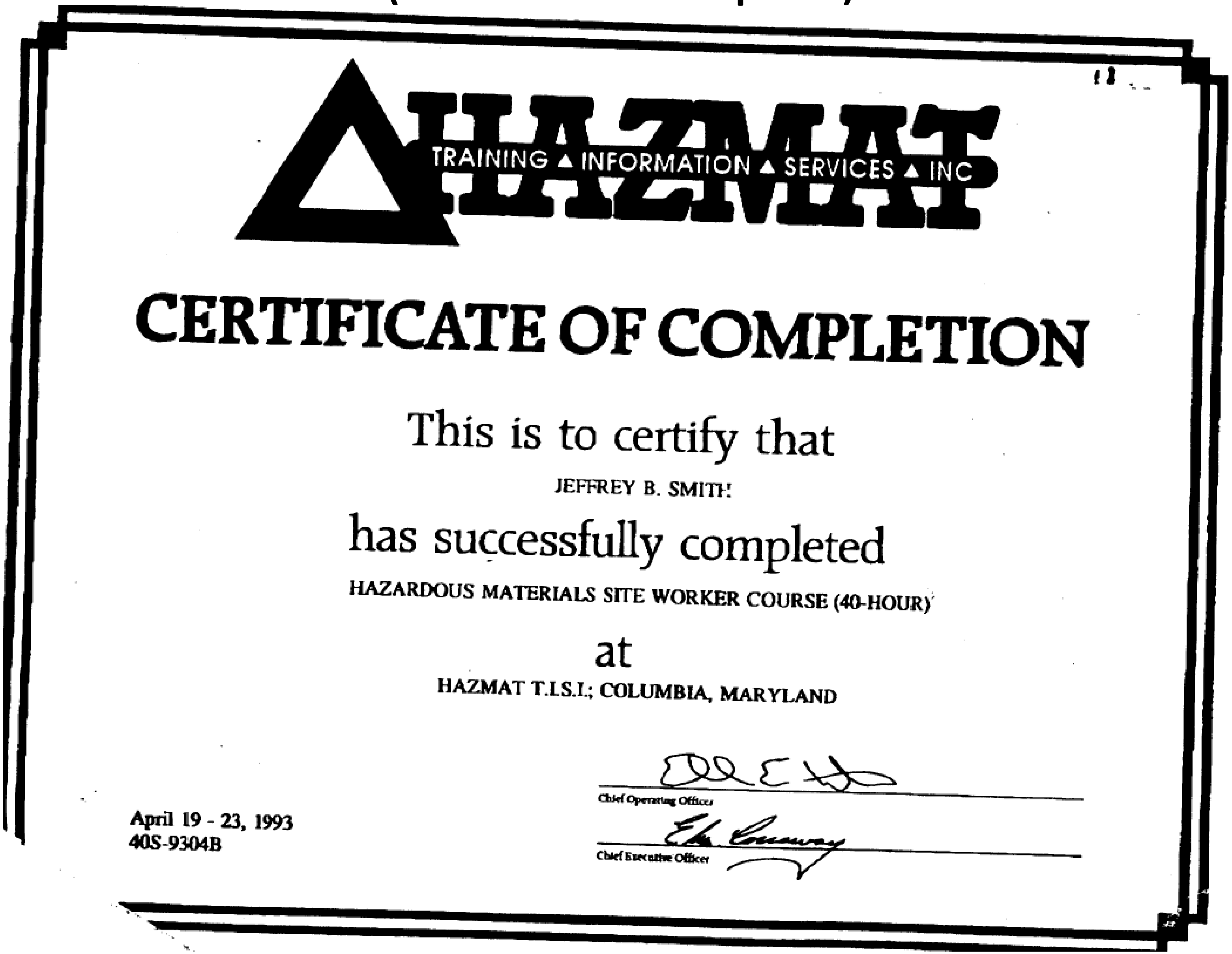
Lake Ontario Ordnance Works; U.S. Army Corps of Engineers–Baltimore; Sampling Supervisor—Served as site manager, and health and safety officer directing 10+ EA employees and 15+ subcontractors during monitoring well installation and hazardous material removal while interacting with both public and private companies and land owners. Served as heavy equipment operator for clearing groundwater survey grid and hazardous waste test trenching and locating. ***Project Dates: 1998–2000***

Smith Safety and Health Certifications

1.	Cover Page and Resume		
2.	40-Hour HAZWOPER Original	(No Expiration)	(04/23/1993)
3.	30-HR Construction	(No Expiration)	(05/14/2009)
4.	8-HR Supervisor	(No Expiration)	(04/25/2008)
5.	8-HR HAZWOPER Refresher	(Annual)	(03/28/2015)
6.	First Aid/CPR	(Biannual)	(12/8/2019)
7.	Blood-Borne Pathogen	(Annual)	(12/8/2018)
8.	Medical Surveillance	(Annual)	(2/9/2019)
9.	Respirator Use	(Annual)	(2/9/2019)
10.	Fit Test Certification	(Annual)	(05/21/2015)

Original 40-Hour HAZWOPER

(Does Not Expire)



HAZMAT

TRAINING ▲ INFORMATION ▲ SERVICES ▲ INC

CERTIFICATE OF COMPLETION

This is to certify that

JEFFREY B. SMITH

has successfully completed

HAZARDOUS MATERIALS SITE WORKER COURSE (40-HOUR)

at

HAZMAT T.I.S.I.; COLUMBIA, MARYLAND

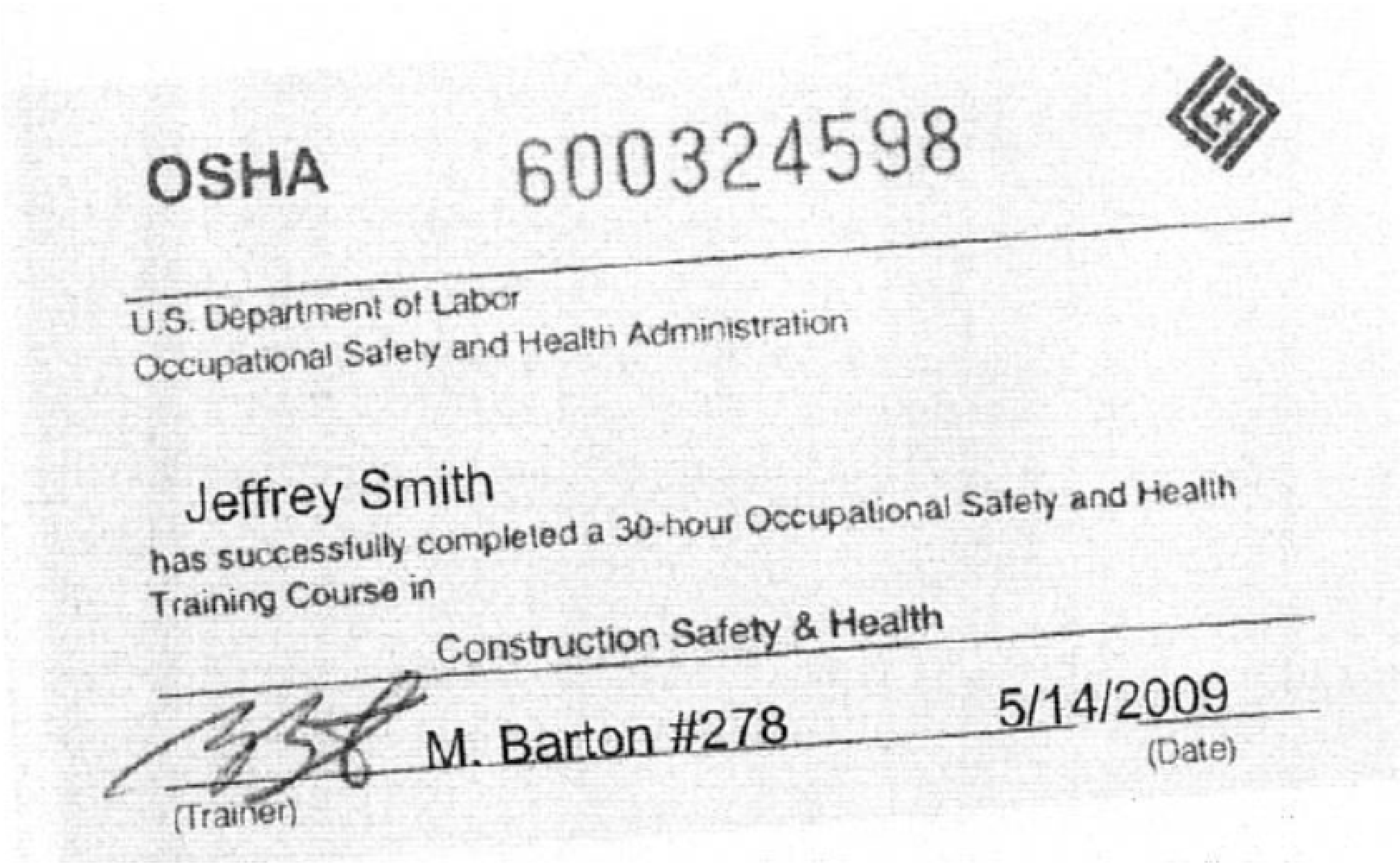
Chief Operating Officer

Chief Executive Officer

April 19 - 23, 1993
40S-9304B

OSHA 30-HR Construction

(Does Not Expire)



OSHA 600324598

U.S. Department of Labor
Occupational Safety and Health Administration

Jeffrey Smith

has successfully completed a 30-hour Occupational Safety and Health Training Course in

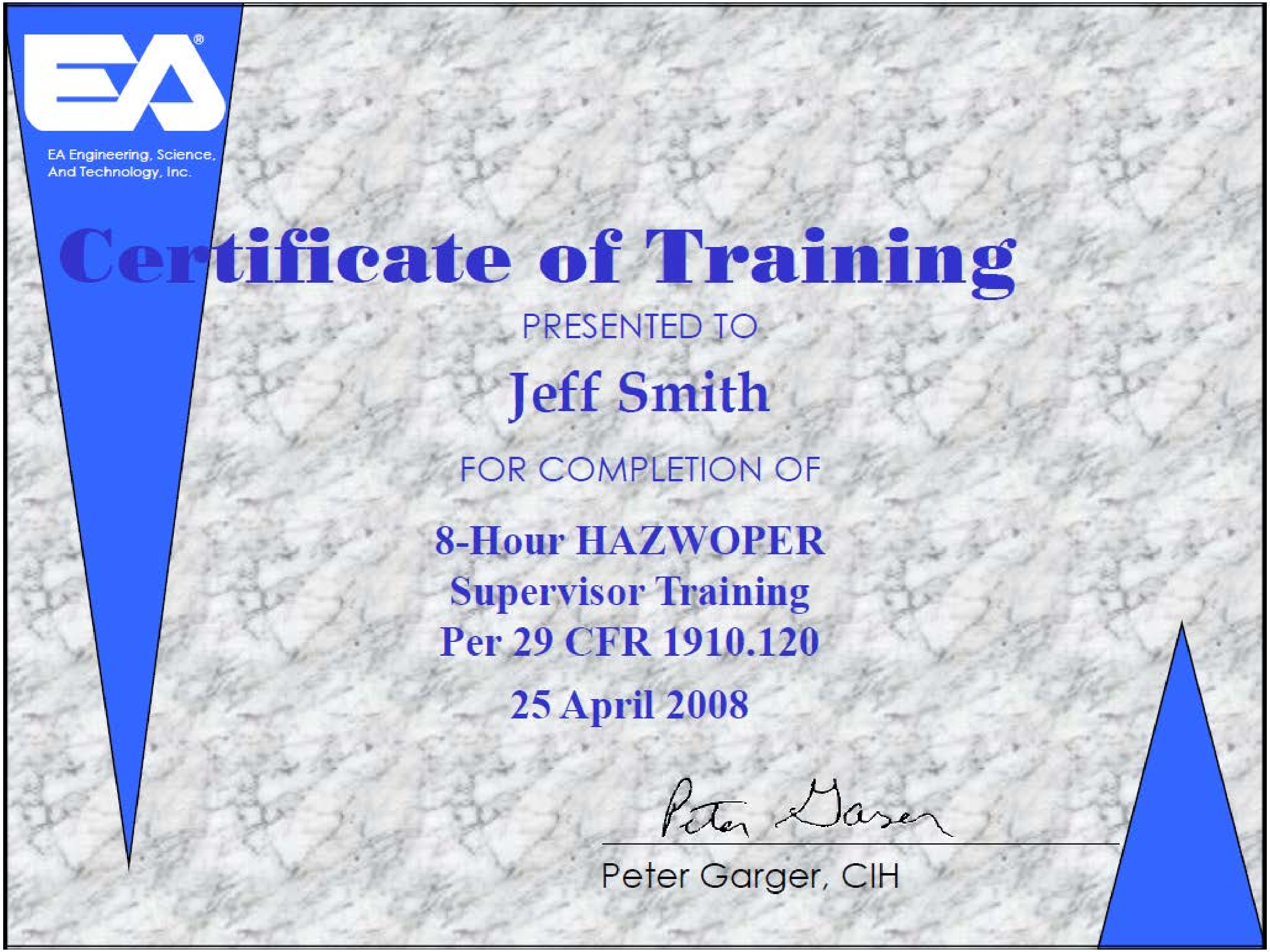
Construction Safety & Health

M. Barton #278 (Trainer)

5/14/2009 (Date)

8-Hour Supervisor Training

(Does Not Expire)



EA Engineering, Science,
And Technology, Inc.

Certificate of Training

PRESENTED TO

Jeff Smith

FOR COMPLETION OF

8-Hour HAZWOPER
Supervisor Training
Per 29 CFR 1910.120

25 April 2008

Peter Garger, CIH

8-Hour HAZWOPER Refresher

(Expires 03/28/2016)

EA Engineering, Science,
and Technology, Inc., PBC

Certificate of Training

Presented to

Jeff Smith

For Completion of

8 Hour HAZWOPER Refresher Training IAW 29 CFR 1910.120 and Blood-Borne Pathogen Training IAW 29 CFR 1910.130

March 23, 2018

Peter Garger

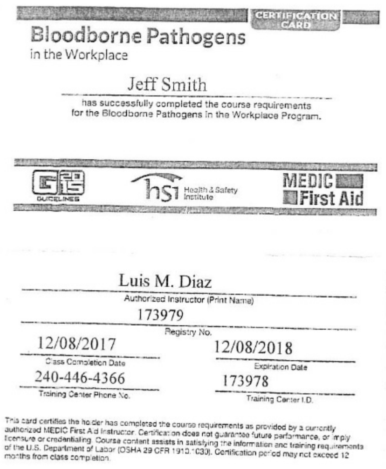
Peter Garger, CIH, CSP

First Aid/CPR

(Expires 12/08/2019)

Blood Borne Pathogens

(Expires 12/08/2018)



CERTIFICATION CARD

Bloodborne Pathogens
in the Workplace

Jeff Smith

has successfully completed the course requirements
for the Bloodborne Pathogens in the Workplace Program.

Luis M. Diaz
Authorized Instructor (Print Name)

173979
Registry No.

12/08/2017
Class Completion Date

12/08/2018
Expiration Date

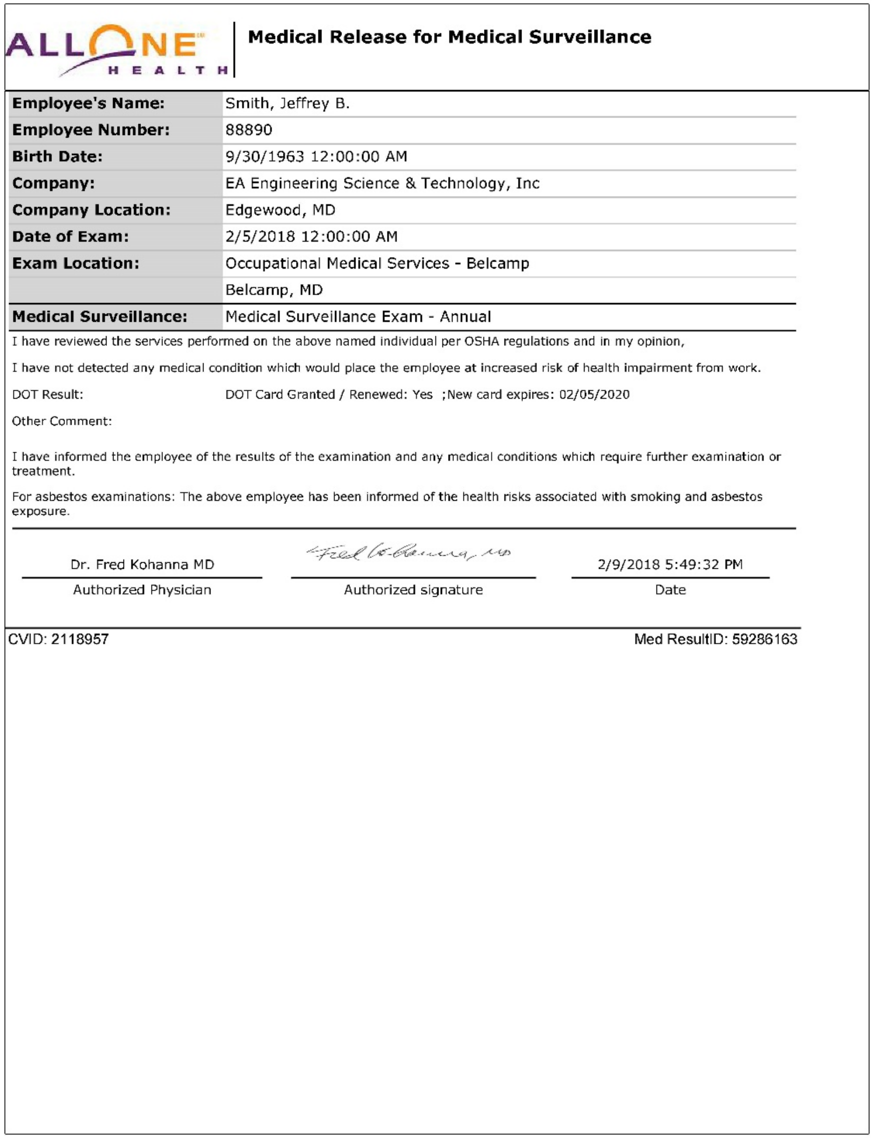
240-446-4366
Training Center Phone No.

173978
Training Center I.D.

This card certifies the holder has completed the course requirements as provided by a currently authorized MEDIC First Aid Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content assists in satisfying the information and training requirements of the U.S. Department of Labor (OSHA 29 CFR 1910.1030). Certification period may not exceed 12 months from class completion.

Medical Surveillance

(Expires 2/9/2019)



ALLONE HEALTH

Medical Release for Medical Surveillance

Employee's Name:	Smith, Jeffrey B.
Employee Number:	88890
Birth Date:	9/30/1963 12:00:00 AM
Company:	EA Engineering Science & Technology, Inc
Company Location:	Edgewood, MD
Date of Exam:	2/5/2018 12:00:00 AM
Exam Location:	Occupational Medical Services - Belcamp
	Belcamp, MD
Medical Surveillance:	Medical Surveillance Exam - Annual

I have reviewed the services performed on the above named individual per OSHA regulations and in my opinion,

I have not detected any medical condition which would place the employee at increased risk of health impairment from work.

DOT Result: DOT Card Granted / Renewed: Yes ;New card expires: 02/05/2020

Other Comment:

I have informed the employee of the results of the examination and any medical conditions which require further examination or treatment.

For asbestos examinations: The above employee has been informed of the health risks associated with smoking and asbestos exposure.

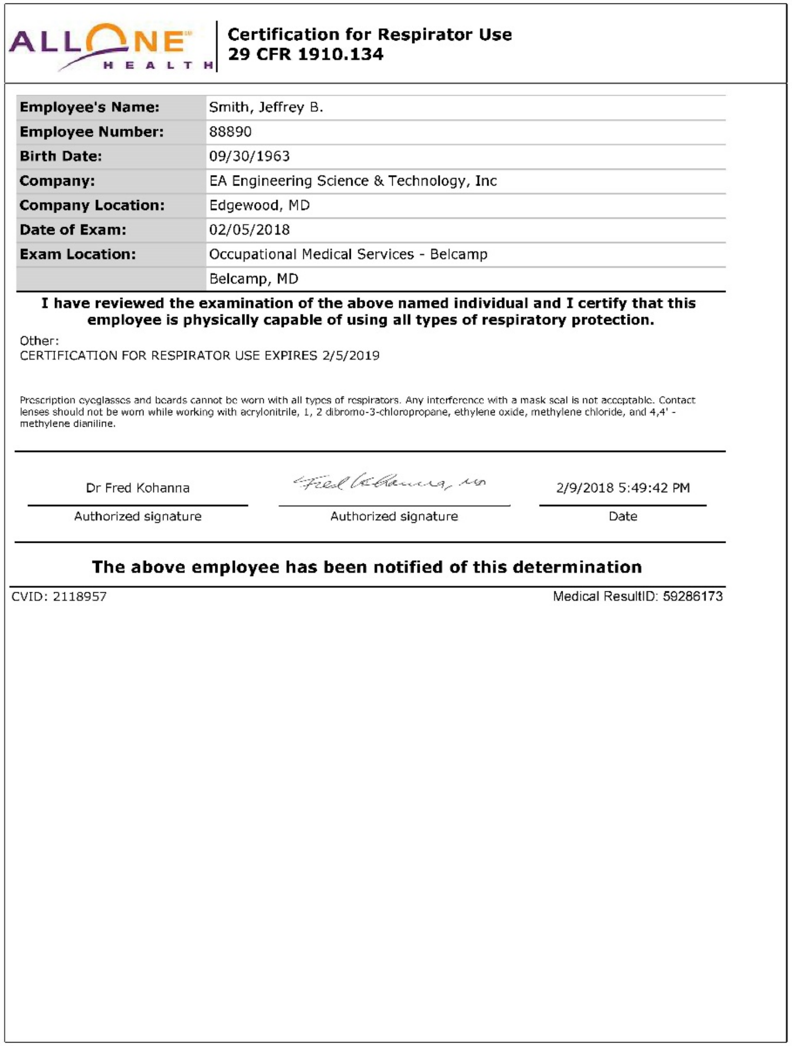
Dr. Fred Kohanna MD	Fred Kohanna, MD	2/9/2018 5:49:32 PM
Authorized Physician	Authorized signature	Date

CVID: 2118957

Med ResultID: 59286163

Respirator Certification of Use

(Expires 2/9/2019)



ALLONE HEALTH

Certification for Respirator Use
29 CFR 1910.134

Employee's Name:	Smith, Jeffrey B.
Employee Number:	88890
Birth Date:	09/30/1963
Company:	EA Engineering Science & Technology, Inc
Company Location:	Edgewood, MD
Date of Exam:	02/05/2018
Exam Location:	Occupational Medical Services - Belcamp
	Belcamp, MD

I have reviewed the examination of the above named individual and I certify that this employee is physically capable of using all types of respiratory protection.

Other:
CERTIFICATION FOR RESPIRATOR USE EXPIRES 2/5/2019

Prescription eyeglasses and beards cannot be worn with all types of respirators. Any interference with a mask seal is not acceptable. Contact lenses should not be worn while working with acrylonitrile, 1, 2 dibromo-3-chloropropane, ethylene oxide, methylene chloride, and 4,4' - methylene dianiline.

Dr Fred Kohanna	Fred Kohanna, MD	2/9/2018 5:49:42 PM
Authorized signature	Authorized signature	Date

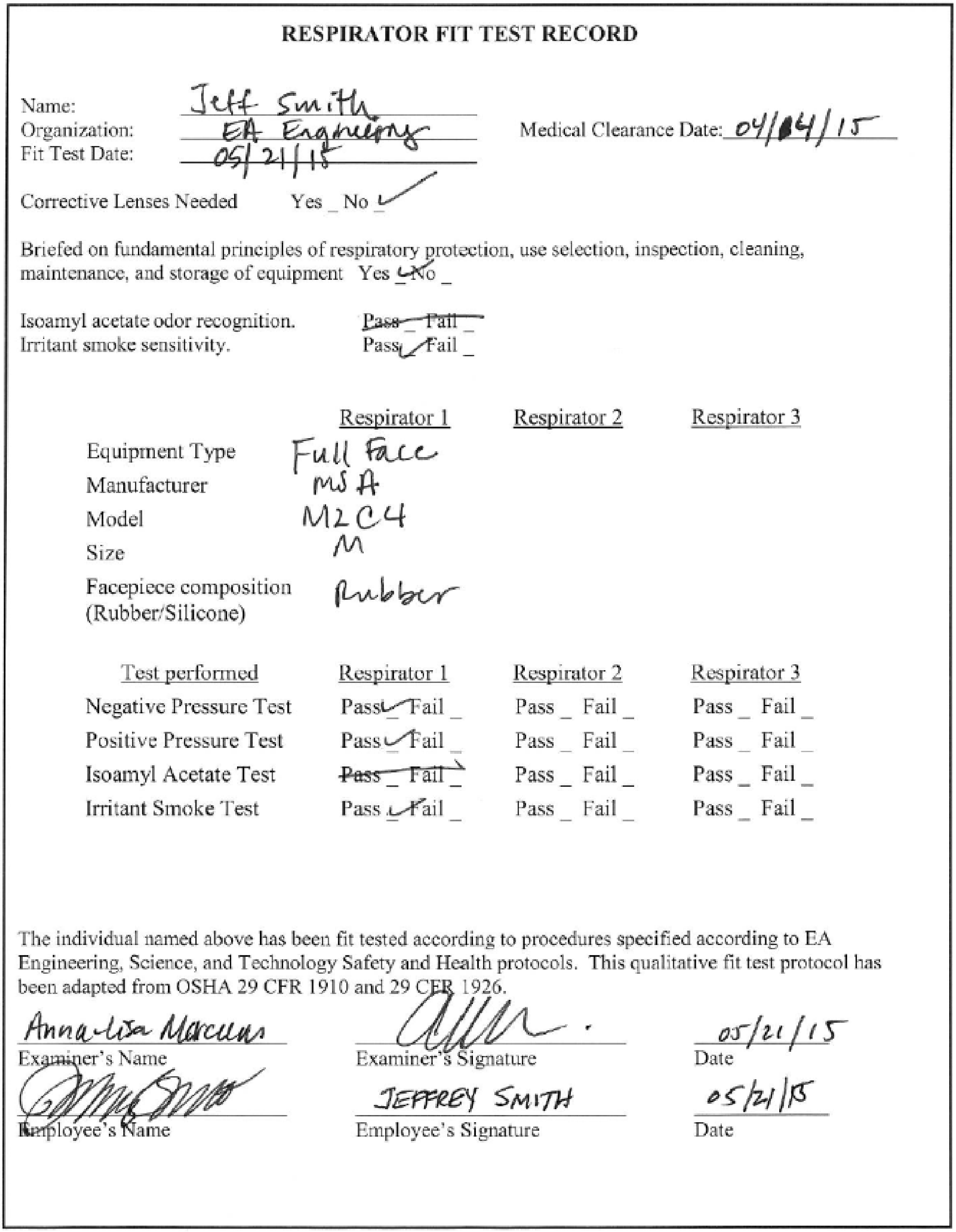
The above employee has been notified of this determination

CVID: 2118957

Medical ResultID: 59286173

Respirator Fit Test

(Expires 05/21/2016)



RESPIRATOR FIT TEST RECORD

Name: Jeff Smith
Organization: EA Engineering
Fit Test Date: 05/21/15
Medical Clearance Date: 04/[illegible]4/15

Corrective Lenses Needed Yes _ [✓ No]

Briefed on fundamental principles of respiratory protection, use selection, inspection, cleaning, maintenance, and storage of equipment [✓ Yes] No _

Isoamyl acetate odor recognition. ~~Pass _ Fail _~~
Irritant smoke sensitivity. [✓ Pass] Fail _

	Respirator 1	Respirator 2	Respirator 3
Equipment Type	Full Face		
Manufacturer	MSA		
Model	M2C4		
Size	M		
Facepiece composition (Rubber/Silicone)	Rubber		

Test performed	Respirator 1	Respirator 2	Respirator 3
Negative Pressure Test	[✓ Pass] Fail _	Pass _ Fail _	Pass _ Fail _
Positive Pressure Test	[✓ Pass] Fail _	Pass _ Fail _	Pass _ Fail _
Isoamyl Acetate Test	~~Pass _ Fail _~~	Pass _ Fail _	Pass _ Fail _
Irritant Smoke Test	[✓ Pass] Fail _	Pass _ Fail _	Pass _ Fail _

The individual named above has been fit tested according to procedures specified according to EA Engineering, Science, and Technology Safety and Health protocols. This qualitative fit test protocol has been adapted from OSHA 29 CFR 1910 and 29 CFR 1926.

Anna-Lisa Marcum		05/21/15
Examiner's Name	Examiner's Signature	Date
	JEFFREY SMITH	05/21/15
Employee's Name	Employee's Signature	Date

JOHN D. MARLOWE

Graduated Basic EOD/UXO School: Canadian EOD Specialty Course, OCT 1979
40 Hour HAZWOPER: NOV 1996
30 Hour Construction Safety: SEP 2013
8 Hour Refresher: JAN 2016
8 Hour Supervisor: NOV 2014
CPR: APR 2015
First Aid: APR 2015

MILITARY EOD EXPERIENCE:

NOV 79 – OCT 84	Canadian Forces Bases Chatham, Canada, 416 TAC (F) SQN, EOD Technician
NOV 84 – AUG 90	Canadian Armed Forces Cold Lake, Canada, Wing 4, AETE, EOD Technician
SEP 90 – JUN 91	Canadian Armed Forces Cold Lake, Canada, Wing 4, 419 TAC(F) SQN, EOD Supervisor
JUL 91 – JUN 96	Canadian Armed Forces Cold Lake, Canada, Wing 4, EOD Center #19 NCO I/C

Total Military EOD Experience: 16 years 8 months

CIVILIAN UXO EXPERIENCE:

OCT 96 – DEC 98	UXO Tech II, Human Factors Applications, Inc., Aberdeen Proving Ground, Maryland, Removal Action
JAN 99 – SEP 99	UXO Tech III, Human Factors Applications, Inc., Aberdeen Proving Ground, Maryland, Removal Action
OCT 99 – JUL 00	UXOSO, Human Factors Applications, Aberdeen Proving Ground, Maryland, Removal Action
AUG 00 – MAR 03	SUXOS, Human Factors Applications, Aberdeen Proving Ground, Maryland, Construction Support
APR 03 – OCT 13	UXOSO, General Physics, Aberdeen Proving Ground, Maryland, Construction Support
NOV 13 – DEC 13	UXO Tech II, EA Engineering, Science, and Technology, Inc., Aberdeen Proving Ground, Maryland, Construction Support

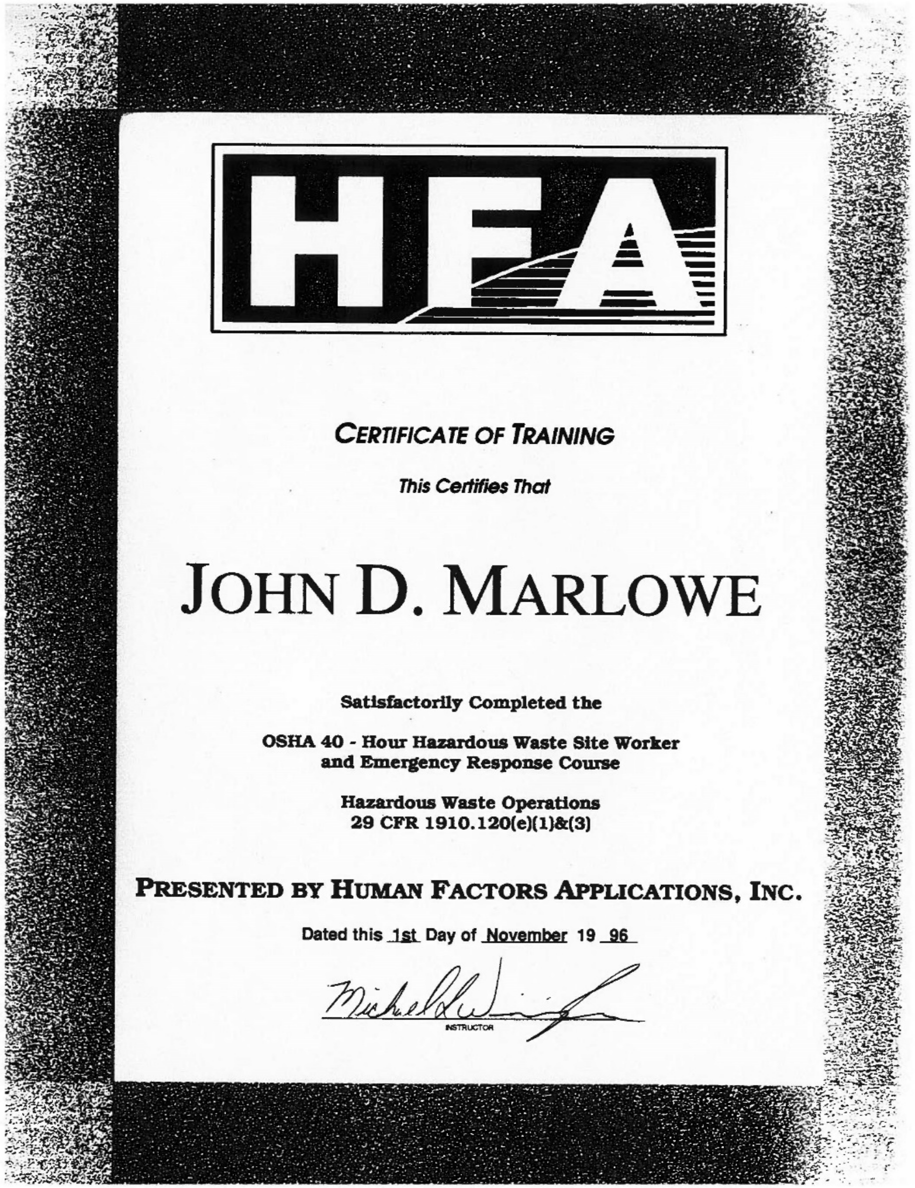
JAN 14 – APR 14	UXO Tech III, EA Engineering, Science, and Technology, Inc., Langley Air Force Base, Virginia, Remedial Investigation
MAY 14 – MAR 15	UXO Tech III, EA Engineering, Science, and Technology, Inc., Aberdeen Proving Ground, Maryland, Construction Support Air Force Base, Virginia, Remedial Investigation
MAY 15 – DEC 15	Site Supervisor/SUXOS, EA Engineering, Science, and Technology, Inc., Combat Readiness Training Center Volk Field, Wisconsin, Interim Removal Action and Remedial Investigation
JAN 16 – MAY 16	UXO Tech III, EA Engineering, Science, and Technology, Inc., Aberdeen Proving Ground, Maryland, Construction Support
JUN 16 – JUL 16	SUXOS, EA Engineering, Science, and Technology, Inc., Joint Base Cape Cod, Massachusetts, Remedial Investigation
JUL 16 –AUG 16	SUXOS, EA Engineering, Science, and Technology, Inc., Former York Naval Ordnance Plant (Formerly Used Defense Site), York, Pennsylvania, Remedial Investigation
AUG 16 – SEP 16	UXOQCS/SO, EA Engineering, Science, and Technology, Inc., Base Realignment and Closure Range 17 Soil Remediation at Patuxent research Refuge, Fort George G. Meade, Maryland, Removal Action
SEP 16 – NOV 16	SUXOS, EA Engineering, Science, and Technology, Inc., Former Mortar Impact Area, U.S. Army Garrison Yuma Proving Ground, Arizona, Interim Removal Action

Total Civilian UXO Experience: 20 years

Marlowe Safety and Health Certifications

1. 40-Hour HAZWOPER Original	(No Expiration)	(11/1/1996)
2. 8-HR Supervisor	(No Expiration)	(11/287/2014)
3. 8-HR Refresher for 40hrHAZWOPER	(Annual)	(1/6/2019)
4. First Aid/CPR	(Biannual)	(3/31/2019)
5. Bloodborne Pathogen	(Annual)	(11/2/2019)
6. Medical Surveillance	(Annual)	(1/27/2019)
7. Certification for Respirator Use	(Annual)	(1/27/2019)
8. Respirator Fit Test Documentation	(Annual)	(6/12/19)
9. Basic Explosive Ordnance Disposal	(No Expiration)	(9/30/1995)

Original 40-Hour HAZWOPER
(Does Not Expire)



HFA

CERTIFICATE OF TRAINING

This Certifies That

JOHN D. MARLOWE

Satisfactorily Completed the

OSHA 40 - Hour Hazardous Waste Site Worker
and Emergency Response Course

Hazardous Waste Operations
29 CFR 1910.120(e)(1)&(3)

PRESENTED BY HUMAN FACTORS APPLICATIONS, INC.

Dated this 1st Day of November 19 96

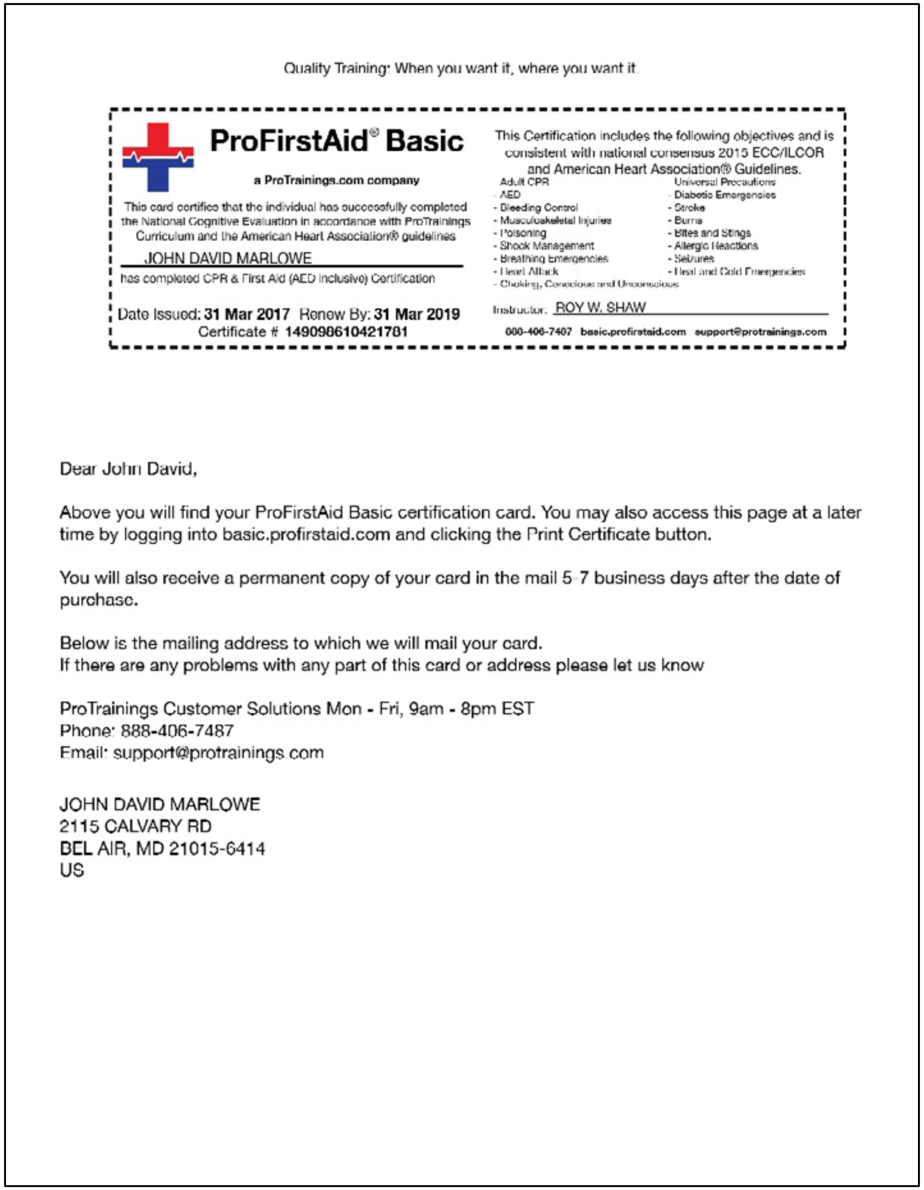
INSTRUCTOR

8-Hour Supervisor Training

(Does Not Expire)

8-Hour HAZWOPER Refresher
(Expires 01/06/2019)

First Aid and Cardiopulmonary Resuscitation (Expires 3/31/2019)



Quality Training: When you want it, where you want it.

ProFirstAid® Basic

a ProTrainings.com company

This card certifies that the individual has successfully completed the National Cognitive Evaluation in accordance with ProTrainings Curriculum and the American Heart Association® guidelines

JOHN DAVID MARLOWE

has completed CPR & First Aid (AED inclusive) Certification

Date Issued: **31 Mar 2017** Renew By: **31 Mar 2019**

Certificate # **149098610421781**

This Certification includes the following objectives and is consistent with national consensus 2015 ECC/ILCOR and American Heart Association® Guidelines.

Adult CPR
- AED
- Bleeding Control
- Musculoskeletal Injuries
- Poisoning
- Shock Management
- Breathing Emergencies
- Heart Attack
- Choking, Conscious and Unconscious

Universal Precautions
- Diabetic Emergencies
- Stroke
- Burns
- Bites and Stings
- Allergic Reactions
- Seizures
- Heat and Cold Emergencies

Instructor: ROY W. SHAW

888-406-7487 basic.profirstaid.com support@protrainings.com

Dear John David,

Above you will find your ProFirstAid Basic certification card. You may also access this page at a later time by logging into basic.profirstaid.com and clicking the Print Certificate button.

You will also receive a permanent copy of your card in the mail 5-7 business days after the date of purchase.

Below is the mailing address to which we will mail your card.
If there are any problems with any part of this card or address please let us know

ProTrainings Customer Solutions Mon - Fri, 9am - 8pm EST
Phone: 888-406-7487
Email: support@protrainings.com

JOHN DAVID MARLOWE
2115 CALVARY RD
BEL AIR, MD 21015-6414
US

Bloodborne Pathogen
(Expires 11/2/2019)

EA Engineering, Science, and Technology, Inc.

Certificate of Training

PRESENTED TO

John Marlow

FOR COMPLETION OF

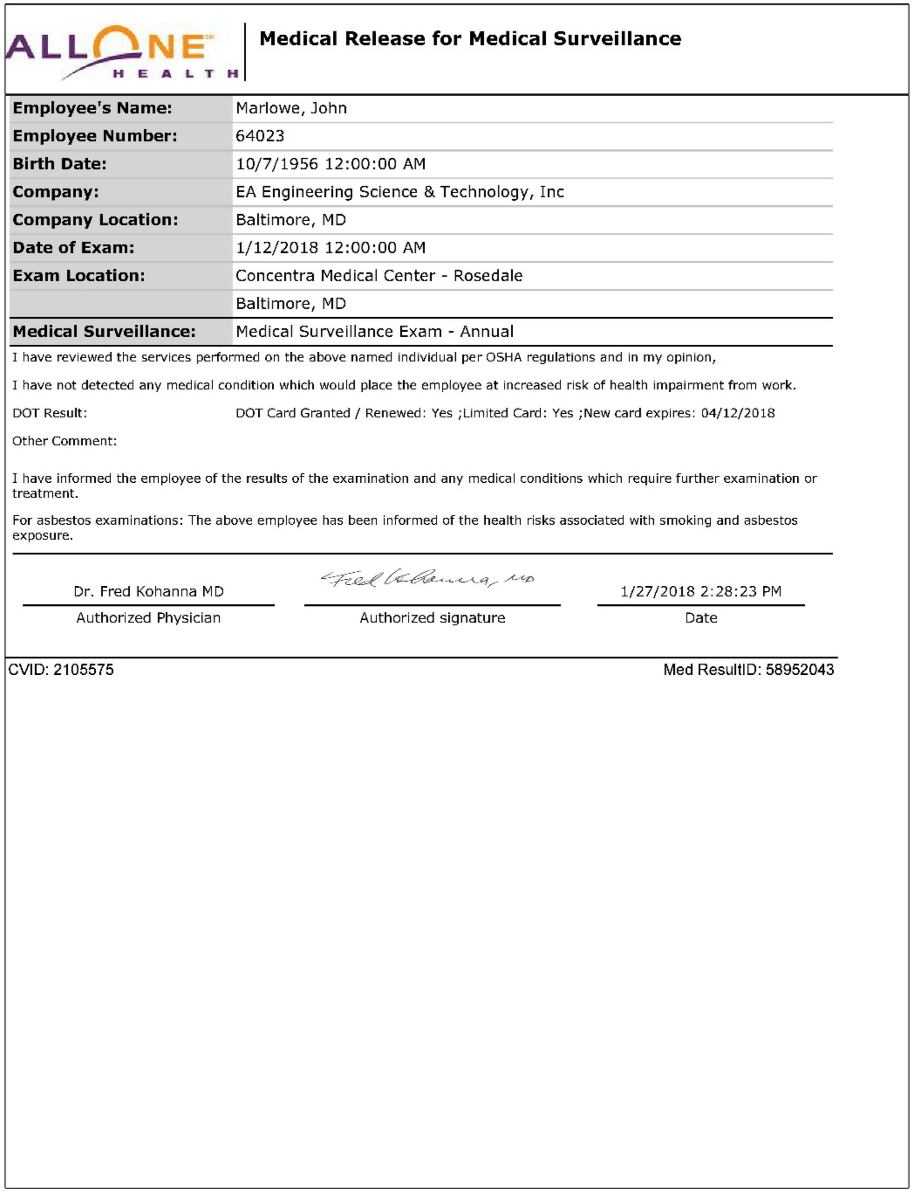
Blood-Borne Pathogen Training
IAW 29 CFR 1910.130

02 November 2018

Peter Garger

Peter Garger, CIH, CSP

Medical Surveillance
(Expires 01/27/2019)



ALLONE HEALTH

Medical Release for Medical Surveillance

Employee's Name:	Marlowe, John
Employee Number:	64023
Birth Date:	10/7/1956 12:00:00 AM
Company:	EA Engineering Science & Technology, Inc
Company Location:	Baltimore, MD
Date of Exam:	1/12/2018 12:00:00 AM
Exam Location:	Concentra Medical Center - Rosedale
	Baltimore, MD
Medical Surveillance:	Medical Surveillance Exam - Annual

I have reviewed the services performed on the above named individual per OSHA regulations and in my opinion,

I have not detected any medical condition which would place the employee at increased risk of health impairment from work.

DOT Result: DOT Card Granted / Renewed: Yes ;Limited Card: Yes ;New card expires: 04/12/2018

Other Comment:

I have informed the employee of the results of the examination and any medical conditions which require further examination or treatment.

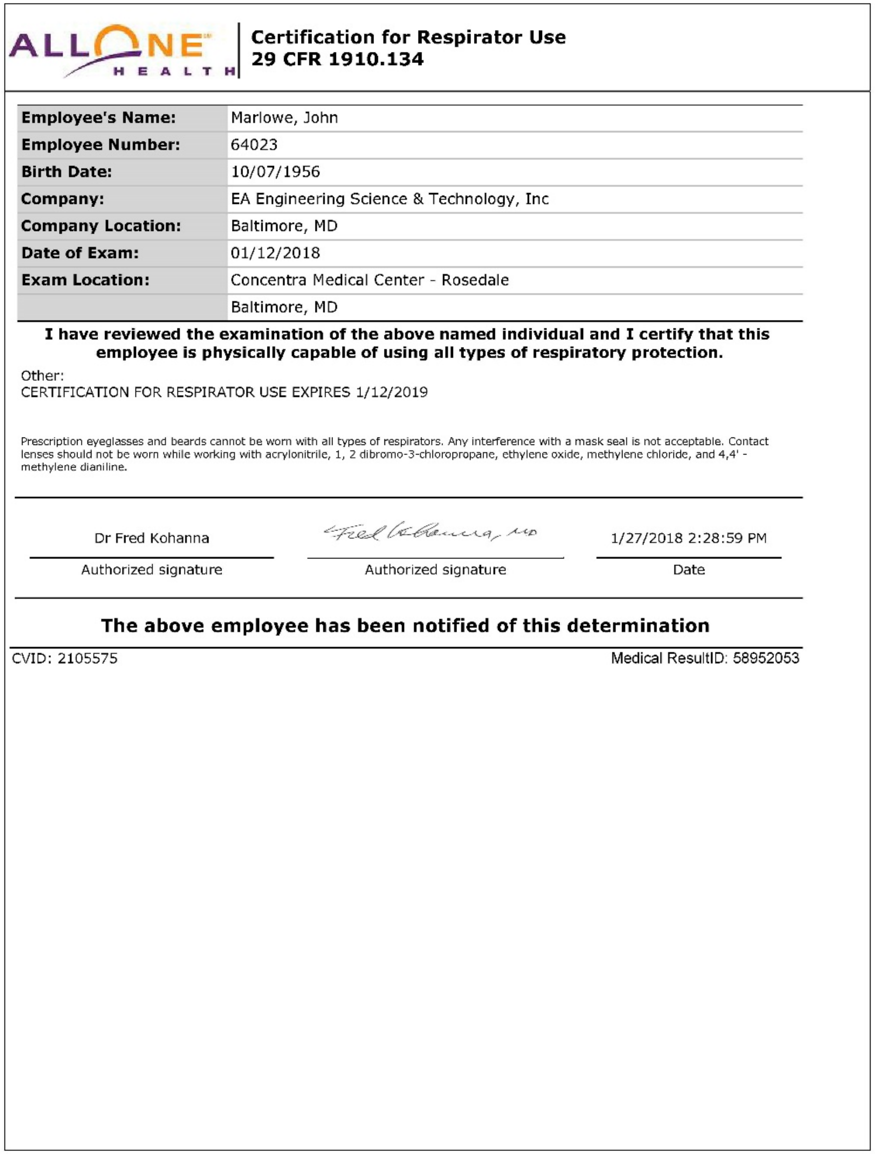
For asbestos examinations: The above employee has been informed of the health risks associated with smoking and asbestos exposure.

Dr. Fred Kohanna MD	Fred Kohanna, MD	1/27/2018 2:28:23 PM
Authorized Physician	Authorized signature	Date

CVID: 2105575

Med ResultID: 58952043

Certification for Respirator Use
(Expires 01/09/2019)



ALLONE HEALTH

Certification for Respirator Use
29 CFR 1910.134

Employee's Name:	Marlowe, John
Employee Number:	64023
Birth Date:	10/07/1956
Company:	EA Engineering Science & Technology, Inc
Company Location:	Baltimore, MD
Date of Exam:	01/12/2018
Exam Location:	Concentra Medical Center - Rosedale
	Baltimore, MD

I have reviewed the examination of the above named individual and I certify that this employee is physically capable of using all types of respiratory protection.

Other:
CERTIFICATION FOR RESPIRATOR USE EXPIRES 1/12/2019

Prescription eyeglasses and beards cannot be worn with all types of respirators. Any interference with a mask seal is not acceptable. Contact lenses should not be worn while working with acrylonitrile, 1, 2 dibromo-3-chloropropane, ethylene oxide, methylene chloride, and 4,4' - methylene dianiline.

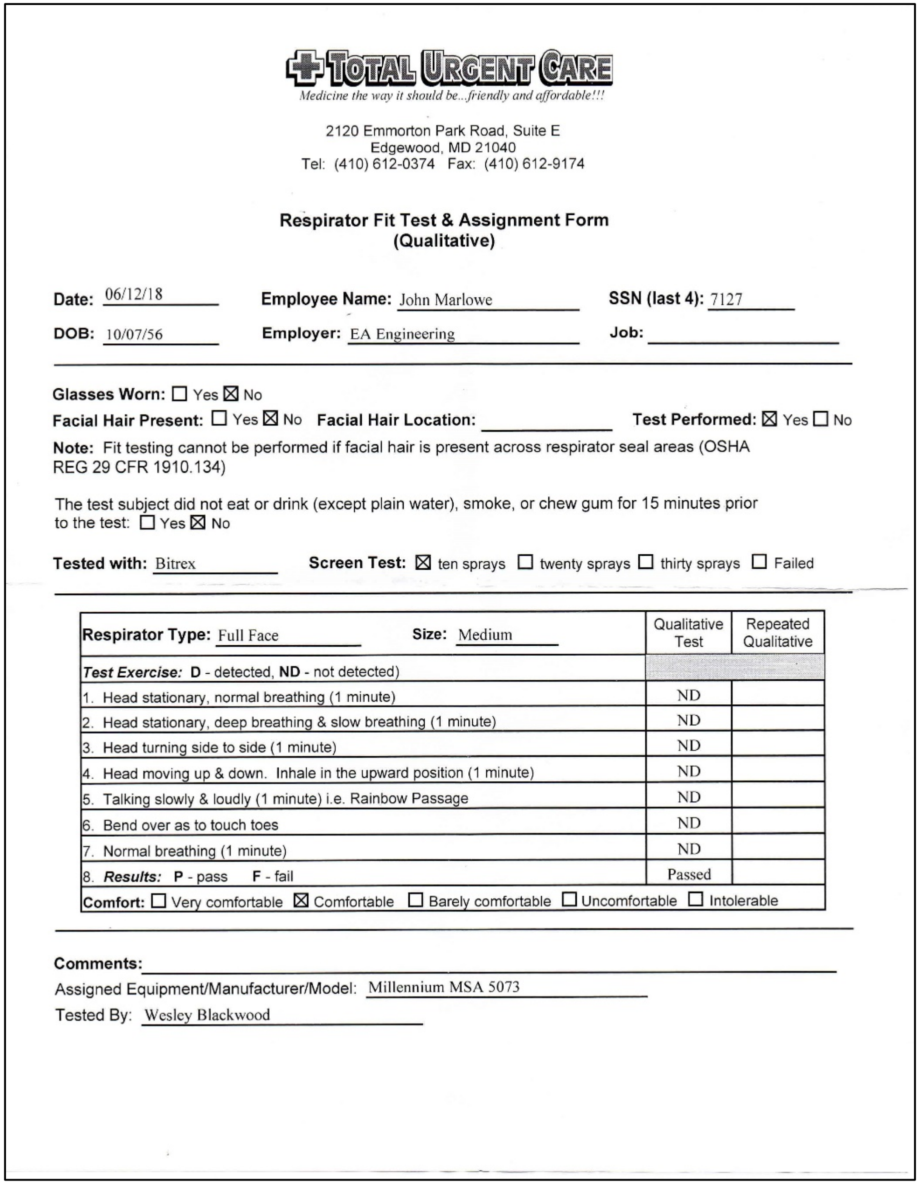
Dr Fred Kohanna	Fred Kohanna, MD	1/27/2018 2:28:59 PM
Authorized signature	Authorized signature	Date

The above employee has been notified of this determination

CVID: 2105575

Medical ResultID: 58952053

Respirator Fit Test Documentation (Expires 6/12/2019)



TOTAL URGENT CARE
Medicine the way it should be...friendly and affordable!!!

2120 Emmorton Park Road, Suite E
Edgewood, MD 21040
Tel: (410) 612-0374 Fax: (410) 612-9174

Respirator Fit Test & Assignment Form
(Qualitative)

Date: 06/12/18 **Employee Name:** John Marlowe **SSN (last 4):** 7127

DOB: 10/07/56 **Employer:** EA Engineering **Job:** ____________

Glasses Worn: ☐ Yes ☒ No

Facial Hair Present: ☐ Yes ☒ No **Facial Hair Location:** ____________ **Test Performed:** ☒ Yes ☐ No

Note: Fit testing cannot be performed if facial hair is present across respirator seal areas (OSHA REG 29 CFR 1910.134)

The test subject did not eat or drink (except plain water), smoke, or chew gum for 15 minutes prior to the test: ☐ Yes ☒ No

Tested with: Bitrex **Screen Test:** ☒ ten sprays ☐ twenty sprays ☐ thirty sprays ☐ Failed

Respirator Type: Full Face **Size:** Medium	Qualitative Test	Repeated Qualitative
Test Exercise: **D** - detected, **ND** - not detected)		
1. Head stationary, normal breathing (1 minute)	ND	
2. Head stationary, deep breathing & slow breathing (1 minute)	ND	
3. Head turning side to side (1 minute)	ND	
4. Head moving up & down. Inhale in the upward position (1 minute)	ND	
5. Talking slowly & loudly (1 minute) i.e. Rainbow Passage	ND	
6. Bend over as to touch toes	ND	
7. Normal breathing (1 minute)	ND	
8. ***Results:*** **P** - pass **F** - fail	Passed	
Comfort: ☐ Very comfortable ☒ Comfortable ☐ Barely comfortable ☐ Uncomfortable ☐ Intolerable		

Comments: ____________

Assigned Equipment/Manufacturer/Model: Millennium MSA 5073

Tested By: Wesley Blackwood

Basic Explosive Ordnance Disposal

(Does Not Expire)

Naval School
Explosive Ordnance Disposal

Certificate of Completion

Presented to

K14-635-678 Sgt. Marlowe, J.D.

For having successfully completed the prescribed course of study for
INTERNATIONAL EXPLOSIVE ORDNANCE DISPOSAL
PHASE II (SURFACE) A - 431 - 0020
on this, the Thirteenth day of October 1995.

CDR J.K. Lake, USN
Commanding Officer

John T. Monk

UXO Safety Officer (UXOSO)

Mr. Monk is a Senior Unexploded Ordnance Supervisor (SUXOS) with more than 27 years of experience in Explosive Ordnance Disposal (EOD) Munitions and Explosives of Concern (MEC) and construction projects including acting as Safety and Health Officer (SSHO) and UXO Safety Officer (UXOSO). His project work focuses primarily on safety during the location, removal/disposal, and clearance of conventional, biological, radiological, and chemical warfare munitions (CWM) munitions. Mr. Monk is trained and experienced in performing air monitoring, implementing emergency procedures, and in selecting and wearing PPE. Mr. Monk has operated as a site safety officer, for MEC-related and non-MEC-related projects for over 72 non-overlapping months. Dates prior to 2009 were not required to meet or exceed the standard 60 month requirement.

Professional Experience

SSHO/Senior UXO/MEC Supervisor/Technical Specialist (1987-Present)—Coordinate with range personnel at installations with regard to safety related and munitions use on ranges both past and present. Experience with construction activities and associated safety and health concerns, investigation of sites for safety and health hazards, ensuring proper selection and use of PPE, use of monitoring equipment, and safety and health compliance. Provide health and safety briefings for personnel on site visits. Provide technical review of remedial design projects including safety procedures. Writes site safety and health plans (SSHP).

Qualifications

Education

Naval Explosive Ordnance Disposal School Indian Head, MD

Registrations/Certifications

USACE UXO Specialist (No. 0737)

Specialized Training

OSHA 30-Hour Construction Safety Course; 2005
40-Hour OSHA Hazardous Waste Operations Safety Training Course; 1998
OSHA Hazardous Waste Supervisor's Training Course
OSHA 8-Hour Site Managers and Supervisors Training Course; 2001
OSHA 8-Hour HAZWOPPER Refresher; June 2013
OSHA physical-July 2013
USACE Construction Quality Management for Contractors Course; 2010
Department of Natural Resources and Environmental Control Soil and Water Conservation (Blue Card) Course; 2005
Competent Person Trenching & Excavation, West Virginia University; 2002
Fall Prevention & Protection Competent Person Training; 2002
Dangerous Goods Shipping Procedures; 2002
First Aid and CPR; 2012
Master EOD Technician; 1996
Range Safety Supervisor
Hazardous Waste Management and Shipping for Environmental Professionals; 2001

EA Project Experience

Aberdeen Proving Grounds Aberdeen Area, and Other Edgewood Areas, Maryland, MEC/UXO Construction Support, Department of Public Works Aberdeen Proving Ground; Ongoing, January 2010 –Present [22 Months over a total period of 48 months]; Site Safety and Health Officer (SSHO) and UXO Safety Officer (UXOSO)—Safety Officer for construction support projects on the Aberdeen and Edgewood Areas overseeing various personnel including subcontractors involved in replacing/repairing utilities, trenching and excavation operations, operating heavy equipment, directional drilling, installing wells, soil remediation, wetlands delineation and constructing new buildings. Provided site-specific awareness training to all onsite personnel, including associated subcontractors and new (additional) onsite personnel, prior to the initiation of all activities. Mr. Monk fulfills this role when not on other assignments therefore the total number of months in that role is fewer than the total number of months (48 from January 2010 to present).

Arnold Air Force Base, Military Munitions Response Program, Remedial Investigation, Tennessee; U.S. Army Corps of Engineers (USACE)–Omaha District; February- May 2013 [4 months]; UXO Quality Control Specialist (UXOQCS) and Site Safety and Health Officer (4 Months)—UXOQCS responsible for insuring all activities were performed by Team personnel as outlined in the Work Plan (WP), Accident Prevention Plan (APP), Site Safety and Health Plan (SSHP) and the Quality Assurance Performance Plan (QAPP). Performed Quality Control procedures on all completed grids by the UXO Team. Inventory and inspection of explosives storage magazines on a weekly bases and observed all demolition activities for disposal of live UXO items. Observe Team personnel perform equipment checks daily. Performed MPPEH procedures on munitions debris, certified as Material Documented as Safe (MDAS) to ship, containerized and shipment to scrap metal facility.

Naval Base Magazine, Guam, Environet-Clear, Tree Planting, Santa Rita, Guam; Environet, Inc.; October-November 2012 [0 non-overlapping months]; Senior UXO Supervisor (SUXOS)— SUXOS responsible for insuring all activities were performed by Team personnel as outlined in the Work Plan (WP), Accident Prevention Plan (APP), Site Safety and Health Plan (SSHP) and the Standard Operating Procedures (SOP). Closely monitored and observed the UXO Team during surface clearance of grids for WWII UXO/MEC items. Closely monitored and observed eleven local contractor personnel perform brush clearing of underbrush for all seven acres of the site. Performed MPPEH procedures on munitions debris and certified for turnover to the Naval Guam EOD detachment and larger items shipped to an off island metal recycling contractor for disposal. Coordinated with the EOD Detachment for disposal of five UXO/MEC items found during all activities.

Alpena Combat Readiness Training Center (CRTC), Military Munitions Response Program, Remedial Investigation, Alpena, Michigan; U.S. Army Corps of Engineers (USACE)–Omaha District; September-October 2012 [0 non-overlapping months]; Senior UXO Supervisor (SUXOS)—SUXOS, ***s***upervised six personnel in MEC remedial investigation operations for the inactive 20mm burn pan areas and sampling activities for water/ soil in the area of the inactive burn pan. Closely monitored/observed the UXO Team and the brush clearing crew while they investigate anomalies in the lanes the brush crew cleared of underbrush and small trees, for the remedial investigation. Assisted in the preparation for the quality inspection by quality assurance/quality control personnel and recorded on daily reports. Ensured all safety procedures were covered during the safety meetings each morning provided by the UXO Safety Officer.

Moody Air Force Base (AFB) Remedial Investigation/Feasibility Study (RI/FS), Valdosta, Georgia; U.S. Army Corps of Engineers (USACE)–Omaha District; July-November 2012 [4 non-overlapping months]; Senior UXO Supervisor (SUXOS)— Supervised five personnel in MEC remedial investigation operations for the inactive 40mm range and sampling activities for water/sediment/soil on the inactive skeet range. Closely monitored and observed the UXO Team in the performance of Mag/Flag and Mag/Dig activities. Assisted in the preparation for the quality inspection by quality assurance/quality control personnel and recorded on daily reports. Ensured all safety procedures were covered during the safety meetings each morning provided by the UXO Safety Officer.

Milford and Sussex Ordnance Company, Milford and Sussex, Delaware, MEC Avoidance activities; DNREC; May & August 2012 [2 non-overlapping months]; Senior UXO Technical Specialist—UXO Safety Officer (UXOSO) for avoidance activities during site walk, direct push water, surface soil sampling activities and recon. Performed morning tailgate safety meetings for the site walk; direct push operations; and water/soil sampling activities. Accompanied 3 personnel during initial site walk activities. Supervised 5 personnel during all activities to ensure all MEC safety procedures were enforced and followed during reconnaissance of old explosives manufacturing buildings and at 8 locations for direct push water and surface soil sampling activities.

Remedial Investigation Offutt AFB, NE; USACE—Omaha District; January 2011 –April 2012 [16 non-overlapping months]: UXO Safety Officer/Quality Control Specialist— Responsible for establishing and ensuring compliance with MEC operational risks, as well as all other site specific hazards and safety requirements including: Chemical Warfare Material (CWM) hazards including enforcement of personnel limits, exclusion zones, emergency personnel decontamination station (EPDS) procedures and setup; explosives exclusion zones, explosives transportation, storage and destruction. Conduct daily safety briefings and safety inspections to ensure compliance with MEC and explosives safety codes; and operate and maintain air Monitoring equipment required at the site for possible CWM. Provide Health and Safety training on heavy equipment operation and trenching activities prior to conducting to conducting operation and trenching activities, Ensure proper equipment checks were performed on heavy equipment prior to daily operations..

Military Munitions Response Program Remedial Investigation of Aberdeen Proving Ground; 2010 –2011 [0 non-overlapping months]; UXOSO and SSHO— Responsible for establishing and ensuring compliance with UXO and explosives operational risks, as well as all other site specific hazards and safety requirements including: enforcement of personnel limits and safety exclusion zones, explosives transportation, storage, and destruction. Conducted daily safety briefings and safety inspections to ensure compliance with UXO and explosives safety codes; and operated and maintained air monitoring equipment required at site for airborne contaminates. Provided Health and Safety training on Heavy Equipment operation and trenching activities prior to conducting equipment operation and trenching activities. Ensured proper equipment checks were performed on heavy equipment prior to daily operations.

***Aberdeen Proving Grounds Aberdeen Area, and Other Edgewood Areas, Maryland, MEC/UXO Construction Support, Department of Public Works Aberdeen Proving Ground; January 2009 – December 2010 [24 non-overlapping months]; Safety Officer*—**Safety Officer for construction support projects on the Aberdeen and Edgewood Areas overseeing various personnel involved in replacing/repairing utilities, operating heavy equipment, installing wells and constructing new buildings. Provided site-specific awareness training to all onsite personnel, including associated subcontractors and new (additional) onsite personnel, prior to the initiation of all activities.

***Operational Range Assessment Program; USACE; 2006 – Present; Safety Officer*—**Implemented and enforces programmatic safety procedures, including providing MEC awareness training, performing tailgate safety briefings, and investigating and reporting accidents and near misses. Roles for this work were as-needed at over 10 different installations and during every sampling season.

Munitions and Explosives of Concern Support at Governor Harry W. Nice Memorial Bridge Improvement Project; 2009; Safety Officer —Prepared and enforced the Accident Prevention Plan for activities occurring on-site including equipment inspection, subsurface boring and trenching. Duties also entailed presenting daily tailgate briefings and performing safety reporting.

Non-Department of Defense, Non-Operational Defense Site Inventory, Western U.S. Region Army National Guard; 2007 – 2009; UXO Safety Officer—Implemented programmatic safety and health plans; reviewed and inspected for compliance of SSHP, provided safety oversight during field operations**.**

St. Georges Bridge, St. Georges, Delaware; USACE–Philadelphia District, Delaware Department of Natural Resources and Environmental Control; 2007; Safety Officer—Responsible for developing and implementing health and safety procedures for all personnel onsite. Supervised field activities including operation of heavy equipment during excavation of remediation pits, maintenance of the site entry and exit log and implementation of PPE usage.

U.S. Air Force, Eielson Air Force Base, Alaska, MEC Geophysical Screening and Anomaly Removal at the Garrison Slough; 2007; Safety Officer — Responsible for developing and implementing health and safety procedures during removal of 600 MEC anomalies below the waterline. Duties included presenting onsite health and safety meetings, compliance with Site Safety and Health Plan, ensuring the proper calibration and use of monitoring equipment and monitoring proper use of personal protective equipment (PPE).

Remedial Investigation/Feasibility Study Wake Island; Air Force Center for Environmental Excellence, Hickam Air Force Base, Hawaii; 2006; Senior UXO/MEC Supervisor/Technical Specialist— Performed daily health, safety and operations briefings, provided safety oversight during boat operations, drilling and monitoring well installation, heavy equipment operations and soil, sediment, surface water and groundwater sample collection.

MEC Design Build, Urunao, Guam; Air Force Center for Environmental Excellence, Andersen Air Force Base; 2004 – 2005; Senior UXO/MEC Supervisor/Technical Specialist—Supervised subcontractor personnel while they investigated UXO anomalies. Developed procedures to document MEC activities on-site including daily safety inspections.

Other Project Experience

Spring Valley, D.C. Geophysical Survey, USACE–Baltimore; 2002—UXO Safety Officer- Responsible for implementing the approved explosives and UXO safety program in compliance with all DOD, Federal, state, and local statutes and codes. Analyzed UXO and explosives operational risks, hazards, and safety requirements; enforced personnel limits and safety exclusion zones for UXO clearance operations, explosives transportation, storage, and destruction; conducted safety inspections to ensure compliance with safety codes; and operated and maintain air monitoring equipment required across nine locations ranging in size from 1 to 2 acres.

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Monk Safety and Health Certifications

1.	40-Hour HAZWOPER Original	(No Expiration)	(05/22/1998)
2.	8-HR Supervisor	(No Expiration)	(05/27/2015)
3.	30-HR Construction	(No Expiration)	(07/15/2005)
4.	8-HR Refresher for 40hrHAZWOPER	(Annual)	(5/17/2018)
5.	First Aid/CPR	(Biannual)	(1/9/2019)
6.	Bloodborne Pathogens Workplace	(Annual)	()
7.	Medical Surveillance	(Annual)	(05/29/2019)
8.	Certification for Respirator Use	(Annual)	(05/29/2019)
9.	Basic Ordnance Disposal	(No Expiration)	(2/19/1987)

Original 40-Hour HAZWOPER
(Does Not Expire)

HFA

CERTIFICATE OF TRAINING

This Certifies That

JOHN MONK

Satisfactorily Completed the

OSHA 40 Hour - Hazardous Waste Site Worker
And Emergency Response Course

Hazardous Waste Operations
29 CFR 1910.120(e)(1)&(3)

PRESENTED BY HUMAN FACTORS APPLICATIONS, INC.

Dated this 22nd Day of May 1998

INSTRUCTOR

8-Hour Supervisor Training

(Does Not Expire)

Certificate of Completion

This certifies that

John T Monk

Has Successfully completed

8 Hour HAZWOPER Supervisor Refresher Training

This certification alone does NOT indicate INITIAL 8 Hour OSHA Supervisor Training

In Accordance With Federal OSHA Regulation 29 CFR 1910.120(e)(8)

And all State OSHA/EPA Regulations as well

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044)

Julius P. Griggs
Julius P. Griggs
Instructor #892

1505275141193
Certificate Number

5/27/2015
Issue Date

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-869-7097 (fax)
www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training
Want to be sure this certificate is valid? Visit safetyunlimited.com/verification

30-Hour Construction
(Does Not Expire)

OSHA 600058970

U.S. Department of Labor
Occupational Safety and Health Administration

John Monk

has successfully completed a 30-hour Occupational Safety and Health Training Course in

Construction Safety & Health

Ron Bruce 63214 7/15/05

(Trainer) (Date)

8-Hour HAZWOPER Refresher
(Expires 03/23/2019)

Certificate of Completion

This certifies that

John T. Monk

has successfully completed

8 Hour HAZWOPER Refresher Training

Refresher certification does NOT necessarily indicate initial 24 or 40 Hour HAZWOPER certification

In Accordance w/Federal OSHA Regulation 29 CFR 1910.120(e) & (p)

And all State OSHA/EPA Regulations as well including 29 CFR 1926.65 for Construction.

This course (Version 3) is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) (Accreditation # 044).

Julius P. Griggs
Julius P. Griggs
Instructor #892

1805175238768
Certificate Number

5/17/2018
Issue Date

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https://www.safetyunlimited.com

Scan this code or visit www.safetyunlimited.com/v to verify certificate.

Proof of initial certification and subsequent refresher training is NOT required to take refresher training

First Aid and Cardiopulmonary Resuscitation (Expires 12/08/2019)

American Red Cross

John Monk

has successfully completed requirements for

Adult First Aid/CPR/AED: valid 2 Years

Date Completed: 01/09/2017

conducted by: American Red Cross

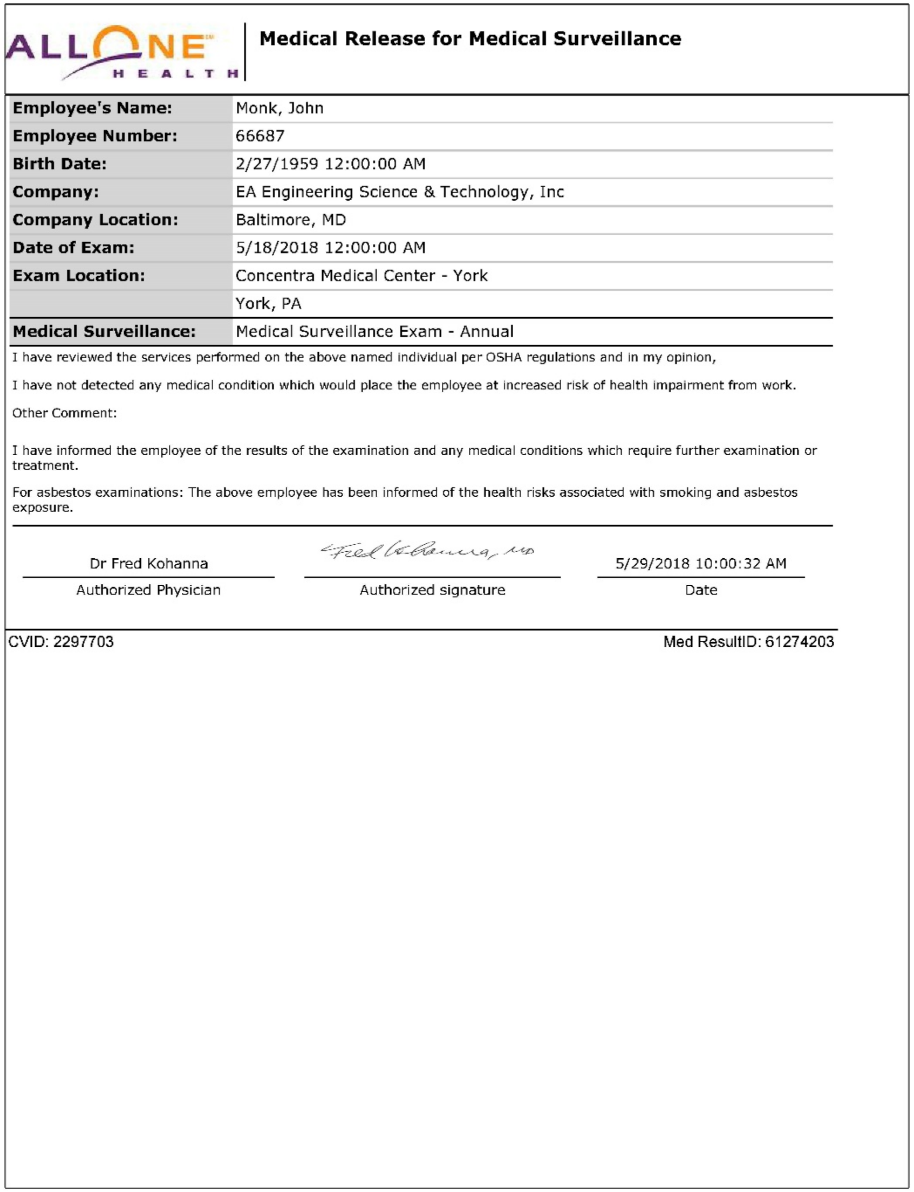
Instructor: Ann Evans

ID: 0ZESVA

Scan code or visit:

redcross.org/confirm

Medical Surveillance
(Expires 05/29/2019)



ALLONE HEALTH

Medical Release for Medical Surveillance

Employee's Name:	Monk, John
Employee Number:	66687
Birth Date:	2/27/1959 12:00:00 AM
Company:	EA Engineering Science & Technology, Inc
Company Location:	Baltimore, MD
Date of Exam:	5/18/2018 12:00:00 AM
Exam Location:	Concentra Medical Center - York
	York, PA
Medical Surveillance:	Medical Surveillance Exam - Annual

I have reviewed the services performed on the above named individual per OSHA regulations and in my opinion,

I have not detected any medical condition which would place the employee at increased risk of health impairment from work.

Other Comment:

I have informed the employee of the results of the examination and any medical conditions which require further examination or treatment.

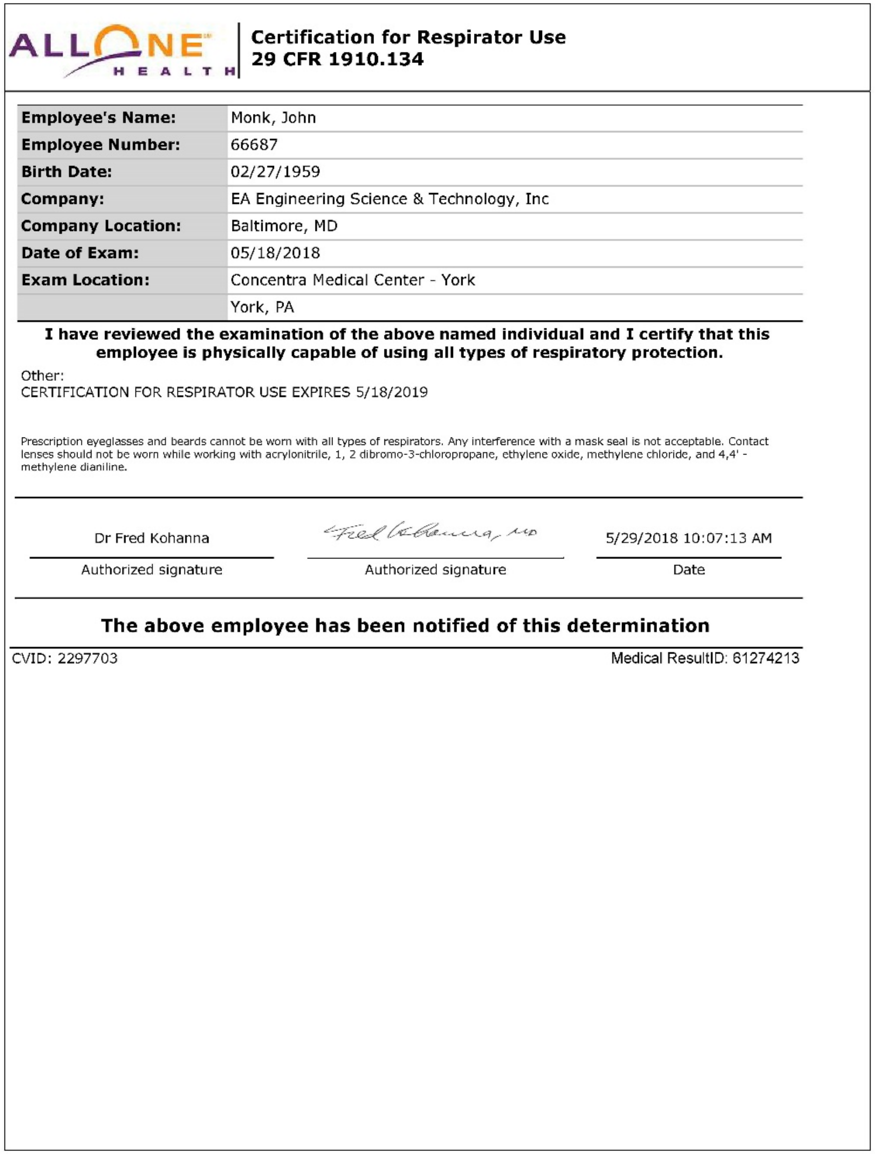
For asbestos examinations: The above employee has been informed of the health risks associated with smoking and asbestos exposure.

Dr Fred Kohanna	Fred Kohanna, MD	5/29/2018 10:00:32 AM
Authorized Physician	Authorized signature	Date

CVID: 2297703

Med ResultID: 61274203

Certification for Respirator Use
(Expires 01/09/2019)



ALLONE HEALTH

Certification for Respirator Use
29 CFR 1910.134

Employee's Name:	Monk, John
Employee Number:	66687
Birth Date:	02/27/1959
Company:	EA Engineering Science & Technology, Inc
Company Location:	Baltimore, MD
Date of Exam:	05/18/2018
Exam Location:	Concentra Medical Center - York
	York, PA

I have reviewed the examination of the above named individual and I certify that this employee is physically capable of using all types of respiratory protection.

Other:
CERTIFICATION FOR RESPIRATOR USE EXPIRES 5/18/2019

Prescription eyeglasses and beards cannot be worn with all types of respirators. Any interference with a mask seal is not acceptable. Contact lenses should not be worn while working with acrylonitrile, 1, 2 dibromo-3-chloropropane, ethylene oxide, methylene chloride, and 4,4' - methylene dianiline.

Dr Fred Kohanna	Fred Kohanna, MD	5/29/2018 10:07:13 AM
Authorized signature	Authorized signature	Date

The above employee has been notified of this determination

CVID: 2297703
Medical ResultID: 61274213

WARD R. STERN
PHONE: (256) 731-9151
EMAIL: wrstern@tecoptic.com

OVERVIEW:

For over thirty years I have planned and accomplished safe execution of work, which consisted of heavy equipment operation, construction, construction safety, quality control, quality assurance, explosives operations, explosive safety, environmental investigations and remediation projects, demining, physical security, C-IED intelligence gathering, EOD instruction and curriculum development.

During this time, I have focused all professional energies on studying and practicing the various facets of the science and art of Explosive Ordnance Disposal (EOD)/ Unexploded Ordnance (UXO). Each project has brought opportunities to employ possessed knowledge, skills and abilities, as well as to acquire new experiences that continue to build my effectiveness in executing the required standard.

Periodically, I provide, gratis, UXO industry related articles and information to the on-line source, UXOInfo.com, as well provide training images to the US Army EOD Training Department, Ft Lee, VA to promote the betterment of the tradecraft/ industry.

NAVAL BASIC EOD SCHOOL: APR - SEP 1981 **OSHA ANNUAL HAZWOPER PHYSICAL DATE:** FEB 2018

OTHER PERTINENT TRAINING: USACE CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS 2016; FIRST AID/ CPR 2016; HAZWOPER 8 HOUR REFRESHER 2018; PRACTICAL LOSS CONTROL LEADERSHIP, DET NORSKE VERITAS 2008; CONSTRUCTION 30 HOUR 2007; OSHA HAZARDOUS WASTE SITE SUPERVISOR TRAINING 2007; CULTURAL RESOURCE MANAGEMENT COMPLIANCE FOR NON-SPECIALISTS 2003; HAZWOPER 40 HOUR 1995; US ARMY AMMUNITION QUALITY ASSURANCE INSPECTOR 1985; US ARMY EXPLOSIVE SAFETY COURSE 1985

USACE # 0349

MILITARY EOD/ CONTRACTOR EOD RELATED POSITIONS:

JUL 12 - JUL 13	Explosives (HME) Instructor, US BATFE Contractor, BATFE HME Course, Redstone Arsenal, AL
MAR 11 - JUN 11	EOD Demolition Instructor, US Army Contractor, Redstone Arsenal, AL
JUL 08 – AUG 10	EOD Fuzing and Demolition Instructor, US Army Contractor, Redstone Arsenal, AL/ EOD Training Developer, US Army Contractor, Ft Lee, VA
MAY 88 - NOV 90	Senior Ammunition Quality Assurance (QA) Inspector, 10th Trans. Bn., Ft. Eustis, VA
MAY 85 - MAY 88	Ammunition QA Inspector, 23rd Ord. Co., Kriegsfeld, Germany
AUG 81 - MAR 85	EOD Technician, 56th EOD, Ft. Indiantown Gap, PA

CIVILIAN UXO EXPERIENCE:

AUG 18 – PRESENT	SUXOS, MMG, Beltway 9963 Project, Orlando, FL – RA: Manage Two UXO Teams, Vegetation Removal, Non-Munition Related Debris (NMRD) Metals Reclamation
APR 18 – JUL 18	UXOSO, MMG, USACE, Arnold AFB, TN – Analog/ DGM RI: Magnetometer Assisted Surface Clearance, subsurface Digital Geophysical Mapping (DGM), target selection, reacquisition and intrusive investigations, Buried Explosive Module (BEM)
NOV 17 – MAR 18	UXOQCS, Bristol Environmental Services, USACE, University of Nevada, Las Vegas, NV – DGM/ Analog RI: MDAS Demilitarization/ Certification, Blind Seeding Program (BSP)
NOV 17 – NOV 17	UXO Tech III, EA Engineering, USACE, Edgewood Arsenal, MD – Analog, Construction Support
OCT 17 – NOV 17	UXOQCS/ UXOSO, AEROTEK, USACE, Ft Polk, LA – Analog RA: MDAS Certification, BSP
JUN 17 – SEP 17	UXOQCS/ UXOSO, EA Engineering, USACE, JBCC, MA – Analog RI: MDAS Certification, BSP
MAR 17 – JUN 17	UXOQCS, EA Engineering, USACE, Camp Claiborne, LA – Analog RA: MDAS Certification, BSP
JAN 17 – MAR 17	UXOQCS/ UXOSO, AECOM, NAVSEA, UXO Outfall Ditch Area, NAS Kingsville, TX – DGM RI and Analog RA: MDAS Certification, BSP, BEM
OCT 16 – NOV 16	SUXOS, BAY WEST LLC, Volk Field, WI – RI: Two Teams Excavation reacquired targets, MDAS Cert., BEM
OCT 16 – OCT 16	UXOQCS/ UXOSO, AECOM, The former Shumaker Naval Ammunition Depot (NAD), Camden AR – Construction Support, MDAS Certification, Thermal Treatment Plant
SEP 16 – SEP 16	UXOQCS/ UXOSO, AECOM, NAVSEA, Fleming Key Dredge Spoils Area, NAS Key West, FL – RI: Excavation reacquired targets, MDAS Certification.
AUG 16 – AUG 16	UXOQCS/UXOSO, EA Engineering, Science and Technology, AFCEE, Hill AFB, UT – RA: Excavation reacquired targets, Heavy Equipment and Power Screen Sifting of former burn pads, Lead Abatement, MDAS Certification, and Demolition Operations.
JUN 16 – JUL 16	UXOQCS/ UXOSO, EA Engineering, AFCEE, Joint Base CC, MA – Pre-RI and Former York Naval Ordnance Plant, York, PA – RI: Excavation reacquired targets, MDAS Certification, X-Ray identification of HEAT MEC 2.36” Rockets, BEM.
APR 16 – MAY 16	Technician III, EOTI Munitions and Env. Svcs, Chaffee, AR – RA: Clearance, MD Sorting.
NOV 15 – DEC 15	SUXOS, ERT, Inc., Ft Hancock, NJ – RI: Two Teams, Selected Target Investigation, Livens Projectiles.
MAY 15 – NOV 15	UXOQCS/UXOSO, AEROTEK, Volk Field, WI – RI: TRANSECTS and RA
NOV 14 - APR 15	UXOQCS, AECOM, Ft McClellan, AL – RI: TRANSECTS
JUL 13 - SEP 14	UXOQCS, Kemron Env Svcs, Ft McClellan, AL – RA, and Tooele AD-South, UT - RA

CIVILIAN UXO EXPERIENCE (continued):

SEP 10 – DEC 10	SUXOS, DynCorp Intl, Fairfax, VA/ US State Dept., Afghanistan – RA: One Team LN, Battle Area Clearance (BAC)
MAR 06 – JUL 08	UXOQC/UXOSO, TetraTech ECI, Bothell, WA and USACE CMCP, Iraq – RA: BAC
JUL 04 - MAR 06	UXOQC/UXOSO, AMEC E&E, Ft A.P Hill, VA – RA/ Hurlburt Field, FL, Ft McCoy, WI – RI
JAN 01 - JUL 04	UXOQC/UXOSO, AMEC E& E, Massachusetts Military Reservation, MA - RI
NOV 00 - DEC 00	Technician III, Plexus Scientific, Columbia, Kansas Army Ammunition Plant, KS – RI: Perchlorate Sump Sampling
OCT 00 - NOV 00	Technician II/ Equipment Operator, Omegasys Env Svcs, Redstone Arsenal, AL - RA
JUN 00 - SEP 00	Technician II, Sudhakar Company Inc., Redstone Arsenal, AL - RA
MAR 99 - JUN 00	UXOQC/UXOSO, Plexus Scientific JAAP, IL - RA LCAAP, KS – RI
SEP 98 - MAR 99	Technician II, ECC, Mare Island Straight, CA - RI
JUN 98 - SEP 98	Technician II, Plexus Scientific, Indiana and Longhorn AA Plant, IN and TX - RI
MAR 98 - JUN 98	Technician II, EOD-T, Panama Canal Zone, Panama - RI
NOV 97 - MAR 98	Technician II/ Heavy Equipment, Ft. Rucker, AL – RA: Construction Support
OCT 97 - NOV 97	Technician III, ETSC Government Services, Wright-Patterson AF Base, OH - RA
AUG 97 - OCT 97	Technician III, OrdSafe Ltd., Texaco Oil, Kwanda Base, Soyo, Angola - RA
JUN 97 - AUG 97	Technician II, HFA, Dolly Sods Wilderness Area, WV - RA
APR 97 - JUN 97	Technician II, EHSI, Berkley, CO - RA
APR 96 - APR 97	Technician II, ETSC Government Services, Joliet Army Ammunition Plant, IL – RI and RA
FEB 96 - APR 96	Technician III/ Heavy Equipment Operator, IT Corp., Williams AFB, AZ – RA
SEP 95 - NOV 95	Technician II, ATG, Leach Lake, CA – RA: (RANGE MAINTENANCE)
MAR 95 - SEP 95	Technician II, ECC, San Diego, CA - RA
FEB 93 - AUG 93	Technician III, CMS Environmental Inc., Demining, Kuwait – RA: BAC
FEB 92 - FEB 93	Technician II, EOD World Services Inc., Kuwait – RA: BAC
JUN 91 - FEB 92	Technician II UXB Intl, Fallon, NV – Range Maintenance, and Dolly Sods, WV – RI

ARTICLES WRITTEN:

“Lessons Learned in Expedient Improvised Protective Works” May 2012, Ward R. Stern, UXOInfo.com

“Using the Portable X-ray to Acquire Positive Identification” October 2010, Ward Stern, UXOInfo.com

DUTIES AND WORK EXPERIENCE SUMMARY:

Possess experience in heavy equipment operations, construction, construction safety, geophysics collection, ordnance identification, quality control, quality assurance, physical security, explosives operations, explosive safety, MDAS (certification, chain of custody, labeling, shipping), Blind Seeding Program (BSP), training and demining. Performed technical safety reviews, developed and prepared required Quality Control (QC) documentation for Government (client) acceptance. Performed QC inspections on work performed. Reviewed and/or provided input to contract documents, such as Statements of Work and Specifications, for safety/ quality-related implications to ensure considerations were properly addressed. Prepared, updated, or assisted in the development of Safety Assessment Reports, Hazard Analyses, and Safety Risk Assessments. Participated/supported System Safety Working Groups (SSWG). Prepared, reviewed, or provided input to Safety Management Plans (SMPs) and Site Safety Program Plans (SSPPs) and related program management safety and quality documentation. Prepared and maintained Hazard Tracking functions for project office. Conducted and reviewed safety and quality assessments.

MANAGEMENT SKILLS SUMMARY:

EXPLOSIVE SAFETY, QUALITY ASSURANCE, CONSTRUCTION SAFETY/QC OPERATIONS AND MANAGEMENT: Performed safety management/ QA and QC oversight functions on various Facilities Demolition, Property Disposal Classification Projects, Metals Reclamation Operations, Range Maintenance Activities, UXO Disposal Operations, Demolitions Training, Environmental Studies, Remedial Investigations (RI), and Removal Actions (RA).

COMPUTER SKILLS: Proficient with Microsoft Office (Word, Excel, PowerPoint), Adobe Acrobat Professional, and Photoshop.

PERSONNEL MANAGEMENT/ TEAM BUILDING SKILLS: Possess sound management background, sound judgment, outstanding problem solving, and excellent communication skills. Experienced in building and managing sustainable, goal-oriented programs.

EDUCATION:

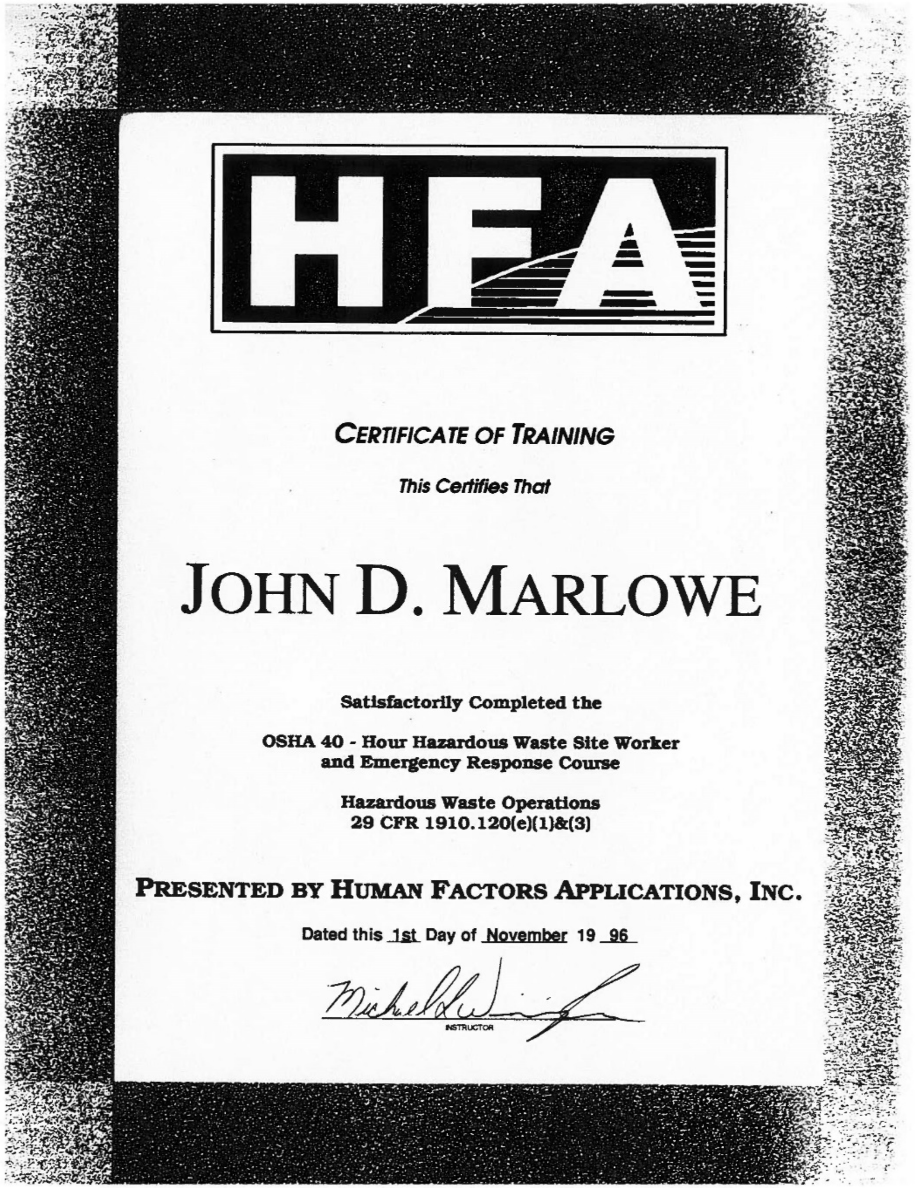
Air University (10/14/1986 - 10/14/1987): Maxwell AFB, Alabama, Certificate - Major: Safety Specialist

Stern Safety and Health Certifications

1.	40-Hour HAZWOPER Original	(No Expiration)	(11/1/1996)
2.	8-HR Supervisor	(No Expiration)	(11/287/2014)
3.	8-HR Refresher for 40hrHAZWOPER	(Annual)	(1/6/2019)
4.	First Aid/CPR	(Biannual)	(3/31/2019)
5.	Medical Surveillance	(Annual)	(01/27/2019)
6.	Certification for Respirator Use	(Annual)	(01/27/2019)
7.	Basic Explosive Ordnance Disposal	(No Expiration)	(9/25/1981)

Original 40-Hour HAZWOPER

(Does Not Expire)



HFA

CERTIFICATE OF TRAINING

This Certifies That

JOHN D. MARLOWE

Satisfactorily Completed the

OSHA 40 - Hour Hazardous Waste Site Worker
and Emergency Response Course

Hazardous Waste Operations
29 CFR 1910.120(e)(1)&(3)

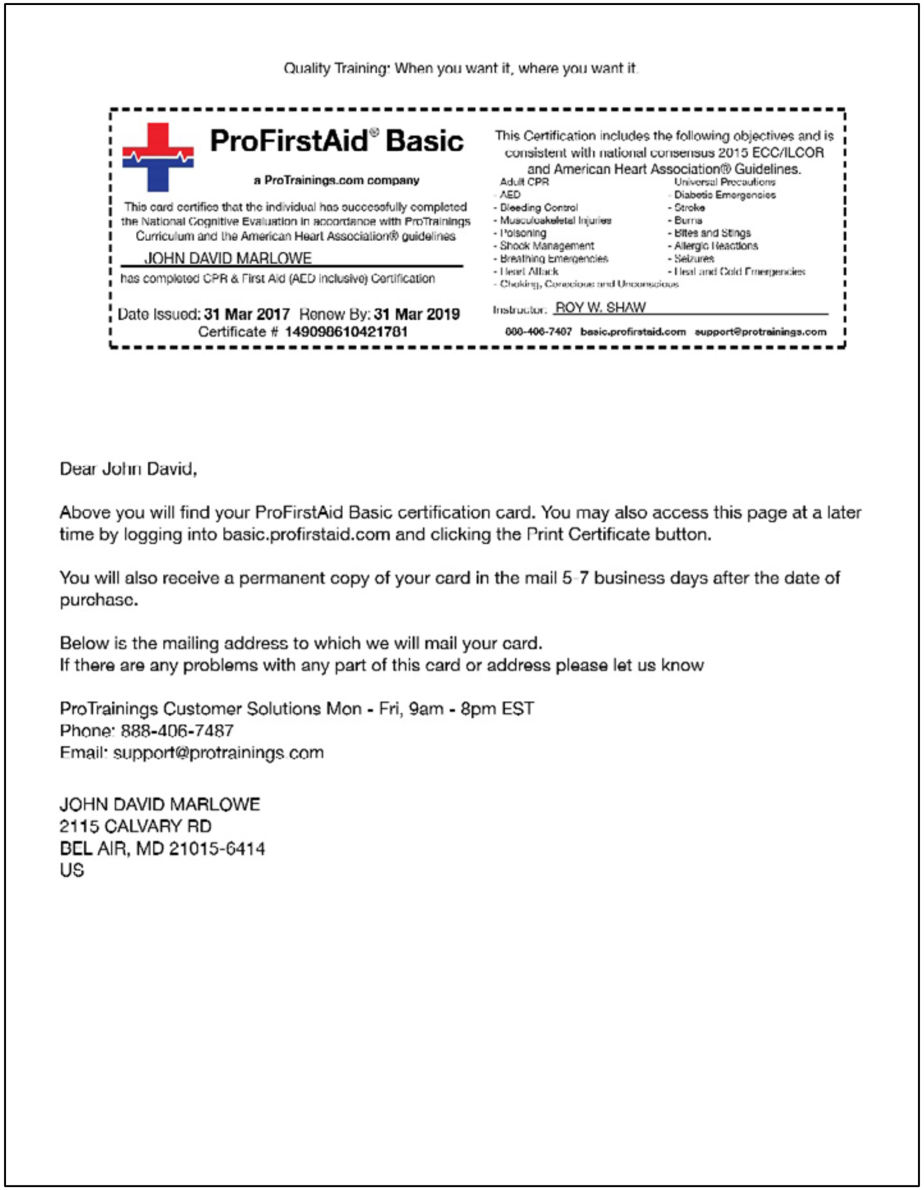
PRESENTED BY HUMAN FACTORS APPLICATIONS, INC.

Dated this 1st Day of November 19 96

Michael

INSTRUCTOR

First Aid and Cardiopulmonary Resuscitation (Expires 3/31/2019)



Quality Training: When you want it, where you want it.

ProFirstAid® Basic

a ProTrainings.com company

This card certifies that the individual has successfully completed the National Cognitive Evaluation in accordance with ProTrainings Curriculum and the American Heart Association® guidelines

JOHN DAVID MARLOWE

has completed CPR & First Aid (AED inclusive) Certification

Date Issued: **31 Mar 2017** Renew By: **31 Mar 2019**
Certificate # **149098610421781**

This Certification includes the following objectives and is consistent with national consensus 2015 ECC/ILCOR and American Heart Association® Guidelines.

Adult CPR
- AED
- Bleeding Control
- Musculoskeletal Injuries
- Poisoning
- Shock Management
- Breathing Emergencies
- Heart Attack
- Choking, Conscious and Unconscious

Universal Precautions
- Diabetic Emergencies
- Stroke
- Burns
- Bites and Stings
- Allergic Reactions
- Seizures
- Heat and Cold Emergencies

Instructor: ROY W. SHAW

888-406-7487 basic.profirstaid.com support@protrainings.com

Dear John David,

Above you will find your ProFirstAid Basic certification card. You may also access this page at a later time by logging into basic.profirstaid.com and clicking the Print Certificate button.

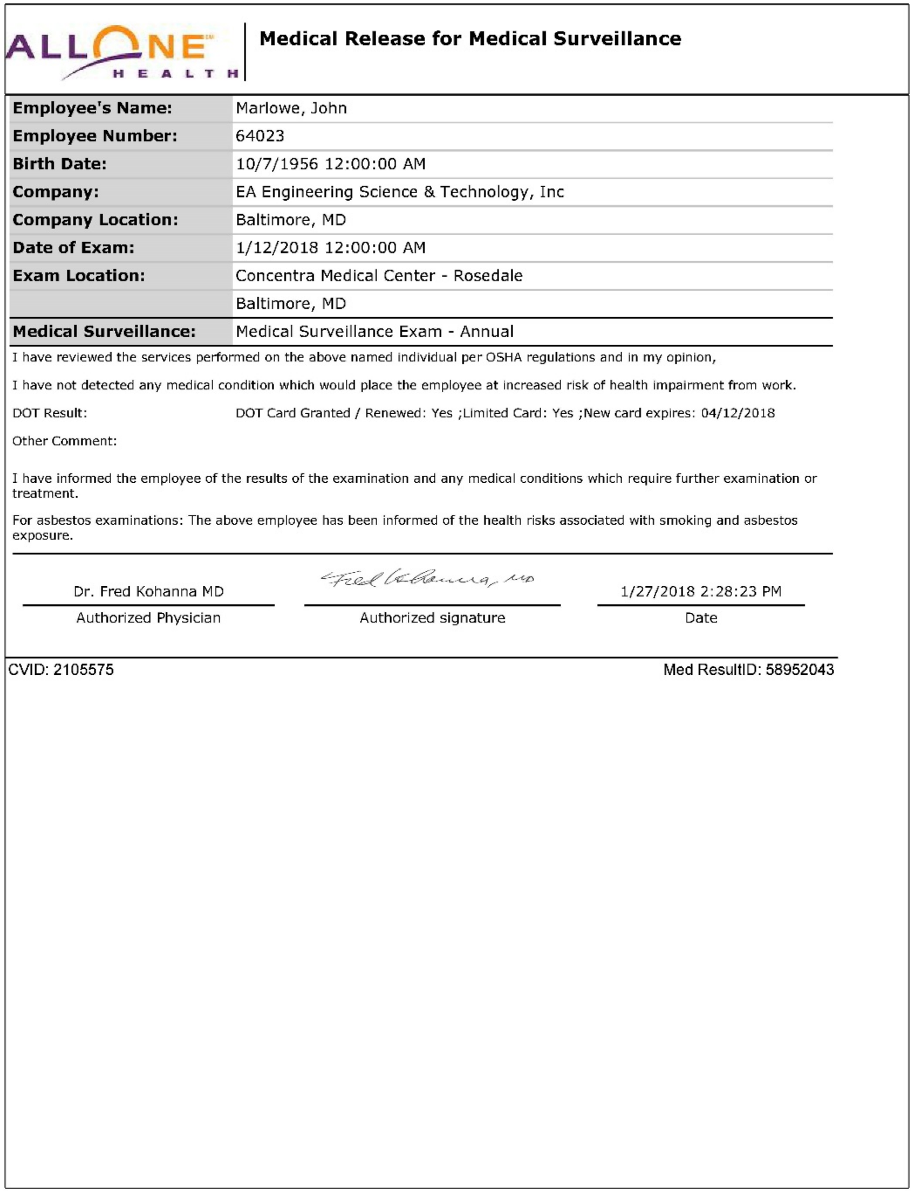
You will also receive a permanent copy of your card in the mail 5-7 business days after the date of purchase.

Below is the mailing address to which we will mail your card.
If there are any problems with any part of this card or address please let us know

ProTrainings Customer Solutions Mon - Fri, 9am - 8pm EST
Phone: 888-406-7487
Email: support@protrainings.com

JOHN DAVID MARLOWE
2115 CALVARY RD
BEL AIR, MD 21015-6414
US

Medical Surveillance
(Expires 01/27/2019)



ALLONE HEALTH

Medical Release for Medical Surveillance

Employee's Name:	Marlowe, John
Employee Number:	64023
Birth Date:	10/7/1956 12:00:00 AM
Company:	EA Engineering Science & Technology, Inc
Company Location:	Baltimore, MD
Date of Exam:	1/12/2018 12:00:00 AM
Exam Location:	Concentra Medical Center - Rosedale
	Baltimore, MD
Medical Surveillance:	Medical Surveillance Exam - Annual

I have reviewed the services performed on the above named individual per OSHA regulations and in my opinion,

I have not detected any medical condition which would place the employee at increased risk of health impairment from work.

DOT Result:	DOT Card Granted / Renewed: Yes ;Limited Card: Yes ;New card expires: 04/12/2018
Other Comment:	

I have informed the employee of the results of the examination and any medical conditions which require further examination or treatment.

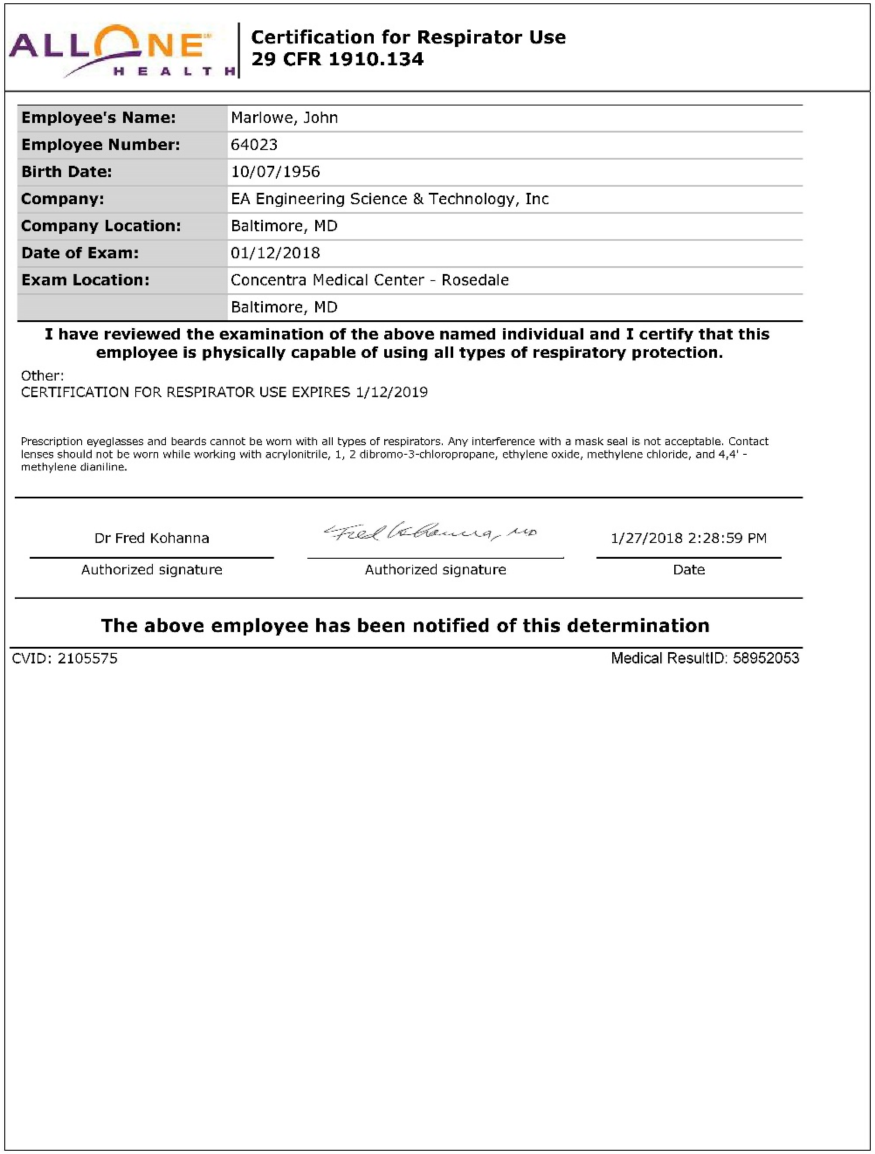
For asbestos examinations: The above employee has been informed of the health risks associated with smoking and asbestos exposure.

Dr. Fred Kohanna MD	Fred Kohanna, MD	1/27/2018 2:28:23 PM
Authorized Physician	Authorized signature	Date

CVID: 2105575

Med ResultID: 58952043

Certification for Respirator Use (Expires 01/09/2019)



ALLONE HEALTH

Certification for Respirator Use
29 CFR 1910.134

Employee's Name:	Marlowe, John
Employee Number:	64023
Birth Date:	10/07/1956
Company:	EA Engineering Science & Technology, Inc
Company Location:	Baltimore, MD
Date of Exam:	01/12/2018
Exam Location:	Concentra Medical Center - Rosedale
	Baltimore, MD

I have reviewed the examination of the above named individual and I certify that this employee is physically capable of using all types of respiratory protection.

Other:
CERTIFICATION FOR RESPIRATOR USE EXPIRES 1/12/2019

Prescription eyeglasses and beards cannot be worn with all types of respirators. Any interference with a mask seal is not acceptable. Contact lenses should not be worn while working with acrylonitrile, 1, 2 dibromo-3-chloropropane, ethylene oxide, methylene chloride, and 4,4' - methylene dianiline.

Dr Fred Kohanna	Fred Kohanna, MD	1/27/2018 2:28:59 PM
Authorized signature	Authorized signature	Date

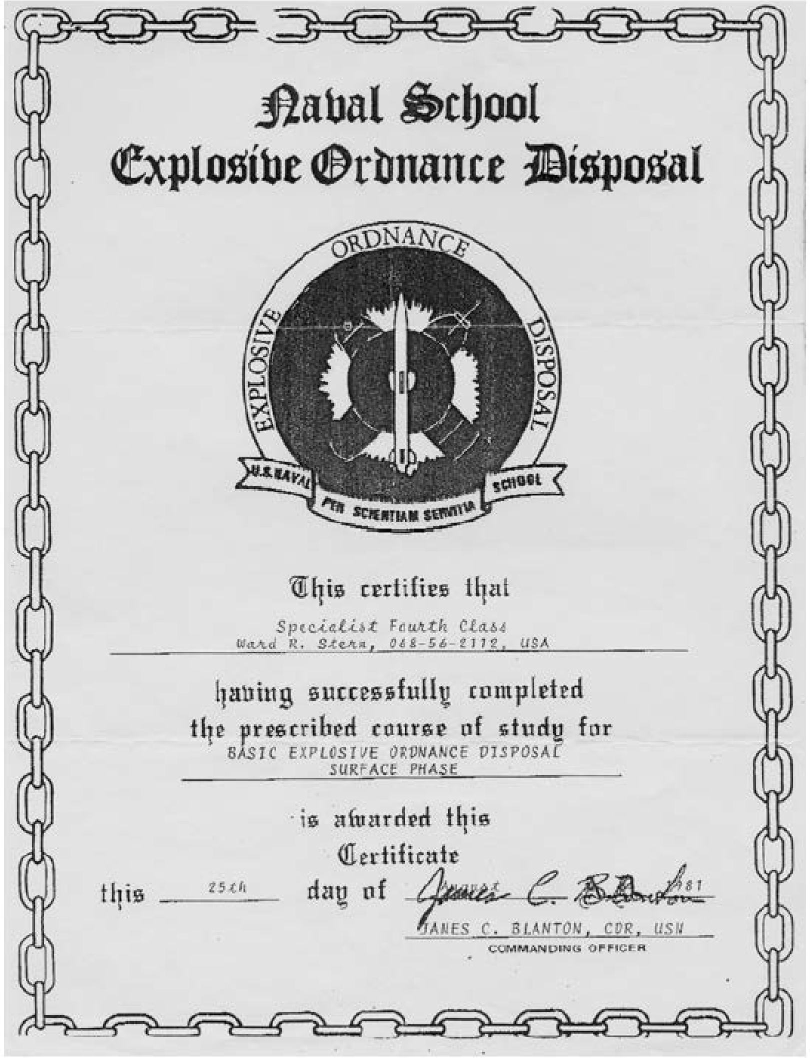
The above employee has been notified of this determination

CVID: 2105575

Medical ResultID: 58952053

Basic Explosive Ordnance Disposal

(Does Not Expire)



Naval School
Explosive Ordnance Disposal

This certifies that

Specialist Fourth Class
Ward R. Stern, 068-56-2112, USA

having successfully completed
the prescribed course of study for
BASIC EXPLOSIVE ORDNANCE DISPOSAL
SURFACE PHASE

is awarded this
Certificate

this 25th day of August 1981

James C. Blanton
JAMES C. BLANTON, CDR, USN
COMMANDING OFFICER

Appendix D

Field and Inspection Forms

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SMALL BOAT INSPECTION CHECKLIST U.S. Army Engineer District, New Orleans	Date of Inspection:
Contractor or Unit	Contract No. Or Activity
Inspected by (Signature)	Witness (Signature)

NOTE: Safety and Health Requirements Manual (EM385-1-1 (15 Sep 08)) references in parentheses.	Yes	No	N/A
1. Are periodic inspections & tests of all marine plant & equipment made to insure safe operating conditions and records retained? (19.A.01(c)(d)).			
2. Are marine plant and/or equipment found to be in unsafe condition, taken out of service and its use prohibited until unsafe conditions are corrected? (19.A.01(e))			
3. Are all items of floating plant or associated equipment stored or placed beyond 20 feet or overhead transmission or distribution lines? (11.E.07)			
4. Has all marine plant & equipment put into use on the job inspected, tested and found to be in safe operating condition before initial use and at least annually thereafter by a qualified person and documentation retained? (19.A.01(a))			
5. Do inspection records maintained at the site become part of the official project file and made available to designated authorities? (19.A.01(d)and (b))			
6. Is the maximum number of passengers that can be safely transported posted on all launches, motorboats and skiffs? (19.F.02(a))			
7. Is a signal device provided on the vessel to give signals required by applicable navigation rules? (19.A.05(c))			
8. Is a fully stocked first aid kit of the proper size on board? (03.B)			
9. Has a Type III/Type V or better USCG personal flotation device (PFD) been provided to all boat passengers and are they properly worn? (Section O5.J)			
10. Are PFD' s inspected for defects, which would alter their buoyancy before and after each use? (05.J.05)			
11. Are defective PFD's or PFD's removed from service? (05.J.02)			
12. Are all PFD's equipped with retro-reflective tape, automatic activating lights and whistles? (05.J.03)			
13. Is each boat equipped with at least one USCG approved life ring or ring buoy with at least 70 feet of solid braid polypropylene line or equal attached? (05.J.03(d))			
14. If adequate lighting is not available (i.e. flood lights/pole lights), are life rings equipped with automatic floating electric water lights (first life ring and at least every third life ring thereafter)? (05.J.03(b))			
15. If the boat or launch is open cabin, is it equipped with a kill switch? (19.F.02(d))			
16. Are all launches and motor boats equipped with fire extinguishers of at least the size and rating(s) specified? (19.F.03; Table 19-1)			
17. Are all carburetors on gasoline engines equipped with backfire trap or flame arrestor? (19.A.06(d))			
18. Are provisions in place to prevent accumulation of fuel and grease on floors and decks and in bilges? (19.A.07(c))			
19. For internal combustion engines with electric spark ignition systems or similar auxiliary engines of this type in cabins, compartments or confined spaces, is the engine equipped with an exhaust fan(s) for ventilating the engine space and bilges? (19.A.10(a)			

MVN Form 385-41R
Sept 2010

Proponent: CEMVN-SS

NOTE: Safety and Health Requirements Manual (EM385-1-1 (15 Sep 08)) references in parentheses.	Yes	No	N/A
20. Are boats powered by internal combustion engines located within compartments or confined spaces equipped with vent fans rated for Class I locations? (19.A.10(g)(1))			
21. Are vent intakes extended to within one foot of the engine compartment bottom? (19.A.10(g)(2))			
22 **BOAT TRAILERING** (Following is related to LA State Law and National Association of Safe Boating Laws. There is no reference to EM-385-1-1 in most cases.)			
a. Is the hitch secured to the tongue locking mechanism sound and non-binding?			
b. Are safety chains and hooks adequate for the size of the load?			
c. Are all lights (brake, turning and running) operating properly?			
d. Are tires in good condition (adequate tread, free of dry rot) and properly inflated?			
e. Are wheel bearings properly lubricated and is the proper torque on the wheel nut?			
f. Are caps and/or buddy bearings installed properly and functional?			
g. Are brakes (if equipped) working properly?			
h. Is the trailer tongue weight proper for the boat carried?			
I. Are rollers and/or bunks properly aligned and in good condition?			
j. Are trailer wheel bearing seals marine grade & do they seal properly to prevent seepage of water into bearings and races?			
k. Has the trailer's master cylinder been checked for proper level of fluid and are there any signs of brake fluid leakage?			
l. Has the trailer's wheel cylinders been inspected for signs of brake fluid leakage under dry conditions?			
m. Is the trailer suspension system adequate and capable of supporting the boat and other equipment loadings?			
n. Is the boat secured at bow and stern when being trailer?			
o. Has a transom saver been installed for support of outboard motor (foot)?			
p. Are trailer safety chains of a sufficient length to properly cradle the trailer tongue?			
23 **TOWING VEHICLE**			
a. Is the vehicle of adequate weight and power to safely tow the loaded boat and trailer?			
b. Is the hitch properly rated for the weight of the boat and trailer to be towed?			
c. Is the hitch secured to the frame (not bumper) of the vehicle?			
d. Is the ball on the hitch the proper size for the trailer to be towed?			
e. Is the ball securely attached to the tow bar?			
f. Is the remote braking mechanism operating properly			
g. Does the towing vehicle have adequately sized rear-view mirrors on both sides?			
h. Is rear suspension of towing vehicle sufficient & in condition to accept trailer tongue weight?			

TAILGATE SAFETY BRIEFING (D-1)

Date: _____/_____/_____ **Location:**______________________

Time: _____________**AM PM** **Team #:** _______________________

1. Reason for Briefing:

	Daily Safety Briefing		New Site Procedure
	Initial Safety Briefing		New Site Information
	New Task Briefing		Review of Site Information
	Periodic Safety Meeting		Other: (Specify)

2. Personnel Attending:

Name	Signature	Position

Briefing Given By:

3. Topics: (Check All That Apply)

	Site Safety Personnel		Decontamination Procedures
	Site/Work Area Description		Emergency Response/Equipment
	Physical Hazards		On-Site Injuries/Illnesses
	Chemical/Biological Hazards		Reporting Procedures
	Heat/Cold Stress		Directions to Medical Facility
	Work/Support Zones		Drug and Alcohol Policies
	PPE		Medical Monitoring
	Safe Work Practices		Evacuation/Egress Procedures
	Air Monitoring		Communications
	Task Being Performed		Confined Spaces
	OE Precautions		Other:

4. Remarks:

ACCIDENT PREVENTION PLAN REVIEW RECORD

SITE: ____________________________________

EA Project No.______________________________

I have read the Accident Prevention Plan and have been briefed on anticipated site hazards, required accident prevention, and emergency response for work to be performed at this site. I agree to conform to all the requirements of this Plan.

Name	Signature	Affiliation	Date

ENVIRONMENTAL MONITORING RECORD

SITE: ____________________

PROJECT NO.: ____________________

INSTRUMENT: ____________________

Time	Monitoring Location	Reading	Corrective Action Taken[(a)]

Comments: ____________________

(a) Corrective actions taken must be documented whenever readings at or above action levels are reached. Monitoring equipment and action levels are specified in Section 9.33 of the Accident Prevention Plan.

Recorded By: ____________________
Site Health & Safety Officer

Date: ____________________

HEALTH AND SAFETY ACTIVITY REPORT

Site: ____ Location:____________________

Weather Cond.: ______________________ Onsite Hours: From _______ To _______

Changes in PPE Levels[1] Work Operations Reasons for Change

Site Safety and Health Plan Violations Corrective Action Specified Corrective Action Taken [2](yes/no)

Observations and Comments:

Completed by: ____ Date:
Site Health and Safety Supervisor

---

[1] Only SSHO may change PPE levels, using only criteria specified in APP/SSHP.

[2] If a deficiency is noted that cannot be immediately corrected, the SSHO will monitor the progress in correcting the deficiency and will document following:

- Date the deficiency was identified
- Description of the deficiency
- Name of the person responsible for correcting the deficiency
- Projected date of correction
- Actual date of correction.

EA Engineering, Science, and Technology, Inc

Employee/Visitor Register and Safety Brief

Date:

Site Entry/Exit		Name (Printed)	Signature	Company
Time In	Time Out			

HEALTH AND SAFETY EQUIPMENT CALIBRATION LOG

Project Name: ___________________ Project Number:

Date	Time	Initials	Instrument Type and ID (i.e., serial number)	Calibration Gas Type and Concentration	Initial Reading (units)	Adjustments Required and Comments	Final Reading (units)

Signature of SSHO:

QUALITY CONTROL

HEALTH AND SAFETY CHECKLIST

Page 1 of 2

Date:

Project Name/Number:________________________________

Site:

Personnel Observed and Locations:

Answer each question by checking the appropriate column (yes, no, or N/A). If "no" is checked, provide an explanation on the form.

Documentation	**Yes**	**No**	**N/A**
1. Is the Accident Prevention Plan (APP) and Site Health and Safety Plan (SSHP) on the Site?	☐	☐	☐
2. Has the SSHP and/or supplement been reviewed, dated, and signed within the last year?	☐	☐	☐
3. Are the tasks being completed reflected in the Supplement?	☐	☐	☐
4. Is there a written acknowledgement that all employees have been briefed on and read the SSHP (signature sheet)?	☐	☐	☐
5. Are the following training records current and available:			
• 40-Hour HAZWOPER for ALL employees?	☐	☐	☐
• 24 Hours Supervised Field Experience?	☐	☐	☐
• 8-Hour HAZWOPER Annual Refresher?	☐	☐	☐
• CPR/First Aid (minimum one person on site)?	☐	☐	☐
• 8-Hour Hazardous Waste Site Supervisor, and refresher?	☐	☐	☐
• Initial Site Health and Safety Briefing?	☐	☐	☐
• Site Health and Safety Briefing for each location or site (record in field log notebook)?	☐	☐	☐
6. Are emergency maps posted at the site and maintained in vehicles?	☐	☐	☐
7. Were fire extinguishers checked on first day?	☐	☐	☐
8. Were applicable Material Safety Data Sheets at the Site (located in IT Sampling Plan)?	☐	☐	☐
9. Are documents current and available that indicate personnel are medically fit to work and wear the required personal protective equipment (if required)?	☐	☐	☐

QUALITY CONTROL

HEALTH AND SAFETY CHECKLIST (continued)

Date:

Project Name/Number:

Site:

	Yes	No	N/A
Observations			
10. Are work zones adequately designated?	☐	☐	☐
11. Is required personal protective equipment available and correctly used, maintained, and stored?	☐	☐	☐
12. Is the following emergency equipment located at each site:	☐	☐	☐
• Fire extinguisher?	☐	☐	☐
• Eye wash (minimal)?	☐	☐	☐
• Communications (walkie talkie or phone)?	☐	☐	☐
• First aid kit?	☐	☐	☐
13. Is the buddy system in use?	☐	☐	☐
14. Are personnel refraining from drinking, chewing, smoking, taking medications, or other hand-to-mouth contact while working in the exclusion zone?	☐	☐	☐
15. Is the site organized to allow the use of lifting equipment, and avoid tripping hazards and spreading contamination?	☐	☐	☐
16. Was a random employee asked if he/she know site hazard and emergency procedures?	☐	☐	☐

The QC Inspector shall sign this checklist upon completion of all items on the checklist.

QC Inspector Signature:

Date:

EA Engineering, Science, and Technology, Inc.

DAILY SAFETY INSPECTION CHECKLIST
(TO BE COMPLETED EACH DAY OF CONSTRUCTION OR HTRW SITE ACTIVITIES)

Site: ______________________ Prepared by SSHO: ______________________
Location: ______________________
Project No.: ______________________ Project Manager: ______________________
Client: ______________________ Date : ______________________

Rating	**Y**	**N**	**N/A**	**Comments/Immediate Corrective Action[1]**
Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) General Requirements				
Are there new onsite personnel? • Did they receive pre-entry briefing and are their names recorded in field logbook or daily log? • Was the USACE PM made aware of the new personnel. • Required training and medical surveillance documentation received (e.g., 40-hr, 8 hr, etc.)?				
Did personnel sign in/out of site?				
Daily tailgate safety meetings conducted and documented?				
Were new activities performed today? Were hazards identified, discussed during the daily safety tailgate, and incorporated into revised APP/SSHP?				
New materials brought on site? MSDSs available?				
Exclusion (EZ), Contamination Reduction (CRZ), and Support Zones (SZ) delineated and enforced?				
General housekeeping measures in place to prevent hazards?				
Emergency Planning				
Were there any changes to emergency contact names, telephone numbers, or hospital? If so, were site personnel made aware and was information distributed/reposted.				
Adequate safety equipment inventory available?				
Fire extinguisher available (monthly inspection of extinguisher will suffice)				
Eyewash station(s) functioning and in place (weekly inspection of eye wash station will suffice)?				
First aid supplies available (weekly inspection of first aid kit will suffice)?				
Communication equipment readily available for emergencies?				
Any reported accidents/incidents at this site? If so, were accident reporting procedures followed?				
Air Monitoring				
Monitoring equipment specified in SSHP available and in working order? Air monitoring instrumentation for this site includes – check each if required/on site, note deficiencies in comments: • Combustible gas meter • Organic vapor analyzer • Contaminant specific analyzer for benzene (if total organic vapor concentrations exceed 0.5 ppm)				
Monitoring equipment calibrated and calibration records				

Y = Satisfactory or Yes; N = Unsatisfactory or No, N/A = Not applicable

Rating	Y	N	N/A	Comments/Immediate Corrective Action[1]
available?				
Environmental and personnel monitoring performed as specified in SSHP?				
PPE				
Proper dermal protection worn by EA and subcontracted employees when handling/ contacting hazardous chemicals or contaminated environmental media?				
Required PPE (hard hats, safety boots / shoes, eye protection with side shields, hearing protection) being worn by EA and subcontracted employees?				
PPE inspection completed by SSHO?				
Drill Rig Operations				
Daily rig inspection completed? Any equipment problems?				
Drill rigs/elevated equipment maintaining minimum 10-ft distance from energized (50 kV) overhead power lines?				
Investigation-derived Waste (IDW)				
Wastes properly staged, secured, and labeled at end of day?				

Additional Comments:

____
Site Safety and Health Officer’s Signature

____
Date

[1] If a deficiency is noted that cannot be immediately corrected, the SSHO will monitor the progress in correcting the deficiency and will document following:

- Date the deficiency was identified
- Description of the deficiency
- Name of the person responsible for correcting the deficiency
- Projected date of correction
- Actual date of correction.

EA Engineering, Science,
and Technology, Inc.

INITIAL SAFETY INSPECTION CHECKLIST
(TO BE COMPLETED FIRST DAY OF SITE ACTIVITIES)

Site: ____________________
Location: ____________________
Project No.: ____________________
Client: ____________________

Prepared by SSHO: ____________________

Project Manager: ____________________
Date : ____________________

Rating	**S**	**U**	**N/A**	**Comments/Immediate Corrective Action**[1]
Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) General Requirements				
Was a pre-entry safety briefing conducted? If so, did it include the following: • Site personnel and roles and authority to stop work? • Competent person(s) for identifying hazards? • Disclosure of potential hazards? • Emergency response procedures including rally point, contacts, location and directions of nearest medical support (hospital)? • Use of fire extinguishers • Vehicle rules/regulations? • Equipment to be used and those personnel qualified to use the equipment? • Methods of decontamination? • Storing/staging of wastes and materials? • Location/use of Material Safety Data Sheets (MSDS)? • Site control, including requirements for documenting entry into the site and procedures for entry and exit into work zones? • Task specific personal protective equipment (PPE) requirements? • Applicable standard operating procedures? • Environmental monitoring requirements and action levels? • Responsibilities for safety of personnel/property? • Safe work practices? • Procedures for maintaining personnel and site sanitation?				
Approved APP/SSHP on site?				
APP/SSHP compliance agreement form signed by onsite personnel, including subcontractors?				
New activities or hazards identified and incorporated into revised APP/SSHP?				
Names of onsite personnel recorded on site sign in sheet?				
Applicable MSDSs on site or available?				
Hazard labeling practices currently being used?				
Records of daily inspections available for review?				
Daily tailgate safety meetings conducted and documented?				
Onsite personnel meet SSHP requirements for medical examinations, fit testing, and training (including subcontractors)?				
Documentation of training, medical examinations, and fit tests available from employer (as applicable)?				
Compliance with specified safe work practices?				
Exclusion (EZ), Contamination Reduction (CRZ), and Support				

S = Satisfactory; U = Unsatisfactory, N/A = Not applicable

Rating	S	U	N/A	Comments/Immediate Corrective Action[1]
Zones (SZ) delineated and enforced?				
Windsock, flag, or ribbons in place to indicate wind direction?				
SZ located upwind from EZ and CRZ, as practicable?				
Emergency Planning				
Emergency telephone numbers posted?				
Emergency telephone numbers up to date?				
Emergency route to hospital posted?				
Local emergency providers notified of site activities?				
Fire extinguisher on site, of adequate size, and inspected within past month?				
Review weather emergency procedures?				
Adequate safety equipment inventory available?				
First aid provider and first aid supplies available?				
Eyewash station(s) functioning and in place?				
Communication equipment readily available for emergencies?				
Any reported accidents/incidents at this site? If so, are the accident/incident reports available for review?				
Air Monitoring				
Monitoring equipment specified in SSHP available and in working order (See Instrumentation list below)?				
Monitoring equipment calibrated and calibration records available?				
Personnel know how to operate monitoring equipment and equipment manuals available on site?				
Environmental and personnel monitoring performed as specified in SSHP?				
Air monitoring instrumentation includes: • Combustible gas meter? • Organic vapor analyzer?				
PPE (SSHO to enforce PPE requirements for EA and subcontractor employess)				
Proper dermal protection worn when handling/ contacting hazardous chemicals or contaminated environmental media?				
Required PPE (hard hats, safety boots / shoes, eye protection with side shields) being worn?				
PPE inspection completed by SSHO?				
Hearing protection available? Worn when required?				
Heavy Equipment Operations				
Equipment operators experienced/properly trained?				
Dust control measures implemented in EZ, as necessary?				
Equipment regularly inspected and maintained?				
Utility lines located and marked prior to construction activities?				
Clearance/digging permits kept onsite and available for review?				
Drill rigs/elevated equipment maintaining minimum 10-ft distance from energized (50 kV) overhead power lines?				
When backing a vehicle up is a spotter used?				
Supplies				

S = Satisfactory; U = Unsatisfactory, N/A = Not applicable

Rating	**S**	**U**	**N/A**	**Comments/Immediate Corrective Action**[1]
Decontamination equipment and supplies on site?				
Fire extinguishers (functioning, inspected, and in field vehicles)?				
Spill cleanup supplies on site?				
Investigation-derived Waste (IDW)				
Wastes properly disposed of?				
Designated location for drummed IDW?				
IDW containers properly labeled?				
Additional Comments:				

____
Site Safety and Health Officer’s Signature

____
Date

[1] If a deficiency is noted that cannot be immediately corrected, the SSHO will monitor the progress in correcting the deficiency and will document following:

- Date the deficiency was identified
- Description of the deficiency
- Name of the person responsible for correcting the deficiency
- Projected date of correction
- Actual date of correction.

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SAFETY INSPECTION REPORT (D-3)

Site / Location: ___________________________ Date: ____/____/____

Type of Inspection: ____ Daily ____ Weekly ____ Re-Inspection ____ Other

Type of Operation Inspected:

____

____

Equipment Inspected: (Specify if Safety or Operational in Nature)

____

____

____

____

____

Comments:

____

____

____

____

____

Deficiencies Found or Noted:

____

____

____

Corrective Action:

____

____

____

Re-Inspection Required: ____ Yes ____ No If Yes, Date of Re-Inspection: ____/____/___

Signature: _______________________________ _________________________________

SO SUXOS / Project Manager

* Copy to Supervisor if Deficiencies or Corrective Action were found, noted or deemed necessary.

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Form D-6

(For Safety Staff only)	REPORT NO.	EROC CODE	**UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT** *(For Use of this Form See Help Menu and USACE Suppl to AR 385-40)*	**REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)**

1. **ACCIDENT CLASSIFICATION**

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER		☐	

2. **PERSONAL DATA**

a. Name *(Last, First, MI)*	b. AGE	c. SEX ☐ MALE ☐ FEMALE	d. SOCIAL SECURITY NUMBER	e. GRADE

f. JOB SERIES/TITLE	g. DUTY STATUS AT TIME OF ACCIDENT ☐ ON DUTY ☐ TDY ☐ OFF DUTY	h. EMPLOYMENT STATUS AT TIME OF ACCIDENT ☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER ☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL ☐ TEMPORARY ☐ STUDENT ☐ OTHER *(Specify)* ____________

3. **GENERAL INFORMATION**

a. DATE OF ACCIDENT *(month/day/year)*	b. TIME OF ACCIDENT *(Military time)* hrs	c. EXACT LOCATION OF ACCIDENT	d. CONTRACTOR'S NAME (1) PRIME: (2) SUBCONTRACTOR:
e. CONTRACT NUMBER ____________ ☐ CIVIL WORKS ☐ MILITARY ☐ OTHER *(Specify)* ____________	f. TYPE OF CONTRACT ☐ CONSTRUCTION ☐ SERVICE ☐ A/E ☐ DREDGE ☐ OTHER *(Specify)* ____________	g. HAZARDOUS/TOXIC WASTE ACTIVITY ☐ SUPERFUND ☐ DERP ☐ IRP ☐ OTHER *(Specify)* ____________	

4. **CONSTRUCTION ACTIVITIES ONLY** *(Fill in line and corresponding code number in box from list - see help menu)*

a. CONSTRUCTION ACTIVITY ____________ (CODE) #	b. TYPE OF CONSTRUCTION EQUIPMENT ____________ (CODE) #

5. INJURY/ILLNESS INFORMATION *(Include name on line and corresponding code number in box for items e, f & g - see help menu)*

a. SEVERITY OF ILLNESS/INJURY ____________ (CODE) #	b. ESTIMATED DAYS LOST	c. ESTIMATED DAYS HOSPITALIZED	d. ESTIMATED DAYS RESTRICTED DUTY

e. BODY PART AFFECTED PRIMARY ____________ (CODE) # SECONDARY ____________ (CODE) #	g. TYPE AND SOURCE OF INJURY/ILLNESS TYPE ____________ (CODE) # SOURCE ____________ (CODE) #
f. NATURE OF ILLNESS/INJURY ____________ (CODE) #	

6. PUBLIC FATALITY *(Fill in line and correspondence code number in box - see help menu)*

a. ACTIVITY AT TIME OF ACCIDENT ____________ (CODE) #	b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ N/A

7. MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE	b. TYPE OF COLLISION	c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
☐☐ PICKUP/VAN ☐☐ AUTOMOBILE	☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END	(1) FRONT SEAT			
☐☐ TRUCK ☐☐ OTHER *(Specify)* ____________	☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER *(Specify)* ____________	(2) REAR SEAT			

8. PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM	b. OWNERSHIP	c. $ AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9. VESSEL/FLOATING PLANT ACCIDENT *(Fill in line and correspondence code number in box from list - see help menu)*

a. TYPE OF VESSEL/FLOATING PLANT ____________ (CODE) #	b. TYPE OF COLLISION/MISHAP ____________ (CODE) #

10. ACCIDENT DESCRIPTION *(Use additional paper, if necessary)*

ENG FORM 3394, MAR 99 **Version 2** EDITION OF SEP 89 IS OBSOLETE.

11. **CAUSAL FACTOR(S)** *(Read Instruction Before Completing)*

a. (Explain YES answers in item 13)	YES	NO
DESIGN: Was design of facility, workplace or equipment a factor?	☐	☐
INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor?	☐	☐
PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor?	☐	☐
OPERATING PROCEDURES: Were operating procedures a factor?	☐	☐
JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred?	☐	☐
HUMAN FACTORS: Did any human factors such as, size or strength of person, etc., contribute to accident?	☐	☐
ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident?	☐	☐

a. *(CONTINUED)*	YES	NO
CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident?	☐	☐
OFFICE FACTORS: Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident?	☐	☐
SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task?	☐	☐
PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?	☐	☐
DRUGS/ALCOHOL: In your opinion, was drugs or alcohol a factor to the accident	☐	☐

b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?

☐ YES *(If yes, attach a copy.)* ☐ NO

12. **TRAINING**

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK? ☐ YES ☐ NO	b. TYPE OF TRAINING. ☐ CLASSROOM ☐ ON JOB	c. DATE OF MOST RECENT FORMAL TRAINING. (Month) (Day) (Year)

13. **FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES** *(See instruction for definition of direct and indirect causes.) (Use additional paper, if necessary)*

a. DIRECT CAUSE

b. INDIRECT CAUSE(S)

14. **ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).**

DESCRIBE FULLY:

15. **DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.**

a. BEGINNING (Month/Day/Year)	b. ANTICIPATED COMPLETION (Month/Day/Year)

c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT CORPS ______ CONTRACTOR ______	d. DATE *(Mo/Da/Yr)*	e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*	f. OFFICE SYMBOL

16. **MANAGEMENT REVIEW** *(1st)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

17. **MANAGEMENT REVIEW** *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

18. **SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW**

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS

SIGNATURE	TITLE	DATE

19. **COMMAND APPROVAL**

COMMENTS

COMMANDER SIGNATURE	DATE

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U.S. Army Corps of Engineers
Safety Inspection Checklist
Drilling Equipment

Date of Inspection	
Location (Plant or Facility)	Contract Number
Contractor Name	Project Name
Inspector Name (Print)	Inspector Signature

This checklist serves as a guide only, it does not replace or eliminate the need to comply with the requirements set forth in Engineering Manual 385-1-1, Safety and Health Requirements Manual, dated 15 September 2008. The references included in this checklist correspond to the applicable sections of EM 385-1-1.

Item Description	REF	Yes	No	N/A	Remarks (Any NO or N/A item)
1. Is drilling equipment operated, inspected, and maintained as specified in the manufacturer's operating manual?	18.H.02				
2. Is a copy of the manual for all drilling equipment available?	18.H.02				
3. Has a survey been conducted to identify overhead electrical hazards and potential ground hazards and their locations identified in the site layout plan?	18.H.03				
4. Are all findings of the survey a part of the AHA?	18.H.03.b				
5. Does the AHA contain copies of Material Safety Data Sheets for all drilling fluids available?	18.H.03.a				
6. Have all members of the drilling crew been trained the operation, inspection, and maintenance of the equipment; the safety features and procedures to be used; and overhead electrical lines and underground hazards?	18.H.05				
7. Does the drilling equipment have two easily accessible emergency shut down devices (one for the operator and one for the helper)?	18.H.06				
8. Is the equipment posted with a warning of electrical hazards?	18.H.07				
9. Is there a spotter or an electrical proximity warning device available to ensure safe distances from power lines are maintained?	18.H.07.b				
10. Before moving earth drilling equipment, has the travel route been surveyed for overhead and terrain hazards, particularly overhead electrical hazards, mast lowered?	18.H.08				
11. Is equipment set-up in a stable manner, with cribbing if necessary?	18.H.09				
12. Are outriggers being used in accordance with the manufacturer's recommendations, if drilling is in confined space are requirements of 34A followed?	18.H.09				
13. Are drill rigs properly secured/identified when parked on highway or shoulder?	18.H.10				
14. Are drill crew members prohibited from wearing loose clothing, jewelry, or equipment which might become caught in moving machinery?	18.H.11.b				

U.S. Army Corps of Engineers Safety Inspection Checklist Drilling Equipment	Date of Inspection

Item Description	REF	Yes	No	N/A	Remarks (Any NO or N/A item)
15. Are slip rings or other rod slipping devices on the drill?	18.H.11.h				
16. Are steps being taken to control dust?	18.H.11.i				
17. Are augers cleaned only when the rotating mechanism is in neutral and the auger is stopped?	18.H.11.j				
18. Are augers guarded?	18.H.11.j				
19. Are open bore holes capped and flagged?	18.H.11.k				
20. Are open excavations barricaded?	18.H.11.k				

Other Remarks

GENERAL. Complete a separate report for each person who was injured, caused, or contributed to the accident (excluding uninjured personnel and witnesses). Use of this form for reporting USACE employee first-aid type injuries not submitted to the Office of Workers' Compensation Programs (OWCP) shall be at the descretion of the FOA commander. Please type or print legibly. Appropriate items shall be marked with an "X" in box(es). If additional space is needed, provide the information on a separate sheet and attach to the completed form. Ensure that these instructions are forwarded with the completed report to the designated management reviewers indicated in sections 16 and 17.

INSTRUCTIONS FOR SECTION 1 - ACCIDENT CLASSIFICATION

(Mark All Boxes That Are Applicable)

a. GOVERNMENT. Mark "CIVILIAN" box if accident involved government civilian employee; mark "MILITARY" box if accident involved U.S. military personnel.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in any government civilian employee injury, illness, or fatality that requires the submission of OWCP Forms CA-1 (injury), CA-2 (illness) or CA-6 (fatality) to OWCP; mark if accident resulted in military personnel lost-time or fatal injury or illness.

(2) PROPERTY DAMAGE - Mark the appropriate box if accident resulted in any damage of $1000 or more to government property (including motor vehicles).

(3) VEHICLE INVOLVED - Mark if accident involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY - Mark if the accident involved an in-house USACE diving activity.

b. CONTRACTOR.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in any contractor lost-time injury/illness or fatality.

(2) PROPERTY DAMAGE - Mark the appropriate box if accident resulted in any damage of $1000 or more to contractor property (including motor vehicles).

(3) VEHICLE INVOLVED - Mark if accident involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY - Mark if the accident involved a USACE Contractor diving activity.

c. PUBLIC.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in public fatality or permanent total disability. (The "OTHER" box will be marked when requested by the FOA to report an unusual non-fatal public accident that could result in claims against the government or as otherwise directed by the FOA Commander).

(2) VOID SPACE - Make no entry.

(3) VEHICLE INVOLVED - Mark if accident resulted in a fatality to a member of the public and involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" is marked.

(4) VOID SPACE - Make no entry.

INSTRUCTIONS FOR SECTION 2 - PERSONAL DATA

a. NAME - (MANDATORY FOR GOVERNMENT ACCIDENTS. OPTIONAL AT THE DISCRETION OF THE FOA COMMANDER FOR CONTRACTOR AND PUBLIC ACCIDENTS). Enter last name, first name, middle initial of person involved.

b. AGE - Enter age.

c. SEX - Mark appropriate box.

d. SOCIAL SECURITY NUMBER - (FOR GOVERNMENT PERSONNEL ONLY) Enter the social security number (or other personal identification number if no social security number issued).

e. GRADE - (FOR GOVERNMENT PERSONNEL ONLY) Enter pay grade. Example: 0-6; E-7; WG-8; WS-12; GS-11; etc.

f. JOB SERIES/TITLE - For government civilian employees enter the pay plan, full series number, and job title, e.g., GS-0810/Civil Engineer. For military personnel enter the primary military occupational specialty (PMOS), e.g., 15A30 or 11G50. For contractor employees enter the job title assigned to the injured person, e.g., carpenter, laborer, surveyor, etc.

g. DUTY STATUS - Mark the appropriate box.

(1) ON DUTY - Person was at duty station during duty hours or person was away from duty station during duty hours but on official business at time of the accident.

(2) TDY - Person was on official business, away from the duty station and with travel orders at time of accident. Line-of-duty investigation required.

(3) OFF DUTY - Person was not on official business at time of accident.

h. EMPLOYMENT STATUS - (FOR GOVERNMENT PERSONNEL ONLY) Mark the most appropriate box. If "OTHER" is marked, specify the employment status of the person.

INSTRUCTION FOR SECTION 3 - GENERAL INFORMATION

a. DATE OF ACCIDENT - Enter the month, day, and year of accident.

b. TIME OF ACCIDENT - Enter the local time of accident in military time. Example: 1430 hrs (not 2:30 p.m.).

c. EXACT LOCATION OF ACCIDENT - Enter facts needed to locate the accident scene, (installation/project name, building number, street, direction and distance from closest landmark, etc.).

d. CONTRACTOR NAME

(1) PRIME - Enter the exact name (title of firm) of the prime contractor.

(2) SUBCONTRACTOR - Enter the name of any subcontractor involved in the accident.

e. CONTRACT NUMBER - Mark the appropriate box to identify if contract is civil works, military, or other: if "OTHER" is marked, specify contract appropriation on line provided. Enter complete contract number of prime contract, e.g., DACW 09-85-C-0100.

f. TYPE OF CONTRACT - Mark appropriate box. A/E means architect/engineer. If "OTHER" is marked, specify type of contract on line provided.

g. HAZARDOUS/TOXIC WASTE ACTIVITY (HTW) - Mark the box to identify the HTW activity being performed at the time of the accident. For Superfund, DERP, and Installation Restoration Program (IRP) HTW activities include accidents that occurred during inventory, predesign, design, and construction. For the purpose of accident reporting, DERP Formerly Used DoD Site (FUDS) activities and IRP activities will be treated separately. For Civil Works O&M HTW activities mark the "OTHER" box.

INSTRUCTIONS FOR SECTION 4 - CONSTRUCTION ACTIVITIES

a. CONSTRUCTION ACTIVITY - Select the most appropriate construction activity being performed at time of accident from the list below. Enter the activity name and place the corresponding code number identified in the box.

CONSTRUCTION ACTIVITY LIST

1. **MOBILIZATION**
2. **SITE PREPARATION**
3. **EXCAVATION/TRENCHING**
4. **GRADING (EARTHWORK)**
5. **PIPING/UTILITIES**
6. **FOUNDATION**
7. **FORMING**
8. **CONCRETE PLACEMENT**
9. **STEEL ERECTION**
10. **ROOFING**
11. **FRAMING**
12. **MASONRY**
13. **CARPENTRY**
14. **ELECTRICAL**
15. **SCAFFOLDING/ACCESS**
16. **MECHANICAL**
17. **PAINTING**
18. **EOUIPMENT/MAINTENANCE**
19. **TUNNELING**
20. **WAREHOUSING/STORAGE**
21. **PAVING**
22. **FENCING**
23. **SIGNING**
24. **LANDSCAPING/IRRIGATION**
25. **INSULATION**
26. **DEMOLITION**

b. TYPE OF CONSTRUCTION EQUIPMENT - Select the equipment involved in the accident from the list below. Enter the name and place the corresponding code number identified in the box. If equipment is not included below, use code 24, "OTHER", and write in specific type of equipment.

CONSTRUCTION EQUIPMENT

1. GRADER
2. DRAGLINE
3. CRANE (ON VESSEL/BARGE)
4. CRANE (TRACKED)
5. CRANE (RUBBER TIRE)
6. CRANE (VEHICLE MOUNTED)
7. CRANE (TOWER)
8. SHOVEL
9. SCRAPER
10. PUMP TRUCK (CONCRETE)
11. TRUCK (CONCRETE/TRANSIT MIXER)
12. DUMP TRUCK (HIGHWAY)
13. DUMP TRUCK (OFF HIGHWAY)
14. TRUCK (OTHER)
15. FORKLIFT
16. BACKHOE
17. FRONT-END LOADER
18. PILE DRIVER
19. TRACTOR (UTILITY)
20. MANLIFT
21. DOZER
22. DRILL RIG
23. COMPACTOR/VIBRATORY ROLLER
24. OTHER

INSTRUCTIONS FOR SECTION 5 - INJURY/ILLNESS INFORMATION

a. SEVERITY OF INJURY/ILLNESS - Reference para 2-10 of USACE Suppl 1 to AR 385-40 and enter code and description from list below.

NOI	**NO INJURY**
FAT	**FATALITY**
PTL	**PERMANENT TOTAL DISABILITY**
PPR	**ERMANENT PARTIAL DISABILITY**
LWD	**LOST WORKDAY CASE INVOLVING DAYS AWAY FROM WORK**
NLW	**RECORDABLE CASE WITHOUT LOST WORKDAYS**
RFA	**RECORDABLE FIRST AID CASE**

b. ESTIMATED DAYS LOST - Enter the estimated number of workdays the person will lose from work.

c. ESTIMATED DAYS HOSPITALIZED - Enter the estimated number of workdays the person will be hospitalized.

d. ESTIMATED DAYS RESTRICTED DUTY - Enter the estimated number of workdays the person, as a result of the accident, will not be able to perform all of their regular duties.

e. BODY PART AFFECTED - Select the most appropriate primary and when applicable, secondary body part affected from the list below. Enter body part name on line and place the corresponding code letters identifying that body part in the box.

GENERAL BODY AREA	CODE	BODY PART NAME
ARM/WRIST	AB	ARM AND WRIST
	AS	ARM OR WRIST
TRUNK, EXTERNAL MUSCULATURE	B1	SINGLE BREAST
	B2	BOTH BREASTS
	B3	SINGLE TESTICLE
	B4	BOTH TESTICLES
	BA	ABDOMEN
	BC	CHEST
	BL	LOWER BACK
	BP	PENIS
	BS	SIDE
	BU	UPPER BACK
	BW	WAIST
	BZ	TRUNK OTHER
HEAD, INTERNAL	C1	SINGLE EAR INTERNAL
	C2	BOTH EARS INTERNAL
	C3	SINGLE EYE INTERNAL
	C4	BOTH EYES INTERNAL
	CB	BRAIN
	CC	CRANIAL BONES
	CD	TEETH
	CJ	JAW
	CL	THROAT, LARYNX
	CM	MOUTH
	CN	NOSE
	CR	THROAT, OTHER
	CT	TONGUE
	CZ	HEAD OTHER INTERNAL
ELBOW	EB	BOTH ELBOWS
	ES	SINGLE ELBOW
FINGER	F1	FIRST FINGER
	F2	BOTH FIRST FINGERS
	F3	SECOND FINGER
	F4	BOTH SECOND FINGERS
	F5	THIRD FINGER
	F6	BOTH THIRD FINGERS
	F7	FOURTH FINGER
	F8	BOTH FOURTH FINGERS
TOE	G1	GREAT TOE
	G2	BOTH GREAT TOES
	G3	TOE OTHER
	G4	TOES OTHER

GENERAL BODY AREA	CODE	BODY PART NAME
HEAD, EXTERNAL	H1	EYES EXTERNAL
	H2	BOTH EYES EXTERNAL
	H3	EAR EXTERNAL
	H4	BOTH EARS EXTERNAL
	HC	CHIN
	HF	FACE
	HK	NECK/THROAT
	HM	MOUTH/LIPS
	HN	NOSE
	HS	SCALP
KNEE	KB	BOTH KNEES
	KS	KNEE
LEG, HIP, ANKLE, BUTTOCK	LB	BOTH LEGS/HIPS/ ANKLES/BUTTOCKS
	LS	SINGLE LEG/HIP ANKLE/BUTTOCK
HAND	MB	BOTH HANDS
	MS	SINGLE HAND
FOOT	PB	BOTH FEET
	PS	SINGLE FOOT
TRUNK, BONES	R1	SINGLE COLLAR BONE
	R2	BOTH COLLAR BONES
	R3	SHOULDER BLADE
	R4	BOTH SHOULDER BLADES
	RB	RIB
	RS	STERNUM (BREAST BONE)
	RV	VERTEBRAE (SPINE; DISC)
	RZ	TRUNK BONES OTHER
SHOULDER	SB	BOTH SHOULDERS
	SS	SINGLE SHOULDER
THUMB	TB	BOTH THUMBS
	TS	SINGLE THUMB
TRUNK, INTERNAL ORGANS	V1	LUNG, SINGLE
	V2	LUNGS, BOTH
	V3	KIDNEY, SINGLE
	V4	KIDNEYS, BOTH
	VH	HEART
	VL	LIVER
	VR	REPRODUCTIVE ORGANS
	VS	STOMACH
	VV	INTESTINES
	VZ	TRUNK, INTERNAL; OTHER

f. NATURE OF INJURY/ILLNESS - Select the most appropriate nature of injury/illness from the list below. This nature of injury/illness shall correspond to the primary body part selected in 5e, above. Enter the nature of injury/illness name on the line and place the corresponding CODE letters in the box provided.

*** The injury or condition selected below must be caused by a specific incident or event <u>which occurred during a single work day or shift.</u>**

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
*TRAUMATIC INJURY OR DISABILITY	TA	AMPUTATION
	TB	BACK STRAIN
	TC	CONTUSION; BRUISE; ABRASION
	TD	DISLOCATION
	TF	FRACTURE
	TH	HERNIA
	TK	CONCUSSION
	TL	LACERATION, CUT
	TP	PUNCTURE
	TS	STRAIN, MULTIPLE
	TU	BURN, SCALD, SUNBURN
	TI	TRAUMATIC SKIN DISEASES/CONDITIONS INCLUDING DERMATITIS
	TR	TRAUMATIC RESPIRATORY DISEASE
	TQ	TRAUMATIC FOOD POISONING
	TW	TRAUMATIC TUBERCULOSIS
	TX	TRAUMATIC VIROLOGICAL/ INFECTIVE/PARASITIC DISEASE
	T1	TRAUMATIC CEREBRAL VASCULAR CONDITION/STROKE
	T2	TRAUMATIC HEARING LOSS
	T3	TRAUMATIC HEART CONDITION
	T4	TRAUMATIC MENTAL DISORDER, STRESS; NERVOUS CONDITION
	T8	TRAUMATIC INJURY - OTHER (EXCEPT DISEASE, ILLNESS)

** A nontraumatic physiological harm or loss of capacity produced by systemic infection; continued or repeated stress or strain; exposure to toxins, poisons, fumes, etc.; or other continued and <u>repeated exposures to conditions of the work environment over a long period of time</u>. For practical purposes, an occupational illness/disease or disability is any reported condition which does not meet the definition of traumatic injury or disability as described above.

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
**NON-TRAUMATIC ILLNESS/DISEASE OR DISABILITY		
RESPIRATORY DISEASE	RA	ASBESTOSIS
	RB	BRONCHITIS
	RE	EMPHYSEMA
	RP	PNEUMOCONIOSIS
	RS	SILICOSIS
	R9	RESPIRATORY DISEASE, OTHER
VIROLOGICAL, INFECTIVE & PARASITIC DISEASES	VB	BRUCELLOSIS
	VC	COCCIDIOMYCOSIS
	VF	FOOD POISONING
	VH	HEPATITIS
	VM	MALARIA
	VS	STAPHYLOCOCCUS
	VT	TUBERCULOSIS
	V9	VIROLOGICAL/INFECTIVE/ PARASITIC - OTHER
DISABILITY, OCCUPATIONAL	DA	ARTHRITIS, BURSITIS
	DB	BACK STRAIN, BACK SPRAIN
	DC	CEREBRAL VASCULAR CONDITION; STROKE

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME
	DD	ENDEMIC DISEASE (OTHER THAN CODE TYPES R&S)
	DE	EFFECT OF ENVIRONMENTAL CONDITION
	DH	HEARING LOSS
	DK	HEART CONDITION
	DM	MENTAL DISORDER, EMOTIONAL STRESS, NERVOUS
CONDITION		
	DR	RADIATION
	DS	STRAIN, MULTIPLE
	DU	ULCER
	DV	OTHER VASCULAR CONDITIONS
	D9	DISABILITY, OTHER
SKIN DISEASE OR CONDITION	SB	BIOLOGICAL
	SC	CHEMICAL
	S9	DERMATITIS, UNCLASSIFIED

g. TYPE AND SOURCE OF INJURY/ILLNESS (CAUSE) - Type and Source Codes are used to describe what caused the incident. The Type Code stands for an ACTION and the Source Code for an OBJECT or SUBSTANCE. Together, they form a brief description of how the incident occurred. Where there are two different sources, code the initiating source of the incident (see example 1, below). Examples:

(1) An employee tripped on carpet and struck his head on a desk.
TYPE: 210 (fell on same level) SOURCE: 0110 (walking/working surface).

NOTE: This example would NOT be coded 120 (struck against) and 0140 (furniture).

(2) A Park Ranger contracted dermatitis from contact with poison ivy/oak.
TYPE: 510 (contact) SOURCE: 0920 (plant)

(3) A lock and dam mechanic punctured his finger with a metal sliver while grinding a turbine blade.
TYPE: 410 (punctured by) SOURCE: 0830 (metal)

(4) An employee was driving a government vehicle when it was struck by another vehicle.
TYPE: 800 (traveling in) SOURCE: 0421 (government-owned vehicle, as driver)

NOTE: The Type Code 800, "Traveling In" is different from the other type codes in that its function is not to identify factors contributing to the injury or fatality, but rather to collect data on the type of vehicle the employee was operating or traveling in at the time of the incident.

Select the most appropriate TYPE and SOURCE identifier from the list below and enter the name on the line and the corresponding code in the appropriate box.

CODE	TYPE OF INJURY NAME
	STRUCK
0110	STRUCK BY
0111	STRUCK BY FALLING OBJECT
0120	STRUCK AGAINST
	FELL, SLIPPED, TRIPPED
0210	FELL ON SAME LEVEL
0220	FELL ON DIFFERENT LEVEL
0230	SLIPPED, TRIPPED (NO FALL)
	CAUGHT
0310	CAUGHT ON
0320	CAUGHT IN
0330	CAUGHT BETWEEN
	PUNCTURED, LACERATED
0410	PUNCTURED BY
0420	CUT BY
0430	STUNG BY
0440	BITTEN BY
	CONTACTED
0510	CONTACTED WITH (INJURED PERSON MOVING)
0520	CONTACTED BY (OBJECT WAS MOVING)
	EXERTED
0610	LIFTED, STRAINED BY (SINGLE ACTION)
0620	STRESSED BY (REPEATED ACTION)
	EXPOSED
0710	INHALED
0720	INGESTED
0730	ABSORBED
0740	EXPOSED TO
0800	TRAVELING IN

CODE	**SOURCE OF INJURY NAME**
0100	BUILDING OR WORKING AREA
0110	WALKING/WORKING SURFACE (FLOOR, STREET, SIDEWALKS, ETC.)
0120	STAIRS, STEPS
0130	LADDER
0140	FURNITURE, FURNISHINGS, OFFICE EQUIPMENT
0150	BOILER, PRESSURE VESSEL
0160	EQUIPMENT LAYOUT (ERGONOMIC)
0170	WINDOWS, DOORS
0180	ELECTRICITY
0200	ENVIRONMENTAL CONDITION
0210	TEMPERATURE EXTREME (INDOOR)
0220	WEATHER (ICE, RAIN, HEAT, ETC.)
0230	FIRE, FLAME, SMOKE (NOT TOBACCO)
0240	NOISE
0250	RADIATION
0260	LIGHT
0270	VENTILATION
0271	TOBACCO SMOKE
0280	STRESS (EMOTIONAL)
0290	CONFINED SPACE
0300	MACHINE OR TOOL
0310	HAND TOOL (POWERED; SAW, GRINDER, ETC.)
0320	HAND TOOL (NONPOWERED)
0330	MECHANICAL POWER TRANSMISSION APPARATUS
0340	GUARD, SHIELD (FIXED, MOVEABLE, INTERLOCK)

CODE	TYPE OF INJURY NAME
0350	VIDEO DISPLAY TERMINAL
0360	PUMP, COMPRESSOR, AIR PRESSURE TOOL
0370	HEATING EQUIPMENT
0380	WELDING EQUIPMENT
0400	VEHICLE
0411	AS DRIVER OF PRIVATELY OWNED/RENTAL VEHICLE
0412	AS PASSENGER OF PRIVATELY OWNED/RENTAL VEHICLE
0421	DRIVER OF GOVERNMENT VEHICLE
0422	PASSENGER OF GOVERNMENT VEHICLE
0430	COMMON CARRIER (AIRLINE, BUS, ETC.)
0440	AIRCRAFT (NOT COMMERCIAL)
0450	BOAT, SHIP, BARGE
0500	MATERIAL HANDLING EQUIPMENT
0510	EARTHMOVER (TRACTOR, BACKHOE, ETC.)
0520	CONVEYOR (FOR MATERIAL AND EQUIPMENT)
0530	ELEVATOR, ESCALATOR, PERSONNEL HOIST
0540	HOIST, SLING CHAIN, JACK
0550	CRANE
0551	FORKLIFT
0560	HANDTRUCK, DOLLY
0600	DUST, VAPOR, ETC.
0610	DUST (SILICA, COAL, ETC.)
0620	FIBERS
0621	ASBESTOS
0630	GASES
0631	CARBON MONOXIDE
0640	MIST, STEAM, VAPOR, FUME
0641	WELDING FUMES
0650	PARTICLES (UNIDENTIFIED)
0700	CHEMICAL, PLASTIC, ETC.
0711	DRY CHEMICAL - CORROSIVE
0712	DRY CHEMICAL - TOXIC
0713	DRY CHEMICAL - EXPLOSIVE
0714	DRY CHEMICAL FLAMMABLE
0721	LIQUID CHEMICAL - CORROSIVE
0722	LIQUID CHEMICAL - TOXIC
0723	LIQUID CHEMICAL - EXPLOSIVE
0724	LIQUID CHEMICAL - FLAMMABLE
0730	PLASTIC
0740	WATER
0750	MEDICINE
0800	INAMINATE OBJECT
0810	BOX, BARREL, ETC.
0820	PAPER
0830	METAL ITEM, MINERAL
0831	NEEDLE
0840	GLASS

CODE	SOURCE OF INJURY NAME
0850	SCRAP, TRASH
0860	WOOD
0870	FOOD
0880	CLOTHING, APPAREL, SHOES
0900	ANIMATE OBJECT
0911	DOG
0912	OTHER ANIMAL
0920	PLANT
0930	INSECT
0940	HUMAN (VIOLENCE)
0950	HUMAN (COMMUNICABLE DISEASE)
0960	BACTERIA, VIRUS (NOT HUMAN CONTACT)
1000	PERSONAL PROTECTIVE EQUIPMENT
1010	PROTECTIVE CLOTHING, SHOES, GLASSES, GOGGLES
1020	RESPIRATOR, MASK
1021	DIVING EQUIPMENT
1030	SAFETY BELT, HARNESS
1040	PARACHUTE

INSTRUCTIONS FOR SECTION 6 - PUBLIC FATALITY

a. ACTIVITY AT TIME OF ACCIDENT - Select the activity being performed at the time of the accident from the list below. Enter the activity name on the line and the corresponding number in the box. If the activity performed is not identified on the list, select from the most appropriate primary activity area (water related, non-water related or other activity), the code number for "Other", and write in the activity being performed at the time of the accident.

WATER RELATED RECREATION

1. Sailing
2. Boating-powered
3. Boating-unpowered
4. Water skiing
5. Fishing from boat
6. Fishing from bank dock or pier
7. Fishing while wading
8. Swimming/supervised area
9. Swimming/designated area
10. Swimming/other area
11. Underwater activities (skin diving, scuba, etc.)
12. Wading
13. Attempted rescue
14. Hunting from boat
15. Other

NON-WATER RELATED RECREATION

16. Hiking and walking
17. Climbing (general)
18. Camping/picnicking authorized area
19. Camping/picnicking unauthorized area
20. Guided tours
21. Hunting
22. Playground equipment
23. Sports/summer (baseball, football, etc.)
24. Sports/winter (skiing, sledding, snowmobiling etc.)
25. Cycling (bicycle, motorcycle, scooter)
26. Gliding
27. Parachuting
28. Other non-water related

OTHER ACTIVITIES

29. Unlawful acts (fights, riots, vandalism, etc.)
30. Food preparation/serving
31. Food consumption
32. Housekeeping
33. Sleeping
34. Pedestrian struck by vehicle
35. Pedestrian other acts
36. Suicide
37. "Other" activities

b. PERSONAL FLOTATION DEVICE USED - If fatality was water-related was the victim wearing a person flotation device? Mark the appropriate box.

INSTRUCTIONS FOR SECTION 7 - MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE - Mark appropriate box for each vehicle involved. If more than one vehicle of the same type is involved, mark both halves of the appropriate box. USACE vehicle(s) involved shall be marked in left half of appropriate box.

b. TYPE OF COLLISION - Mark appropriate box.

c. SEAT BELT - Mark appropriate box.

INSTRUCTIONS FOR SECTION 8 - PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM - Describe all property involved in accident. Property/material involved means material which is damaged or whose use or misuse contributed to the accident. Include the name, type, model; also include the National Stock Number (NSN) whenever applicable.

b. OWNERSHIP - Enter ownership for each item listed. (Enter one of the following: USACE; OTHER GOVERNMENT; CONTRACTOR; PRIVATE)

c. $ AMOUNT OF DAMAGE - Enter the total estimated dollar amount of damage (parts and labor), if any.

INSTRUCTIONS FOR SECTION 9 - VESSEL/ FLOATING PLANT ACCIDENT

a. TYPE OF VESSEL/FLOATING PLANT - Select the most appropriate vessel/floating plant from list below. Enter name and place corresponding number in box. If item is not listed below, enter item number for "OTHER" and write in specific type of vessel floating plant.

VESSEL/FLOATING PLANTS

1. ROW BOAT
2. SAIL BOAT
3. MOTOR BOAT
4. BARGE
5. DREDGE/HOPPER
6. DREDGE/SIDE CASTING
7. DREDGE/DIPPER
8. DREDGE/CLAMSHELL, BUCKET
9. DREDGE/PIPE LINE
10. DREDGE/DUST PAN
11. TUG BOAT
12. OTHER

b. COLLISION/MISHAP - Select from the list below the object(s) that contributed to the accident or were damaged in the accident.

COLLISION/MISHAP

1. COLLISION W/OTHER VESSEL
2. UPPER GUIDE WALL
3. UPPER LOCK GATES
4. LOCK WALL
5. LOWER LOCK GATES
6. LOWER GUIDE WALL
7. HAULAGE UNIT
8. BREAKING TOW
9. TOW BREAKING UP
10. SWEPT DOWN 0N DAM
11. BUOY/DOLPHIN/CELL
12. WHARF OR DOCK
13. OTHER

INSTRUCTIONS FOR SECTION 10 - ACCIDENT DESCRIPTION

DESCRIBE ACCIDENT - Fully describe the accident. Give the sequence of events that describe what happened leading up to and including the accident. Fully identify personnel and equipment involved and their role(s) in the accident. Ensure that relationships between personnel and equipment are clearly specified. Continue on blank sheets if necessary and attach to this report.

INSTRUCTIONS FOR SECTION 11 - CAUSAL FACTORS

a. Review thoroughly. Answer each question by marking the appropriate block. If any answer is yes, explain in item 13 below. Consider, as a minimum, the following:

(1) DESIGN - Did inadequacies associated with the building or work site play a role? Would an improved design or layout of the equipment or facilities reduce the likelihood of similar accidents? Were the tools or other equipment designed and intended for the task at hand?

(2) INSPECTION/MAINTENANCE - Did inadequately or improperly maintained equipment, tools, workplace, etc. create or worsen any hazards that contributed to the accident? Would better equipment, facility, work site or work activity inspections have helped avoid the accident?

(3) PERSON'S PHYSICAL CONDITION - Do you feel that the accident would probably not have occurred if the employee was in "good" physical condition? If the person involved in the accident had been in better physical condition, would the accident have been less severe or avoided altogether? Was over exertion a factor?

(4) OPERATING PROCEDURES - Did a lack of or inadequacy within established operating procedures contribute to the accident? Did any aspect of the procedures introduce any hazard to, or increase the risk associated with the work process? Would establishment or improvement of operating procedures reduce the likelihood of similar accidents?

(5) JOB PRACTICES - Were any of the provisions of the Safety and Health Requirements Manual (EM 385-1-1) violated? Was the task being accomplished in a manner which was not in compliance with an established job hazard analysis or activity hazard analysis? Did any established job practice (including EM 385-1-1) fail to adequately address the task or work process? Would better job practices improve the safety of the task?

(6) HUMAN FACTORS - Was the person under undue stress (either internal or external to the job)? Did the task tend toward overloading the capabilities of the person; i.e., did the job require tracking and reacting to many external inputs such as displays, alarms, or signals? Did the arrangement of the workplace tend to interfere with efficient task performance? Did the task require reach, strength, endurance, agility, etc., at or beyond the capabilities of the employee? Was the work environment ill-adapted to the person? Did the person need more training, experience, or practice in doing the task? Was the person inadequately rested to perform safely?

(7) ENVIRONMENTAL FACTORS - Did any factors such as moisture, humidity, rain, snow, sleet, hail, ice, fog, cold, heat, sun, temperature changes, wind, tides, floods, currents, dust, mud, glare, pressure changes, lightning, etc., play a part in the accident?

(8) CHEMICAL AND PHYSICAL AGENT FACTORS - Did exposure to chemical agents (either single shift exposure or long-term exposure) such as dusts, fibers (asbestos, etc.), silica, gases (carbon monoxide, chlorine, etc.,), mists, steam, vapors, fumes, smoke, other particulates, liquid or dry chemicals that are corrosive, toxic, explosive or flammable, byproducts of combustion or physical agents such as noise, ionizing radiation, non-ionizing radiation (UV radiation created during welding, etc.) contribute to the accident/incident?

(9) **OFFICE FACTORS** - Did the fact that the accident occurred in an office setting or to an office worker have a bearing on its cause? For example, office workers tend to have less experience and training in performing tasks such as lifting office furniture. Did physical hazards within the office environment contribute to the hazard?

(10) **SUPPORT FACTORS** - Was the person using an improper tool for the job? Was inadequate time available or utilized to safely accomplish the task? Were less than adequate personnel resources (in terms of employee skills, number of workers, and adequate supervision) available to get the job done properly? Was funding available, utilized, and adequate to provide proper tools, equipment, personnel, site preparation, etc.?

(11) **PERSONAL PROTECTIVE EQUIPMENT** - Did the person fail to use appropriate personal protective equipment (gloves, eye protection, hard-toed shoes, respirator, etc.) for the task or environment? Did protective equipment provided or worn fail to provide adequate protection from the hazard(s)? Did lack of or inadequate maintenance of protective gear contribute to the accident?

(12) **DRUGS/ALCOHOL** - Is there any reason to believe the person's mental or physical capabilities, judgment, etc., were impaired or altered by the use of drugs or alcohol? Consider the effects of prescription medicine and over the counter medications as well as illicit drug use. Consider the effect of drug or alcohol induced "hangovers".

b. **WRITTEN JOB/ACTIVITY HAZARD ANALYSIS** - Was a written Job/Activity Hazard Analysis completed for the task being performed at the time of the accident? Mark the appropriate box. If one was performed, attach a copy of the analysis to the report.

INSTRUCTIONS FOR SECTION 12 - TRAINING

a. **WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?** - For the purpose of this section "trained" means the person has been provided the necessary information (either formal and/or on-the-job (OJT) training) to competently perform the activity/task in a safe and healthful manner.

b. **TYPE OF TRAINING** - Mark the appropriate box that best indicates the type of training; (classroom or on-the-job) that the injured person received before the accident happened.

c. **DATE OF MOST RECENT TRAINING** - Enter the month, day, and year of the last formal training completed that covered the activity task being performed at the time of the accident.

INSTRUCTIONS FOR SECTION 13 - CAUSES

a. DIRECT CAUSES - The direct cause is that single factor which most directly lead to the accident. See examples below.

b. INDIRECT CAUSES - **I**ndirect causes are those factors which contributed to but did not directly initiate the occurrence of the accident.

Examples for section 13:

a. Employee was dismantling scaffold and fell 12 feet from unguarded opening.

> **Direct cause: failure to provide fall protection at elevation.**
> **Indirect causes: failure to enforce USACE safety requirements; improper training/motivation of employee (possibility that employee was not knowledgeable of USACE fall protection requirements or was lax in his attitude towards safety); failure to ensure provision of positive fall protection whenever elevated; failure to address fall protection during scaffold dismantling in phase hazard analysis.**

b. Private citizen had stopped his vehicle at intersection for red light when vehicle was struck in rear by USACE vehicle. (Note: USACE vehicle was in proper/safe working condition).

> **Direct cause:** failure of USACE driver to maintain control of and stop USACE vehicle within safe distance.
> **Indirect cause:** failure of employee to pay attention to driving (defensive driving).

INSTRUCTIONS FOR SECTION 14 - ACTION TO ELIMINATE CAUSE(S)

DESCRIPTION - Fully describe all the actions taken, anticipated, and recommended to eliminate the cause(s) and prevent reoccurrence of similar accidents/illnesses. Continue on blank sheets of paper if necessary to fully explain and attach to the completed report form.

INSTRUCTIONS FOR SECTION 15 - DATES FOR ACTION

a. **BEGIN DATE** - Enter the date when the corrective action(s) identified in section 14 will begin.

b. **COMPLETE DATE** - Enter the date when the corrective action(s) identified in section 14 will be completed.

c. **TITLE AND SIGNATURE** - Enter the title and signature of supervisor completing the accident report. For a GOVERNMENT employee accident/illness the immediate supervisor will complete and sign the report. For PUBLIC accidents the USACE Project Manager/Area Engineer responsible for the USACE property where the accident happened shall complete and sign the report. For CONTRACTOR accidents the Contractor's project manager shall complete and sign the report and provide to the USACE supervisor responsible for oversight of that contractor activity. This USACE supervisor shall also sign the report. Upon entering the information required in 15.d, 15.e and 15.f below, the responsible USACE supervisor shall forward the report for mangement review as indicated in section 16.

d. **DATE SIGNED** - Enter the month, day, and year that the report was signed by the responsible supervisor.

e. **ORGANIZATION NAME** - For GOVERNMENT employee accidents enter the USACE organization name (Division, Branch, Section, etc.) of the injured employee. For PUBLIC accidents enter the USACE organization name for the person identified in block 15.c. For CONTRACTOR accidents enter the USACE organization name for the USACE office responsible for providing contract administration oversight.

f. **OFFICE SYMBOL** - Enter the latest complete USACE Office Symbol for the USACE organization identified in block 15.e.

INSTRUCTIONS FOR SECTION 16 - MANAGEMENT REVIEW (1st)

1ST REVIEW - Each USACE FOA shall determine who will provide 1st management review. The responsible USACE supervisor in section 15.c shall forward the completed report to the USACE office designated as the 1st Reviewer by the FOA. Upon receipt, the Chief of the Office shall review the completed report, mark the appropriate box, provide substantive comments, sign, date, and forward to the FOA Staff Chief (2nd review) for review and comment.

INSTRUCTIONS FOR SECTION 17 - MANAGEMENT REVIEW (2nd)

2ND REVIEW - The FOA Staff Chief (i.e., FOA Chief of Construction, Operations, Engineering, Planning, etc.) shall mark the appropriate box, review the completed report, provide substantive comments, sign, date, and return to the FOA Safety and Occupational Health Office.

INSTRUCTIONS FOR SECTION 18 - SAFETY AND OCCUPATIONAL HEALTH REVIEW

3RD REVIEW - The FOA Safety and Occupational Health Office shall review the completed report, mark the appropriate box, ensure that any inadequacies, discrepancies, etc. are rectified by the responsible supervisor and management reviewers, provide substantive comments, sign, date and forward to the FOA Commander for review, comment, and signature.

INSTRUCTION FOR SECTION 19 - COMMAND APPROVAL

4TH REVIEW - The FOA Commander shall (to include the person designated Acting Commander in his absence) review the completed report, comment if required, sign, date, and forward the report to the FOA Safety and Occupational Health Office. Signature authority shall not be delegated.

EA Engineering, Science,
and Technology, Inc., PBC

SAFETY AUDIT CHECKLIST

Site: ______________________________
Location: ______________________________
Project No.: ______________________________
Client: ______________________________

Prepared by: ______________________________
Audit Date: ______________________________
Project Manager: ______________________________
Site Safety and Health Officer : ______________________________

Rating	**S**	**U**	**N/A**	**Comments**
Site Safety and Health Plan (SSHP) General Requirements				
Was a pre-entry safety briefing conducted? If so, did it include the following: • Disclosure of potential hazards? • Procedures for clearances/entry to restricted areas? • Emergency response? • Vehicle rules/regulations? • Equipment to be used? • Material handling restrictions? • Transporting/storing hazardous materials? • Personal protective equipment (PPE)? • Applicable standard operating procedures? • Methods of decontamination? • Responsibilities for safety of personnel/property? • Location/use of Material Safety Data Sheets (MSDS)? • Safe work practices?				
Approved SSHP on site?				
SSHP compliance agreement form signed by onsite personnel, including subcontractors?				
New activities or hazards identified and incorporated into revised SSHP?				
Names of onsite personnel recorded in field logbook or daily log?				
Applicable MSDSs on site or available?				
Hazard labeling practices currently being used?				
Designated Site Safety and Health Officer (SSHO) present? • Designated alternate SSHO? • SSHO conducts daily inspections of site/work zones? • Records of daily inspections available for review?				
Daily tailgate safety meetings conducted and documented?				
Onsite personnel meet SSHP requirements for medical examinations, fit testing, and training (including subcontractors)?				
Documentation of training, medical examinations, and fit tests available from employer (as applicable)?				
Compliance with specified safe work practices?				
Exclusion (EZ), Contamination Reduction (CRZ), and Support Zones (SZ) delineated and enforced?				
Windsock, flag, or ribbons in place to indicate wind direction?				
SZ located upwind from EZ and CRZ, as practicable?				
Emergency Planning				
Emergency telephone numbers posted?				
Emergency telephone numbers up to date?				

S = Satisfactory; U = Unsatisfactory, N/A = Not applicable

Rating	**S**	**U**	**N/A**	**Comments**
Emergency route to hospital posted?				
Local emergency providers notified of site activities?				
Review weather emergency procedures?				
Adequate safety equipment inventory available?				
First aid provider and first aid supplies available?				
Eyewash station(s) functioning and in place?				
Communication equipment readily available for emergencies?				
Any reported accidents/incidents at this site? If so, are the accident/incident reports available for review?				
Air Monitoring				
Monitoring equipment specified in SSHP available and in working order (See Instrumentation list below)?				
Monitoring equipment calibrated and calibration records available?				
Personnel know how to operate monitoring equipment and equipment manuals available on site?				
Environmental and personnel monitoring performed as specified in SSHP?				
Heat stress monitoring being conducted and “cool-down” breaks implemented?				
Air monitoring instrumentation includes: • Combustible gas meter? • Oxygen meter? • Organic vapor analyzer? • Hydrogen sulfide monitor				
PPE				
Proper dermal protection worn when handling/ contacting hazardous chemicals or contaminated environmental media?				
Required PPE (hard hats, safety boots / shoes, eye protection with side shields) being worn?				
Personal flotation device (PFD) available? Worn when required?				
Reflective vests available? Worn when required?				
Hearing protection available? Worn when required?				
Heavy Equipment Operations				
Equipment operators experienced/properly trained?				
Dust control measures implemented in EZ, as necessary?				
Equipment regularly inspected and maintained?				
Utility lines located and marked prior to construction activities?				
Clearance/digging permits kept onsite and available for review?				
Drill rigs/elevated equipment maintaining minimum 10-ft distance from energized (50 kV) overhead power lines?				
Traffic control barricades in place (28-in traffic cones/flags/barricade tape)?				
Proper PPE, including hearing protection/reflective vests used?				
When backing a vehicle up is a spotter used?				

S = Satisfactory; U = Unsatisfactory, N/A = Not applicable

Rating	**S**	**U**	**N/A**	**Comments**
Working Near Water/Wastewater Treatment Areas				
In areas lacking guardrails, wearing PFDs?				
Buddy system in place and observed?				
Supplies				
Decontamination equipment and supplies on site?				
Fire extinguishers (functioning, inspected, and in field vehicles)?				
Spill cleanup supplies on site?				
Power Tools/Electrical Hazards				
Proper PPE used?				
Lock-out/Tag-out system in place and observed?				
Power tools and power cords inspected and maintained?				
Investigation-derived Waste (IDW)				
Wastes properly disposed of?				
Designated location for drummed IDW?				
IDW containers properly labeled?				

Additional Comments:

____
Auditor's Signature

____
Site Safety and Health Officer's Signature

____
Date

____
Date

S = Satisfactory; U = Unsatisfactory, N/A = Not applicable

10. ACCIDENT DESCRIPTION *(Continuation)*

13a. DIRECT CAUSE *(Continuation)*

13b. **INDIRECT CAUSES** *(Continuation)*

14. **ACTION(S) TAKEN, ANTICIPATED, OR RECOMMENDED TO ELIMINATE CAUSE(S)** *(Continuation)*

Appendix E

Site Safety and Health Plan

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REVISION 1
SITE SAFETY AND HEALTH PLAN

MILITARY MUNITIONS RESPONSE PROGRAM AND HAZARDOUS TOXIC AND RADIOACTIVE WASTE SITES REMEDIAL INVESTIGATION THROUGH DECISION DOCUMENT AT THE IONA ISLAND NAVAL AMMUNITION DEPOT FORMERLY USED DEFENSE SITE, ROCKLAND COUNTY, NEW YORK

PREPARED BY:

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., PBC
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Hunt Valley, Maryland 21031

MAY 2019

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LIST OF ACRONYMS AND ABBREVIATIONS

°mg/m3	Milligram per cubic meter
%	Percent
°F	Degrees Fahrenheit
ABIH	American Board of Industrial Hygiene
AHA	Activity hazard analysis
AL	Action Level (OSHA)
ANSI	American National Standards Institute
AOC	Area of concern
APP	Accident prevention plan
BZ	Breathing zone
C	Ceiling limit
Ca	Carcinogen
CNS	Central nervous system
CIH	Certified Industrial Hygienist
COPC	Contaminant of potential concern
CNS	Central nervous system
CPR	Cardiopulmonary resuscitation
CSP	Certified Safety Professional
DD	Decision document
DMM	Discarded Military Munitions
DoD	Department of Defense
EA	EA Engineering, Science, and Technology, Inc., PBC
ESP	Explosives Site Plan
f/cc	Fibers per cubic meter
ft	Foot (feet)
FUDS	Formerly Used Defense Site
GIS	Geographic information system
HFD	Hazard fragment distance
HTRW	Hazardous Toxic and Radioactive Waste
IDHL	Immediately dangerous to life and health
IFV	Inhalable fraction and vapor
in.	Inch(es)
MC	Munitions constituents
MD	Munitions debris

MEC	Munitions and explosives of concern

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

MMRP	Military Munition Response Program
MPPEH	Munitions potentially presenting an explosive hazard
MRS	Munitions Response Site
N.D.	Not determined
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PEL	Permissible Exposure limit
PPE	Personal protective equipment
ppm	Parts per million
RI	Remedial investigation
SHM	Safety and Health Manager
SSHP	Site Safety and Health Plan
SSHO	Site Safety and Health Officer
STEL	Short term exposure limit (15 min)
SUXOS	Senior Unexploded Ordnance Supervisor
SVOC	Semi-volatile organic compound
TLV	Threshold limit level
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UST	Underground storage tank
UXO	Unexploded Ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer

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1. SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

This Site Safety and Health Plan (SSHP) has been prepared by EA Engineering, Science, and Technology, Inc., PBC (EA) to support the Military Munition Response Program (MMRP) and Hazardous Toxic and Radioactive Waste (HTRW) Remedial Investigation (RI) through Decision Document (DD) for the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS), Rockland County, New York. Section 2.2 provides “Phases of Work” in the Accident Prevention Plan (APP). USACE is conducting work at the site under the Defense Environmental Restoration Program for FUDs using the processes under the Comprehensive Environmental Response, Compensation, and Liability Act. The FUDS program cleans up only Department of Defense (DoD)-generated eligible contamination, which occurred before the transfer of the property to private owners or federal, state or local governments. There are three FUDS projects at the former Iona Island Naval Ammunition Depot FUDS:

- C02NY074401 Containerized Hazardous Toxic and Radioactive Waste (CON/HTRW)
- C02NY074402 HTRW
- C02NY074403 Military MMRP.

This SSHP addresses the FUDS MMRP and HTRW project categories. The FUDS CON/HTRW was closed out in 2012.

The FUDS MMRP includes one Munitions Response Site (MRS), MRS-01 1903 Explosion area (approximately 124.2 acres of land and inland water. MRS-01 extends beyond the FUDS boundary (Figure 2-1 of the APP). Historical records include several reports of ordnance items found within the FUDS and identify the potential for additional ordnance items, including Munitions and Explosives of Concern (MEC), Munitions Debris (MD), and discarded military munitions (DMM), to be found within the FUDS. Anecdotal evidence identifies the potential for DMM around and/or downstream of three former loading docks, where munitions may have been dropped into the Hudson River during the loading and unloading of supply vessels. Additionally, several potential MEC items have been reportedly sighted in low-tide conditions in an area of Round Island referred to as a “dump site” (Alion 2008).

The FUDS HTRW includes and 19 Areas of Concern (AOCs) located in the footprints of former site facilities (Figure 2-1 of the APP). Historical DoD activities at the AOCs may have resulted in the release of contaminants to environmental media (surface soil, subsurface soil, sediment, and groundwater) at concentrations that may pose a risk to human health and ecological receptors.

1.1 SITE LOCATION AND BACKGROUND

The Iona Island Naval Ammunition Depot FUDS is located along the Hudson River on Iona Island and Round Island in the town of Stony Brook, Rockland County, New York, and consists of approximately 118–129 acres of land and inland water. The Depot was actively used by the U.S. Naval Department for ammunition storage for approximately 50 years, from 1900 to 1947. During

Navy use, site activities reportedly included preparing, assembling, maintaining, inspecting, testing, and issuing ammunition, but did not include manufacturing activities (Alion 2008). An explosion in 1903 former Building Numbers 209 and 210, originating from the approximate center of the Depot at former Building Numbers 209 and 210, is thought to have thrown stored ammunition shells as far as 1,250 feet from the blast.

Investigations have been ongoing at Iona Island since 1992 and include:

- 1992—USACE performed an initial site visit and produced a Preliminary Assessment which identified the potential for groundwater and soil contamination near former buildings, aboveground storage tanks, paint and coal storage, dump area, and incinerator locations based on historical use (Bluestone 2018).

- 1995—USACE produced a Revised Site Survey Summary Sheet, listing several remaining structures as beneficially used by the present owner (Bluestone 2018).

- 1996—USACE contractor (Greeley-Polhemus Group, Inc. and Smith Technology Corporation) conducted surface soil sampling at AOCs identified by USACE. Metals, semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs) were identified in samples; metals were determined to be the primary contaminant of environmental concern. The report recommended a site risk evaluation and additional sampling to further delineate metals and SVOC contamination (Greeley-Polhemus Group, Inc. 1997).

- 1997—USACE completed an Archive Search Report documenting archival information and interviews with site personnel. USACE also performed a site visit; no hazards were discovered during the inspection (USACE 1998).

- 2007—USACE contractor (Alion Science and Technology Corporation and EA [subcontractor]) conducted an MMRP Site Inspection, which included sampling for munitions constituents (MC) and a qualitative site reconnaissance. The site reconnaissance was performed at low tide along the shoreline near former dock areas and the Dumping Area; no MD or MEC were observed. Potential human and ecological risks from MC were identified in sediment samples. The Final Site Investigation Report recommended further action (RI/Feasibility Study) for both MEC and MC (Alion 2008).

- 2011—USACE contractor (Green Seal Environmental, Inc.) conducted a geophysical survey to identify and remove underground storage tanks (USTs). Two USTs were identified and removed. Based on the condition of the USTs and the results of the confirmation soil sampling, soil remediation was not required (Green Seal, Inc. 2012).

- 2017—USACE prepared a FUDS Interim Risk Management Communication Assessment Summary to assess whether additional public safety outreach is necessary. USACE concluded that landowner notification letters were sufficient; one landowner notification letter with a project safety guide was mailed, no calls were received by the toll-free information center (USACE 2017).

- 2018—The U.S. Army Geospatial Center performed a Historical Photographic Analysis of the Former Iona Island Naval Ammunition Depot FUDS on behalf of USACE New England and Baltimore Districts. Historical aerial photography, documents (including text, tables, photographs, and maps), design drawings, and disposal data from 1931 to the present was used to locate and identify former buildings that may be related to hazard toxic and radioactive waste. Data generated during the analysis is summarized in a September 2018 report and is compiled in a Geographic Information System (GIS) package (USAGC 2018).

1.2 CONTAMINANT CHARACTERIZATION

Based on historical information and previous investigations, potential MEC present at Iona Island include:

- 1-pounder, 6-pounders, 6-inch (in.) and 13-in. ammunition distributed throughout MRS-01 land, water or wetland areas from the 1903 explosion at former Building Numbers 209 and 210
- DMM within the FUDS property boundary (including within MRS-01)
- DMM in water near or downstream of the former loading docks in the Hudson River
- DMM in the previously identified “dump site” between Iona Island and Round Island
- DMM adjacent to former or existing munitions storage igloos and gun positions.

Potential contaminants associated with MEC include MEC and lead associated with breached items potentially in soil and sediment .

Environmental samples collected during surface soil sampling activities (Greeley-Polhemus Group, Inc. 1997) and the 2007 MMRP Site Inspection (Alion 2008), reported metals (particularly lead) and semivolatile organic compounds (SVOCS) (primarily polycyclic aromatic hydrocarbons [PAH]) in soil and sediment at concentrations above applicable screening criteria. Metals and SVOCs have therefore been identified as COPCs for 16 HTRW AOCs. VOCs have been identified as COPCs for former AST AOCs.

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2. HAZARD/RISK EVALUATION

The primary work phases are described in Section 2.2 of the APP. Each task has been analyzed to assess the potential safety, chemical, physical, and biological hazards that may be encountered by site personnel and prescribe the proper engineering and/or administrative controls and/or personal protective equipment (PPE). These controls will ensure that the risks to site personnel safety and health are reduced or eliminated while performing the project. The results of the task hazard analysis are documented using a task-specific Activity Hazard Analysis (AHA). An AHA has been developed for each task associated with this project. **Table 2-1** summarizes the site-specific hazard evaluation for each task. The AHAs are provided in Appendix A of the APP. The primary hazard groups of concern associated with this site are as follows:

- Chemical hazards
- General physical hazards
- Fire/explosion hazards
- Hand and power tools
- Heavy equipment hazards (mini excavator)
- Utilities
- Weather hazards
- Material handling/moving/lifting hazards
- Biological hazards
- MEC hazards
- Small boating hazards
- Diving conditions.

2.1 CHEMICAL HAZARDS

The potential for exposure to chemical hazards may occur during intrusive investigation and waste management activities. Potential site chemicals are identified on **Table 2-2** based on the contaminant characterization presented in Section 1.2 and chemicals to be used onsite. Section 7 presents the exposure limits, routes of exposure, and symptoms of exposure for chemicals of potential concern that may be present at this site. It should be noted that gasoline and diesel may be used during the completion of work tasks and are not related to the FUDS site. Control of chemical hazards will include the use of PPE and proper hygiene practices for dermal contact with engineering controls to reduce and/or eliminate exposure through inhalation.

Dermal contact with chemical hazards is possible. Many hazardous chemicals are readily absorbed through the skin. Therefore, dermal protection appropriate for the chemical will be worn when handling or contacting potentially contaminated environmental media (Chapter 5).

2.2 GENERAL PHYSICAL HAZARDS

Field operations at the site may include many general physical hazards, such as:

- Holes, ditches, marshes with water filled depressions and channels.
- Precariously positioned objects, which may cause crushing or other injuries (e.g., hand tools, field equipment, safety equipment)
- Sharp objects (e.g., metal shards, debris or trash in the woods, hydraulic lines in vehicles) that may cause cuts, injection, or other injuries
- Slippery surfaces, posing slip and fall hazards (e.g., boat decks)
- Uneven terrain, posing slip, trip, and fall hazards (all activities)
- Unstable surfaces (e.g., wetlands) that may pose fall, or other injuries.

Site personnel will look constantly, closely, and carefully for these basic safety hazards and inform the Site Safety and Health Officer (SSHO) of conditions that may present a hazard. If hazards are present, these hazards will be recorded by the SSHO and discussed in daily briefings. Precautionary measures will be taken to prevent injury. Materials handling can vary from heavy equipment handling to manually moving/lifting items. Hazards associated with materials handling at MRS-01 and the 19 AOCs may cause physical injury.

Physical injuries to back and abdominal muscles from improperly lifting of loads are the most common occupational injuries reported. Such injuries can range from relatively mild strains to major, permanently disabling injuries. Before lifting a load (e.g., sample coolers, field equipment), personnel will consider the overall weight, distribution of weight, unwieldiness or awkwardness of the load, distance to be carried, obstacles to be negotiated, site conditions, and visibility. Workers will lift with their legs, keeping their back straight, keep the load close to their body, not twist while lifting, and not lift more than 50 pounds.

2.3 FIRE/EXPLOSION HAZARDS

Section 9.11 in the APP discusses the Fire Prevention and Protection Plan and the associated fire and explosion hazards.

2.4 HEAVY EQUIPMENT HAZARDS

The use of heavy equipment (e.g., mini-excavators) may pose safety hazards to site workers during excavation. Heavy equipment work will be conducted only by trained, licensed (as required by state law), and experienced personnel. Site workers will remain outside the turning radius of moving equipment and will maintain visual contact with the equipment operator to prevent harm from collisions between heavy equipment and site personnel.

No personnel are permitted to work underneath heavy equipment or hoisted loads because this practice poses a serious crushing hazard. Personnel must remain 25 ft or more from equipment when in use. Belts, pulleys, sheaves, gears, chains, shafts, clutches, drums, flywheels, and other moving parts (internal or external) of equipment can pose injury hazards. Site personnel are prohibited from approaching the gears/belts/pulleys of equipment when the equipment is operating to prevent physical harm in the form of abrasions, lacerations, or other physical harm.

Exhaust from equipment powered by combustion engines (no steam engines will be onsite) will be properly located so that release of exhaust does not endanger workers or obstruct the view of the operator. Gasoline-operated equipment (vehicles and heavy equipment) will be re-fueled properly to prevent fire hazards; power will be off, no smoking allowed, and proper dispensing equipment will be used (fire extinguishers nearby and self-locking cans or other approved dispensers will be used if not filled at a stand-alone commercial gas station). Additionally, USACE-approved spill kits will be present when refilling fuel containers onsite. When not operational, equipment (stated above and listed specifically in the AHAs in Appendix A of the APP) will be set and locked so that it cannot be activated, released, dropped, etc.

2.5 UTILITIES

The SSHO will be responsible for ensuring that the utility locating service has completed a utility marking for the site prior to site intrusive work. These markings show an estimated location of underground installations, including sewer, telephone, fuel, electric, water lines or other underground installations that reasonably may be expected to be encountered during invasive work. Site maps and site-specific knowledge from Palisades Interstate Park Commission personnel will also be utilized when available to note underground hazards. Use of a pipe and cable locator or metal detector may also be necessary to accomplish locating these hazards. The following are the utility clearance phone numbers for Dig Safely New York:

811 or 1-800-962-7962.

Underground utilities pose hazards to workers involved in invasive operations such as excavating, drilling, and direct-push sampling. These hazards include electrical hazards, explosion, and asphyxiation, as well as costly and annoying hazards associated with damaging communication, sewer, and water lines. Prior to commencement of invasive operations, underground utilities, including buried wires, pipes, tanks, etc., will be visibly marked with flags or marking paint to alert workers to areas unsafe for digging/excavating. Personnel will be aware that although an area may be "cleared," unanticipated hazards may occur. Intrusive subsurface work will be located at least 3 ft from utility markings.

Workers will be alert for unanticipated events such as snapping cables, excavation into unmarked underground utilities, etc. Such occurrences will prompt involved individuals to halt work immediately and take appropriate corrective measures to gain control of the situation.

2.6 HAND AND POWER TOOLS

An AHA for hand tool use is provided in Appendix A of the APP.

- **Use, Inspection, and Maintenance:**
    - Tools failing inspection will not be used.
    - Impact tools, such as chisels, will be kept free of mushroomed heads.
    - Wooden handles will be kept free of splinters or cracks and will be kept tight in the tool.
    - Hand and power tools will be used, inspected, and maintained in accordance with the manufacturer’s instructions and recommendations and will be used only for the purpose for which designed.
    - Hand and power tools will be inspected, tested, and determined to be in safe operating condition before use; continued periodic inspections will be made to ensure safe operating condition and proper maintenance.
    - Hand and power tools will be in good repair and with all required safety devices installed and properly adjusted; tools having defects that will impair their strength or render them unsafe will be removed from service.
    - Electric power-operated tools will be double insulated or properly grounded.
- **Guarding:**
    - Power tools designed to accommodate guards will be equipped with such guards.
    - Portable power-driven circular saws will be equipped with guards above and below the base plate or shoe. When the tool is withdrawn from work, the lower guard will automatically and instantly return to the covering position.
- **Switches:**
    - All hand-held powered drills, tappers, fastener drivers, horizontal, vertical, and angle grinders with wheels greater than 2 in. in diameter, disc sanders, belt sanders, reciprocating saws, saber saws, and other similar operating powered tools shall be equipped with a momentary contact “on-off” control and may have a lock-on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

  - All other hand-held powered tools, such as circular saws, chain saws, and percussion tools without positive accessory holding means, shall be equipped with a constant pressure switch that will shut off the power when the pressure is released.

- **PPE:**

  - Loose and frayed clothing, loose long hair, dangling jewelry (including dangling rings, chains, earrings, and wristwatches) will not be worn while working with power tools.

  - Employees using hand and power tools and exposed to the hazard of falling, flying, abrading, and splashing objects, or exposed to harmful dust, fumes, mists, vapors, or gases will be provided with the PPE necessary to protect them from the hazard.

2.7 WEATHER HAZARDS

To safely mitigate the hazards from severe weather (i.e., heavy rains, electrical storms, or heavy snowfall), site personnel (including the SSHO) will look for indications of impending severe weather (e.g., changes in wind direction, cloud formation, or humidity) and monitor weather conditions online using a weather station that is part of the National Oceanic and Atmospheric Administration (NOAA) weather radio network. If severe weather is likely, based on weather review, site personnel will retreat to their support vehicle. If site personnel observe lightning within 6 miles of the project site, as based on a lightning detector, NOAA radio application, and/or a lightning strike map monitored by the SSHO, all site activity will be halted immediately. The SSHO will monitor weather conditions, and activity will not resume for 30 minutes following cessation of severe weather. The SSHO is responsible for providing site personnel notification that work may resume. Hazards associated with heat stress and cold stress are described in Chapter 8. Weather hazards related to vessel operations are included in Appendix G of the APP.

2.8 MATERIAL HANDLING/MOVING/LIFTING HAZARDS

Material handling at hazardous waste sites can vary from heavy equipment handling to manually moving/lifting items. Hazards associated with material handling include physical injury, detonation, fire, explosion, and vapor generation among others. Injuries to back and abdominal muscles from improperly lifting of loads are the most common occupational injuries reported. Such injuries can range from relatively mild strains to major, permanently disabling injuries. Before lifting a load, personnel will consider the overall weight, distribution of weight, unwieldiness or awkwardness of the load, distance to be carried, obstacles to be negotiated, site conditions, and visibility. Loads anticipated to be moved during activities at the Iona Island FUDS include coolers, samples, sampling equipment, general hand tools, and health and safety equipment. When using equipment to move materials, proper work practices will be followed, and equipment used will be designed for the task to be performed. Equipment will be inspected in accordance with the requirements presented in Chapter 7 of the APP.

2.9 BIOLOGICAL HAZARDS

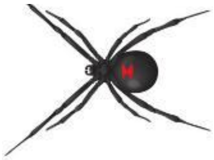
A survey of the potential biological hazards (harmful plants, animals, insects, and marine life) was conducted for work areas at the Iona Island FUDS. The results are summarized in the subsections below.

2.9.1 Insects

 **Carpenter Bee**	 **Bumble Bee**	 **Yellow Jacket**
 **Horse Fly**		

Environment	Nests/hives are found in brush, grasses, and on the ground (especially for wasps). Habitat is more likely in wooded areas.
Health Hazards	Stinging of site personnel (bees and yellow jacket) and biting of site personnel (horse flies). Swelling and discomfort are typical; however, some people (rare) are hypersensitive to the injected toxins.
Symptoms	Swelling, itching, and minor pain are typical symptoms. Persons hypersensitive to the injected toxins may experience anaphylactic shock (violent and immediate response: intense swelling of body, life-threatening, potentially fatal).
Treatment	Refer to First Aid Procedures below.
Protective Measures	***Awareness*: ** Note the presence of habitat or potential habitat and demarcate as appropriate (SSHO will apply paint/tape/other to mark the location; employees will stay clear of the habitat). ***PPE*: ** Level D PPE is required. Personnel will spray exposed skin with insect repellant containing DEET (approximately 33 percent solution) and clothing with insect repellant containing permethrin/permanone or DEET. ***Note*: ** Personnel with hypersensitivity to stings are required to carry an antidote pen on their person, instruct personnel on the use and location of the pen, and notify the SSHO. If stung, personnel must notify the SSHO immediately.
First Aid Procedures	General first aid procedures in the event of a sting include washing the area with soap and water, removing the stinger (if present), applying a cold compress, and applying a topical antihistamine. In the event of excessive swelling (greater than 10 centimeters), swelling of the lips/throat, faintness, dizziness, confusion, rapid heartbeats, hives, or nausea/cramps/vomiting occurs notify the SSHO and seek professional medical treatment. An antidote pen will be applied to address anaphylactic shock.
Inoculation	Not applicable.

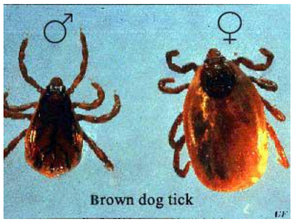
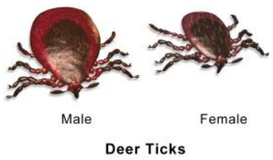
2.9.2 Arachnids (Spiders)



Black Widow Spider

Environment/ Habitat	The Black Widow typically weave disorderly webs; however, they leave their webs to hunt and are typically found in woodpiles. At night, these spiders may seek warmth in work gloves, boots, or previously worn clothing.
Health Hazards	The toxicity of the venom is inversely proportional to size. The venom of the black widow may be potent and can develop localized infection; however, systemic symptoms are more frequent (listed below).
Symptoms	Symptoms of spider bites from the widow species include low severity symptoms (swelling, itching, and minor pain), systemic response (nausea, vomiting, fever, rashes, muscle and joint pain), and localized severe symptoms (necrotizing ulcers, severe swelling, and potential gangrene).
Treatment	Refer First Aid Procedures below.
Protective Measures	***Awareness:*** Typically, a bite from this spider is not noticed until several hours later when the symptoms above become noticeable or severe. Look for disorderly webs; shake out clothing, boots, and gloves prior to wearing; and minimize disturbance of potential habitat. ***PPE:*** Level D PPE is required. Personnel will spray exposed skin with insect repellant containing DEET (approximately 33 percent solution) and clothing with insect repellant containing permethrin/permanone or DEET. If bitten, personnel must notify the SSHO immediately.
First Aid Procedures	***Venomous Spider Bites:*** Wash the area with soap and water; apply a cold compress and elevate the area above the level of the heart; then seek professional medical treatment. DO NOT apply heat or steroid creams, remove venom by suction, apply electricity, or apply a tourniquet.
Inoculation	Not Applicable.

2.9.3 Ticks

			
Brown Dog Tick	**Wood Tick**	**Deer Tick**	**Lone Star Tick**
Environment	Ticks are typically found along well-defined paths of grassy or transitional vegetation waiting for hosts to pass. Ticks cannot fly or jump and wait on leaves or long grasses in a position called questing—holding two pairs of legs outstretched while two pairs of legs maintain a connection on the vegetation. Ticks detect breath, body odors, body heat, moisture changes, and vibrations and may seek attachment locations with thin skin (e.g., ears) or elevated body heat (e.g., underarms, groin, and armpits). Abundant habitat for ticks is present within undergrowth and becomes more limited within fully established forests. Ticks are most active between March and October.		
Health Hazards	Transmission of Lyme Disease, Rocky Mountain Spotted Fever, Tularemia, Babesiosis, Ehrlichiosis, and Southern Tick Associated Rash Illness. These illnesses are caused by either a parasite or a bacterium transmitted by the tick. Secondary infection due to bite and/or leaving mouthparts in epidermis.		
Symptoms	A bite area may be tender and mildly swollen. Symptoms of the tick-borne illnesses listed above may include a rash, headaches, swelling, and potentially worsening symptoms including nausea, vomiting, abdominal pain, muscle pain, lack of appetite, and upper respiratory symptoms. A rash *may* occur; however, it does not occur in every case. Therefore, the absence of a rash does not indicate absence of infection. Monitor the bite location for signs of infection (possible but unlikely) including increased swelling and/or a localized fever.		
Treatment	Refer to First Aid Procedures below for acute actions. Treatment is required by medical professionals and typically includes a complete dose of an antibiotic.		
Protective Measures	***Awareness:*** Wear light-colored clothing and perform tick checks in the morning, in the evening, after bathing, and intermittently throughout the day. During work hours, have other site personnel inspect clothing for the presence of ticks. ***PPE:*** Level D PPE is required. Personnel will spray exposed skin with insect repellant containing DEET (approximately 33 percent solution) and clothing with insect repellant containing permethrin/permanone or DEET. Tuck and tape for ticks: tuck trouser legs into boots and tape boots to trouser legs. Also, tuck shirts into pants and wear a belt.		
First Aid Procedures	If the tick is embedded, remove the tick using tweezers to grasp the tick at the mouthparts and pull straight out (do not twist/jerk as the mouthparts may separate from the tick and increase the risk of infection). Clean the bite area with soap and water, alcohol (free phase or within hand sanitizers), and apply antibiotic ointment beneath a bandage. Monitor yourself and other site personnel for symptoms described above. Report all tick bites, suspected tick bites, and/or potential symptoms of tick-borne illness to the SSHO immediately and less than 24 hours from the incident.		
Inoculation	Currently, there is no vaccine available for the illnesses listed above.		

2.9.4 Poisonous Snakes

		
Eastern Massasauga	**Timber Rattlesnake**	**Copperhead Snake**

Environment	Snakes are found sunning themselves on rocks and boulders, logs, roads, and/or open areas and are typically found wherever small rodents are present as a food source.
Health Hazards	***Bites***: Physical injury and deleterious response to snake venom including severe pain. The Copperhead is responsible for the most bites; however, the venom is not generally fatal. Mortality is linked to availability of medical attention, not venom toxicity.
Symptoms	***Physical Injury***: Pair of puncture marks, redness and swelling, and severe pain. ***Venom Response***: Nausea and vomiting, labored breathing, disturbed vision, increased salivation and sweating, and localized numbness or tingling of face and/or limbs.
Treatment	Refer to First Aid Procedures below, seek professional medical attention.
Protective Measures	***Awareness***: Snakes avoid confrontation whenever possible. Look for snakes and habitat when walking within the work areas. ***PPE***: Level D PPE is required. The small fangs of the Copperhead are unlikely to penetrate work trousers. Snake chaps are required in overgrown areas.
First Aid Procedures	Following any snake bite, attempt to note the color and shape of the snake and seek professional medical attention immediately. Keep very still and very calm and sit with the bite location *below* heart level; wash the bite with soap and water; clean the area with alcohol; cover the bite with antibiotic ointment and a clean, dry, dressing. **DO NOT:** handle/capture the snake; wait for symptoms to appear; apply a tourniquet; lance the wound; apply suction; immerse in water; ingest alcohol or caffeine.
Inoculation	Not applicable.

2.9.5 Poisonous Plants

A survey of poisonous plants in the region indicated the presence of Poison Ivy and Poison Oak.

		
	Poison Ivy (Shrub)	**Poison Oak**
Environment	The plants listed above are all regionally found on Iona Island.	
Health Hazards	***Poison Ivy (Urushiol Oil)*:** Poison Ivy secretes urushiol oil, which causes contact dermatitis that can become severe if introduced into mucous membranes (i.e., eyes, nose).	
Symptoms	Swelling and itching; red rash within a few days of contact; bumps, streaking, and weeping blisters (blisters fluids not contagious). The rare potential exists for a severe allergic reaction including severe swelling or difficulty breathing.	
Treatment	Refer to First Aid Procedures below.	
Protective Measures	***Awareness*:** Identify and avoid the plants listed above. Attempt to access the sampling locations using another route, or slightly relocate sampling locations, if the plants are present in the work area. Notify the SSHO if/when these plants are observed. ***Prevention:*** Clean tools used near known or suspected Poison Ivy with soap/water. ***PPE*:** Modified Level D PPE is required.	
First Aid Procedures	***Urushiol Oil*:** Immediately rinse skin and wash with soap and water; apply a cold compress and hydrocortisone cream (do not apply to open blisters); and seek professional medical attention if severe swelling or difficulty breathing is observed. Generally, an oral antihistamine (e.g., diphenhydramine) may be taken to reduce the allergic response.	
Inoculation	Not applicable.	

2.9.6 Harmful Animals

No harmful animals harboring fleas or disease are anticipated to be near the zones of work. If wild animals are encountered, retreat to the support vehicle, and notify the SSHO immediately.

2.9.7 Plants Causing Skin and Tissue Injury

Contact with sharp leaves, nettles, and thorns are of special concern to site personnel. This concern stems from the fact that punctures, cuts, and even minor scrapes caused by accidental contact may result in non-infectious skin lesions, and the introduction of fungi or bacteria through the skin or eye. This is especially important because the warm moist environment created inside protective clothing is ideal for the propagation of fungal and bacterial infection. Personnel receiving any of the injuries listed above, even minor scrapes, will report it immediately to the SSHO for initial and continued observation and care of the injury. Keeping the skin covered as much as possible (i.e., long pants and long-sleeved shirts) in areas where these plants are known to exist will limit much of the potential exposure. If the rash is scratched, secondary infections can occur. Avoid contact with sharp leaves, thorns, and nettles; maintain proper hygiene; and wear Level D PPE.

2.10 MUNITIONS AND EXPLOSIVES OF CONCERN HAZARDS

MEC may be encountered at the site. All personnel should be alert for MEC. Avoidance procedures and techniques will be utilized on tasks not associated with the MEC investigation. Personnel performing tasks related to MEC investigation will follow the approved practices and procedures identified in the approved planning documents. Specific descriptions of potential MEC onsite are presented under separate cover in the Explosive Site Plan (ESP). A list of MEC-related tasks to be performed during this project is provided below:

- Unexploded Ordnance (UXO) escort of non-UXO qualified personnel (MEC avoidance)
- Surface clearance of land-based geophysical investigation areas
- Surface and subsurface MEC investigation
- Underwater MEC investigation
- Material potentially presenting an explosive hazard inspection and certification as material documented as safe prior to packaging for shipment
- Quality control inspection of completed field activities.

All project personnel will adhere to safe work procedures when working in an area with potential MEC. The following general precautions with regard to MEC will be observed at all times:

- DO NOT touch or move any ordnance item(s) regardless of the markings or apparent condition unless qualified to do so.
- DO NOT visit an ordnance site if an electrical storm is occurring or approaching. If a storm approaches during a site visit, leave the site immediately and seek shelter.
- DO NOT use radios or cellular phones in the vicinity of suspect ordnance items.
- DO NOT drive vehicles into a suspected MEC area; use clearly marked lanes.
- DO NOT carry matches, lighters, or other flame-producing devices onto a munitions response site.

- DO NOT rely on color code for positive identification of ordnance item(s) nor their contents.

- Approach ordnance items from the side; avoid approaching the front or rear areas.

- Always assume ordnance items contain a live charge until it can be ascertained otherwise by a qualified individual.

2.10.1 Specific Actions to be taken upon Locating MPPEH

Do not be misled by markings on the ordnance item stating practice or inert. Even practice items may have explosive charges that are used to mark/spot the point of impact; or the item could be incorrectly marked.

- Follow Engineer Manual 385-1-97 Safety Precautions (USACE 2014) for the type of munitions or MEC encountered.

- Do not roll the item over or scrape the item to identify the markings.

- The location of any ordnance items found during sweep activities should be clearly marked so they can be easily located and avoided. Follow the procedures set forth in the MEC Quality Assurance Project Plan.

- Upon locating any munitions potentially presenting an explosive hazard (MPPEH), notify the Unexploded Ordnance Safety Officer (UXOSO) and/or the SSHO so appropriate measures can be taken.

2.11 BOAT OPERATIONS AND DIVING HAZARDS

Hazards associated with boat operations including notice to mariners are addressed in Appendix G (Marine Safety) of the APP and hazards associated with diving are addressed in Appendix H (Diving Safety Plan) of the APP.

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Table 2-1 Site-Specific Hazard Evaluation for Land Based Activities

Potential Hazards[a]	Controls or training being utilized[b]	Applicable AHAs (to be completed) [c]	Activities											
			Mobilization and Demobilization	Land Survey	Detector-Aided Surface Clearance	Land-Based Geophysical Survey	Brush Clearing	Intrusive Investigation Mag and Dig	Intrusive Investigation Target of Interest Investigation	Direct Push Technology Soil Boring	Bedrock Well Installation	Groundwater Sampling	Soil Sampling	Sediment Sampling
Chemical Hazards														
MCs to include explosives and potentially lead (source – breached MEC items)	Site control by the Senior Unexploded Ordnance Supervisor (SUXOS), Level D PPE, Site-specific awareness training	General, Intrusive Investigation, Anomaly Avoidance, MPPEH Inspection, Well Installation, Direct-push Soil Boring, Groundwater Sampling, Soil Sampling, and Sediment Sampling						X	X	X	X	X	X	X
Chemical constituents of concern (includes metals, SVOC, and VOC; source – historical operations)	Level D PPE, Site-specific awareness training	General, Intrusive Investigation, Direct-push Soil Boring, Well Installation, Ground-water Sampling, Soil Sampling, and Sediment Sampling								X	X	X	X	X
Fuels (source – onsite vehicles and equipment)	Level D PPE, site-specific awareness training	General	X	X	X	X	X	X	X	X	X	X	X	X
Physical Hazards														
General Hazards	Level D PPE, site-specific awareness training	General	X	X	X	X	X	X	X	X	X	X	X	X
MEC	Site control by the SUXOS, Level D PPE, site-specific awareness training	General	X	X	X	X	X	X	X	X	X	X	X	X
Fire/Explosion	Site control by the SUXOS or SSHO, Site-specific awareness training	MPPEH Inspection, Direct-push Soil Boring, Well Installation	X				X	X	X	X	X			
Heavy Equipment (Mini Excavator and drill rigs)	Operator with training and experience, Site specific awareness training	Intrusive Investigation, Direct-push Soil Boring, Well Installation						X	X	X	X			
Utilities	Site specific awareness training	Intrusive Investigation, Direct Push Soil Boring, Well Installation						X	X	X	X			
Hand and Power Tools	Site specific awareness training	Large Hand Tools	X				X							
Weather Hazards	Site specific awareness training	General	X	X	X	X	X	X	X	X	X	X	X	X
Material Handling and Moving	Site specific awareness training	General, Intrusive Investigation, MPPEH Inspection, Direct-push Soil Boring, Well Installation	X					X	X	X	X	X		
Heat Stress	Site specific awareness training	General	X	X	X	X	X	X	X	X	X	X	X	X
Cold Stress	Site specific awareness training	General	X	X	X	X	X	X	X	X	X	X	X	X
Water Hazards	Site specific awareness training	Boating and Diving							X					
Cumulative Trauma Disorder	Task-specific awareness training	General	X	X	X	X	X	X	X	X	X	X	X	X
Biological Hazards														
Insects, Ticks, and Spiders	Site specific awareness training, insect repellent, Level D PPE	General	X	X	X	X	X	X	X	X	X	X	X	X
Poisonous Snakes	Site specific awareness training, insect repellent, Level D PPE	General	X	X	X	X	X	X	X	X	X	X	X	X
Wild Animals	Site specific awareness training, insect repellent, Level D PPE	General	X	X	X	X	X	X	X	X	X	X	X	X
Poisonous Plants	Site specific awareness training, Level D PPE	General	X	X	X	X	X	X	X	X	X	X	X	X

(a) Each hazard is evaluated in Section 2 of the SSHP. Required training is detailed in Section 6 of the APP. Site-specific activity hazard analyses for each task, including appropriate controls, are presented in Appendix A of the APP.
NOTES:
MPPEH = Material potentially presenting an explosive hazard.

An American Board of Industrial Hygiene (ABIH) - Certified Industrial Hygienist (CIH) and a Certified Safety Professional (CSP) has performed the above evaluation:

Pete Garger

5 December 2018

Name: Peter Garger, CIH (ABIH No. 3118)
CSP (Board of Certified Safety Professionals No. 20560)

Date

Title: Director of Safety and Health/Safety and Health Manager (SHM)

Table 2-2 Site-Specific Hazard Evaluation for Water-Based Activities

Potential Hazards[a]	Controls or training being utilized[b]	Applicable AHAs (to be completed)[c]	Activities		
			Mobilization/ Demobilization	Diving Magnetometer Survey	Intrusive Marine Investigation
Chemical Hazards					
Munitions Constituents to include explosives and potentially lead (source – breached MEC items)	Site control by the SUXOS, Level D PPE, Site-specific awareness training	General, Intrusive Investigation, MEC Avoidance, MPPEH Inspection, Soil Sampling			X
Fuels (source – onsite vehicles and equipment)	Level D PPE, Site-specific awareness training	General, Intrusive Investigation	X	X	X
Physical Hazards					
General hazards	Level D PPE, site specific awareness training	General	X	X	X
Munitions and explosives of concern (MEC)	Site control by the SUXOS, Level D PPE, site specific awareness training	General	X	X	X
Fire/Explosion	Site control by the SUXOS or SSHO Site-specific awareness training	General, MPPEH Inspection, MEC Disposal		X	X
Hand and Power Tools	Site-specific awareness training	Large Hand Tools Use	X		
Weather Hazards	Site-specific awareness training	General	X	X	X
Material Handling and Moving	Site-specific awareness training	General, Intrusive Investigation, Diving, Boating Operations	X	X	X
Boat Capsizing/Sinking	Operator with training and experience, site specific awareness training	Boating Operations	X	X	X
Drowning	Operator with training and experience, Certified Diver , site specific awareness training	Boating Operations and Diving	X	X	X
Man Overboard	Operator with training and experience, Certified Diver, site specific awareness training	Boating Operations and Diving	X	X	X
Struck by hazards	Operator with training and experience, Certified Diver, site specific awareness training	Boating Operations and Diving	X	X	X
Decompression Sickness	Certified Diver, site specific awareness training	Diving		X	X
Heat Stress	Site-specific awareness training	General	X	X	X
Cold Stress	Site-specific awareness training	General	X	X	X
Cumulative Trauma Disorder	Task-specific awareness training	General	X	X	X
Biological Hazards					
Insects, ticks, and spiders in marsh	Site-specific awareness training, insect repellent, Level D PPE	General	X		

NOTES:

(a) Each hazard will be evaluated in Section 2 of the Site Safety and Health Plan (SSHP) of the Accident Prevention Plan (APP). Required training will be detailed in Section 6 of the APP.

(b) The required site specific training will be conducted prior to site mobilization and during site mobilization as required. The SSHO and/or UXOSO, as applicable will brief all visitors to the site on the site hazards and controls as they pertain to the site and activities being conducted. All visitors will be required to sign a visitor log and will be escorted at all times by the field manager, SSHO, SUXOS, or UXOSO/UXOQCS as appropriate depending on the ongoing activity. Training includes Safety and Occupational Health Training (29 CFR 1910.120 (e)-compliant 40-Hour HAZWOPER) for all field personnel performing tasks noted above unless noted otherwise and MEC-Awareness training by UXOSO. Additionally, operators with training and experience will be used for equipment operation and boating. Where appropriate, training will be documented through certificates (i.e. 40-hour OSHA training, etc.) that will be presented in Attachment C of the APP.

(c) Site-specific AHA for each task will be developed and used by the field crews/workers performing the work, with the assistance of others (SSHO, UXOSO, Quality Control, Superintendent, etc.) as needed. The initial, accepted AHAs will be provided to and used by the field crews/workers that are performing the activities. AHAs are considered living documents and they are intended to be updated by the workers as needed in the field.

An American Board of Industrial Hygiene (ABIH) - Certified Industrial Hygienist (CIH) and a Certified Safety Professional (CSP) has performed the above evaluation:

Pete Garger
20 November 2018

Name: Peter Garger, CIH (ABIH No. 3118) Date
CSP (Board of Certified Safety Professionals No. 20560) Title: Director of Safety and Health/Safety and Health Manager (SHM)

Table 2-3 Potential Site Chemical Hazards

Compound	Probably Effects Level or Threshold Limit Value/Short-Term Exposure Limit	Immediately Dangerous to Life or Health	Route of Exposure	Symptoms
Volatile Organic Compound				
Acetone	500 ppm	2,500 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, nose, throat; headache, dizziness, central nervous system (CNS) depressant, dermatitis.
Bromoform *Skin*	0.5 ppm	850 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, respiratory system; CNS depressant; liver, kidney damage.
Bromomethane (Methyl bromide) *Skin*	1 ppm	Ca 250 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, respiratory system; muscular weakness, incoherence, visual disturbance, vertigo; nausea, vomiting, headache; malaise; hand tremor; convulsions; dyspnea; skin vesiculation. Liquid: frostbite; carcinogen.
2-Butanone (MEK)	200 ppm/300 ppm	3,000 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, skin, nose; headache, dizziness; vomiting; dermatitis.
Carbon disulfide *Skin*	1 ppm	500 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Dizziness, headache, poor sleep, fatigue, nervousness, anorexia, low-weight; psychosis; polyneuritis; Parkinson-like syndrome; ocular changes; coronary heart disease; gastritis; kidney, liver injury; eye, skin burns; dermatitis; reproductive effects.
Carbon tetrachloride *Skin*	5 ppm/10 ppm	Ca 200 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin; CNS depressant; nausea, vomiting; liver, kidney injury; drowsiness, dizziness, incoherence; carcinogen.
Chlorobenzene	10 ppm	1,000 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, skin, nose; drowsiness, incoherence, CNS depressant.
Chloroethane (Ethyl chloride) *Skin*	100 ppm	3,800 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Incoherence, inebriation; abdominal cramps; cardiac arrhythmia, cardiac arrest; liver, kidney damage.
Chloroform	10 ppm C 50 ppm	Ca 500 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin; dizziness, mental dullness, nausea, confusion; headache, fatigue, anesthesia; enlarged liver; carcinogen.
Chloromethane (Methyl chloride) *Skin*	50 ppm/100 ppm C 200 ppm	Ca 2,000 ppm	Inhalation, Skin/Eye Contact	Dizziness, nausea, vomiting; visual disturbance, stagger, slurred speech, convulsions, coma; liver, kidney damage; Liquid: frostbite; reproductive, teratogenic effects; carcinogen.
1,1-Dichloroethane (1,1-DCA)	100 ppm	3,000 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated skin; CNS depressant; liver, kidney, lung damage.
1,1-Dichloroethylene (1,1-DCE) (Vinylidene chloride)	5 ppm	Ca	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, throat; dizziness, headache, nausea; liver and kidney dysfunction.
1,2-Dichloroethylene	200 ppm	1,000 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, respiratory system; CNS depressant.
1,3-Dichloropropene (cis- and trans-)	1 ppm	Ca	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, skin, upper respiratory system; eye, skin burns; lassitude, loss of appetite, diarrhea, vomiting, slowing of pulse; CNS depressant.
Diesel Fuel (total hydrocarbons) *Skin*	100 mg/m^3 (approximately 15 ppm)	—	Inhalation, Ingestion, Skin/Eye Contact	Dermatitis.
Ethanol	1000 ppm	3300 ppm	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose; headache, drowsiness, lassitude (weakness, exhaustion), narcosis; cough; liver damage; anemia; reproductive, teratogenic effects
Ethylene dichloride (1,2-Dichloroethane)	10 ppm	Ca 50 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, corneal opacity; CNS depressant; nausea, vomiting; dermatitis; liver, kidney, CNS damage; carcinogen.
Formaldehyde	C 0.3 ppm	Ca 20 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritation eyes, nose, throat, respiratory system; lacrimation (discharge of tears); cough; wheezing; [potential occupational carcinogen]
Gasoline	300 ppm/500 ppm	Ca	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonitis (aspiration liquid); possible liver, kidney damage; [potential occupational carcinogen]
2-Hexanone (MBK) *Skin*	5 ppm/10 ppm	1,600 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, nose; peritoneal neuritis; weakness, paresthesia; dermatitis; headache; drowsiness.
Kerosene/Jet Fuels (as total hydrocarbon vapor) *Skin*	200 mg/m^3 (approximately 35 ppm)	—	Inhalation, Ingestion, Skin/Eye Contact	Skin irritant; CNS impairment; upper respiratory irritant.

Compound	Probably Effects Level or Threshold Limit Value/Short-Term Exposure Limit	Immediately Dangerous to Life or Health	Route of Exposure	Symptoms
Methanol *Skin*	200 ppm / 250 ppm STEL	25,000 ppm	Inhalation, Ingestion, Skin Contact, Absorption	Irritated eyes (watering, inflamed lids, painful sensitization to light), nose irritation, headache, fatigue, nausea, visual impairment. Gastrointestinal irritation, possible kidney impairment. Feeling of coldness, dryness, cracking leading to dermatitis; headache, fatigue, visual disturbances.
Methane	1,000 ppm	1.5 %	Inhalation	CNS impairment; cardiac sensitization; at 1.5% creates oxygen depletion.
4-Methyl-2-pentanone (MIBK)	20 ppm/75 ppm	500 ppm	Inhalation, Ingestion, Skin/Eye Contact	Upper respiratory tract irritant; irritated eyes, skin, mucous membranes; dizziness; headache, narcosis, coma; dermatitis.
Methylene chloride (Dichloromethane)	25 ppm/125 ppm 12.5 AL	Ca 2,300 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, skin; fatigue, weakness, sleepiness, light-headedness, nausea.
Methyl tert-butyl ether (MTBE)	50 ppm	—	Inhalation, Ingestion, Skin/Eye Contact	Upper respiratory tract irritant; kidney damage.
Styrene	20 ppm/40 ppm C 200 ppm	700 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, nose; respiratory system; headache, fatigue, dizziness, confusion, malaise, drowsiness, weakness, unsteady gait; narcosis; defatting dermatitis; possible liver injury, reproductive effects.
1,1,2,2-Tetrachloroethane (1,1,2,2-TECA) *Skin*	1 ppm	100 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Nausea, vomiting, abdominal pain; tremor fingers; jaundice, hepatitis, liver tenderness; dermatitis; kidney damage; carcinogen.
Tetrachloroethylene (PCE) (Perchloroethylene)	25 ppm/100 ppm C 200 ppm	Ca 150 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, nose, throat; nausea, flush face, dizziness, headache, liver damage.
1,1,1-Trichloroethane (TCA) (Methyl chloroform)	350 ppm/450 ppm	700 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, skin; headache, lassitude, CNS depressant, poor equilibrium; dermatitis; cardiac arrhythmia; liver damage.
1,1,2-Trichloroethane (1,1,2-TCA) *Skin*	10 ppm	Ca 100 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, nose; CNS depressant; liver, kidney damage, dermatitis; carcinogen.
Trichloroethylene (TCE)	10 ppm/25 ppm C 200 ppm	Ca 1,000 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin; headache, dizziness, vertigo, visual distortion, fatigue, giddiness, vomiting, dermatitis, nausea.
Vinyl chloride	1 ppm/C 5 ppm 0.5 ppm AL	Ca	Inhalation, Skin/Eye Contact (with liquid)	Weakness, abdominal pain, GI bleeding, enlarged liver.
Semi-Volatile Organic Compound				
Benzidine *Skin*	— (exposures by all routes should be as low as possible)	Ca	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Hematosis, secondary anemia from hemolysis, acute cystitis, acute liver disorders, dermatitis; painful, irregular urination; bladder cancer.
Di-n-butyl-phthalate	5 mg/m^3	4,000 mg/m^3	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, upper respiratory system, and stomach.
1,2-Dichlorobenzene (o-DCB)	25 ppm/50 ppm	200 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, nose; liver and kidney damage, skin blisters.
1,4-Dichlorobenzene (p-DCB)	10 ppm	Ca 150 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Headache, eye irritation, profuse rhinitis, weight loss, nausea, vomiting.
3-3' Dichlorobenzidine	— (exposures by all routes should be as low as possible)	Ca	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Skin sensitivity, dermatitis; headache, dizziness; caustic burns; frequent urination; dysuria; hematosis; GI upset; upper respiratory infection; carcinogen.
Diethyl phthalate	5 mg/m^3	None	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, skin, nose, throat; headache, dizziness, nausea; lacrimitis; possible polyneuritis, vestibular dysfunction; pain, numbness, weakness, spasms in arms and legs.
Dimethyl phthalate	5 mg/m^3	2,000 mg/m^3	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, upper respiratory system; stomach pain.
Hexachlorobutadiene *Skin*	0.02 ppm	Ca	Inhalation, Ingestion, Absorption, Skin/Eye Contact	In animals: irritated eyes, skin, respiratory system; kidney damage; carcinogen.

Compound	Probably Effects Level or Threshold Limit Value/Short-Term Exposure Limit	Immediately Dangerous to Life or Health	Route of Exposure	Symptoms
Hexachlorocyclopentadiene	0.01 ppm	None	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, respiratory system; eye, skin burns; lacrimitis; sneezing, coughing, dyspnea, salivating, pulmonary edema; nausea, vomiting, diarrhea.
Hexachloroethane *Skin*	1 ppm	Ca 300 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, mucous membranes; carcinogen.
Isophorone	C 5 ppm	200 ppm	Inhalation, Ingestion, Skin/Eye Contact	Irritated eyes, nose, throat; headache, nausea, dizziness, fatigue dermatitis, narcosis.
2-Methyl phenol (o-Cresol) *Skin*	5 ppm	250 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, mucous membranes; CNS effects: confusion, depression, respiratory failure; dyspnea, irregular rapid respiration, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage.
3-Methyl phenol (m-Cresol) *Skin*	5 ppm	250 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, mucous membranes; CNS effects: confusion, depression, respiratory failure; dyspnea, irregular rapid respiration, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage.
4-Methyl phenol (p-Cresol) *Skin*	5 ppm	250 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, mucous membranes; CNS effects: confusion, depression, respiratory failure; dyspnea, irregular rapid respiration, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage.
4-Nitroaniline (p-Nitroanaline) *Skin*	3 mg/m^3	300 mg/m^3	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated nose, throat; cyanosis, ataxia; tachycardia, tachypnea; dyspnea; irritability; vomiting, diarrhea; convulsions; respiratory arrest; anemia; methemoglobinemia; jaundice.
N-Nitrosodimethylamine *Skin*	— (exposures by all routes should be as low as possible)	Ca	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Nausea, vomiting, diarrhea, abdominal cramps; headache; fever; enlarged liver, jaundice; decreased liver, kidney, pulmonary function; carcinogen.
Pentachlorophenol (PCP) *Skin*	0.5 mg/m^3	2.5 mg/m^3	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, nose, throat; sneezing, coughing; weakness, anorexia, low-weight; sweating; headache, dizziness; nausea, vomiting; dyspnea; chest pain; high fever; dermatitis.
Phenol *Skin*	5 ppm	250 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, nose, throat; weight loss, dark urine, liver and kidney damage, muscle ache, skin burns, dermatitis, tremors, convulsions.
1,2,4-Trichlorobenzene	C 5 ppm	—	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Irritated eyes, skin, mucous membrane; liver/kidney damage, possible teratogenic effects.
Semi-volatile Organic Compounds (PAH)				
Benzo[a]anthracene	0.2 mg/m^3 [a]	80 mg/m^3 [a] Ca	Inhalation, Skin/Eye Contact	Dermatitis, bronchitis; suspected human carcinogen.
Benzo[a]pyrene	0.2 mg/m^3 [a]	80 mg/m^3 [a] Ca	Inhalation, Skin/Eye Contact	Dermatitis, bronchitis; suspected human carcinogen.
Benzo[b]fluoranthene	0.2 mg/m^3 [a]	80 mg/m^3 [a] Ca	Inhalation, Skin/Eye Contact	Dermatitis, bronchitis; suspected human carcinogen.
Chrysene	0.2 mg/m^3 [a]	80 mg/m^3 [a] Ca	Inhalation, Skin/Eye Contact	Dermatitis, bronchitis; suspected human carcinogen.
Naphthalene	10 ppm/15 ppm	250 ppm	Inhalation, Ingestion, Absorption, Skin/Eye Contact	Eye irritation, headache, confusion, vomiting, profuse sweating, abdominal pain.
Metals				
Antimony (Sb)	0.5 mg/m^3	50 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Irritated eyes, skin, nose, throat, mouth; coughing, dizziness, headache, nausea, vomiting, diarrhea, stomach cramps, insomnia, loss of smell.
Arsenic (inorganic compounds as As)	0.01 mg/m^3 0.005 mg/m^3 AL	Ca 5 mg/m^3 (as As)	Inhalation and Ingestion via particulates, Skin/Eye Contact	Ulceration of nasal septum, dermatitis, gastrointestinal bleeding.
Barium (and soluble compounds as Ba)	0.5 mg/m^3	50 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Upper respiratory irritation, muscle spasm, slow pulse, irritated eyes, skin.
Beryllium (and compounds as Be)	0.00005 mg/m^3 C 0.005 mg/m^3	Ca 4 mg/m^3	Inhalation via particulates, Skin/Eye Contact	Berylliosis (chronic exposure): anorexia, low-weight; weakness, chest pain; cough, clubbing of fingers, cyanosis, pulmonary insufficiency; irritated eyes; dermatitis; carcinogen.

Compound	Probably Effects Level or Threshold Limit Value/Short-Term Exposure Limit	Immediately Dangerous to Life or Health	Route of Exposure	Symptoms
Cadmium (Cd)	0.005 mg/m^3 0.0025 mg/m^3 AL	Ca 9 mg/m^3	Inhalation and Ingestion via particulates	Pulmonary edema, dyspnea, cough, chest tight, subs pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; loss of smell; emphysema, proteinuria, mild anemia; carcinogen.
Chromium (Cr), Metal, II, and III compounds	0.5 mg/m^3	250 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Histologic fibrosis of lungs; irritated eyes and skin.
Chromium (Cr)VI compounds as CrO_3	0.005 mg/m^3 0.0025 mg/m^3 AL	Ca 15 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Irritation respiratory system; nasal septum perforation; liver, kidney damage; leukocytosis (increased blood leukocytes), leukopenia (reduced blood leukocytes), eosinophilia; eye injury, conjunctivitis; skin ulcer, sensitization dermatitis; [potential occupational carcinogen]
Cobalt (and inorganic compounds as Co)	0.02 mg/m^3	20 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Irritation of nasal membranes, pharynx, nasal perforation, eye irritation.
Copper (Cu)	1 mg/m^3 0.1 mg/m^3 for fumes as Cu	100 mg/m^3	Inhalation via particulates, Skin/Eye Contact	Irritated eyes, upper respiratory system; metal fume fever: chills, muscular ache, nausea, fever, dry throat, cough, weakness, lassitude; metallic or sweet taste; discoloration of skin, hair.
Lead (and inorganic compounds as Pb)	0.050 mg/m^3 0.030 mg/m^3 AL	100 mg/m^3 (as Pb)	Inhalation and Ingestion via particulates, Skin/Eye Contact	Lassitude, insomnia, pallor, anoxia, weight loss, constipation, abdominal pain, colic, anemia, wrist paralysis.
Manganese (and inorganic compounds as Mn)	0.02 mg/m^3 C 5 mg/m^3	500 mg/m^3	Inhalation and Ingestion via particulates	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage; CNS function (neurobehavioral and neuropsychological changes).
Mercury (Hg) *Skin*	0.01/0.03 mg/m^3 alkyl compounds 0.025 mg/m^3 elemental and inorganic forms 0.1 mg/m^3 aryl compounds C 0.1 mg/m^3 elemental and inorganic forms	10 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Dizziness, nausea, vomiting, diarrhea, constipation, skin burns, emotional distance.
Nickel (Ni)	1.5 mg/m^3 elemental 0.1 mg/m^3 soluble inorganic compounds 0.2 mg/m^3 insoluble inorganic compounds	Ca 10 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Sensitive skin, asthma, nasal cavity irritation, pneumonitis, carcinogen.
Selenium (and compounds as Se)	0.2 mg/m^3	1 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Irritation eyes, skin, nose, and throat; headache, chills, dyspnea, bronchitis, metallic taste, garlic breath, liver/spleen damage.
Silver (metal dust and soluble compounds as Ag)	0.01 mg/m^3	10 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Blue-gray eyes, nasal septum, throat, skin; irritability, ulceration of skin; GI disturbance.
Thallium (and soluble compounds as Tl) *Skin*	0.02 mg/m^3 (I)	15 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact, Absorption	Nausea, diarrhea, abdominal pain, vomiting, peripheral neuropathy, tremor, chest pain, pulmonary edema.
Vanadium pentoxide (dust or fume as V_2O_5)	C 0.05 mg/m^3 respirable fraction	35 mg/m^3	Inhalation and Ingestion via particulates, Skin/Eye Contact	Irritated eyes, skin, throat; green tongue, metallic taste, eczema, cough, wheezing, bronchitis.
Acids / Corrosives				
Hydrochloric acid (as hydrogen chloride gas)	C 2 ppm	50 ppm	Inhalation, Absorption, Skin/Eye Contact	Irritation of skin, eyes, mucous membranes, esophagus, stomach; nausea, vomiting, intense thirst, diarrhea, erosion of exposed teeth
Nitric acid	2 ppm/4 ppm	25 ppm	Inhalation, Absorption, Skin/Eye Contact	Corrosive to body tissue. Dental erosion, irritation, corrosive burns of skin, eyes, upper respiratory tract, delayed pulmonary edema, pneumonitis, bronchitis.
Sulfuric acid	0.2 mg/m^3 thoracic fraction 1 mg/m^3	15 mg/m^3	Inhalation, Absorption, Skin/Eye Contact	Immediately damaging to any body tissue, it contacts at high concentrations. Severe or permanent damage to eyes, upper respiratory tract and lung damage.

Compound	Probably Effects Level or Threshold Limit Value/Short-Term Exposure Limit	Immediately Dangerous to Life or Health	Route of Exposure	Symptoms
Sodium Hydroxide	C 2 mg/m^3	10 mg/m^3	Inhalation, Ingestion, Skin/Eye Contact	Dissolves living tissue. Immediate burning to upper digestive tract, esophagus, stomach; painful swallowing; excessive salivation; excessive fluid surrounding lips, chin, tongue, coffee-ground like vomit, rapid/faint pulse, cold clammy skin, adhesion of lid to eyeball.
Other				
Portland Cement	1 mg/m^3 (E, R)	5000 mg/m^3	Inhalation, Ingestion, Skin and/or Eye Contact	Irritation eyes, skin, nose; cough, expectoration; exertional dyspnea (breathing difficulty), wheezing, chronic bronchitis; dermatitis.

(a) The PEL and IDLH are representative of coal tar pitch volatiles.
E = The value is for particulate matter containing no asbestos and < 1% crystalline silica.
I = Inhalable fraction
IDLH = Immediately Dangerous to Life and Health
IFV = Inhalable Fraction and Vapor
PAH = Polycyclic aromatic hydrocarbons
PEL = Permissible Exposure Limit
ppm = Parts per million
R = Respirable fraction
TLV = Threshold Limit Value
STEL = Short Term Exposure Limit (15 min)
AL = Action Level (OSHA)
C = Ceiling Limit
Ca = Carcinogen
CNS = Central Nervous System
GI = Gastrointestinal
N.D. = Not determined
Skin = Skin absorption can contribute to overall body dose
f/cc = Fibers per cubic centimeter of air.

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3. STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

Section 4 of the APP provides the organization, qualifications, and responsibilities of project staff. Appendix C of the APP presents resumes and/or certifications.

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4. TRAINING

This information is presented in Section 6 of the APP.

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5. PERSONAL PROTECTIVE EQUIPMENT

Based on the hazard assessment conducted by the SHM, and for tasks where engineering controls cannot eliminate the occupational hazards at the Iona Island FUDS, PPE is required. Employees have received Occupational Safety and Health Administration (OSHA) compliant PPE training as part of Hazardous Waste Operations and Emergency Response training.

5.1 SELECTION

The selection of the appropriate PPE was performed by the SHM. The type of PPE and level of protection will be reevaluated periodically[1] by the SSHO, with feedback from site workers, in light of any new information about the site or site operations. Selection of the protective ensembles described below conforms to the levels of protection as described in the National Institute for Occupational Safety and Health Publication 85–115. Selection is based on an evaluation of the performance characteristics of the PPE relative to the site requirements/ limitations, task-specific condition and duration, and hazards and potential hazards identified at the site.

5.2 PERSONAL PROTECTIVE EQUIPMENT USE

As stated above, EA will provide PPE and the proper training on its maintenance and use; however, the employees are required to use the PPE as provided and for the use of which it was intended.

5.3 TRAINING AND PROPER FITTING

Employees have received OSHA compliant PPE training as part of Hazardous Waste Operations and Emergency Response training. If the SSHO determines during site work that an employee needs to be re-trained, the SSHO will not allow the employee to perform the work activities until this re-training has occurred and will document the re-training as described in Table 6-1 of the APP.

5.4 INSPECTION AND IN-USE MONITORING

Inspection of PPE will be performed prior to use by the employee and is listed in Table 7-1 of the APP. PPE that does not pass inspection will be discarded and replaced.

5.5 MAINTENANCE AND STORAGE

Disposable PPE will be removed and disposed of in the contamination reduction zone. All PPE will be properly stored in site vehicles.

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[1] As required, but typically associated with a set of changing conditions requiring evaluation of PPE changes.

5.6 LEVELS OF PROTECTION AND REQUIREMENTS

Levels of protection at the Iona Island FUDS include Level D, and Modified Level D. PPE required as part of first aid activities is not presented in this section; however, it will be provided for first aid/cardiopulmonary resuscitation (CPR) providers.

5.6.1 Level D Protection

Work tasks at the Iona Island FUDS contain no known atmospheric hazards and do not include splashes, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemicals; therefore, Level D PPE includes:

- Work clothing consisting of long-sleeve shirts and work pants when working in heavily vegetated areas with potential for exposure to poisonous plants. Short sleeve shirts are acceptable when outside of heavily vegetated areas or when worn in conjunction with over-the-counter barrier creams. Coveralls are also acceptable at all times.

- Heavy-duty cloth or leather gloves, as necessary during brush cutting or other operations as identified in the AHAs (cut-resistant recommended). Not for work involving the handling of environmental samples.

- Steel-toe or composite boots (in accordance with American National Standards Institute [ANSI] Z41 and American Society for Testing and Materials International Standards F2412 and F2413).

- Hearing protection (earplugs or muffs) when in the exclusion zone within 25 ft of heavy equipment in operation

- Hard hats in accordance with ANSI/International Safety Equipment Association Z89.1; for operations with overhead hazards (drilling).

- High visibility apparel (e.g., blaze orange/yellow clothing and/or reflective safety vests) apparel is required when in the exclusion zone or when working near heavy equipment or traffic. It should be noted that that during hot work (e.g., welding), personnel either wear a flame-retardant safety vest or another employee (spotter) with a safety vest will be assigned to act as a lookout during the hot work.

- Safety glasses (Z87.1-rated) when cutting brush or otherwise exposed to flying debris.

- All disposable PPE will be bagged in plastic bags for non-hazardous disposal.

5.6.2 Modified Level D Protection

Modified Level D Protection includes Level D protection with the addition of nitrile gloves (when directly handling soil).

5.6.3 Level C Protection

Level C Protection is required only if environmental monitoring during drilling activities exceeds 5 ppm in the breathing zone and is not controllable by engineering controls and will include:

- Level D or Modified Level D requirements above.
- Respirators (See Respiratory Protection Plan in Section 9.9 of the APP).
- Protective face shields.

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6. MEDICAL SURVEILLANCE

Site personnel for work to be completed at the Iona Island FUDS will be required to be enrolled in the medical surveillance program with their employer. Site workers that anticipate being exposed to contaminants at the permissible exposure limit for 30 or more days a year or that may don respiratory protection will be enrolled in a medical surveillance program and will satisfactorily complete a comprehensive medical examination by or under the supervision of a licensed physician knowledgeable in occupational medicine prior to the initiation of field work. EA employees and subcontractors involved in those activities that may contact contaminated media (specifically, sampling activities and addressing investigation-derived waste) will be in the medical surveillance program. Medical examinations will be provided according to the following schedule:

- Prior to fieldwork assignment
- At least annually for employees covered by the program (biennially for those employees that do limited site work, with the approval of the occupational physician)
- At termination of employment or reassignment to an area where the employee had not been examined within the past 6 months
- As soon as possible after the development of signs or symptoms that may indicate an overexposure to hazardous substances or health hazards
- More frequently if the physician deems such examination necessary to maintain employee health.

Documentation for compliance with medical surveillance will be kept onsite[2]. Further documentation is maintained in EA's Office of Human Resources (410-584-7000). The records shall be complete and accurate and will be kept on file for at least 30 years after termination of employment. A minimum of the following information shall be kept:

- Name and social security number
- Physician's written opinions, recommendations, limitations, and test results
- Employee medical complaints related to hazardous waste operations
- Information provided to the physician by the employee concerning possible exposures, accidents, etc.

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[2] This information is also initially presented in Attachment C of the APP.

6.1 FIRST AID AND MEDICAL TREATMENT

At least two onsite workers will be currently certified in both first aid and CPR by the American Red Cross or equivalent organization. Documentation of all personnel certifications will be kept onsite. EA has identified a hospital for emergency medical care for this project site. The hospital to be used during emergencies for this site is the New York Presbyterian Hudson Valley Hospital (914) 737-9000.

Employees will have the telephone number to the hospital during working hours should an occupational illness or injury occur. Individuals onsite currently certified in first aid will be called out at the start of each day's activities during the health and safety meeting. Certifications will be present onsite and will include separate Engineer Manual 385-1-1 03.A.06a-c-compliant bloodborne pathogen training. For information on this training, refer to Section 6 of the APP. A site-specific Bloodborne Pathogen Exposure Control Plan is contained in Section 9.6 of the APP.

6.2 MEDICAL RESTRICTION

Should an occupational injury or illness occur that restricts or limits an employee's ability to function at full capacity, EA maintains a policy of providing these employees with restricted or modified duty assignments whenever possible to allow them to continue to be productive.

6.3 MEDICAL RECORDS

Medical and personal exposure monitoring records will be maintained according to the requirements of 29 Code of Federal Regulations 1910.120 (f) and shall be kept for a minimum of 30 years beyond employment. Employee confidentiality shall be maintained.

7. EXPOSURE MONITORING

7.1 GENERAL

Exposure monitoring for temperature will be instituted during operations at the site. The monitoring program may be modified by the SHM with input from the UXOSO and or the SSHO, if site conditions and monitoring results warrant. Monitoring will be accomplished under the direction of the UXOSO and or the SSHO, who will interpret the results. Environmental monitoring requirements are presented on Table 7-1.

7.2 AIR MONITORING PROGRAM

The air monitoring program will include monitoring of personnel and work zones to assess levels of employee exposure, establish that the work zone designations are valid, and verify that the respiratory protection being worn by personnel (if required) is adequate during HTRW RI intrusive activities only (drilling) and MMRP RI intrusive activities (test pitting)/excavation. As specified in Table 7-1 (Environmental Monitoring Requirements, Action Levels, and Exposure Limits), air monitoring will be conducted during dust-generating tasks:

- Establish baseline concentrations and conduct negative exposure assessments
- Periodically during site operations.

Personnel properly trained in air monitoring procedures will perform necessary operation, calibration, and maintenance of air monitoring equipment.

7.2.1 General Area Monitoring

At a minimum, one general area monitor will be utilized during dust-generating, intrusive subsurface work, and noise-generating work activities to monitor airborne contaminants and noise; additional monitors may be utilized depending upon the configuration of the work area, number of workers, and/or type of work activity being conducted. General area monitoring will be conducted utilizing air samplers with flow rates sufficient to provide total sample volumes that will satisfy analytical instrument detection requirements.

7.2.2 Breathing Zone Monitoring

BZ monitoring will be conducted for VOCs using a photoionization detector as indicated on **Table 7-1**.

7.2.3 Real-Time Air Monitoring

Real-time monitoring of ambient dust levels will be conducted in work zones and other onsite areas to assess total dust concentrations during intrusive activities. Measurements will be collected at the anticipated source and in the breathing zone of site personnel during work operations.

7.2.4 Perimeter Monitoring

If general area or real-time air monitoring within work areas indicates readings above action levels, real-time monitoring for total dust concentrations and/or monitoring for airborne particulates will be conducted at the perimeter of the site during intrusive activities. If ambient dust levels exceed established action levels for a sustained period of time beyond the perimeter of the site, work will be stopped and the SHM and Project Manager will be notified. A decision will then be made as to how to proceed with the work and how to more fully characterize the airborne emissions. Work zones may need to be modified as a result of air monitoring readings during perimeter monitoring. If perimeter monitoring is warranted, the requirements presented in **Table 7-1** will be utilized.

7.3 CALIBRATION AND MAINTENANCE

Monitoring instruments will be calibrated initially and instructions in the manufacturers' operations manuals regarding calibration, cleaning, and maintenance of the instruments will be followed. A calibration and maintenance log for each instrument will also be maintained (Appendix D of the APP). The log should contain detailed descriptions of problems encountered with the instrument along with any records of factory calibration and repair.

Table 7-1 Environmental Monitoring Requirements, Action Levels, and Exposure Limits

Hazard	Instrument	Location/Type of Monitoring	Frequency	Action Level	Exposure Limit	Response
VOCs	Total Volatile Organics Detector (photoionization detector)	Breathing Zone during HTRW intrusive activities (drilling)	Every 30 minutes	Above background	5 ppm	Begin perimeter monitoring. Monitor continuously for total volatile organics. Begin contaminant specific monitoring for benzene (see below).
				>5 and <50 ppm		Upgrade to Level C. If total organic concentrations exceed 50 ppm, evacuate.
		Perimeter monitoring during HTRW intrusive activities (drilling)	2 times per day	Above background		Shut down operations and identify source of contamination and control by engineering controls.
Total Dust (Particulates not otherwise specified)	Real-time dust meter	Area Personal during intrusive activities (drilling and excavation)	Baseline and Periodic	5 mg/m^3	ACGIH = 10 mg/m^3 as "Particulates not otherwise specified" (inhalable particulates) PEL = 15 mg/m^3 (Nuisance dust)	If reading exceeds the Action Level, monitor continuously and notify SSHO. Implement engineering controls. If reading exceeds the Exposure Limit, stop work and notify SSHO.
Noise	Dosimeter	Area Personal during drilling	Baseline and Periodic	85 decibels 115 decibels	85-140 decibel	Hearing protection will be donned at 85 decibels Double hearing protection at levels above 115 decibels.
Temperature	Thermometer	Area	Baseline	Heat – Table 8-1 Cold – Table 8-3	Cold - 26°F	Heat – refer to Table 8-2 for work-rest regimen Cold – 26°F ensure no continuous skin exposure to cold (wear layers, gloves, etc.)

NOTES:
°F = Degrees Fahrenheit
ACGIH = American Conference of Governmental Industrial Hygienists
$\text{PEL}_{\text{[Resp. fr.]}}$ = Permissible Exposure Limit for respirable fraction of dust.

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8. HEAT AND COLD STRESS

It is the responsibility of the SSHO and each employee to ensure that temperature stress controls are adequate for the site conditions and tasks. All employees, and specifically the SSHO, are empowered and expected to stop or modify work and take any precautionary measures to prevent temperature related illnesses. Temperatures at the site range from an average low of 24°F to an average high of 47°F in January and an average low of 65°F to an average high of 92°F in July; therefore, all necessary precautions will be taken.

8.1 HEAT STRESS

Heat stress hazards can occur even in temperatures not commonly considered “hot” due to the level of physical activity, the level of PPE the worker is wearing, or the physical condition of the worker. Site training will include symptoms of heat-related illnesses and prevention techniques. Personnel will be familiar with the signs and symptoms of heat stress, including the following.

Heat Cramps—Muscle spasms in the abdomen or limbs. Frequent rest periods and fluid intake are appropriate measures to prevent or reduce heat cramps.

Heat Exhaustion—Severe dehydration; pale, clammy skin; profuse sweating; dizziness, light-headedness; slurred speech; rapid pulse; confusion; fainting; fatigue; cool skin; nausea. Affected personnel will be escorted from the site, set in a cool, shaded area, and given fluids slowly.

Heat Stroke—Life-threatening condition occurring when the body’s temperature-regulating system improperly functions. Heat stroke is characterized by hot dry skin; rapid, deep breathing; lack of perspiration; delirium; high fever (often 106°F or more); nausea; and unconsciousness. Brain damage and/or death may occur if body temperature is not reduced. Provide fluids, use cooling devices (hose-down or shower), call emergency medical services or transport to hospital immediately.

Heat stress prevention techniques include:

- Resting frequently in a shaded or air-conditioned area.
- Allowing workers who are not acclimatized to take additional breaks.
- Drink at least 8 ounces of water or diluted Gatorade every 15–20 minutes.
- Monitoring workers on a periodic basis as described below.

Heat stress monitoring will be conducted in a manner that anticipates and prevents the onset of heat stress symptoms (i.e., work-rest regimens). The radial pulse of each worker will be counted by the SSHO during a 30-second period as early as possible during the rest period immediately following work activities. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will be maintained. If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be shortened by another one-third. When ambient temperatures are expected to exceed 75°F, the resting heart rate of each worker will be measured prior to the start of onsite activities. The suggested frequency for physiological monitoring is provided in **Table 8-1**. The suggested and work-rest regimen is provided in **Table 8-2**.

Other factors, such as a worker's level of acclimation, level of physical fitness, and age, may increase or decrease his/her susceptibility to heat stress. Before assigning a task to an individual worker, these factors will be taken into account to ensure that the task will not endanger the worker's health. Sunscreen lotions will be provided and used per manufacturer's recommendations.

If a heat-related illness is suspected or observed, the affected person will be moved to a cool or shaded area and given plenty of liquids to consume. If symptoms of a heat stroke are observed, the victim will be cooled, and site personnel will immediately call 911.

8.2 COLD STRESS

Cold stress hazards are most likely to occur at low temperatures or low wind chill factors, with wet, windy conditions contributing to risk. As temperatures could fluctuate during these events, workers will be trained in signs and symptoms of cold stress and controls. If unexpected cold weather occurs, workers will be trained in signs and symptoms of cold stress and controls. Workers will be familiar with the signs and symptoms of cold stress, which include:

- ***Hypothermia***—Cold-induced decreasing of the core body temperature that produces shivering, numbness, drowsiness, and muscular weakness. If severe enough, it can lead to unconsciousness and death.

- ***Frostbite***—Constriction of blood vessels in the extremities, decreasing the supply of warming blood may result in formation of ice crystals in the tissues, causing tissue damage. Condition may range from frostnip, which is a numbing of extremities, to deep-freezing tissue beneath the skin. Symptoms include white or grayish skin, blisters, numbness, mental confusion, failing eyesight, fainting, shock, and cessation of breathing. Death may occur from heart failure.

Pain in the extremities may be the first warning of cold stress and precautions will be taken to reduce exposure. Maximum severe shivering will be taken as a sign of immediate danger to the worker and exposure to cold will be immediately terminated. Personnel exhibiting signs and symptoms of cold stress will be removed from the site and given appropriate first aid. Emergency medical services will be contacted if symptoms are severe (e.g., more than numbness of the extremities or shivering). Employees will not be immersed in water.

As a precautionary measure, employees will wear layers of loose-fitting clothing including insulated coveralls, head cover, gloves, and boots when temperatures fall below 40°F. Protection of the hands, feet, and head is particularly important because these are likely to be injured first by cold. However, actual injury to hands, feet, and head is not likely to occur without prior development of early signs of hypothermia such as numbing and shivering. Bare skin contact with cold surfaces (below 32°F) will be avoided. No continuous exposure to cold is permitted when the air speed and temperature results in an equivalent chill temperature of 26ºF or less. The equivalent chill temperature will be determined by the using the wind chill temperature shown in **Table 8-3**. Warm rest areas (support vehicles) will be provided. Air temperature and wind speed will be monitored at least every 4 hours at air temperatures below 45ºF.

Table 8-1 Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[(a)]

Adjusted Temperature (°F)[(b)]		Monitoring Interval (Minutes of Work)
90	Above 90	45
87.5	90	60
82.5	87.5	90
77.5	82.5	120
72.5	77.5	150

(a) Assumes work levels of 250 kilocalories/hour (e.g., a moderate work level). Consider increasing the frequency for heavier work rates. For the purpose of this chart, a normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

(b) Adjusted Air Temperature: Calculate the adjusted air temperature by using this equation:
AdjustedTemperature(°F) = *AirTemperature*(°F) + ([*13*] × [*% sunshine*]).
Measure the air temperature with a standard thermometer, with the bulb shielded from radiant heat. Estimate the percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow.
100% sunshine = no cloud cover and a sharp, distinct shadow.
0% sunshine = cloud cover and no shadows.

Adapted from: National Institute for Occupational Safety and Health/OSHA/U.S. Coast Guard/U.S. Environmental Protection Agency Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, Chapter 8 (1985).

Table 8-2 Suggested Work-Rest Regimen

Ambient Temperature (°F)	Work Period (Hours)	Rest Period (Minutes)
70	3.0	15
75	2.5	15
80	2.0	15
85	1.5	15
90	1.0	15
95	0.5	15

Table 8-3 Wind Chill Temperature

Air Temperature (ºF)		Wind Speed (miles per hour)										
		0	5	10	15	20	25	30	35	40	45	50
	40	40	36	34	32	30	29	28	28	27	26	26
	35	35	31	27	25	24	23	22	21	20	19	19
	30	30	25	21	19	17	16	15	14	13	12	12
	25	25	19	15	13	11	9	8	7	6	5	4
	20	20	13	9	6	4	3	1	0	-1	-2	-3
	15	15	7	3	0	-2	-4	-5	-7	-8	-9	-10
	10	10	1	-4	-7	-9	-11	-12	-14	-15	-16	-17
	5	5	-5	-10	-13	-15	-17	-19	-21	-22	-23	-24
	0	0	-11	-16	-19	-22	-24	-26	-27	-29	-30	-31
	-5	-5	-16	-22	-26	-29	-31	-33	-34	-36	-37	-38
	-10	-10	-22	-28	-32	-35	-37	-39	-41	-43	-44	-45
	-15	-15	-28	-35	-39	-42	-44	-46	-48	-50	-51	-52
	-20	-20	-34	-41	-45	-48	-51	-53	-55	-57	-58	-60
	-25	-25	-40	-47	-51	-55	-58	-60	-62	-64	-65	-67
	-30	-30	-46	-53	-58	-61	-64	-67	-69	-71	-72	-74
	-35	-35	-52	-59	-64	-68	-71	-73	-76	-78	-79	-81
	-40	-40	-57	-66	-71	-74	-78	-80	-82	-84	-86	-88
	-45	-45	-63	-72	-77	-81	-84	-87	-89	-91	-93	-95

Green:	**LITTLE DANGER** (frostbite occurs in >2 hours in dry, exposed skin)
Yellow:	**INCREASED DANGER** (frostbite could occur in 45 minutes or less in dry, exposed skin)
Red:	**GREAT DANGER** (frostbite could occur in 5 minutes or less in dry, exposed skin)

Adapted from: Sustaining Health and Performance in Cold Weather Operations: U.S. Army Research Institute of Environmental Medicine. October 2001.

9. STANDARD OPERATING PROCEDURES, ENGINEERING CONTROLS, AND WORK PRACTICES

9.1 SITE RULES

During field activities, personnel will remain in verbal, radio, or mobile phone contact with each other. Mobile phones will not be used within the UXO exclusion zone. The Site Manager, SSHO, SUXOS, and UXOSO/UXO Quality Control Specialist (UXOQCS) will use mobile telephones and will be responsible for handling communications during emergencies that may arise. Safe work practices that will be followed by site workers include, but are not limited to, the following rules (which are described in more detail in pertinent sections of the APP):

- Working before or after daylight hours without special permission is prohibited.
- Eating and drinking, chewing gum or tobacco, and smoking in the exclusion zone is prohibited.
- Possessing, using, purchasing, distributing, or having controlled substances in their system throughout the day or during meal breaks is prohibited.
- Consuming or possessing alcoholic beverages is prohibited.
- Good housekeeping—The storage container and/or conex box will be kept as clean as possible including frequent trash removal and efforts to keep floors dry and clean. Work areas will be kept clear of debris, tools, or other potential tripping hazards.
- Immediately repair or replace defective PPE, but not while in the work area.
- Prescription drugs will not be taken by personnel unless specifically approved by a qualified occupational physician and then only within the support zone.
- Personnel onsite will use the buddy system; visual contact will be maintained between team members while in the work area.

9.2 DAILY STARTUP AND SHUTDOWN PROCEDURES

The following general protocols will be followed daily prior to start of work activities and are a summarization of activities, training, and documentation covered in pertinent sections of the APP for the Iona Island FUDS:

- The SSHO and/or UXOSO will review site conditions to establish whether modification of work and safety plans is needed.
- Personnel will be briefed and updated on new safety procedures as appropriate.
- Safety equipment will be checked for proper function.

- The SSHO and/or UXOSO will ensure that first aid equipment is readily available.
- The SSHO and/or UXOSO will conduct monitoring activities and document accordingly.

9.2.1 Material and Drum Handling

Loads will be lifted using the power of the leg muscles rather than the back, stomach, or arm muscles. The item will be approached to balance the load evenly. Backs will be kept straight and the arms nearly parallel with the body. The knees will be bent to grasp the load. Lifting will be done by straightening the legs without bending the body, holding the load as close to the body as possible and the back remaining as straight as possible. Risks associated with moving loads are described more fully in the APP and the AHAs; however, items likely moved will be restricted to equipment, supplies, and monitoring equipment. Bulky, heavy loads (approximately 50 pounds or greater) will be handled by at least two people, ensuring that the load is level and evenly distributed between personnel helping to carry it. Carriers will know the destination and path for the objects.

9.2.2 Spill Containment

Information pertaining to spill containment and emergency responses related to spills is presented in Section 9.2.3 of the APP.

9.2.3 Site Control Measures

Work zones are designed to prevent employees, visitors, and the surrounding environment from exposure to contamination during intrusive site activities. Site work zones will be established by the Field Manager/SSHO/SUXOS/UXOSO prior to initiating operations to control site access during site activities. Establishment of site work zones is based upon site conditions, activities, and exposure potentials. Exclusion zones for MEC-related activities refer to a larger, and more temporally-limited, area than the exclusion zone required for non-MEC-related activities.

9.2.3.1 Exclusion Zone

For MEC investigation activities, the exclusion zone/quantity distance arc will follow the approved ESP for the Iona Island FUDS. Minimum separation distances for this project will be determined in accordance with the final DDESB-approved ESP. As indicated in the ESP, the hazard fragment distances (HFDs) for non-essential personnel is based on an unintentional detonation. This HFD will be the exclusion zone around work areas when intrusive investigation work is being performed. The UXOSO will establish the exclusion zone around the work area.

9.2.4 Emergency Equipment and First Aid

Emergency equipment and first aid information is presented in Section 12.

10. PERSONNEL HYGIENE AND DECONTAMINATION

Fieldwork will be conducted in Level D or Modified Level D (when handling soil, sediment, or groundwater directly).

Site personnel will wash their hands prior to ingestion of food, liquids or any other hand-to-mouth activities and when leaving the area designated as the exclusion zone. Hand washing with potable water, soap, and paper towels will be available onsite. The site vehicles will also be furnished with hand sanitizer.

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11. EQUIPMENT DECONTAMINATION

It is imperative that equipment and vehicles that come into contact with contaminated site media be decontaminated before allowing the items to leave the work area. Downhole drilling equipment and sampling equipment will be decontaminated, and the decontamination liquid will be containerized.

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12. EMERGENCY EQUIPMENT AND FIRST AID

A complete first aid kit (1 per team or 25 personnel) meeting the requirements of a Type III, 16-unit or larger in a waterproof container will be readily available onsite and will contain, at a minimum, a pocket mouthpiece for CPR, absorbent compresses, adhesive bandages, adhesive tape, antiseptic swabs, burn gel, sterile pads, and a triangular bandage. The contents of the kit(s) will be evaluated and possibly modified for this specific project. At least one ANSI Z308.1-2015 first aid kit will be onsite and smaller first aid kit(s) will be transported in onsite vehicles.

The contents will be checked prior to their use for sterility and to replace expended items. The UXOSO and/or the SSHO will inventory the kit(s) at least every 3 months and document the results on the daily inspection form. Expended or non-sterile contents will be replaced with serviceable items.

Prior to the start of work, the UXOSO and or the SSHO will discuss with site personnel the prevention steps, symptoms, and medical personnel available to assist with injuries or questions on diseases, plants, or animals that could be encountered while working on this project. Diseases, plants, and animals are discussed in Section 2.

A working cell phone or radio with adequate signal in this area will be maintained onsite and fully charged at the start of each workday. Marine operations communication equipment is included in Appendix G of the APP, submitted as a subsequent addendum to the APP.

An appropriate fire extinguisher will be maintained in each vehicle. Site personnel are trained in the use of fire extinguishers commensurate with Table 6-1 of the APP.

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13. EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

Emergency response and contingency procedures are discussed in Section 9.2 of the APP including emergency contact telephone numbers. Directions and route to the nearest hospital are presented in Section 9.2 of the APP.

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14. REFERENCES

Alion Science and Technology (Alion). 2008. *Final Site Inspection Report for the Iona Island Naval Ammunition Depot. DERP FUDS No. C02NY074403.* Prepared for US Army Engineering and Support Center, Huntsville and U.S. Army Corps of Engineers Baltimore District. September.

Bluestone *Environmental Group, Inc. 2018. Technical Memorandum. Records Review and Site Visit: Former Iona Island Naval Ammunition Dump. FUDS Project Number C02NY074402.* Prepared for U.S. Army Corps of Engineers New England District. February.

Greeley-Polhemus Group, Inc. (Greeley-Polhemus) 1997. *Data Collection Activities at DERP-FUDS SITES: Iona Island Naval Ammunition Depot, Stony Point, New York (DERP-FUD SITE NO. C02NY0744). Draft Report.* Prepared for U.S. Army Corps of Engineers New York District. April.

Green Seal Environmental, Inc. 2012. *Final Underground Storage Tank Removal Action Closure Report, Formerly Used Defense Site Project #C02NY074401, Iona Island (Naval Ammunition Depot), Tomkins Cove, New York.* Prepared for U.S. Army Corps of Engineers New England District. May.

U.S. Army Corps of Engineers (USACE). 1998. *Archives Search Report. Iona Island Naval Ammunition Depot, Rockland County, New York (Project Number – C02NY074403).* Defense Environmental Restoration Program for Formerly Used Defense Sites, Ordnance and Explosives, Chemical Warfare Materials. USACE St. Louis District. March.

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U.S. Army Geospatial Center (USAGC). 2018. *Former Naval Ammunition Depot Iona Island, New York. Historical Photographic Analysis.* Prepared for U.S. Army Corps of Engineers New England and Baltimore Districts. September.

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Appendix F

Material Safety Data Sheets/Safety Data Sheets

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Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and GHS

Effective date: 05/12/2015 **Revision:** 05/12/2015

LIQUINOX

1 Identification of the Substance/mixture and of the Company/Undertaking

1.1 Product identifier

Trade name: **LIQUINOX**

Application of the substance / the preparation: Hand detergent.

1.2 Relevant identified uses of the substance or mixture and uses advised against:

No additional information available.

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer/Supplier:

Alconox, Inc.
30 Glenn St., Suite 309
White Plains, NY 10603
Phone: 914-948-4040

Further information obtainable from: Product Safety Department.

1.4 Emergency telephone number:

ChemTel Inc.: (800)255-3924, +1 (813)248-0585

2 Hazards Identification

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008:

Classification according to Directive 67/548/EEC or Directive 1999/45/EC:

GHS07

Skin Irrit. 2, H315: Causes skin irritation.

Information concerning particular hazards for human and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to the latest editions of the EU-lists, and extended by company and literature data

2.2 Label elements

Labelling according to Regulation (EC) No 1272/2008:

The product is classified and labelled according to the CLP regulation.

Hazard pictograms:

GHS07

Signal word: Warning

Hazard-determining components of labelling:

Alkyl benzene sulfonic acid, sodium salt.

Hazard statements:

H315: Causes skin irritation.

Precautionary statements:

P332+P313: If skin irritation occurs: Get medical advice/attention.

P302+P352: IF ON SKIN: Wash with plenty of soap and water.

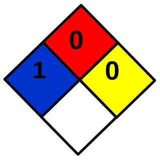
P501: Dispose of contents/container in accordance with local/regional/national/international regulations.

Other Hazard description:

WHMIS-classification and symbols:

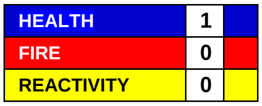
D2B - Toxic material causing other toxic effects

NFPA ratings (scale 0 - 4)



Health = 1
Fire = 0
Reactivity = 0

HMIS-ratings (scale 0 - 4)



HEALTH	1	🟦
FIRE	0	🟥
REACTIVITY	0	🟨

Health = 1
Fire = 0
Reactivity = 0

2.3 Other hazards

Results of PBT and vPvB assessment

PBT: Not applicable.
vPvB: Not applicable.

3 Composition/Information on Ingredients

3.2 Chemical characterization: Mixture

Description: Hazardous ingredients of mixture listed below.

Identifying Nos.	Description	Wt. %
CAS: 68081-81-2	Alkyl benzene sulfonic acid, sodium salt	10 - 25%
CAS: 1300-72-7 EINECS: 215-090-9	Sodium xylene sulphonate	2.5 - 10%
CAS: 84133-50-6	Alcohol Ethoxylate	2.5 - 10%
CAS: 68603-42-9 EINECS: 271-657-0	Coconut diethanolamide	2.5 - 10%
CAS: 17572-97-3 EINECS: 241-543-5	Ethylenediaminetetraacetic acid, tripotassium salt	2.5 - 10%

Additional information: For the wording of the listed risk phrases refer to section 16.

4 First Aid Measures

4.1 Description of first aid measures

General information:

Take affected persons out into the fresh air.

After inhalation:

Supply fresh air; consult doctor in case of complaints.

After skin contact:

Immediately wash with water and soap and rinse thoroughly for 30 minutes. If skin irritation continues, consult a doctor.

After eye contact:

Remove contact lenses if worn.

Rinse opened eye for at least 30 minutes under running water, lifting upper and lower lids occasionally. Immediately consult a doctor.

After swallowing:

Do not induce vomiting; call for medical help immediately. Rinse out mouth and then drink plenty of water.

A person vomiting while laying on their back should be turned onto their side.

4.2 Most important symptoms and effects, both acute and delayed:

Irritating, all routes of exposure.

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information available.

5 Firefighting Measures

5.1 Extinguishing media:

Suitable extinguishing agents:

CO2, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

5.2 Special hazards arising from the substance or mixture:

No additional information available.

5.3 Advice for firefighters:

Protective equipment:

Wear self-contained respiratory protective device.

Wear fully protective suit.

6 Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures:

Ensure adequate ventilation.

Particular danger of slipping on leaked/spilled product.

6.2 Environmental precautions:

Dilute with plenty of water.

Do not allow to enter sewers/ surface or ground water.

6.3 Methods and material for containment and cleaning up:

Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).

Clean the affected area carefully; suitable cleaners are: Warm water

Dispose contaminated material as waste according to item 13. Ensure adequate ventilation.

6.4 Reference to other sections:

See Section 7 for information on safe handling.

See Section 8 for information on personal protection equipment.

See Section 13 for disposal information

7 Handling and Storage

7.1 Precautions for safe handling:

No special precautions are necessary if used correctly.

Information about fire - and explosion protection:

No special measures required.

7.2 Conditions for safe storage, including any incompatibilities:

Storage:

Requirements to be met by storerooms and receptacles: No special requirements.

Information about storage in one common storage facility: No special requirements.

Further information about storage conditions: None

7.3 Specific end use(s): No additional information available.

8 Exposure Controls/Personal Protection

8.1 Control parameters

Ingredients with limit values that require monitoring at the workplace:

The product does not contain any relevant quantities of materials with critical values that have to be monitored at the workplace.

Additional information: The lists valid during the making were used as basis.

8.2 Exposure controls:

Personal protective equipment:

General protective and hygienic measures:

Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Avoid contact with the eyes and skin.

Respiratory protection:

Not required under normal conditions of use.

Protection of hands:

Protective gloves

The glove material has to be impermeable and resistant to the product. Selection of the glove material should be based on the penetration time, rates of diffusion and the degradation of the glove material.

Material of gloves:

The selection of a suitable gloves does not only depend on the material, but also on the quality, and varies from manufacturer to manufacturer.

Penetration time of glove material:

The exact break through time has to be determined by the manufacturer of the protective gloves. DO NOT exceed the breakthrough time set by the Manufacturer.

For long term contact, gloves made of the following materials are considered suitable:

Butyl rubber, BR
Nitrile rubber, NBR
Natural rubber (NR)
Neoprene gloves

Eye protection:

Safety glasses
Goggles recommended during refilling.

Body protection: Protective work clothing

9 Physical and Chemical Properties

9.1 Information on basic physical and chemical properties:

General Information:	
Appearance:	
Form:	Liquid
Color:	Light Yellow
Odor:	Odorless
Odor threshold:	Not determined.
pH-value:	8.5
Change in condition:	
Melting point/Melting range:	Not determined.
Boiling point/Boiling range:	100°C
Flash point:	Not applicable.
Flammability (solid, gaseous):	Not applicable.
Ignition temperature:	Not applicable.
Decomposition temperature:	Not determined.
Self-igniting:	Product is not selfigniting.
Danger of explosion:	Product does not present an explosion hazard.
Explosion limits:	
Lower:	Not determined.
Upper:	Not determined.
Vapor pressure at 20°C:	23 hPa
Density:	1.08 g/cm³
Relative density:	Not determined.
Vapor density:	Not determined.
Evaporation rate:	Not determined.
Solubility in / Miscibility with water:	Fully miscible.
Segregation coefficient (n-octanol/water):	Not determined.
Viscosity:	
Dynamic:	Not determined.
Kinematic:	Not determined.
Solvent content:	
Organic solvents:	Not determined.
Solids content:	Not determined.
9.2 Other information:	No additional information available.

10 Stability and Reactivity

10.1 Reactivity:

10.2 Chemical stability:

Thermal decomposition / conditions to be avoided:

No decomposition if used according to specifications.

10.3 Possibility of hazardous reactions:

Reacts with strong oxidizing agents. Reacts with strong acids.

10.4 Conditions to avoid:

No additional information available.

10.5 Incompatible materials:

No additional information available.

10.6 Hazardous decomposition products:
Carbon monoxide and carbon dioxide
Sulphur oxides (SOx)
Nitrogen oxides

11 Toxicological Information

11.1 Information on toxicological effects:

Toxicity data: Toxicity data is available for mixture:

Primary irritant effect:

On the skin: Irritating to skin and mucous membranes.

On the eye: Strong irritant with the danger of severe eye injury.

Sensitization: No sensitizing effects known.

Additional toxicological information:

The product shows the following dangers according to the calculation method of the General EU Classification Guidelines for Preparations as issued in the latest version: Irritant

12 Ecological Information

12.1 Toxicity:

Aquatic toxicity: No additional information available.

12.2 Persistence and degradability: Biodegradable.

12.3 Bioaccumulative potential: Does not accumulate in organisms.

12.4 Mobility in soil: No additional information available.

Additional ecological information:

General notes:

Water hazard class 1 (German Regulation) (Self-assessment): slightly hazardous for water.
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
Must not reach sewage water or drainage ditch undiluted or un-neutralized.

12.5 Results of PBT and vPvB assessment:

PBT: Not applicable.

vPvB: Not applicable.

12.6 Other adverse effects: No additional information available.

13 Disposal Considerations

13.1 Waste treatment methods:

Recommendation:

Smaller quantities can be disposed of with household waste.

Small amounts may be diluted with plenty of water and washed away. Dispose of bigger amounts in accordance with Local Authority requirements.

The surfactant used in this product complies with the biodegradability criteria as laid down in Regulation (EC) No. 648/2004 on detergents. Data to support this assertion are held at the disposal of the competent authorities of the Member States and will be made available to them, at their direct request or at the request of a detergent manufacturer.

Uncleaned packaging:

Recommendation: Disposal must be made according to official regulations.

Recommended cleansing agents: Water, together with cleansing agents, if necessary.

14 Transport Information

14.1 UN-Number:

DOT, ADR, ADN, IMDG, IATA:	Not Regulated

14.2 UN proper shipping name:

DOT, ADR, IMDG, IATA:	Not Regulated

14.3 Transport hazard class(es):
DOT, ADR, IMDG, IATA:

Class:	Not Regulated
Label:	-

14.4 Packing group:

DOT, ADR, IMDG, IATA:	Not Regulated

14.5 Environmental hazards:

Marine pollutant:	No

14.6 Special precautions for user:	Not applicable.

14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code: Not applicable.

UN "Model Regulation":	Not Regulated

15 Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture:
United States (USA):
SARA:
Section 355 (extremely hazardous substances): None of the ingredient is listed.
Section 313 (Specific toxic chemical listings): None of the ingredient is listed.
TSCA (Toxic Substances Control Act): All ingredients are listed.

Proposition 65 (California):
Chemicals known to cause cancer: None of the ingredient is listed.
Chemicals known to cause reproductive toxicity for females: None of the ingredient is listed.
Chemicals known to cause reproductive toxicity for males: None of the ingredient is listed.
Chemicals known to cause developmental toxicity: None of the ingredient is listed.

Carcinogenic Categories:
EPA (Environmental Protection Agency): None of the ingredient is listed.
TLV (Threshold Limit Value established by ACGIH): None of the ingredient is listed.
NIOSH-Ca (National Institute for Occupational Safety and Health): None of the ingredient is listed.
OSHA-Ca (Occupational Safety & Health Administration): None of the ingredient is listed.
Canadá:
Canadian Domestic Substances List (DSL): All ingredients are listed.
Canadian Ingredient Disclosure list (limit 0.1%): None of the ingredient is listed.
Canadian Ingredient Disclosure list (limit 1%): None of the ingredient is listed.

15.2 Chemical safety assessment: A Chemical Safety Assessment has not been carried out.

16 Other Information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Relevant phrases:
H315: Causes skin irritation.

Abbreviations and Acronyms:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.
IMDG: International Maritime Code for Dangerous Goods.
DOT: US Department of Transportation.
IATA: International Air Transport Association.
GHS: Globally Harmonized System of Classification and Labelling of Chemicals.
ACGIH: American Conference of Governmental Industrial Hygienists.
NFPA: National Fire Protection Association (USA).
HMIS: Hazardous Materials Identification System (USA).
WHMIS: Workplace Hazardous Materials Information System (Canada).
VOC: Volatile Organic Compounds (USA, EU).
LC50: Lethal concentration, 50 percent.
LD50: Lethal dose, 50 percent.

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Methanol

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 07/03/2013 Revision date: 11/15/2013 Supersedes: 10/02/2013 Version: 1.2

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Substance

Substance name : Methanol

CAS No : 67-56-1

Product code : VT430

Formula : CH4O

Synonyms : acetone alcohol / alcohol C1 / alcohol, methyl / carbinol / colonial spirits / columbian spirits / green wood spirits / manhattan spirits / methyl alcohol / methyl hydrate / methyl hydroxide / methylen / methylol / monohydroxymethane / pyroligneous spirit / pyroxylic spirit / wood alcohol / wood naphtha

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Solvent

1.3. Details of the supplier of the safety data sheet

Val Tech Diagnostics, A Division of LabChem Inc
Jackson's Pointe Commerce Park Building 1000
1010 Jackson's Pointe Court
Zelienople, PA 16063
T 412-826-5230
F 724-473-0647

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300 or 011-703-527-3887

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

GHS-US classification

Flam. Liq. 2	H225
Acute Tox. 3 (Oral)	H301
Acute Tox. 3 (Dermal)	H311
Acute Tox. 3 (Inhalation)	H331
STOT SE 1	H370

2.2. Label elements

GHS-US labelling

Hazard pictograms (GHS-US) :

GHS02

GHS06

GHS08

Signal word (GHS-US) : Danger

Hazard statements (GHS-US) : H225 - Highly flammable liquid and vapour
H301+H311+H331 - Toxic if swallowed, in contact with skin or if inhaled
H370 - Causes damage to organs (liver, kidneys, central nervous system, optic nerve) (Dermal, oral)

Precautionary statements (GHS-US) : P210 - Keep away from heat, sparks, open flames, hot surfaces. - No smoking
P233 - Keep container tightly closed
P240 - Ground/bond container and receiving equipment
P241 - Use explosion-proof electrical, ventilating, lighting equipment
P242 - Use only non-sparking tools
P243 - Take precautionary measures against static discharge
P260 - Do not breathe mist, vapours, spray
P264 - Wash exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P271 - Use only outdoors or in a well-ventilated area
P280 - Wear protective gloves, protective clothing, eye protection, face protection

P301 + P310 - IF SWALLOWED: immediately call a POISON CENTER or doctor/physician
P303 + P361 + P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
P304 + P340 - IF INHALED: remove victim to fresh air and keep at rest in a position comfortable for breathing
P330 - If swallowed, rinse mouth
P363 - Wash contaminated clothing before reuse
P370 + P378 - In case of fire: Use carbon dioxide (CO2), powder, alcohol-resistant foam for extinction
P403 + P233 - Store in a well-ventilated place. Keep container tightly closed
P235 - Keep cool
P405 - Store locked up
P501 - Dispose of contents/container to comply with local, state and federal regulations

2.3. Other hazards

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS-US)

No data available

SECTION 3: Composition/information on ingredients

3.1. Substance

Substance type : Mono-constituent
Name : Methanol
CAS No : 67-56-1
EC no : 200-659-6
EC index no : 603-001-00-X

Name	Product identifier	%	GHS-US classification
Methanol (Main constituent)	(CAS No) 67-56-1	100	Flam. Liq. 2, H225 Acute Tox. 3 (Oral), H301 Acute Tox. 3 (Dermal), H311 Acute Tox. 3 (Inhalation), H331 STOT SE 1, H370

Full text of H-phrases: see section 16

3.2. Mixture

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general	Check the vital functions. Unconscious: maintain adequate airway and respiration. Respiratory arrest: artificial respiration or oxygen. Cardiac arrest: perform resuscitation. Victim conscious with laboured breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Never give alcohol to drink.
First-aid measures after inhalation	Remove the victim into fresh air. Immediately consult a doctor/medical service.
First-aid measures after skin contact	Wash immediately with lots of water. Soap may be used. Do not apply (chemical) neutralizing agents. Remove clothing before washing. Consult a doctor/medical service.
First-aid measures after eye contact	Rinse with water. Take victim to an ophthalmologist if irritation persists.
First-aid measures after ingestion	Rinse mouth with water. Give nothing to drink. Do not induce vomiting. Immediately consult a doctor/medical service. Call Poison Information Centre (www.big.be/antigif.htm). Ingestion of large quantities: immediately to hospital. Take the container/vomit to the doctor/hospital. Doctor: administration of chemical antidote. Doctor: gastric lavage.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries after inhalation	Slight irritation. EXPOSURE TO HIGH CONCENTRATIONS: Coughing. Symptoms similar to those listed under ingestion.
Symptoms/injuries after skin contact	Symptoms similar to those listed under ingestion. Slight irritation.
Symptoms/injuries after eye contact	Redness of the eye tissue. Lacrimation.

Symptoms/injuries after ingestion	: Nausea. Vomiting. AFTER ABSORPTION OF HIGH QUANTITIES: FOLLOWING SYMPTOMS MAY APPEAR LATER: Change in the haemogramme/blood composition. Headache. Feeling of weakness. Abdominal pain. Muscular pain. Central nervous system depression. Dizziness. Mental confusion. Drunkenness. Coordination disorders. Disturbed motor response. Disturbances of consciousness. Visual disturbances. Blindness. Respiratory difficulties. Cramps/uncontrolled muscular contractions.
Chronic symptoms	: ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Red skin. Dry skin. Skin rash/inflammation. Headache. Disturbed tactile sensibility. Visual disturbances. Sleeplessness. Gastrointestinal complaints. Cardiac and blood circulation effects.

4.3. Indication of any immediate medical attention and special treatment needed

Hospitalize at once. Until victim can be cared for by specialized staff:

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media	: Preferably: alcohol resistant foam. Water spray. BC powder. Carbon dioxide.
Unsuitable extinguishing media	: Solid water jet ineffective as extinguishing medium.

5.2. Special hazards arising from the substance or mixture

Fire hazard	: DIRECT FIRE HAZARD. Highly flammable. Gas/vapour flammable with air within explosion limits. INDIRECT FIRE HAZARD. May be ignited by sparks.
Explosion hazard	: DIRECT EXPLOSION HAZARD. Gas/vapour explosive with air within explosion limits. INDIRECT EXPLOSION HAZARD. may be ignited by sparks. Reactions with explosion hazards: see "Reactivity Hazard".
Reactivity	: On heating: release of toxic/corrosive/combustible gases/vapours (formaldehyde). Upon combustion: CO and CO2 are formed. Violent to explosive reaction with (some) metal powders and with (strong) oxidizers. Violent exothermic reaction with (some) acids and with (some) halogens compounds.

5.3. Advice for firefighters

Firefighting instructions	: Cool tanks/drums with water spray/remove them into safety. Do not move the load if exposed to heat. Take account of toxic fire-fighting water. Use water moderately and if possible collect or contain it.
Protection during firefighting	: Do not enter fire area without proper protective equipment, including respiratory protection.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment	: Gas-tight suit.
Emergency procedures	: Keep upwind. Mark the danger area. Consider evacuation. Close doors and windows of adjacent premises. Stop engines and no smoking. No naked flames or sparks. Spark- and explosionproof appliances and lighting equipment. Keep containers closed. Wash contaminated clothes.

6.1.2. For emergency responders

Protective equipment	: Equip cleanup crew with proper protection.
Emergency procedures	: Stop leak if safe to do so. Ventilate area.

6.2. Environmental precautions

Prevent soil and water pollution. Prevent spreading in sewers.

6.3. Methods and material for containment and cleaning up

For containment	: Contain released substance, pump into suitable containers. Consult "Material-handling" to select material of containers. Plug the leak, cut off the supply. Dam up the liquid spill. Try to reduce evaporation. Measure the concentration of the explosive gas-air mixture. Dilute combustible/toxic gases/vapours with water spray. Take account of toxic/corrosive precipitation water. Provide equipment/receptacles with earthing. Do not use compressed air for pumping over spills.
Methods for cleaning up	: Take up liquid spill into a non combustible material e.g.: sand, earth, vermiculite slaked lime or soda ash. Scoop absorbed substance into closing containers. See "Material-handling" for suitable container materials. Carefully collect the spill/leftovers. Damaged/cooled tanks must be emptied. Do not use compressed air for pumping over spills. Clean contaminated surfaces with an excess of water. Take collected spill to manufacturer/competent authority. Wash clothing and equipment after handling.

6.4. Reference to other sections

No additional information available

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Comply with the legal requirements. Remove contaminated clothing immediately. Clean contaminated clothing. Handle uncleaned empty containers as full ones. Thoroughly clean/dry the installation before use. Do not discharge the waste into the drain. Do not use compressed air for pumping over. Use spark-/explosionproof appliances and lighting system. Take precautions against electrostatic charges. Keep away from naked flames/heat. Keep away from ignition sources/sparks. Observe strict hygiene. Keep container tightly closed. Measure the concentration in the air regularly. Work under local exhaust/ventilation.

Hygiene measures : Do not eat, drink or smoke when using this product. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Wash contaminated clothing before reuse.

7.2. Conditions for safe storage, including any incompatibilities

Incompatible products : Strong oxidizers. Strong bases. Strong acids. Acid anhydrides. Acid chlorides.

Incompatible materials : Direct sunlight. Heat sources. Sources of ignition.

Heat and ignition sources : KEEP SUBSTANCE AWAY FROM: heat sources. ignition sources.

Prohibitions on mixed storage : KEEP SUBSTANCE AWAY FROM: combustible materials. oxidizing agents. (strong) acids. (strong) bases. halogens. amines. water/moisture.

Storage area : Store at room temperature. Keep out of direct sunlight. Store in a dry area. Keep container in a well-ventilated place. Fireproof storeroom. Keep locked up. Provide for a tub to collect spills. Provide the tank with earthing. Unauthorized persons are not admitted. Aboveground. Meet the legal requirements.

Special rules on packaging : SPECIAL REQUIREMENTS: closing. dry. clean. correctly labelled. meet the legal requirements. Secure fragile packagings in solid containers.

Packaging materials : SUITABLE MATERIAL: steel. stainless steel. iron. glass. MATERIAL TO AVOID: lead. aluminium. zinc. polyethylene. PVC.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Methanol (67-56-1)		
USA ACGIH	ACGIH TWA (ppm)	200 ppm
USA ACGIH	ACGIH STEL (ppm)	200 ppm
USA OSHA	OSHA PEL (TWA) (mg/m³)	260 mg/m³
USA OSHA	OSHA PEL (TWA) (ppm)	200 ppm

8.2. Exposure controls

Appropriate engineering controls : Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure. Keep concentrations well below lower explosion limits.

Personal protective equipment : Safety glasses. Protective clothing. Gloves. Full protective flameproof clothing. Face shield.

Materials for protective clothing : GIVE EXCELLENT RESISTANCE: No data available. GIVE GOOD RESISTANCE: polyethylene/ethylenevinylalcohol. styrene-butadiene rubber. viton. GIVE LESS RESISTANCE: chloroprene rubber. chlorinated polyethylene. natural rubber. nitrile rubber/PVC. GIVE POOR RESISTANCE: leather. neoprene. nitrile rubber. polyethylene. PVA. PVC. polyurethane.

Hand protection : Gloves.

Eye protection : Combined eye and respiratory protection. Safety glasses.

Skin and body protection : Head/neck protection. Protective clothing.

Respiratory protection : Gas mask with filter type AX at conc. in air > exposure limit. Wear gas mask with filter type A if conc. in air > exposure limit. High vapour/gas concentration: self-contained respirator.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state : Liquid

Appearance	:	Liquid.
Molecular mass	:	32.04 g/mol
Colour	:	Colourless.
Odour	:	Characteristic odour. Mild odour. Pleasant odour. Alcohol odour. Commercial/unpurified substance: Irritating/pungent odour.
Odour threshold	:	2000 - 8800 ppm 2620 - 11528 mg/m³
pH	:	No data available
Relative evaporation rate (butylacetate=1)	:	4.1
Relative evaporation rate (ether=1)	:	6.3
Melting point	:	-98 °C
Freezing point	:	No data available
Boiling point	:	65 °C
Flash point	:	11 °C
Critical temperature	:	240 °C
Self ignition temperature	:	455 °C
Decomposition temperature	:	No data available
Flammability (solid, gas)	:	No data available
Vapour pressure	:	128 hPa
Vapour pressure at 50 °C	:	552 hPa
Critical pressure	:	79547 hPa
Relative vapour density at 20 °C	:	1.1
Relative density	:	0.79
Relative density of saturated gas/air mixture	:	1.0
Density	:	792 kg/m³
Solubility	:	Soluble in water. Soluble in ethanol. Soluble in ether. Soluble in acetone. Soluble in chloroform. Water: Complete Ethanol: Complete Ether: Complete Acetone: Complete
Log Pow	:	-0.77 (Experimental value; Other,Experimental value; Other)
Log Kow	:	No data available
Viscosity, kinematic	:	No data available
Viscosity, dynamic	:	0.6 mPa.s (20 °C)
Explosive properties	:	No data available
Oxidising properties	:	No data available
Explosive limits	:	5.5 - 36.5 vol %

9.2. Other information

Minimum ignition energy	:	0.14 mJ
Saturation concentration	:	166 g/m³
VOC content	:	100 %
Other properties	:	Clear. Hygroscopic. Volatile. Substance has neutral reaction.

SECTION 10: Stability and reactivity

10.1. Reactivity

On heating: release of toxic/corrosive/combustible gases/vapours (formaldehyde). Upon combustion: CO and CO2 are formed. Violent to explosive reaction with (some) metal powders and with (strong) oxidizers. Violent exothermic reaction with (some) acids and with (some) halogens compounds.

10.2. Chemical stability

Hygroscopic.

10.3. Possibility of hazardous reactions

No additional information available

10.4. Conditions to avoid

Direct sunlight. High temperature. Incompatible materials. Open flame. Sparks. Overheating.

10.5. Incompatible materials

Strong oxidizers. Strong bases. Strong acids. Peroxides. Acid anhydrides. Acid chlorides.

10.6. Hazardous decomposition products

Carbon dioxide. Carbon monoxide.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Toxic if swallowed. Toxic in contact with skin. Toxic if inhaled.

Methanol (\f)67-56-1	
LD50 oral rat	> 5000 mg/kg (1187-2769 mg/kg bodyweight; Rat; Rat)
LD50 dermal rabbit	15800 mg/kg (Rabbit)
LC50 inhalation rat (mg/l)	85 mg/l/4h (Rat)
LC50 inhalation rat (ppm)	64000 ppm/4h (Rat)

Skin corrosion/irritation : Not classified

Serious eye damage/irritation : Not classified

Respiratory or skin sensitisation : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : Causes damage to organs (liver, kidneys, central nervous system, optic nerve) (Dermal, oral).

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

Symptoms/injuries after inhalation : Slight irritation. EXPOSURE TO HIGH CONCENTRATIONS: Coughing. Symptoms similar to those listed under ingestion.

Symptoms/injuries after skin contact : Symptoms similar to those listed under ingestion. Slight irritation.

Symptoms/injuries after eye contact : Redness of the eye tissue. Lacrimation.

Symptoms/injuries after ingestion : Nausea. Vomiting. AFTER ABSORPTION OF HIGH QUANTITIES: FOLLOWING SYMPTOMS MAY APPEAR LATER: Change in the haemogramme/blood composition. Headache. Feeling of weakness. Abdominal pain. Muscular pain. Central nervous system depression. Dizziness. Mental confusion. Drunkenness. Coordination disorders. Disturbed motor response. Disturbances of consciousness. Visual disturbances. Blindness. Respiratory difficulties. Cramps/uncontrolled muscular contractions.

Chronic symptoms : ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Red skin. Dry skin. Skin rash/inflammation. Headache. Disturbed tactile sensibility. Visual disturbances. Sleeplessness. Gastrointestinal complaints. Cardiac and blood circulation effects.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : Classification concerning the environment: not applicable.

Ecology - air : TA-Luft Klasse 5.2.5/I.

Ecology - water : Not harmful to fishes (LC50(96h) >1000 mg/l). Not harmful to invertebrates (Daphnia) (EC50 (48h) > 1000 mg/l). Not harmful to algae (EC50 (72h) >1000 mg/l). Slightly harmful to bacteria (EC50: 100 - 1000 mg/l). Inhibition of activated sludge.

Methanol (67-56-1)	
LC50 fishes 1	15400 mg/l (96 h; Lepomis macrochirus; Lethal)
EC50 Daphnia 1	> 10000 mg/l (48 h; Daphnia magna; Lethal)
LC50 fish 2	10800 mg/l 96 h; Salmo gairdneri (Oncorhynchus mykiss)
EC50 Daphnia 2	24500 mg/l (48 h; Daphnia magna)
Threshold limit other aquatic organisms 1	6600 mg/l (16 h; Pseudomonas putida)
Threshold limit algae 1	530 mg/l (192 h; Microcystis aeruginosa)
Threshold limit algae 2	8000 mg/l (168 h; Scenedesmus quadricauda)

12.2. Persistence and degradability

Methanol (67-56-1)	
Persistence and degradability	Readily biodegradable in water. Biodegradable in the soil.
Biochemical oxygen demand (BOD)	0.6 - 1.12 g O^2/g substance
Chemical oxygen demand (COD)	1.42 g O^2/g substance
ThOD	1.5 g O^2/g substance
BOD (% of ThOD)	0.8 % ThOD

12.3. Bioaccumulative potential

Methanol (67-56-1)	
BCF fish 1	< 10 (Leuciscus idus)
Log Pow	-0.77 (Experimental value; Other,Experimental value; Other)
Bioaccumulative potential	Low potential for bioaccumulation (BCF < 500).

12.4. Mobility in soil

Methanol (67-56-1)	
Surface tension	0.023 N/m (20 °C)

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Remove waste in accordance with local and/or national regulations. Hazardous waste shall not be mixed together with other waste. Different types of hazardous waste shall not be mixed together if this may entail a risk of pollution or create problems for the further management of the waste. Hazardous waste shall be managed responsibly. All entities that store, transport or handle hazardous waste shall take the necessary measures to prevent risks of pollution or damage to people or animals. Recycle by distillation. Incinerate under surveillance with energy recovery. Do not discharge into drains or the environment. Obtain the consent of pollution control authorities before discharging to wastewater treatment plants.

Additional information : LWCA (the Netherlands): KGA category 06. Hazardous waste according to Directive 2008/98/EC.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1230 Methanol, 3, II

UN-No.(DOT) : 1230

DOT NA no. : UN1230

DOT Proper Shipping Name : Methanol

Department of Transportation (DOT) Hazard Classes : 3 - Class 3 - Flammable and combustible liquid 49 CFR 173.120

Hazard labels (DOT) : 3 - Flammable liquid

DOT Symbols : D - Proper shipping name for domestic use only, or to and from Canada

Packing group (DOT) : II - Medium Danger

DOT Special Provisions (49 CFR 172.102) : IB2 - Authorized IBCs: Metal (31A, 31B and 31N); Rigid plastics (31H1 and 31H2); Composite (31HZ1). Additional Requirement: Only liquids with a vapor pressure less than or equal to 110 kPa at 50 C (1.1 bar at 122 F), or 130 kPa at 55 C (1.3 bar at 131 F) are authorized.
T7 - 4 178.274(d)(2) Normal............ 178.275(d)(3)
TP2 - a. The maximum degree of filling must not exceed the degree of filling determined by the following: (image) Where: tr is the maximum mean bulk temperature during transport, tf is the temperature in degrees celsius of the liquid during filling, and a is the mean coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (tf) and the maximum mean bulk temperature during transportation (tr) both in degrees celsius. b. For liquids transported under ambient conditions may be calculated using the formula: (image) Where: d15 and d50 are the densities (in units of mass per unit volume) of the liquid at 15 C (59 F) and 50 C (122 F), respectively.

DOT Packaging Exceptions (49 CFR 173.xxx) : 150

DOT Packaging Non Bulk (49 CFR 173.xxx) : 202

DOT Packaging Bulk (49 CFR 173.xxx) : 242

DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27) : 1 L

DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75) : 60 L

DOT Vessel Stowage Location : B - (i) The material may be stowed ‘‘on deck’’ or ‘‘under deck’’ on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers, or one passenger per each 3 m of overall vessel length; and (ii) ‘‘On deck only’’ on passenger vessels in which the number of passengers specified in paragraph (k)(2)(i) of this section is exceeded.

DOT Vessel Stowage Other : 40 - Stow ‘‘clear of living quarters’’

Additional information

Other information : No supplementary information available.

State during transport (ADR-RID) : as liquid.

ADR

Transport document description : UN 1230 Methanol, 3 (6.1), II, (D/E)

Packing group (ADR) : II

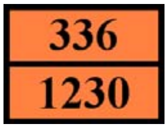
Class (ADR) : 3 - Flammable liquid

Hazard identification number (Kemler No.) : 336

Classification code (ADR) : FT1

Danger labels (ADR) : 3 - Flammable liquids
6.1 - Toxic substances

Orange plates :



Tunnel restriction code : D/E

Transport by sea

UN-No. (IMDG) : 1230

Class (IMDG) : 3 - Flammable liquids

Subsidiary risk (IMDG) : 6.1

EmS-No. (1) : F-E

MFAG-No : 19

EmS-No. (2) : S-D

Air transport

UN-No.(IATA) : 1230

Class (IATA) : 3 - Flammable Liquids

Packing group (IATA)	: II - Medium Danger
Subsidiary risk (IATA)	: 6.1

SECTION 15: Regulatory information

15.1. US Federal regulations

Methanol (67-56-1)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory Listed on SARA Section 313 (Specific toxic chemical listings)	
RQ (Reportable quantity, section 304 of EPA's List of Lists) :	5000 lb
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard Fire hazard

15.2. International regulations

CANADA

Methanol (67-56-1)	
Listed on the Canadian DSL (Domestic Substances List) inventory.	
WHMIS Classification	Class B Division 2 - Flammable Liquid Class D Division 2 Subdivision A - Very toxic material causing other toxic effects Class D Division 2 Subdivision B - Toxic material causing other toxic effects

EU-Regulations

No additional information available

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Flam. Liq. 2	H225
Acute Tox. 3 (Inhalation)	H331
Acute Tox. 3 (Dermal)	H311
Acute Tox. 3 (Oral)	H301
STOT SE 1	H370
STOT SE 1	H370
STOT SE 1	H370

Full text of H-phrases: see section 16

Classification according to Directive 67/548/EEC or 1999/45/EC

F; R11
T; R23/24/25
T; R39/23/24/25

Full text of R-phrases: see section 16

15.2.2. National regulations

Methanol (67-56-1)
Listed on the Canadian Ingredient Disclosure List

15.3. US State regulations

Methanol(67-56-1)	
U.S. - California - Proposition 65 - Developmental Toxicity	Yes
No significance risk level (NSRL)	23000 µg/day

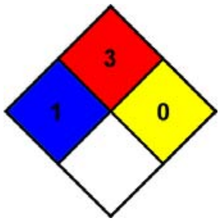
SECTION 16: Other information

Full text of H-phrases: see section 16:

Acute Tox. 3 (Dermal)	Acute toxicity (dermal), Category 3
Acute Tox. 3 (Inhalation)	Acute toxicity (inhal.), Category 3

Acute Tox. 3 (Oral)	Acute toxicity (oral), Category 3
Flam. Liq. 2	Flammable liquids, Category 2
STOT SE 1	Specific target organ toxicity — single exposure, Category 1
H225	Highly flammable liquid and vapour
H301	Toxic if swallowed
H311	Toxic in contact with skin
H331	Toxic if inhaled
H370	Causes damage to organs

NFPA health hazard	1 - Exposure could cause irritation but only minor residual injury even if no treatment is given.
NFPA fire hazard	3 - Liquids and solids that can be ignited under almost all ambient conditions.
NFPA reactivity	0 - Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health	2 Moderate Hazard - Temporary or minor injury may occur
Flammability	3 Serious Hazard
Physical	0 Minimal Hazard
Personal Protection	H

SDS US ValTech

Safety Data Sheet

Material Name: Gasoline All Grades

SDS No. 9950
US GHS

Synonyms: Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

Phone: 732-750-6000 Corporate EHS
Emergency # 800-424-9300 CHEMTREC
www.hess.com (Environment, Health, Safety Internet Website)

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Flammable Liquid - Category 2
Skin Corrosion/Irritation - Category 2
Germ Cell Mutagenicity - Category 1B
Carcinogenicity - Category 1B
Toxic to Reproduction - Category 1A
Specific Target Organ Toxicity (Single Exposure) - Category 3 (respiratory irritation, narcosis)
Specific Target Organ Toxicity (Repeat Exposure) - Category 1 (liver, kidneys, bladder, blood, bone marrow, nervous system)
Aspiration Hazard - Category 1
Hazardous to the Aquatic Environment – Acute Hazard - Category 3

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

DANGER

Hazard Statements

Highly flammable liquid and vapour.
Causes skin irritation.
May cause genetic defects.
May cause cancer.
May damage fertility or the unborn child.
May cause respiratory irritation.
May cause drowsiness or dizziness.
Causes damage to organs (liver, kidneys, bladder, blood, bone marrow, nervous system) through prolonged or repeated exposure.
May be fatal if swallowed and enters airways.
Harmful to aquatic life.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed.
Ground/bond container and receiving equipment.
Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Wear protective gloves/protective clothing/eye protection/face protection.
Wash hands and forearms thoroughly after handling.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Do not breathe mist/vapours/spray.
Use only outdoors or in well-ventilated area.
Do not eat, drink or smoke when using this product.
Avoid release to the environment.

Response

In case of fire: Use water spray, fog, dry chemical fire extinguishers or hand held fire extinguisher.
IF ON SKIN (or hair): Wash with plenty of soap and water. Remove/Take off immediately all contaminated clothing and wash before reuse. If skin irritation occurs, get medical advice/attention.
IF exposed or concerned: Get medical advice/attention.
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a poison center or doctor/physician if you feel unwell.
Get medical advice/attention if you feel unwell.
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. Do not induce vomiting.

Storage

Store in a well-ventilated place.
Keep cool. Keep container tightly closed.
Store locked up.

Disposal

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
86290-81-5	Gasoline, motor fuel	100
108-88-3	Toluene	1-25
106-97-8	Butane	<10
1330-20-7	Xylenes (o-, m-, p- isomers)	1-15
95-63-6	Benzene, 1,2,4-trimethyl-	<6
64-17-5	Ethyl alcohol	0-10
100-41-4	Ethylbenzene	<3
71-43-2	Benzene	0.1-4.9

110-54-3	Hexane	0.5-4

A complex blend of petroleum-derived normal and branched-chain alkane, cycloalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol). Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

First Aid: Skin

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or with waterless hand cleanser. Obtain medical attention if irritation or redness develops.

First Aid: Ingestion

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or gaseous extinguishing agent.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment. Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution, flammable vapors may accumulate in closed containers.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

USE ONLY AS A MOTOR FUEL.
DO NOT SIPHON BY MOUTH

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

Incompatibilities

Keep away from strong oxidizers.

* * * Section 8 - Exposure Controls / Personal Protection * * *

Component Exposure Limits

Gasoline, motor fuel (86290-81-5)

ACGIH: 300 ppm TWA
500 ppm STEL

Toluene (108-88-3)

ACGIH: 20 ppm TWA
OSHA: 200 ppm TWA; 375 mg/m3 TWA
150 ppm STEL; 560 mg/m3 STEL
NIOSH: 100 ppm TWA; 375 mg/m3 TWA
150 ppm STEL; 560 mg/m3 STEL

Butane (106-97-8)

ACGIH: 1000 ppm TWA (listed under Aliphatic hydrocarbon gases: Alkane C1-4)
OSHA: 800 ppm TWA; 1900 mg/m3 TWA
NIOSH: 800 ppm TWA; 1900 mg/m3 TWA

Xylenes (o-, m-, p- isomers) (1330-20-7)

ACGIH: 100 ppm TWA
150 ppm STEL
OSHA: 100 ppm TWA; 435 mg/m3 TWA
150 ppm STEL; 655 mg/m3 STEL

Benzene, 1,2,4-trimethyl- (95-63-6)

NIOSH: 25 ppm TWA; 125 mg/m3 TWA

Ethyl alcohol (64-17-5)

ACGIH: 1000 ppm STEL
OSHA: 1000 ppm TWA; 1900 mg/m3 TWA
NIOSH: 1000 ppm TWA; 1900 mg/m3 TWA

Ethylbenzene (100-41-4)

ACGIH: 20 ppm TWA
OSHA: 100 ppm TWA; 435 mg/m3 TWA
125 ppm STEL; 545 mg/m3 STEL
NIOSH: 100 ppm TWA; 435 mg/m3 TWA
125 ppm STEL; 545 mg/m3 STEL

Benzene (71-43-2)

ACGIH: 0.5 ppm TWA
2.5 ppm STEL
Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA: 5 ppm STEL (Cancer hazard, Flammable, See 29 CFR 1910.1028, 15 min); 0.5 ppm Action Level; 1 ppm TWA
NIOSH: 0.1 ppm TWA
1 ppm STEL

Hexane (110-54-3)

ACGIH: 50 ppm TWA
Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA: 500 ppm TWA; 1800 mg/m3 TWA
NIOSH: 50 ppm TWA; 180 mg/m3 TWA

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile, neoprene, or PVC are recommended.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Translucent, straw-colored or light yellow	**Odor:**	Strong, characteristic aromatic hydrocarbon odor. Sweet-ether like
Physical State:	Liquid	**pH:**	ND
Vapor Pressure:	6.4 - 15 RVP @ 100 °F (38 °C) (275-475 mm Hg @ 68 °F (20 °C)	**Vapor Density:**	AP 3-4
Boiling Point:	85-437 °F (39-200 °C)	**Melting Point:**	ND
Solubility (H2O):	Negligible to Slight	**Specific Gravity:**	0.70-0.78
Evaporation Rate:	10-11	**VOC:**	ND
Percent Volatile:	100%	**Octanol/H2O Coeff.:**	ND
Flash Point:	-45 °F (-43 °C)	**Flash Point Method:**	PMCC
Upper Flammability Limit (UFL):	7.6%	**Lower Flammability Limit (LFL):**	1.4%
Burning Rate:	ND	**Auto Ignition:**	>530°F (>280°C)

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

Incompatible Products

Keep away from strong oxidizers.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

* * * Section 11 - Toxicological Information * * *

Acute Toxicity

A: General Product Information

Harmful if swallowed.

B: Component Analysis - LD50/LC50

Gasoline, motor fuel (86290-81-5)

Inhalation LC50 Rat >5.2 mg/L 4 h; Oral LD50 Rat 14000 mg/kg; Dermal LD50 Rabbit >2000 mg/kg

Toluene (108-88-3)

Inhalation LC50 Rat 12.5 mg/L 4 h; Inhalation LC50 Rat >26700 ppm 1 h; Oral LD50 Rat 636 mg/kg; Dermal LD50 Rabbit 8390 mg/kg; Dermal LD50 Rat 12124 mg/kg

Butane (106-97-8)

Inhalation LC50 Rat 658 mg/L 4 h

Xylenes (o-, m-, p- isomers) (1330-20-7)
Inhalation LC50 Rat 5000 ppm 4 h; Inhalation LC50 Rat 47635 mg/L 4 h; Oral LD50 Rat 4300 mg/kg; Dermal LD50 Rabbit >1700 mg/kg

Benzene, 1,2,4-trimethyl- (95-63-6)
Inhalation LC50 Rat 18 g/m3 4 h; Oral LD50 Rat 3400 mg/kg; Dermal LD50 Rabbit >3160 mg/kg

Ethyl alcohol (64-17-5)
Oral LD50 Rat 7060 mg/kg; Inhalation LC50 Rat 124.7 mg/L 4 h

Ethylbenzene (100-41-4)
Inhalation LC50 Rat 17.2 mg/L 4 h; Oral LD50 Rat 3500 mg/kg; Dermal LD50 Rabbit 15354 mg/kg

Benzene (71-43-2)
Inhalation LC50 Rat 13050-14380 ppm 4 h; Oral LD50 Rat 1800 mg/kg

Hexane (110-54-3)
Inhalation LC50 Rat 48000 ppm 4 h; Oral LD50 Rat 25 g/kg; Dermal LD50 Rabbit 3000 mg/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

Moderate irritant. Contact with liquid or vapor may cause irritation.

Potential Health Effects: Ingestion

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Potential Health Effects: Inhalation

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This product may cause genetic defects.

Carcinogenicity

A: General Product Information

May cause cancer.

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

B: Component Carcinogenicity

Gasoline, motor fuel (86290-81-5)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans

Toluene (108-88-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999]; Monograph 47 [1989] (Group 3 (not classifiable))

Xylenes (o-, m-, p- isomers) (1330-20-7)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999]; Monograph 47 [1989] (Group 3 (not classifiable))

Ethyl alcohol (64-17-5)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
IARC: Monograph 100E [in preparation] (in alcoholic beverages); Monograph 96 [2010] (in alcoholic beverages) (Group 1 (carcinogenic to humans))

Ethylbenzene (100-41-4)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
IARC: Monograph 77 [2000] (Group 2B (possibly carcinogenic to humans))

Benzene (71-43-2)

ACGIH: A1 - Confirmed Human Carcinogen
OSHA: 5 ppm STEL (Cancer hazard, Flammable, See 29 CFR 1910.1028, 15 min); 0.5 ppm Action Level; 1 ppm TWA
NIOSH: potential occupational carcinogen
NTP: Known Human Carcinogen (Select Carcinogen)
IARC: Monograph 100F [in preparation]; Supplement 7 [1987]; Monograph 29 [1982] (Group 1 (carcinogenic to humans))

Reproductive Toxicity

This product is suspected of damaging fertility or the unborn child.

Specified Target Organ General Toxicity: Single Exposure

This product may cause drowsiness or dizziness.

Specified Target Organ General Toxicity: Repeated Exposure

This product causes damage to organs through prolonged or repeated exposure.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Very toxic to aquatic life with long lasting effects. Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

Gasoline, motor fuel (86290-81-5)

Test & Species		Conditions
96 Hr LC50 Alburnus alburnus	119 mg/L [static]	
96 Hr LC50 Cyprinodon variegatus	82 mg/L [static]	
72 Hr EC50 Pseudokirchneriella subcapitata	56 mg/L	
24 Hr EC50 Daphnia magna	170 mg/L	

Toluene (108-88-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	15.22-19.05 mg/L [flow-through]	1 day old
96 Hr LC50 Pimephales promelas	12.6 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	5.89-7.81 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	14.1-17.16 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	5.8 mg/L [semi-static]	
96 Hr LC50 Lepomis macrochirus	11.0-15.0 mg/L [static]	
96 Hr LC50 Oryzias latipes	54 mg/L [static]	
96 Hr LC50 Poecilia reticulata	28.2 mg/L [semi-static]	
96 Hr LC50 Poecilia reticulata	50.87-70.34 mg/L [static]	
96 Hr EC50 Pseudokirchneriella subcapitata	>433 mg/L	
72 Hr EC50 Pseudokirchneriella subcapitata	12.5 mg/L [static]	
48 Hr EC50 Daphnia magna	5.46 - 9.83 mg/L [Static]	
48 Hr EC50 Daphnia magna	11.5 mg/L	

Xylenes (o-, m-, p- isomers) (1330-20-7)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	13.4 mg/L [flow-through]	

96 Hr LC50 Oncorhynchus mykiss	2.661-4.093 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	13.5-17.3 mg/L	
96 Hr LC50 Lepomis macrochirus	13.1-16.5 mg/L [flow-through]	
96 Hr LC50 Lepomis macrochirus	19 mg/L	
96 Hr LC50 Lepomis macrochirus	7.711-9.591 mg/L [static]	
96 Hr LC50 Pimephales promelas	23.53-29.97 mg/L [static]	
96 Hr LC50 Cyprinus carpio	780 mg/L [semi-static]	
96 Hr LC50 Cyprinus carpio	>780 mg/L	
96 Hr LC50 Poecilia reticulata	30.26-40.75 mg/L [static]	
48 Hr EC50 water flea	3.82 mg/L	
48 Hr LC50 Gammarus lacustris	0.6 mg/L	

Benzene, 1,2,4-trimethyl- (95-63-6)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	7.19-8.28 mg/L [flow-through]	
48 Hr EC50 Daphnia magna	6.14 mg/L	

Ethyl alcohol (64-17-5)

Test & Species		Conditions
96 Hr LC50 Oncorhynchus mykiss	12.0 - 16.0 mL/L [static]	
96 Hr LC50 Pimephales promelas	>100 mg/L [static]	
96 Hr LC50 Pimephales promelas	13400 - 15100 mg/L [flow-through]	
48 Hr LC50 Daphnia magna	9268 - 14221 mg/L	
24 Hr EC50 Daphnia magna	10800 mg/L	
48 Hr EC50 Daphnia magna	2 mg/L [Static]	

Ethylbenzene (100-41-4)

Test & Species		Conditions
96 Hr LC50 Oncorhynchus mykiss	11.0-18.0 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	4.2 mg/L [semi-static]	
96 Hr LC50 Pimephales promelas	7.55-11 mg/L [flow-through]	
96 Hr LC50 Lepomis macrochirus	32 mg/L [static]	
96 Hr LC50 Pimephales promelas	9.1-15.6 mg/L [static]	
96 Hr LC50 Poecilia reticulata	9.6 mg/L [static]	
72 Hr EC50 Pseudokirchneriella subcapitata	4.6 mg/L	
96 Hr EC50 Pseudokirchneriella subcapitata	>438 mg/L	
72 Hr EC50 Pseudokirchneriella subcapitata	2.6 - 11.3 mg/L [static]	

96 Hr EC50 Pseudokirchneriella subcapitata	1.7 - 7.6 mg/L [static]	
48 Hr EC50 Daphnia magna	1.8 - 2.4 mg/L	

Benzene (71-43-2)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	10.7-14.7 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	5.3 mg/L [flow-through]	
96 Hr LC50 Lepomis macrochirus	22.49 mg/L [static]	
96 Hr LC50 Poecilia reticulata	28.6 mg/L [static]	
96 Hr LC50 Pimephales promelas	22330-41160 µg/L [static]	
96 Hr LC50 Lepomis macrochirus	70000-142000 µg/L [static]	
72 Hr EC50 Pseudokirchneriella subcapitata	29 mg/L	
48 Hr EC50 Daphnia magna	8.76 - 15.6 mg/L [Static]	
48 Hr EC50 Daphnia magna	10 mg/L	

Hexane (110-54-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	2.1-2.98 mg/L [flow-through]	
24 Hr EC50 Daphnia magna	>1000 mg/L	

Persistence/Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

Component Marine Pollutants

This material contains one or more of the following chemicals required by US DOT to be identified as marine pollutants.

Component	CAS #	
Gasoline, motor fuel	86290-81-5	DOT regulated marine pollutant

DOT Information

Shipping Name: Gasoline
UN #: 1203 **Hazard Class:** 3 **Packing Group:** II
Placard:

* * * Section 15 - Regulatory Information * * *

Regulatory Information

A: Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Toluene (108-88-3)
SARA 313: 1.0 % de minimis concentration
CERCLA: 1000 lb final RQ; 454 kg final RQ

Xylenes (o-, m-, p- isomers) (1330-20-7)
SARA 313: 1.0 % de minimis concentration
CERCLA: 100 lb final RQ; 45.4 kg final RQ

Benzene, 1,2,4-trimethyl- (95-63-6)
SARA 313: 1.0 % de minimis concentration

Ethylbenzene (100-41-4)
SARA 313: 0.1 % de minimis concentration
CERCLA: 1000 lb final RQ; 454 kg final RQ

Benzene (71-43-2)
SARA 313: 0.1 % de minimis concentration
CERCLA: 10 lb final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule); 4.54 kg final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule)

Hexane (110-54-3)

SARA 313: 1.0 % de minimis concentration
CERCLA: 5000 lb final RQ; 2270 kg final RQ

SARA Section 311/312 – Hazard Classes

Acute Health	Chronic Health	Fire	Sudden Release of Pressure	Reactive
X	X	X	--	--

Component Marine Pollutants

This material contains one or more of the following chemicals required by US DOT to be identified as marine pollutants.

Component	CAS #	
Gasoline, motor fuel	86290-81-5	DOT regulated marine pollutant

State Regulations

Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA	RI
Gasoline, motor fuel	86290-81-5	No	No	No	No	Yes	No
Toluene	108-88-3	Yes	Yes	Yes	Yes	Yes	No
Butane	106-97-8	Yes	Yes	Yes	Yes	Yes	No
Xylenes (o-, m-, p- isomers)	1330-20-7	Yes	Yes	Yes	Yes	Yes	No
Benzene, 1,2,4-trimethyl-	95-63-6	No	Yes	Yes	Yes	Yes	No
Ethyl alcohol	64-17-5	Yes	Yes	Yes	Yes	Yes	No
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	Yes	No
Benzene	71-43-2	Yes	Yes	Yes	Yes	Yes	No
Hexane	110-54-3	No	Yes	Yes	Yes	Yes	No

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.
WARNING! This product contains a chemical known to the state of California to cause reproductive/developmental effects.

Component Analysis - WHMIS IDL

The following components are identified under the Canadian Hazardous Products Act Ingredient Disclosure List:

Component	CAS #	Minimum Concentration
Toluene	108-88-3	1 %
Butane	106-97-8	1 %
Benzene, 1,2,4-trimethyl-	95-63-6	0.1 %
Ethyl alcohol	64-17-5	0.1 %
Ethylbenzene	100-41-4	0.1 %
Benzene	71-43-2	0.1 %
Hexane	110-54-3	1 %

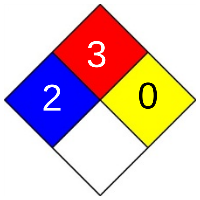
Additional Regulatory Information

Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
Gasoline, motor fuel	86290-81-5	No	DSL	EINECS
Toluene	108-88-3	Yes	DSL	EINECS
Butane	106-97-8	Yes	DSL	EINECS
Xylenes (o-, m-, p- isomers)	1330-20-7	Yes	DSL	EINECS
Benzene, 1,2,4-trimethyl-	95-63-6	Yes	DSL	EINECS
Ethyl alcohol	64-17-5	Yes	DSL	EINECS
Ethylbenzene	100-41-4	Yes	DSL	EINECS
Benzene	71-43-2	Yes	DSL	EINECS
Hexane	110-54-3	Yes	DSL	EINECS

* * * Section 16 - Other Information * * *

NFPA® Hazard Rating	Health	2
	Fire	3
	Reactivity	0



HMIS® Hazard Rating	Health	2	Moderate
	Fire	3	Serious
	Physical	0	Minimal
			*Chronic

Key/Legend

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration., NJTSR = New Jersey Trade Secret Registry.

Literature References

None

Other Information

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

End of Sheet

Safety Data Sheet

Material Name: Diesel Fuel, All Types

SDS No. 9909
US GHS

Synonyms: Ultra Low Sulfur Diesel; Low Sulfur Diesel; No. 2 Diesel; Motor Vehicle Diesel Fuel; Non-Road Diesel Fuel; Locomotive/Marine Diesel Fuel

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

Phone: 732-750-6000 Corporate EHS
Emergency # 800-424-9300 CHEMTREC
www.hess.com (Environment, Health, Safety Internet Website)

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Flammable Liquids - Category 3
Skin Corrosion/Irritation – Category 2
Germ Cell Mutagenicity – Category 2
Carcinogenicity - Category 2
Specific Target Organ Toxicity (Single Exposure) - Category 3 (respiratory irritation, narcosis)
Aspiration Hazard – Category 1
Hazardous to the Aquatic Environment, Acute Hazard – Category 3

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

DANGER

Hazard Statements

Flammable liquid and vapor.
Causes skin irritation.
Suspected of causing genetic defects.
Suspected of causing cancer.
May cause respiratory irritation.
May cause drowsiness or dizziness.
May be fatal if swallowed and enters airways.
Harmful to aquatic life.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed.
Ground/bond container and receiving equipment.

Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Wear protective gloves/protective clothing/eye protection/face protection.
Wash hands and forearms thoroughly after handling.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Avoid breathing fume/mist/vapours/spray.

Response
In case of fire: Use water spray, fog or foam to extinguish.
IF ON SKIN (or hair): Wash with plenty of soap and water. Remove/Take off immediately all contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention.
IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a poison center/doctor if you feel unwell.
If swallowed: Immediately call a poison center or doctor. Do NOT induce vomiting.
IF exposed or concerned: Get medical advice/attention.

Storage
Store in a well-ventilated place. Keep cool.
Keep container tightly closed.
Store locked up.

Disposal
Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
68476-34-6	Fuels, diesel, no. 2	100
91-20-3	Naphthalene	<0.1

A complex mixture of hydrocarbons with carbon numbers in the range C9 and higher.

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

First Aid: Skin

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or with waterless hand cleanser. Obtain medical attention if irritation or redness develops. Thermal burns require immediate medical attention depending on the severity and the area of the body burned.

First Aid: Ingestion

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, and other gaseous agents.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment. Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution, flammable vapors may accumulate in closed containers.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

Handle as a combustible liquid. Keep away from heat, sparks, excessive temperatures and open flame! No smoking or open flame in storage, use or handling areas. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks."

Incompatibilities

Keep away from strong oxidizers.

* * * Section 8 - Exposure Controls / Personal Protection * * *

Component Exposure Limits

Fuels, diesel, no. 2 (68476-34-6)

ACGIH:	100 mg/m3 TWA (inhalable fraction and vapor, as total hydrocarbons, listed under Diesel fuel) Skin - potential significant contribution to overall exposure by the cutaneous route (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH:	10 ppm TWA 15 ppm STEL Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA:	10 ppm TWA; 50 mg/m3 TWA
NIOSH:	10 ppm TWA; 50 mg/m3 TWA 15 ppm STEL; 75 mg/m3 STEL

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile, neoprene, or PVC are recommended.

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Clear, straw-yellow.	**Odor:**	Mild, petroleum distillate odor
Physical State:	Liquid	**pH:**	ND
Vapor Pressure:	0.009 psia @ 70 °F (21 °C)	**Vapor Density:**	>1.0
Boiling Point:	320 to 690 °F (160 to 366 °C)	**Melting Point:**	ND
Solubility (H2O):	Negligible	**Specific Gravity:**	0.83-0.876 @ 60°F (16°C)
Evaporation Rate:	Slow; varies with conditions	**VOC:**	ND
Percent Volatile:	100%	**Octanol/H2O Coeff.:**	ND
Flash Point:	>125 °F (>52 °C) minimum	**Flash Point Method:**	PMCC
Upper Flammability Limit (UFL):	7.5	**Lower Flammability Limit (LFL):**	0.6
Burning Rate:	ND	**Auto Ignition:**	494°F (257°C)

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

Incompatible Products

Keep away from strong oxidizers.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

* * * Section 11 - Toxicological Information * * *

Acute Toxicity

A: General Product Information

Harmful if swallowed.

B: Component Analysis - LD50/LC50

Naphthalene (91-20-3)

Inhalation LC50 Rat >340 mg/m3 1 h; Oral LD50 Rat 490 mg/kg; Dermal LD50 Rat >2500 mg/kg; Dermal LD50 Rabbit >20 g/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

Contact with eyes may cause mild irritation.

Potential Health Effects: Ingestion

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Potential Health Effects: Inhalation

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This material has been positive in a mutagenicity study.

Carcinogenicity

A: General Product Information

Suspected of causing cancer.

Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal’s skin with soap and water between applications reduced tumor formation.

B: Component Carcinogenicity

Fuels, diesel, no. 2 (68476-34-6)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
NTP: Reasonably Anticipated To Be A Human Carcinogen (Possible Select Carcinogen)
IARC: Monograph 82 [2002] (Group 2B (possibly carcinogenic to humans))

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

This product is not reported to have any specific target organ general toxicity repeat exposure effects.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

Fuels, diesel, no. 2 (68476-34-6)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	35 mg/L [flow-through]	

Naphthalene (91-20-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	5.74-6.44 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	1.6 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	0.91-2.82 mg/L [static]	
96 Hr LC50 Pimephales promelas	1.99 mg/L [static]	

96 Hr LC50 Lepomis macrochirus	31.0265 mg/L [static]
72 Hr EC50 Skeletonema costatum	0.4 mg/L
48 Hr LC50 Daphnia magna	2.16 mg/L
48 Hr EC50 Daphnia magna	1.96 mg/L [Flow through]
48 Hr EC50 Daphnia magna	1.09 - 3.4 mg/L [Static]

Persistence/Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

DOT Information

Shipping Name: Diesel Fuel

NA #: 1993 **Hazard Class:** 3 **Packing Group:** III

Placard:

* * * Section 15 - Regulatory Information * * *

Regulatory Information

Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Naphthalene (91-20-3)

CERCLA: 100 lb final RQ; 45.4 kg final RQ

SARA Section 311/312 – Hazard Classes

Acute Health	Chronic Health	Fire	Sudden Release of Pressure	Reactive
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product may contain listed chemicals below the de minimis levels which therefore are not subject to the supplier notification requirements of Section 313 of the Emergency Planning and Community Right- To-Know Act (EPCRA) of 1986 and of 40 CFR 372. If you may be required to report releases of chemicals listed in 40 CFR 372.28, you may contact Hess Corporate Safety if you require additional information regarding this product.

State Regulations

Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA	RI
Fuels, diesel, no. 2	68476-34-6	No	No	No	Yes	No	No
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	Yes	No

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.

Component Analysis - WHMIS IDL

No components are listed in the WHMIS IDL.

Additional Regulatory Information

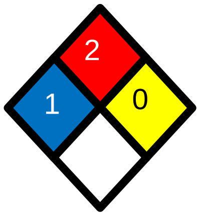
Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
Fuels, diesel, no. 2	68476-34-6	Yes	DSL	EINECS
Naphthalene	91-20-3	Yes	DSL	EINECS

* * * Section 16 - Other Information * * *

NFPA® Hazard Rating

Health	1
Fire	2
Reactivity	0



HMIS® Hazard Rating

Health	1*	Slight
Fire	2	Moderate
Physical	0	Minimal
		*Chronic

Key/Legend

ACGIH = American Conference of Governmental Industrial Hygienists; ADG = Australian Code for the Transport of Dangerous Goods by Road and Rail; ADR/RID = European Agreement of Dangerous Goods by Road/Rail; AS = Standards Australia; DFG = Deutsche Forschungsgemeinschaft; DOT = Department of Transportation; DSL = Domestic Substances List; EEC = European Economic Community; EINECS = European Inventory of Existing Commercial Chemical Substances; ELINCS = European List of Notified Chemical Substances; EU = European Union; HMIS = Hazardous Materials Identification System; IARC = International Agency for Research on Cancer; IMO = International Maritime Organization; IATA = International Air Transport Association; MAK = Maximum Concentration Value in the Workplace; NDSL = Non-Domestic Substances List; NFPA = National Fire Protection Association; NOHSC = National Occupational Health & Safety Commission; NTP = National Toxicology Program; STEL = Short-term Exposure Limit; TDG = Transportation of Dangerous Goods; TLV = Threshold Limit Value; TSCA = Toxic Substances Control Act; TWA = Time Weighted Average

Literature References

None

Other Information

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

End of Sheet

PULSAFEEDER®
A Unit of IDEX Corporation

Last Reviewed: May 2013
Next Review Due: May 2016

Pulsalube #7

pulsafeeder.com

Safety Data Sheet
Premium #7H Hydraulic Oil

Section1: Product and Company Identification

PRODUCT NAME:	Super ATF
MSDS NUMBER:	778846
INTENDED USE:	Automatic Transmission Fluid
MANUFACTURER/SUPPLIER:	Phillips 66 Lubricants P.O. Box 4428 Houston, TX 77210
EMERGENCY HEALTH AND SAFETY NUMBER:	Chemtrec: 800-424-9300 (24 hours)
CUSTOMER SERVICE:	U.S.: 800-822-6457 or International: +1-83-2486-3363
TECHNICAL INFORMATION:	1-877-445-9198
SDS INFORMATION:	800-762-0942 SDS@P66.com www.Phillips66.com

Section 2: Hazard(s) Identification

This material is not considered hazardous according to OSHA criteria.

NFPA

Section 3: Composition / Information on Ingredients

Component	CASRN	Concentration[1]
Lubricant Base Oil (Petroleum)	VARIOUS	>90
Additives	Proprietary	<10

[1] All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

Section 4: First Aid Measures

EYE CONTACT: If irritation or redness develops from exposure, flush eyes with clean water. If symptoms persist, seek medical attention.

SKIN CONTACT: Remove contaminated shoes and clothing and cleanse affected area(s) thoroughly by washing with mild soap and water or a waterless hand cleaner. If irritation or redness develops and persists, seek medical attention.

INHALATION (BREATHING): First aid is not normally required. If breathing difficulties develop, move victim away from source of exposure and into fresh air in a position comfortable for breathing. Seek immediate medical attention.

INGESTION (SWALLOWING): First aid is not normally required; however, if swallowed and symptoms develop, seek medical attention.

NOTES TO PHYSICIAN: Acute aspirations of large amounts of oil-laden material may produce a serious aspiration pneumonia. Patients who aspirate these oils should be followed for the development of long-term sequelae. Inhalation exposure to oil mists below current workplace exposure limits is unlikely to cause pulmonary abnormalities.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Conditions which may be aggravated by exposure include skin disorders

Section 5: Fire-Fighting Measures

NFPA 704 HAZARD CLASS

Health: 0 **Flammability:** 1 **Instability:** 0 (0-Minimal, 1-Slight, 2-Moderate, 3-Serious, 4-Severe)

UNUSUAL FIRE & EXPLOSION HAZARDS: This material may burn, but will not ignite readily. If container is not properly cooled, it can rupture in the heat of a fire.

EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, foam, or water spray is recommended. Water or foam may cause frothing of materials heated above 212°F / 100°C. Carbon dioxide can displace oxygen. Use caution when applying carbon dioxide in confined spaces. Simultaneous use of foam and water on the same surface is to be avoided as water destroys the foam.

FIRE FIGHTING INSTRUCTIONS: For fires beyond the initial stage, emergency responders in the immediate hazard area should wear protective clothing. When the potential chemical hazard is unknown, in enclosed or confined spaces, a self contained breathing apparatus should be worn. In addition, wear other appropriate protective equipment as conditions warrant (see Section 8).

Isolate immediate hazard area and keep unauthorized personnel out. Stop spill/release if it can be done safely. Move undamaged containers from immediate hazard area if it can be done safely. Water spray may be useful in minimizing or dispersing vapors and to protect personnel. Cool equipment exposed to fire with water, if it can be done safely. Avoid spreading burning liquid with water used for cooling purposes.

HAZARDOUS COMBUSTION PRODUCTS: Combustion may yield smoke, carbon monoxide, and other products of incomplete combustion. Oxides of sulfur, nitrogen or phosphorus may also be formed.

See Section 9 for Flammable Properties including Flash Point and Flammable (Explosive) Limits

Section 6: Accidental Release Measures

PERSONAL PRECAUTIONS: This material may burn, but will not ignite readily. Keep all sources of ignition away from spill/release. Stay upwind and away from spill/release. Avoid direct contact with material. For large spillages, notify persons down wind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Wear appropriate protective equipment, including respiratory protection, as conditions warrant (see Section 8). See Sections 2 and 7 for additional information on hazards and precautionary measures.

ENVIRONMENTAL PRECAUTIONS: Stop spill/release if it can be done safely. Prevent spilled material from entering sewers, storm drains, other unauthorized drainage systems, and natural waterways. Use water sparingly to minimize environmental contamination and reduce disposal requirements. If spill occurs on water notify appropriate authorities and advise shipping of any hazard. Spills into or upon navigable waters, the contiguous zone, or adjoining shorelines that cause a sheen or discoloration on the surface of the water, may require notification of the National Response Center (phone number 800-424-8802).

METHODS FOR CONTAINMENT AND CLEAN-UP: Notify relevant authorities in accordance with all applicable regulations. Immediate cleanup of any spill is recommended. Dike far ahead of spill for later recovery or disposal. Absorb spill with inert material such as sand or vermiculite, and place in suitable container for disposal. If spilled on water remove with appropriate methods (e.g. skimming, booms or absorbents). In case of soil contamination, remove contaminated soil for remediation or disposal, in accordance with local regulations.

Recommended measures are based on the most likely spillage scenarios for this material; however local conditions and regulations may influence or limit the choice of appropriate actions to be taken.

Section 7: Handling and Storage

PRECAUTIONS FOR SAFE HANDLING: Keep away from flames and hot surfaces. Wash thoroughly after handling. Use good personal hygiene practices and wear appropriate personal protective equipment (see section 8).

Spills will produce extremely slippery surfaces. Do not enter confined spaces such as tanks or pits without following proper entry procedures such as ASTM D-4276 and 29CFR 1910.146. Do not wear contaminated clothing or shoes.

CONDITIONS FOR SAFE STORAGE: Keep container(s) tightly closed and properly labeled. Use and store this material in cool, dry, well-ventilated area away from heat and all sources of ignition. Store only in approved containers. Keep away from any incompatible material (see Section 10). Protect container(s) against physical damage.

"Empty" containers retain residue and may be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury or death. "Empty" drums should be completely drained, properly bunged, and promptly shipped to the supplier or a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations. Before working on or in tanks which contain or have contained this material, refer to OSHA regulations, ANSI Z49.1, and other references pertaining to cleaning, repairing, welding, or other contemplated operations.

Section 8: Exposure Controls / Personal Protection

Component	ACGIH	OSHA	Other
Lubricant Base Oil (Petroleum)	TWA: 5mg/m³ STEL: 10 mg/m³ as Oil Mist, if Generated	TWA: 5mg/m³ as Oil Mist, if Generated	---

Note: State, local or other agencies or advisory groups may have established more stringent limits. Consult an industrial hygienist or similar professional, or your local agencies, for further information.

ENGINEERING CONTROLS: If current ventilation practices are not adequate to maintain airborne concentrations below the established exposure limits, additional engineering controls may be required.

EYE/FACE PROTECTION: The use of eye protection that meets or exceeds ANSI Z.87.1 is recommended to protect against potential eye contact, irritation, or injury. Depending on conditions of use, a face shield may be necessary.

SKIN/HAND PROTECTION: The use of gloves impervious to the specific material handled is advised to prevent skin contact. Users should check with manufacturers to confirm the breakthrough performance of their products. Suggested protective materials: Nitrile

RESPIRATORY PROTECTION: Where there is potential for airborne exposure above the exposure limit a NIOSH certified air purifying respirator equipped with R or P95 filters may be used.

A respiratory protection program that meets or is equivalent to OSHA 29 CFR 1910.134 and ANSI Z88.2 should be followed whenever workplace conditions warrant a respirator's use. Air purifying respirators provide limited protection and cannot be used in atmospheres that exceed the maximum use concentration (as directed by regulation or the manufacturer's instructions), in oxygen deficient (less than 19.5 percent oxygen) situations, or under conditions that are immediately dangerous to life and health (IDLH).

Suggestions provided in this section for exposure control and specific types of protective equipment are based on readily available information. Users should consult with the specific manufacturer to confirm the performance of their protective equipment. Specific situations may require consultation with industrial hygiene, safety, or engineering professionals.

Section 9: Physical and Chemical Properties

NOTE: Unless otherwise stated, values are determined at 20°C (68°F) and 760 mm Hg (1 atm). Data represent typical values and are not intended to be specifications.

APPEARANCE:	Red
PHYSICAL FORM:	Liquid
ODOR:	Petroleum
ODOR THRESHOLD:	No data
pH:	Not applicable
VAPOR PRESSURE:	<1 mm Hg
VAPOR DENSITY (AIR=1):	>1
INITIAL BOILING POINT/RANGE:	No data
MELTING/FREEZING POINT:	No data
SOLUBILITY IN WATER:	Negligible
PARTITION COEFFICIENT (N-OCTANOL/WATER) (KOW):	No data
SPECIFIC GRAVITY (WATER=1):	0.85 - 0.86 @ 60ºF (15.6ºC)
BULK DENSITY:	7.08 - 7.16 lbs/gal
VISCOSITY:	6.8 - 7.7 cSt @ 100°C; 30.0 - 34.0 cSt @ 40°C
PERCENT VOLATILE:	Negligible
EVAPORATION RATE (NBUAC=1):	<1

FLASH POINT: Minimum 315 °F / 157 °C
TEST METHOD: Pensky-Martens Closed Cup (PMCC), ASTM D93, EPA 1010
LOWER EXPLOSIVE LIMITS (VOL % IN AIR): No data
UPPER EXPLOSIVE LIMITS (VOL % IN AIR): No data
AUTO-IGNITION TEMPERATURE: No data

Section 10: Stability and Reactivity

STABILITY: Stable under normal ambient and anticipated conditions of use.

CONDITIONS TO AVOID: Extended exposure to high temperatures can cause decomposition. Avoid all possible sources of ignition.

MATERIALS TO AVOID (INCOMPATIBLE MATERIALS): Avoid contact with strong oxidizing agents and strong reducing agents.

HAZARDOUS DECOMPOSITION PRODUCTS: Not anticipated under normal conditions of use.

HAZARDOUS POLYMERIZATION: Not known to occur.

Section 11: Toxicological Information

Information on Toxicological Effects of Substance/Mixture

Acute Toxicity	Hazard	Additional Information	LC50/LD50 Data
Inhalation	Unlikely to be harmful		>5 mg/L (mist, estimated)
Dermal	Unlikely to be harmful		> 2 g/kg (estimated)
Oral	Unlikely to be harmful		> 5 g/kg (estimated)

Aspiration Hazard: Not expected to be an aspiration hazard.

Skin Corrosion/Irritation: Not expected to be irritating. Repeated exposure may cause skin dryness or cracking.

Serious Eye Damage/Irritation: Not expected to be irritating.

Symptoms of Overexposure: Inhalation of oil mists or vapors generated at elevated temperatures may cause respiratory irritation. Accidental ingestion can result in minor irritation of the digestive tract, nausea and diarrhea.

Skin Sensitization: This product is not classified as a sensitizer, but contains low concentrations (0.1 - < 1%) of a known skin sensitizer.

Respiratory Sensitization: No information available.

Specific Target Organ Toxicity (Single Exposure): Not expected to cause organ effects from single exposure.

Specific Target Organ Toxicity (Repeated Exposure): Not expected to cause organ effects from repeated exposure.

Carcinogenicity: Not expected to cause cancer.

Germ Cell Mutagenicity: Not expected to cause heritable genetic effects.

Reproductive Toxicity: Not expected to cause reproductive toxicity.

Information on Toxicological Effects of Components

Lubricant Base Oil (Petroleum)

Carcinogenicity: The petroleum base oils contained in this product have been highly refined by a variety of processes including severe hydrocracking/hydroprocessing to reduce aromatics and improve performance characteristics. All of the oils meet the IP-346 criteria of less than 3 percent PAH's and are not considered carcinogens by NTP, IARC, or OSHA.

Section 12: Ecological Information

Toxicity:

All acute aquatic toxicity studies on samples of lubricant base oils show acute toxicity values greater than 100 mg/L for invertebrates, algae and fish. These tests were carried out on water accommodated fractions and the results are consistent with the predicted aquatic toxicity of these substances based on their hydrocarbon compositions. Classification: No classified hazards.

PERSISTENCE AND DEGRADABILITY: The hydrocarbons in this material are not readily biodegradable, but since they can be degraded by microorganisms, they are regarded as inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: Log Kow values measured for the hydrocarbon components of this material are greater than 5.3, and therefore regarded as having the potential to bioaccumulate. In practice, metabolic processes may reduce bioconcentration.

MOBILITY IN SOIL: Volatilization to air is not expected to be a significant fate process due to the low vapor pressure of this material. In water, base oils will float and spread over the surface at a rate dependent upon viscosity. There will be significant removal of hydrocarbons from the water by sediment adsorption. In soil and sediment, hydrocarbon components will show low mobility with adsorption to sediments being the predominant physical process. The main fate process is expected to be slow biodegradation of the hydrocarbon constituents in soil and sediment.

OTHER ADVERSE EFFECTS: None anticipated.

Section 13: Disposal Considerations

The generator of a waste is always responsible for making proper hazardous waste determinations and needs to consider state and local requirements in addition to federal regulations.

This material, if discarded as produced, would not be a federally regulated RCRA "listed" hazardous waste and is not believed to exhibit characteristics of hazardous waste. See Sections 7 and 8 for information on handling, storage and personal protection and Section 9 for physical/chemical properties. It is possible that the material as produced contains constituents which are not required to be listed in the MSDS but could affect the hazardous waste determination. Additionally, use which results in chemical or physical change of this material could subject it to regulation as a hazardous waste.

This material under most intended uses would become "Used Oil" due to contamination by physical or chemical impurities. Whenever possible, Recycle used oil in accordance with applicable federal and state or local regulations. Container contents should be completely used and containers should be emptied prior to discard.

Section 14: Transport Information

U.S. Department of Transportation (DOT)

Shipping Description:	***Not regulated***
Note:	***If shipped by land in a packaging having a capacity of 3,500 gallons or more, the provisions of 49 CFR, Part 130 apply. (Contains oil)***

International Maritime Dangerous Goods (IMDG)

Shipping Description:	***Not regulated***
Note:	***U.S. DOT compliance requirements may apply. See 49 CFR 171.22, 23 & 25.***

International Civil Aviation Org. / International Air Transport Assoc. (ICAO/IATA)

UN/ID #:	***Not regulated***
Note:	***U.S. DOT compliance requirements may apply. See 49 CFR 171.22, 23 & 24.***

	LTD. QTY	**Passenger Aircraft**	**Cargo Aircraft Only**
Packaging Instruction #:	---	---	---
Max. Net Qty. Per Package:	---	---	---

Section 15: Regulatory Information

CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs (in pounds):

This material does not contain any chemicals subject to the reporting requirements of SARA 302 and 40 CFR 372.

CERCLA/SARA - Section 311/312 (Title III Hazard Categories)

Acute Health:	No
Chronic Health:	No
Fire Hazard:	No
Pressure Hazard:	No
Reactive Hazard:	No

CERCLA/SARA - Section 313 and 40 CFR 372:
This material does not contain any chemicals subject to the reporting requirements of SARA 313 and 40 CFR 372.

EPA (CERCLA) Reportable Quantity (in pounds):
This material does not contain any chemicals with CERCLA Reportable Quantities.

California Proposition 65:
Warning: This material may contain detectable quantities of the following chemicals, known to the State of California to cause cancer, birth defects or other reproductive harm, and which may be subject to the warning requirements of California Proposition 65 (CA Health & Safety Code Section 25249.5):

Component	Type of Toxicity
Ethyl Acrylate	Cancer

International Hazard Classification

Canada:
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the Regulations.

WHMIS Hazard Class:
None

National Chemical Inventories
All components are either listed on the US TSCA Inventory, or are not regulated under TSCA
All components are either on the DSL, or are exempt from DSL listing requirements

U.S. Export Control Classification Number: EAR99

Section 16: Other Information

DATE OF ISSUE:	28-Mar-2012
STATUS:	FINAL
PREVIOUS ISSUE DATE:	02-Sep-2008
REVISED SECTIONS OR BASIS FOR REVISION:	Manufacturer (Section 1)
SDS NUMBER:	778846

GUIDE TO ABBREVIATIONS:
ACGIH = American Conference of Governmental Industrial Hygienists; CASRN = Chemical Abstracts Service Registry Number; CEILING = Ceiling Limit (15 minutes); CERCLA = The Comprehensive Environmental Response, Compensation, and Liability Act; EPA = Environmental Protection Agency; GHS = Globally Harmonized System; IARC = International Agency for Research on Cancer; INSHT = National Institute for Health and Safety at Work; IOPC = International Oil Pollution Compensation; LEL = Lower Explosive Limit; NE = Not Established; NFPA = National Fire Protection Association; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; PEL = Permissible Exposure Limit (OSHA); SARA = Superfund Amendments and Reauthorization Act; STEL = Short Term Exposure Limit (15 minutes); TLV = Threshold Limit Value (ACGIH); TWA = Time Weighted Average (8 hours); UEL = Upper Explosive Limit; WHMIS = Worker Hazardous Materials Information System (Canada)

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES:
The information presented in this Material Safety Data Sheet is based on data believed to be accurate as of the date this Material Safety Data Sheet was prepared. HOWEVER, NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY IS EXPRESSED OR IS TO BE IMPLIED REGARDING THE ACCURACY OR COMPLETENESS OF THE INFORMATION PROVIDED ABOVE, THE RESULTS TO BE OBTAINED FROM THE USE OF THIS INFORMATION OR THE PRODUCT, THE SAFETY OF THIS PRODUCT, OR THE HAZARDS RELATED TO ITS USE. No responsibility is assumed for any damage or injury resulting from abnormal use or from any failure to adhere to recommended practices. The information provided above, and the product, are furnished on the condition that the person receiving them shall make their own determination as to the suitability of the product for their particular purpose and on the condition that they assume the risk of their use. In addition, no authorization is given nor implied to practice any patented invention without a license.

Safety Data Sheet

Material Name: Hess 10W30 Motor Oil

SDS No. 8957
US GHS

Synonyms: Valvoline Product Code 52670413

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

Phone: 732-750-6000 Corporate EHS
Emergency # 800-424-9300 CHEMTREC
www.hess.com (Environment, Health, Safety Internet Website)

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Skin Corrosion/Irritation – Category 2
Specific Target Organ Toxicity – Category 3 (narcosis)
Carcinogenicity - Category 1B

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

WARNING

Hazard Statements

Causes skin irritation.
May cause cancer.
May cause drowsiness or dizziness.

Precautionary Statements

Prevention

Wash hands and forearms thoroughly after handling.
Wear protective gloves/protective clothing/eye protection.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Avoid breathing fume/mist/vapors/spray.
Use only outdoors or in a well-ventilated area.

Response

If on skin: Wash with plenty of soap and water. Take off contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention.
If exposed or concerned: Get medical advice/attention.
If inhaled: Remove person to fresh air and keep in a position comfortable for breathing. Call poison center or doctor if you feel unwell.

Storage

Store locked up.
Store in a well-ventilated place.
Keep container tightly closed.

Disposal

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
64742-65-0	Petroleum distillates, solvent dewaxed heavy paraffinic	83-93

Petroleum-based lubricating oil with detergent/dispersant engine oil package with zinc compounds.

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes

If symptoms develop, move individual away from exposure and into fresh air. Flush eyes gently with water while holding eyelids apart. If symptoms persist or there is visual difficulty, seek medical attention.

First Aid: Skin

Remove contaminated clothing. Wash exposed area with soap and water. If symptoms persist, seek medical attention. Launder clothing before reuse.

First Aid: Ingestion

Seek medical attention. If individual is drowsy or unconscious, do not give anything by mouth; place individual on the left side with the head down. Contact a physician, medical facility, or poison control center for advice about whether to induce vomiting. If possible, do not leave individual unattended.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

First Aid: Notes to Physician

Acute aspiration of large amounts of oil-laden material may produce a serious aspiration hazard. Patients who aspirate these oils should be followed for the development of long-term sequelae. Repeated aspiration of mineral oil can produce chronic inflammation of the lungs (i.e. lipoid pneumonia) that may progress to pulmonary fibrosis. Symptoms are often subtle and radiological changes appear worse than clinical abnormalities. Occasionally, persistent cough, irritation of the upper respiratory tract, shortness of breath with exertion, fever, and bloody sputum occur. Inhalation exposure to oil mists below current workplace exposure limits is unlikely to cause pulmonary abnormalities. Preexisting disorders of the following organs (or organ systems) may be aggravated by exposure to this material: skin.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.

Never use welding or cutting torch on or near drum (even empty) because product (even just residue) can ignite explosively. No special fire hazards are known to be associated with this product. Dense smoke may be generated while burning.

Hazardous Combustion Products

May form: carbon dioxide and carbon monoxide, oxides of sulfur, nitrogen and phosphorous, various hydrocarbons.

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or gaseous extinguishing agent.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment. Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution, flammable vapors may accumulate in closed containers.

SMALL SPILL: Absorb liquid on vermiculite, floor absorbent or other absorbent material. Persons not wearing proper personal protective equipment should be excluded from area of spill.

LARGE SPILL: Prevent run-off to sewers, streams, or other bodies of water. If run-off occurs, notify authorities as required, that a spill has occurred. Persons not wearing proper personal protective equipment should be excluded from area of spill until clean-up has been completed.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

Handle as a combustible liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks."

Incompatibilities

Avoid contact with: acids, halogens, strong oxidizing agents.

* * * Section 8 - Exposure Controls / Personal Protection * * *

Component Exposure Limits

ACGIH, OSHA, and NIOSH have not developed exposure limits for any of this product's components.

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Not normally required. However, wear resistant gloves such as nitrile rubber to prevent irritation which may result from prolonged or repeated skin contact with product.

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

To prevent repeated or prolonged skin contact, wear impervious clothing and boots. Wear normal work clothing covering arms and legs.

Hygiene Measures

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Dry, clear and bright	**Odor:**	None
Physical State:	Liquid	**pH:**	ND
Vapor Pressure:	ND	**Vapor Density:**	ND
Boiling Point:	>425 °F (218.3°C) @ 760.00 mmHg	**Melting Point:**	ND
Solubility (H2O):	Negligible	**Specific Gravity:**	0.881 @ 60°F (16°C)
Evaporation Rate:	Slower than ethyl ether	**VOC:**	ND
Viscosity:	<= 3300.0 cps @ -20°C; 10.0 - 11.0 cst @ 100°C	**Octanol/H2O Coeff.:**	ND
Flash Point:	430 °F (221.1 °C)	**Flash Point Method:**	COC
Upper Flammability Limit (UFL):	ND	**Lower Flammability Limit (LFL):**	ND
Burning Rate:	ND	**Auto Ignition:**	ND

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

None

Incompatible Products

Avoid contact with: acids, halogens, strong oxidizing agents.

Hazardous Decomposition Products

May form: aldehydes, carbon dioxide and carbon monoxide, hydrogen sulfide, oxides of sulfur, nitrogen and phosphorus, toxic fumes, various hydrocarbons.

* * * Section 11 - Toxicological Information * * *

Acute Toxicity

A: General Product Information

Harmful if large amounts are swallowed.

B: Component Analysis - LD50/LC50

Petroleum distillates, solvent dewaxed heavy paraffinic (64742-65-0)

Inhalation LC50 Rat >4.7 mg/L 4 h; Oral LD50 Rat >5000 mg/kg; Dermal LD50 Rabbit >5000 mg/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

May cause mild skin irritation. Prolonged or repeated contact may dry the skin. Symptoms include redness, burning, drying and cracking of the skin, and skin burns. Additional symptoms of skin contact include: acne. Passage of this material into the body through the skin is possible, but it is unlikely that this would result in harmful effects during safe handling and use.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

May cause mild eye irritation. Symptoms include stinging, tearing, and redness.

Potential Health Effects: Ingestion

Swallowing small amounts of this material during normal handling is not likely to cause harmful effects. Swallowing large amounts may be harmful.

Potential Health Effects: Inhalation

It is possible to breathe this material under certain conditions of handling and use (for example, during heating, spraying, or stirring). Breathing small amounts of this material during normal handling is not likely to cause harmful effects. Breathing large amounts may be harmful. Symptoms usually occur at air concentrations higher than the recommended exposure limits.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This product is not reported to have any mutagenic effects.

Carcinogenicity

A: General Product Information

May cause cancer.

Used motor oil has been shown to cause skin cancer in laboratory animal continually exposed by repeated applications.

B: Component Carcinogenicity

None of this product's components are listed by ACGIH, IARC, OSHA, NIOSH, or NTP.

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

This product is not reported to have any specific target organ general toxicity repeat exposure effects.

Aspiration Respiratory Organs Hazard

Acute aspiration of large amounts of oil-laden material may produce a serious aspiration hazard.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

Petroleum distillates, solvent dewaxed heavy paraffinic (64742-65-0)

Test & Species		Conditions
96 Hr LC50 Oncorhynchus mykiss	>5000 mg/L	
48 Hr EC50 Daphnia magna	>1000 mg/L	

Persistence/Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

DOT Information

Shipping Name: Not Regulated

* * * Section 15 - Regulatory Information * * *

Regulatory Information

Component Analysis

None of this products components are listed under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65), or CERCLA (40 CFR 302.4).

SARA Section 311/312 – Hazard Classes

Acute Health	Chronic Health	Fire	Sudden Release of Pressure	Reactive
X	X	--	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

ZINC C1-C14 ALKYLDITHIOPHOSPHATE (CAS No. 68649-42-3)

State Regulations

Component Analysis - State

None of this product's components are listed on the state lists from CA, MA, MN, NJ, PA, or RI.

Component Analysis - WHMIS IDL

No components are listed in the WHMIS IDL.

Additional Regulatory Information

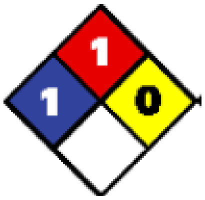
Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
Petroleum distillates, solvent dewaxed heavy paraffinic	64742-65-0	Yes	DSL	EINECS

* * * Section 16 - Other Information * * *

NFPA® Hazard Rating

Health	1
Fire	1
Reactivity	0



HMIS® Hazard Rating

Health	1*	Slight
Fire	1	Slight
Physical	0	Minimal
		*Chronic

Key/Legend

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration., NJTSR = New Jersey Trade Secret Registry.

Literature References

None

Other Information

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

End of Sheet

SAFETY DATA SHEET

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

DEET

Synonyms: N,N-Diethyl-m-toluamide, DETA

Chemical Abstracts Registry No: 134-62-3

1.2. Relevant identified uses of the substance or mixture and uses advised against

Insect repellent

1.3. Details of the supplier of the safety data sheet

Vertellus Performance Materials Inc.
2110 High Point Road
Greensboro, NC 27403 USA

e-mail Address: sds@vertellus.com

1.4. Emergency telephone number

Vertellus: 1-336-292-1781
CHEMTREC (USA): 1-800-424-9300 (collect calls accepted)
CHEMTREC (International): 1-703-527-3887 (collect calls accepted)
NRCC (China): +86 532 83889090

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

(According to Regulation (EC) No 1272/2008)	(According to Directive 67/548/EEC)
Skin Corrosion/Irritation Category 2 Serious Eye Irritation Category 2 Environmental Chronic Category 3 Acute Toxicity Oral Category 4	**Symbol:** Xn, Xi **Risk Phrases:** R52/53: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. R36/38: Irritating to eyes and skin. R22: Harmful if swallowed. **Safety Phrases:** S2: Keep out of the reach of children. S61: Avoid release to the environment. Refer to safety data sheet.

2.2. Label elements

Hazard Symbols (Pictogram):

Signal Word: Warning

Hazard Precautions:
H315 - Causes skin irritation.
H302 - Harmful if swallowed.
H319 - Causes serious eye irritation.
H412 - Harmful to aquatic life with long lasting effects.

Prevention Precautionary Statements:
P270 - Do not eat, drink or smoke when using this product.
P273 - Avoid release to the environment.

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	P280 - Wear protective gloves/protective clothing/eye protection/face protection.
First Aid Precautionary Statements:	P302+P352 - IF ON SKIN: Wash with plenty of soap and water. P305+P351+P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. P337+P313 - If eye irritation persists: Get medical advice/attention. P362 - Take off contaminated clothing and wash before reuse.
Storage Precautionary Statements:	Not required.
Disposal Precautionary Statements:	P501 - Dispose of contents/container in accordance with local/regional/national/international regulation for hazardous wastes.

2.3. Other hazards

Other Hazards: Not applicable.

SECTION 3: Composition/information on ingredients

3.1. Substances or 3.2. Mixtures

Ingredient	CAS Number	Concentration (weight %)	EC Number	CLP Inventory/ Annex VI	EU DSD Classification (67/548/EEC)	EU CLP Classification (1272/2008)
N,N-Diethyl-m-toluamide (DEET)	134-62-3	~ 100	205-149-7	616-018-00-2	Xi, Xn R52/53-R36/38- R22	Aquatic Chronic 3; H412 Acute Tox. 4; H302 Eye Irrit. 2; H319 Skin Irrit. 2; H315

NOTE: See Section 8 for exposure limit data for these ingredients. See Section 15 for trade secret information (where applicable). See Section 16 for the full text of the R-phrases above.

SECTION 4: First aid measures

4.1. Description of first aid measures

Skin Contact:	Wash thoroughly after skin contact.
Eye Contact:	Immediately flush eyes with plenty of water. Get medical attention, if irritation persists.
Inhalation:	Remove from exposure. If not breathing, give artificial respiration and call a physician. Seek medical advice if symptoms persist.
Ingestion:	If swallowed, contact physician or poison control center immediately.

4.2 Most important symptoms and effects, both acute and delayed

Acute:	May be harmful if ingested in sufficient quantities. Contact with skin may cause slight irritation. Moderately irritating to eyes. High gas, vapor, or mist concentrations may be harmful if inhaled.
Delayed Effects:	None known.

4.3. Indication of any immediate medical attention and special treatment needed

Note to Physician: No specific indications. Treatment should be based on the judgment of the physician in response to the reactions of the patient.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Appropriate Extinguishing Media:	Foam, dry chemical, carbon dioxide, water spray

5.2. Special hazards arising from the substance or mixture

Hazardous Products of Combustion:	Combustion will produce carbon monoxide, carbon dioxide and oxides of nitrogen.
Potential for Dust Explosion:	Not applicable.
Special Flammability Hazards:	Not applicable.

5.3. Advice for firefighters

Basic Fire Fighting Guidance:	Wear self-contained breathing apparatus and protective clothing. Normal firefighting procedures may be used.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Evacuation Procedures:	Isolate the hazard area and deny entry to unnecessary and unprotected personnel.
Special Instructions:	See Section 8 for personal protective equipment recommendations. Remove all contaminated clothing to prevent further absorption. Decontaminate affected personnel using the first aid procedures in Section 4. Leather shoes that have been saturated must be discarded.

6.2. Environmental precautions

Prevent releases to soils, drains, sewers and waterways.

6.3. Methods and material for containment and cleaning up

Remove all ignition sources. Ventilate the area of spill or leak. Wear protective equipment during clean-up. Contain spilled liquid with sand or vermiculite and place in chemical waste container. Prevent runoff from entering drains, sewers, and streams. After collection of material, flush area with water. Dispose of contents & container in accordance with local, regional, national or international regulations.

6.4. Reference to other sections

Refer to section 8 for information on selecting personal protective equipment. Refer to section 13 for information on spilled product, absorbent and clean up material disposal instructions.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for Unique Hazards:	Not applicable.
Practices to Minimize Risk:	Wear appropriate protective equipment when performing maintenance on contaminated equipment. Wash hands thoroughly before eating or smoking after handling this material. Do not eat, drink or smoke in work areas. Prevent contact with incompatible materials. Avoid spills and keep away from drains. Handle in a manner to prevent generation of aerosols, vapors or dust clouds.

Special Handling Equipment:	Not applicable.

7.2. Conditions for safe storage, including any incompatibilities

Storage Precautions & Recommendations:	This product should be stored at ambient temperature in a dry, well-ventilated location. Keep container closed when not in use.
Dangerous Incompatibility Reactions:	Incompatible with oxidizing materials.
Incompatibilities with Materials of Construction:	None known

7.3. Specific end use(s)

If a chemical safety assessment has been completed an exposure scenario is attached as an annex to this Safety Data Sheet. Refer to this annex for the specific exposure scenario control parameters for uses identified in subsection 1.2.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Occupational Exposure Limit:	Not applicable.
Air Monitoring Method:	Collection Media: Tenax®; Analysis Method: LCMS/MS

8.2. Exposure controls

Also see the annex to this SDS (if applicable) for specific exposure scenario controls.

Other Engineering Controls:	All operations should be conducted in well-ventilated conditions. Local exhaust ventilation should be provided.
Personal Protective Equipment:	Impervious gloves, boots, and clothing, chemical goggles or face shield where necessary, and a NIOSH approved chemical cartridge respirator or supplied air breathing apparatus.
Respirator Caution:	Observe OSHA regulations for respirator use (29 CFR 1910.134). Air-purifying respirators must not be used in oxygen-deficient atmospheres.
Thermal Hazards:	Not applicable.
Environmental Exposure Controls:	The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Select controls based on a risk assessment of local circumstances. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Appearance, State & Odor (ambient temperature):	Clear, oily liquid with mild, characteristic odor		
Molecular Formula:	$C_{12}H_{17}NO$	Molecular Weight:	191.27
Vapor Pressure:	0.0048 mm Hg @ 32.4°C	Evaporation Rate:	< 1 (Butyl Acetate = 1)
Specific Gravity or Density:	0.998 @ 20°C	Vapor Density (air = 1):	6.7

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Boiling Point:	284.2°C @ 760 mm Hg	Freezing / Melting Point:	-43°C (-45°F) (pour point)
Solubility in Water:	11.2 mg/mL @ 25°C	Octanol / Water Coefficient:	2.4 @ 22°C
pH:	No data available.	Odor Threshold:	No data available.
Viscosity:	21.86 cS @ 20°C	Autoignition Temperature:	> 200°C
Flash Point and Method:	291°F (144°C) Tag Closed Cup	Flammable Limits:	No data available.
Flammability (solid, gas):	Not applicable.	Decomposition Temperature:	No data available.
Explosive Properties:	Not explosive.	Oxidizing Properties:	Not an oxidizer.

SECTION 10: Stability and reactivity

10.1. Reactivity	Not classified as dangerously reactive.
10.2. Chemical stability	Stable
10.3. Possibility of hazardous reactions	Will not occur.
10.4. Conditions to avoid	Uncontrolled exposure to high temperatures.
10.5. Incompatible materials	Incompatible with oxidizing materials.
10.6. Hazardous decomposition products	Combustion will produce carbon monoxide, carbon dioxide and oxides of nitrogen.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute Oral LD_{50}:	1892 mg/kg (rat)	[KEY] Moore 2000a
Acute Dermal LD_{50}:	> 5000 mg/kg (rat)	[KEY] Moore 2001a
Acute Inhalation LC_{50}:	> 2.02 mg/L/4 hr (rat)	[KEY] Moore 2000b
Skin Irritation:	Slightly irritating to skin. [Moore 2000c]	
Eye Irritation:	Moderately irritating to eyes. [Moore 2001b]	
Skin Sensitization:	Not a sensitizer [Moore 2001c]	
Mutagenicity:	*In vitro* gene mutation in bacteria: Negative. *In vitro* cytogenicity in mammalian cells: Negative. *In vitro* gene mutation in mammalian cells: Negative in two separate studies. [DEET CAR 2010]	
Reproductive / Developmental Toxicity:	There were no effects on reproduction in a 2-generation study in rats. No teratogenic effects observed in the studies up to maternally toxic doses; embryotoxicity was only expressed as decreased fetal body weights (rats). [DEET CAR 2010]	
Carcinogenicity:	2-year rat and 18-month mouse studies: no treatment related tumors observed at highest dose tested. [DEET CAR 2010]	
Target Organs:	No data available.	

Primary Route(s) of Exposure:	Skin contact and absorption, eye contact, and inhalation. Ingestion is not likely to be a primary route of exposure.
Most important symptoms and effects, both acute and delayed	May be harmful if ingested in sufficient quantities. Contact with skin may cause slight irritation. Moderately irritating to eyes. High gas, vapor, or mist concentrations may be harmful if inhaled. Delayed Effects: None known.
Additive or Synergistic effects:	None known.

SECTION 12: Ecological information

12.1. Toxicity	EC_{50} (48h) *Daphnia* = 75 ppm	[KEY] Forbis 1985
	LC_{50} (96h) *Oncorhynchus mykiss* (rainbow trout) = 97 mg/L	[KEY] Palmer 2002
	NOEC (72-hr) *Pseudokirchneriella subcapitata* (algae) = 8 mg/L	[KEY] Desjardins 2002
	LC_{50} *Colinus virginianus* (Northern bobwhite quail) = 1375 mg/kg	[KEY] Grimes 1989
12.2. Persistence and degradability	Readily biodegradable. [Schaefer 2002]	
12.3. Bioaccumulative potential	Bioconcentration is not expected to occur.	
12.4. Mobility in soil	This material is expected to have high mobility in soil. It absorbs weakly to most soil types.	
12.5. Results of PBT and vPvB assessment	This substance is not a PBT or vPvB.	
12.6. Other adverse effects	BCF = 22; Koc = 43.3 [Schaefer 2002; Lezotte 2002]	

SECTION 13: Disposal considerations

13.1. Waste treatment methods

US EPA Waste Number:	Non-Hazardous
Waste Disposal:	NOTE: Generator is responsible for proper waste characterization. State hazardous waste regulations may differ substantially from federal regulations. Dispose of this material responsibly, and in accordance with standard practice for disposal of potentially hazardous materials as required by applicable international, national, regional, state or local laws, and environmental protection duty of care principles. Do NOT dump into any sewers, on the ground, or into any body of water. For disposal within the EC, the appropriate classification code according to the European Community List of Wastes should be used. Note that disposal regulations may also apply to empty containers and equipment rinsates.

SECTION 14: Transport information

The following information applies to all shipping modes (DOT/IATA/ICAO/IMDG/ADR/RID/ADN), unless otherwise indicated:

14.1. UN number	Not applicable	14.2. UN proper shipping name	Insect repellent other than agricultural (DEET)
14.3. Transport hazard class(es)	Not applicable	14.4. Packing group	Not applicable
14.5. Environmental hazards	Not applicable		
14.6. Special precautions for user	Not applicable.		
NA Emergency Guidebook Numbers:	Not applicable	IMDG EMS:	Not applicable;
14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code			Not applicable.

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SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

Chemical Inventory Lists:	Status:		
TSCA:	Listed	EINECS:	205-149-7
Canada(DSL/NDSL):	DSL	Japan:	(3)-1321
Korea:	KE-10492	Australia:	Listed
China:	Listed	Philippines:	Listed
Taiwan:	Listed	New Zealand:	Listed

German Water Hazard Classification: ID Number 4679, hazard class 2 - hazard to waters *(N,N-Diethyl-m-toluamid)*

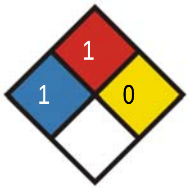
SARA 313: Not applicable.

Reportable Quantities: Not applicable.

State Regulations: This product is regulated under various pesticide laws (e.g., US FIFRA, EU Biocides Regulation) at international, federal and state levels. Contact DEETRegulatory@Vertellus.com with any questions.

HMIS:

NFPA:



15.2. Chemical safety assessment

Not applicable.

SECTION 16: Other information

Full text of R phrases in Section 3:

R52/53: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R36/38: Irritating to eyes and skin.
R22: Harmful if swallowed.

Key Data Sources:

- [DEET CAR 2010] Directive 98/8/EC concerning the placing biocidal products on the market, Inclusion of active substances in Annex I or IA to Directive 98/8/EC, Assessment Report, N,N- diethyl-meta-toluamide (DEET) Product-type 19 (Repellents and attractants), 11 March 2010.
- [Desjardins 2002] Desjardins, D, Kendall, T, and Krueger, H (2002) DEET: A 96-Hour Toxicity Test with the Freshwater Alga (*Selenastrum capricornutum*). Wildlife International, Ltd., Project No. 538A-102 (unpublished).
- [Forbis 1985] Forbis, AD and Burgess, D (1985) Acute Toxicity of N,N-Diethyl-Meta-Toluamide (DEET) to *Daphnia magna*. Analytical Bio-Chemistry Laboratories, Inc., Report No. 33909 (unpublished).
- [Grimes 1989] Grimes, J and Jaber, M (1989) An Evaluation of DEET in an Acute Oral Toxicity Study with the Bobwhite. Wildlife International Ltd., Project No. 262-101 (unpublished).
- [Lezotte 2002] Lezotte, FJ and Nixon, WB (2002) DEET: An Evaluation of Hydrolysis as a Function of pH. Wildlife International, Ltd., Project No. 538C-103 (unpublished).
- [Moore 2000a] Moore, GE (2000) Acute Oral Toxicity with DEET Insect Repellent. Product Safety Labs, Project No. 8392 (unpublished).
- [Moore 2000b] Moore, GE (2000) Acute Inhalation Toxicity Test with DEET Insect Repellent. Product Safety Labs, Project No. 8394 (unpublished).
- [Moore 2000c] Moore, GE (2000) Primary Skin Irritation Test with DEET Insect Repellent. Product Safety Labs, Project No. 8396 (unpublished).

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- [Moore 2001a] Moore, GE (2001) Acute Dermal Toxicity Study - Limit Test with N, N-Diethyl-m-toluamide. Product Safety Labs, Project No. 10883 (unpublished).
- [Moore 2001b] Moore, GE (2001) Primary Eye Irritation Study in Rabbits with N,N-Diethyl-m-toluamide. Product Safety Labs, Project No. 10885 (unpublished).
- [Moore 2001c] Moore, GE (2001) Dermal Sensitization Study in Guinea Pigs (Buehler Method) with N,N-Diethyl-m-toluamide Product Safety Labs, Project No. 10887 (unpublished).
- [Palmer 2002] Palmer, SJ, Kendall, TZ and Krueger, HO (2002) A 96-Hour Static Acute Toxicity Test with the Rainbow Trout (*Oncorhynchus mykiss*). Wildlife International, Ltd., Project No. 538A-101 (unpublished) [Ref. No. 100049].
- [Schaefer 2002] Schaefer, EC and Siddiqui, AI (2002) Ready Biodegradability by the Carbon Dioxide Evolution Test Method. Wildlife International, Ltd., Project No. 538E-102 (unpublished).

Classification Method: On basis of test data

Legend of Abbreviations:

ACGIH = American Conference on Governmental Industrial Hygienists.
CAS = Chemical Abstracts Service.
CFR = Code of Federal Regulations.
DSL/NDSL = Domestic Substances List/Non-Domestic Substances List.
EC = European Community.
EINECS = European Inventory of Existing Commercial Chemical Substances.
ELINCS = European List of Notified Chemical Substances.
EU = European Union.
GHS = Globally Harmonized System.
LC = Lethal Concentration.
LD = Lethal Dose.
NFPA = National Fire Protection Association.
NIOSH = National Institute of Occupational Safety and Health.
NTP = National Toxicology Program.
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Limit.
RQ = Reportable Quantity.
SARA = Superfund Amendments and Reauthorization Act of 1986.
TLV = Threshold Limit Value.
WHMIS = Workplace Hazardous Materials Information System.

Important Note: Please note that the information contained herein is furnished without warranty of any kind. Users should consider these data only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use and disposal of these materials and the safety and health of employees and customers. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. The information contained herein may change without prior notice. THIS SAFETY DATA SHEET SUPERSEDES ALL PREVIOUS EDITIONS.

Revision Date:	18 Aug 2014	Original Date of Issue:	No data available.
Issued by:	Regulatory Management Department	Email:	SDS@Vertellus.com
Revision Details:	Revised format		

SAFETY DATA SHEET

Kidde 90 Multi-Purpose ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)

1. IDENTIFICATION

Product Name	Kidde 90 Multi-Purpose ABC Dry Chemical (Fire Extinguishing Agent, Pressurized and Non-pressurized)
Other Names	ABC, Ammonium Phosphate, Monoammonium Phosphate, Tri-Class
Recommended use of the chemical and restrictions on use	
Identified uses	Fire Extinguishing Agent
Restrictions on use	Consult applicable fire protection codes
Company Identification	Kidde Residential & Commercial 1016 Corporate Park Drive Mebane, NC 27302 USA
Customer Information Number	(919) 563-5911 (919) 304-8200
Emergency Telephone Number	
CHEMTREC Number	(800) 424-9300 (703) 527-3887 (International)
Issue Date	October 1, 2015
Supersedes Date	April 10, 2015

Safety Data Sheet prepared in accordance with OSHA's Hazard Communication Standard (29 CFR 1910.1200) and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

2. HAZARD IDENTIFICATION

This SDS covers the product listed above as sold in pressurized and non-pressurized containers. GHS classifications for both forms are listed below.

GHS Classification – Pressurized

Hazard Classification
Gas under pressure – Compressed gas

Label Elements
Hazard Symbols

Signal Word: Warning

Hazard Statements
Contents under pressure; may explode if heated.

2. HAZARD IDENTIFICATION

Precautionary Statements
Prevention
None
Response
None
Storage
Protect from sunlight.
Store in well-ventilated place.
Disposal
None

GHS Classification: Non - pressurized

Hazard Classification
This product is classified as not hazardous in accordance with the Globally Harmonized System of Classification and Labelling (GHS).

Label Elements
Hazard Symbols
None

Signal Word: None

Hazard Statements
None

Precautionary Statements
Prevention
None
Response
None
Storage
None
Disposal
None

Other Hazards
Mica may contain small quantities of quartz (crystalline silica) as an impurity. Prolonged exposure to respirable crystalline silica dust at concentrations exceeding the occupational exposure limits may increase the risk of developing a disabling lung disease known as silicosis. IARC found limited evidence for pulmonary carcinogenicity of crystalline silica in humans.

Specific Concentration Limits
The values listed below represent the percentages of ingredients of unknown toxicity.

Acute oral toxicity	< 10%
Acute dermal toxicity	< 10%
Acute inhalation toxicity	< 10%
Acute aquatic toxicity	< 10%

3. COMPOSITION/INFORMATION ON INGREDIENTS

This product is a mixture.

Component	CAS Number	Concentration
Monoammonium Phosphate	7722-76-1	85 - 95%
Ammonium Sulfate	7783-20-2	< 5%
Mica	12001-26-2	< 5%
Clay	1332-58-7	< 5%
Amorphous Silica	7631-86-9	< 5%
Dye	NA	<1%

Note: Pressurized product uses nitrogen or compressed air as the expellant.

4. FIRST- AID MEASURES

Description of necessary first-aid measures

Eyes

Immediately flood the eye with plenty of water for at least 15 minutes, holding the eye open. Obtain medical attention if soreness or redness persists.

Skin

Wash skin thoroughly with soap and water. Obtain medical attention if irritation persists.

Ingestion

Dilute by drinking large quantities of water and obtain medical attention.

Inhalation

Move victim to fresh air. Obtain medical attention immediately for any breathing difficulty.

Most important symptoms/effects, acute and delayed

Aside from the information found under Description of necessary first aid measures (above) and Indication of immediate medical attention and special treatment needed, no additional symptoms and effects are anticipated.

Indication of immediate medical attention and special treatment needed

Notes to Physicians

Treat symptomatically.

5. FIRE - FIGHTING MEASURES

Suitable Extinguishing Media

This preparation is used as an extinguishing agent and therefore is not a problem when trying to control a fire. Use extinguishing agent appropriate to other materials involved. Keep pressurized containers and surroundings cool with water spray as they may rupture or burst in the heat of a fire.

Specific hazards arising from the chemical

Pressurized containers may explode in heat of fire.

Special Protective Actions for Fire-Fighters

Wear full protective clothing and self-contained breathing apparatus as appropriate for specific fire conditions.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures
Wear appropriate protective clothing. Prevent skin and eye contact. Remove leaking container to a safe place. Ventilate the area.

Environmental Precautions
Prevent large quantities of the material from entering drains or watercourses.

Methods and materials for containment and cleaning up
Sweep up or vacuum and transfer into suitable containers for recovery or disposal.

7. HANDLING AND STORAGE

Precautions for safe handling
Wear appropriate protective clothing. Prevent skin and eye contact.

Conditions for safe storage
Pressurized containers should be properly stored and secured to prevent falling or being knocked over. Do not drag, slide or roll pressurized containers. Do not drop pressurized containers or permit them to strike against each other. Never apply flame or localized heat directly to any part of the pressurized or plastic container. Store pressurized and plastic containers away from high heat sources. Storage area should be: - cool - dry - well ventilated - under cover - out of direct sunlight

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters
Exposure limits are listed below, if they exist.

Mica
ACGIH TLV: 3 mg/m^3 TWA, measured as respirable fraction of the aerosol.
OSHA PEL: 20 mppcf, <1% crystalline silica
Clay as Kaolin, Respirable Fraction
ACGIH TLV: 2 mg/m^3 TWA
OSHA PEL: 15 mg/m^3 TWA, total dust
5 mg/m^3 TWA, respirable fraction
Nuisance Dust Limit
OSHA PEL: 50 mppcf or 15 mg/m^3 TWA, total dust
15 mppcf or 5 mg/m^3 TWA, respirable fraction

Appropriate engineering controls
Use with adequate ventilation. If this product is used in a pressurized system, there should be local procedures for the selection, training, inspection and maintenance of this equipment. When used in large volumes, use local exhaust ventilation.

Individual protection measures
Respiratory Protection
Not normally required. Use dust mask where dustiness is prevalent, or TLV is exceeded. In oxygen deficient atmospheres, use a self contained breathing apparatus, as an air purifying respirator will not provide protection.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Skin Protection
Gloves
Eye/Face Protection
Chemical goggles or safety glasses with side shields.
Body Protection
Normal work wear.

9. PHYSICAL AND CHEMICAL PROPERTIES

Non- Pressurized

Appearance

Physical State	Solid (powder)
Color	Pale Yellow
Odor	Odorless
Odor Threshold	No data available
pH	Not applicable
Specific Gravity	No data available
Boiling Range/Point (°C/F)	Not applicable
Melting Point (°C/F)	No data available
Flash Point (PMCC) (°C/F)	Not flammable
Vapor Pressure	No data available
Evaporation Rate (BuAc=1)	No data available
Solubility in Water	No data available
Vapor Density (Air = 1)	Not applicable
VOC (g/l)	None
VOC (%)	None
Partition coefficient (n-octanol/water)	No data available
Viscosity	No data available
Auto-ignition Temperature	No data available
Decomposition Temperature	No data available
Upper explosive limit	No data available
Lower explosive limit	No data available
Flammability (solid, gas)	No data available

Expellant - Nitrogen

Appearance

Physical State	Compressed gas
Color	Colorless
Odor	None
Odor Threshold	No data available
pH	Not applicable
Specific Gravity	0.075 lb/ft^3 @70^{o}F as vapor
Boiling Range/Point (°C/F)	-196^{o}C/-321 ^{o}F
Melting Point (°C/F)	No data available
Flash Point (PMCC) (°C/F)	Not flammable
Vapor Pressure	No data available
Evaporation Rate (BuAc=1)	No data available
Solubility in Water	No data available

9. PHYSICAL AND CHEMICAL PROPERTIES

Vapor Density (Air = 1)	Not applicable
VOC (g/l)	None
VOC (%)	None
Partition coefficient (n-octanol/water)	No data available
Viscosity	Not applicable
Auto-ignition Temperature	No data available
Decomposition Temperature	No data available
Upper explosive limit	Not explosive
Lower explosive limit	Not explosive
Flammability (solid, gas)	Not flammable

10. STABILITY AND REACTIVITY

Reactivity
Pressurized containers may rupture or explode if exposed to heat.

Chemical Stability
Stable under normal conditions.

Possibility of hazardous reactions
Hazardous polymerization will not occur.

Conditions to Avoid
Exposure to direct sunlight - contact with incompatible materials

Incompatible Materials
Strong oxidizing agents - strong acids - sodium hypochlorite

Hazardous Decomposition Products
Oxides of carbon - ammonia - oxides of phosphorus - nitrogen oxides

11. TOXICOLOGICAL INFORMATION

Acute Toxicity
<u>Monoammonium Phosphate:</u>
Oral LD50 (Rat) 5750 mg/kg
Dermal LD50 (Rabbit) >5000mg/kg
Inhalation LC50 (Rat) 5.1mg/l
<u>Ammonium Sulfate</u>:
Oral LD50 (Rat) 4250 mg/kg
Dermal LD50 (Rabbit) >2000mg/kg
<u>Mica</u>:
Oral LD50 (Rat) >2000 mg/kg
<u>Amorphous Silica:</u>
Oral LD50 (Rat) >5000 mg/kg
Dermal LD50 (Rabbit) >2000mg/kg

11. TOXICOLOGICAL INFORMATION

Clay:
Oral LD50 (Rat) >5000 mg/kg
Dermal LD50 (Rabbit) >5000mg/kg
Nitrogen
Simple asphyxiant

Specific Target Organ Toxicity (STOT) – single exposure
Monoammonium Phosphate: Available data indicates this component is not expected to cause target organ effects after a single exposure.
Ammonium Sulfate: Available data indicates this component is not expected to cause target organ effects after a single exposure.
Nitrogen: Exposure to nitrogen gas at high concentrations can cause suffocation by reducing oxygen available for breathing. Breathing very high concentrations can cause dizziness, shortness of breath, unconsciousness or asphyxiation.

Specific Target Organ Toxicity (STOT) – repeat exposure
Monoammonium Phosphate: Available data indicates this component is not expected to cause target organ effects after repeat exposure.
Ammonium Sulfate: Available data indicates this component is not expected to cause target organ effects after repeat exposure.

Serious Eye damage/Irritation
Monoammonium Phosphate: Not irritating (rabbit)
Ammonium Sulfate: Not irritating (rabbit)
Mica: Not irritating (rabbit)

Skin Corrosion/Irritation
Monoammonium Phosphate: Not irritating in rabbit test study
Ammonium Sulfate: Not irritating (rabbit)
Mica: Not irritating (rabbit)

Respiratory or Skin Sensitization
Monoammonium Phosphate: Not skin sensitizing based on test (Mouse local lymphnode assay (LLNA)) on an analogous compound
Ammonium Sulfate: Not sensitizing in Guinea pig maximisation test

Carcinogenicity
Mica may contain small quantities of quartz (crystalline silica) as an impurity. Prolonged exposure to respirable crystalline silica dust at concentrations exceeding the occupational exposure limits may increase the risk of developing a disabling lung disease known as silicosis. IARC has classified Silica Dust, Crystalline, in the form of quartz or cristobalite as 1 (carcinogenic to humans).

Germ Cell Mutagenicity
Monoammonium Phosphate: Not mutagenic in the mouse lymphoma cells in mammalian cell gene mutation assay
Ammonium Sulfate: Negative results in Ames Test, in vitro mammalian chromosome aberration test, and mammalian cell gene mutation assay.

11. TOXICOLOGICAL INFORMATION

Reproductive Toxicity
Monoammonium Phosphate: Available data indicates this component is not expected to cause reproductive toxicity or birth defects.
Ammonium Sulfate: Available data indicates this component is not expected to cause reproductive toxicity or birth defects.

Aspiration Hazard
Not an aspiration hazard.

12. ECOLOGICAL INFORMATION

Ecotoxicity
Monoammonium Phosphate:
LC50 rainbow trout >100 mg/l 96h
LC50 water flea 1790 mg/l 72h (similar substance)

Mobility in soil
No relevant studies identified.

Persistence/Degradability
No relevant studies identified.

Bioaccumulative Potential
No relevant studies identified.

Other adverse effects
No relevant studies identified.

13. DISPOSAL CONSIDERATIONS

Disposal Methods
Dispose of container in accordance with all applicable local and national regulations.

14. TRANSPORT INFORMATION

Safety Data Sheet information is intended to address a specific material and not various forms or states of containment.

Special Precautions for Shipping:
Individuals must be certified as Hazardous Material Shipper for all transportation modes.
Pressurized Fire Extinguishers are considered a hazardous material by the US Department of Transportation and Transport Canada.

DOT CFR 172.101 Data	Fire extinguishers, 2.2, UN1044
UN Proper Shipping Name	Fire extinguishers
UN Class	(2.2)
UN Number	UN1044
UN Packaging Group	Not applicable

14. TRANSPORT INFORMATION

Classification for AIR Transportation (IATA)	Consult current IATA Regulations prior to shipping by air.
Classification for Water Transport IMDG	Consult current IMDG Regulations prior to shipping by water.

When shipping via ground, portable fire extinguishers pressurized to less than 241 psi and of less than 1100 cubic inches in size meet the requirements of “Limited Quantity” as referenced in 49 CFR 173.309 (2010). There is no limited quantity designation for fire extinguishers when shipped by air or water.

This section is believed to be accurate at the time of preparation. It is not intended to be a complete statement or summary of the applicable laws, rules, or hazardous material regulations, and is subject to change. Users have the responsibility to confirm compliance with all laws, rules, and hazardous material regulations in effect at the time of shipping.

15. REGULATORY INFORMATION

United States TSCA Inventory
This product contains ingredients that are listed on or exempt from listing on the EPA Toxic Substance Control Act Chemical Substance Inventory.

Canada DSL Inventory
All ingredients in this product are listed on the Domestic Substance List (DSL) or the Non-Domestic Substance List (NDSL) or are exempt from listing.

SARA Title III Sect. 311/312 Categorization: Pressurized
Pressure hazard
SARA Title III Sect. 311/312 Categorization: Non-pressurized
None

SARA Title III Sect. 313
This product does not contain any chemicals that are listed in Section 313 at or above de minimis concentrations.

16. OTHER INFORMATION

NFPA Ratings
NFPA Code for Health - 1
NFPA Code for Flammability - 0
NFPA Code for Reactivity - 0
NFPA Code for Special Hazards - None

HMIS Ratings
HMIS Code for Health - 1
HMIS Code for Flammability - 0
HMIS Code for Physical Hazard - 0
HMIS Code for Personal Protection - See Section 8
*Chronic

16. OTHER INFORMATION

Legend

ACGIH: American Conference of Governmental Industrial Hygienists
CAS#: Chemical Abstracts Service Number
EC50: Effect Concentration 50%
IARC: International Agency for Research on Cancer
LC50: Lethal Concentration 50%
LD50: Lethal Dose 50%
N/A: Denotes no applicable information found or available
OSHA: Occupational Safety and Health Administration
PEL: Permissible Exposure Limit
STEL: Short Term Exposure Limit
TLV: Threshold Limit Value
TSCA: Toxic Substance Control Act

Revision Date: October 1, 2015
Replaces: April 10, 2015
Changes made: Update to Section 14.

Information Source and References

This SDS is prepared by Hazard Communication Specialists based on information provided by internal company references.

Prepared By: EnviroNet LLC.

The information and recommendations presented in this SDS are based on sources believed to be accurate. Kidde Residential & Commercial assumes no liability for the accuracy or completeness of this information. It is the user's responsibility to determine the suitability of the material for their particular purposes. In particular, we make NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, with respect to such information, and we assume no liability resulting from its use. Users should ensure that any use or disposal of the material is in accordance with applicable Federal, State, and local laws and regulations.

Safety Data Sheet
acc. to OSHA HCS

Printing date 07/13/2015 *Reviewed on 07/13/2015*

1 Identification

· ***Product identifier***

· ***Trade name:*** *SUN X SPF 30+ BROAD SPECTRUM SUNCREEN LOTION*

· ***Details of the supplier of the safety data sheet***
· ***Manufacturer/Supplier:***
CoreTex Products, Inc.
1850 Sunnyside Ct.
Bakersfield, CA 93308
skincare@coretexproducts.com

· ***Information department:*** *Product safety department*
· ***Emergency telephone number:*** *CHEMTEL - 1.800.255.3924 - 24 HOURS*

2 Hazard(s) identification

· ***Classification of the substance or mixture***
The product is not classified according to the Globally Harmonized System (GHS).

· ***Classification according to Directive 67/548/EEC or Directive 1999/45/EC*** *Not applicable.*
· ***Information concerning particular hazards for human and environment:***
The product does not have to be labeled due to the calculation procedure of international guidelines.
· ***Classification system:***
The classification was made according to the latest editions of international substances lists, and expanded upon from company and literature data.

· ***Label elements***

· ***Labelling according to EU guidelines:***
Observe the general safety regulations when handling chemicals.
The product is not subject to identification regulations according to directives on hazardous materials.
· ***Classification system:***
· ***NFPA ratings (scale 0 - 4)***

Health = 0
Fire = 0
Reactivity = 0

· ***HMIS-ratings (scale 0 - 4)***

Health = 0
Fire = 0
Reactivity = 0

· ***Other hazards***
· ***Results of PBT and vPvB assessment***
· ***PBT:*** *Not applicable.*
· ***vPvB:*** *Not applicable.*

3 Composition/information on ingredients

· ***Chemical characterization: Mixtures***
· ***Description:*** *Mixture of the substances listed below with nonhazardous additions.*

4 First-aid measures

· ***Description of first aid measures***
· ***General information:*** *No special measures required.*
· ***After inhalation:*** *Supply fresh air; consult doctor in case of complaints.*
· ***After skin contact:*** Product may irritate sensitive skin.
· ***After eye contact:*** *Rinse opened eye for several minutes under running water.*
· ***After swallowing:*** *If symptoms persist consult doctor.*
· ***Information for doctor:***
· ***Most important symptoms and effects, both acute and delayed*** *No further relevant information available.*
· ***Indication of any immediate medical attention and special treatment needed***
No further relevant information available.

5 Fire-fighting measures

· ***Extinguishing media***
· ***Suitable extinguishing agents:***
CO2, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
· ***Special hazards arising from the substance or mixture*** *No further relevant information available.*
· ***Advice for firefighters***
· ***Protective equipment:*** *No special measures required.*

6 Accidental release measures

· ***Personal precautions, protective equipment and emergency procedures*** *Not required.*
· ***Environmental precautions:*** *Dilute with plenty of water.*
· ***Methods and material for containment and cleaning up:***
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
· ***Reference to other sections***
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7 Handling and storage

· ***Handling:***
· ***Precautions for safe handling*** *No special measures required.*
· ***Information about protection against explosions and fires:*** *No special measures required.*

· ***Conditions for safe storage, including any incompatibilities***
· ***Storage:*** *Store at room temperature and out of direct sun.*
· ***Requirements to be met by storerooms and receptacles:*** *No special requirements.*
· ***Information about storage in one common storage facility:*** *Not required.*
· ***Further information about storage conditions:*** *None.*
· ***Specific end use(s)*** *No further relevant information available.*

8 Exposure controls/personal protection

· ***Additional information about design of technical systems:*** *No further data; see item 7.*

· ***Control parameters***
· ***Components with limit values that require monitoring at the workplace:***
The product does not contain any relevant quantities of materials with critical values that have to be monitored at the workplace.
· ***Additional information:*** *The lists that were valid during the creation were used as basis.*

· ***Exposure controls***
· ***Personal protective equipment:***
· ***General protective and hygienic measures:***
The usual precautionary measures for handling chemicals should be followed.
· ***Breathing equipment:*** *Not required.*
· ***Protection of hands:***
The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation
· ***Material of gloves***
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.
· ***Penetration time of glove material***
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.
· ***Eye protection:*** *Goggles recommended during refilling.*

9 Physical and chemical properties

· ***Information on basic physical and chemical properties***	
· ***General Information***	
· ***Appearance:***	
Form:	*Viscous*
Color:	*Whitish*
· ***Odor:***	*Characteristic*
· *Odor threshold:*	*Not determined.*
· ***pH-value at 20 °C (68 °F):***	*5.4*
· ***Change in condition***	
Melting point/Melting range:	*Undetermined.*
Boiling point/Boiling range:	*100 °C (212 °F)*
· ***Flash point:***	*Not applicable.*
· ***Flammability (solid, gaseous):***	*Not applicable.*
· ***Ignition temperature:***	
Decomposition temperature:	*Not determined.*
· ***Auto igniting:***	*Product is not self-igniting.*
· ***Danger of explosion:***	*Product does not present an explosion hazard.*
· ***Explosion limits:***	
Lower:	*Not determined.*
Upper:	*Not determined.*
· ***Vapor pressure at 20 °C (68 °F):***	*23 hPa (17 mm Hg)*

· ***Density:***	*Not determined.*
· ***Relative density***	*Not determined.*
· ***Vapour density***	*Not determined.*
· ***Evaporation rate***	*Not determined.*
· ***Solubility in / Miscibility with***	
Water:	*Fully miscible.*
· ***Partition coefficient (n-octanol/water):***	*Not determined.*
· ***Viscosity:***	
Dynamic:	*Not determined.*
Kinematic at 20 °C (68 °F):	*37000 cstk (DIN 53211/4)*
· ***Solvent content:***	
Organic solvents:	*0.9 %*
Water:	*67.6 %*
VOC content:	*0.9 %* *13.0 g/l / 0.11 lb/gl*
Solids content:	*31.5 %*
· ***Other information***	*No further relevant information available.*

10 Stability and reactivity

· ***Reactivity***
· ***Chemical stability***
· ***Thermal decomposition / conditions to be avoided:*** *No decomposition if used according to specifications.*
· ***Possibility of hazardous reactions*** *No dangerous reactions known.*
· ***Conditions to avoid*** *No further relevant information available.*
· ***Incompatible materials:*** *No further relevant information available.*
· ***Hazardous decomposition products:*** *No dangerous decomposition products known.*

11 Toxicological information

· ***Information on toxicological effects***
· ***Acute toxicity:***
· ***Primary irritant effect:***
· ***on the skin:*** *No irritant effect.*
· ***on the eye:*** *No irritating effect.*
· ***Sensitization:*** *No sensitizing effects known.*
· ***Additional toxicological information:***
The product is not subject to classification according to internally approved calculation methods for preparations:
When used and handled according to specifications, the product does not have any harmful effects according to our experience and the information provided to us.

12 Ecological information

· ***Toxicity***
· ***Aquatic toxicity:*** *No further relevant information available.*
· ***Persistence and degradability*** *No further relevant information available.*

· ***Behavior in environmental systems:***
· ***Bioaccumulative potential*** *No further relevant information available.*
· ***Mobility in soil*** *No further relevant information available.*
· ***Additional ecological information:***
· ***General notes:*** *Generally not hazardous for water*
· ***Results of PBT and vPvB assessment***
· ***PBT:*** *Not applicable.*
· ***vPvB:*** *Not applicable.*
· ***Other adverse effects*** *No further relevant information available.*

13 Disposal considerations

· ***Waste treatment methods***
· ***Recommendation:*** *Smaller quantities can be disposed of with household waste.*

· ***Uncleaned packagings:***
· ***Recommendation:*** *Disposal must be made according to official regulations.*
· ***Recommended cleansing agent:*** *Water, if necessary with cleansing agents.*

14 Transport information

· ***UN-Number*** · ***DOT, ADN, IMDG, IATA***	*Void*
· ***UN proper shipping name*** · ***DOT, ADN, IMDG, IATA***	*Void*
· ***Transport hazard class(es)***	
· ***DOT, ADN, IMDG, IATA*** · ***Class***	*Void*
· ***Packing group*** · ***DOT, IMDG, IATA***	*Void*
· ***Environmental hazards:*** · ***Marine pollutant:***	*No*
· ***Special precautions for user***	*Not applicable.*
· ***Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code***	*Not applicable.*
· ***UN "Model Regulation":***	-

15 Regulatory information

· ***Safety, health and environmental regulations/legislation specific for the substance or mixture***
· ***Sara***

· ***Section 355 (extremely hazardous substances):***

None of the ingredients is listed.

· ***Section 313 (Specific toxic chemical listings):***

None of the ingredients is listed.

· **TSCA (Toxic Substances Control Act):**

None of the ingredients is listed.

· **Proposition 65**

· **Chemicals known to cause cancer:**

None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for females:**

None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for males:**

None of the ingredients is listed.

· **Chemicals known to cause developmental toxicity:**

None of the ingredients is listed.

· **Carcinogenic categories**

· **EPA (Environmental Protection Agency)**

None of the ingredients is listed.

· **TLV (Threshold Limit Value established by ACGIH)**

None of the ingredients is listed.

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**

None of the ingredients is listed.

· **OSHA-Ca (Occupational Safety & Health Administration)**

None of the ingredients is listed.

· **Product related hazard informations:**

Observe the general safety regulations when handling chemicals.

The product is not subject to identification regulations according to directives on hazardous materials.

· **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Abbreviations and acronyms:**

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
ELINCS: European List of Notified Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
VOC: Volatile Organic Compounds (USA, EU)

Appendix G

Marine Safety

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Float Plan

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Iona Island MMRP Survey, Iona Island New York, Vessel Float Plan
EA Project # 63029587

Filed by: VESSEL CAPTAIN, DATE

DRAFT – FINAL FLOAT PLAN TO BE FILED BY FIELD CREW PRIOR TO MOBILIZATION

Vessel will be inspected by U.S. Coast Guard Auxiliary Personnel prior to Mobilization and documentation of inspection attached to final Float Plan.

All vessel operations will be conducting according to EA's Corporate Vessel Operations Manual (Appendix G) and follow EA's Standard Operating Procedures for Small Boat Operations (Appendix G).

Vessel Specs: VESSEL NAME

Registration: VESSEL REGISTRATION

Propulsion: VESSEL PROPULSION

Launch Location: Haverstraw Bay Park Boat Ramp, 21 Gagan Road, Haverstraw, NY 10927

Safety Equipment: 3 Fire extinguishers, flare gun, horn, safety whistle, USCG Type IV Throwable life ring, USCG Type III life jackets, USCG Type I life jackets

Personnel on board: To Be Determined

Cell Phones: To Be Determined

Allergies: To Be Determined

Sampling Type: Magnetometer Survey and UXO Diving Operations

Operational Area: Hudson River, Nearshore areas on the eastern side of Iona Island, NY. See Attached Figure 1-1.

Onshore Contacts: Site Project Manager / Site Supervisor or other designated site contact.

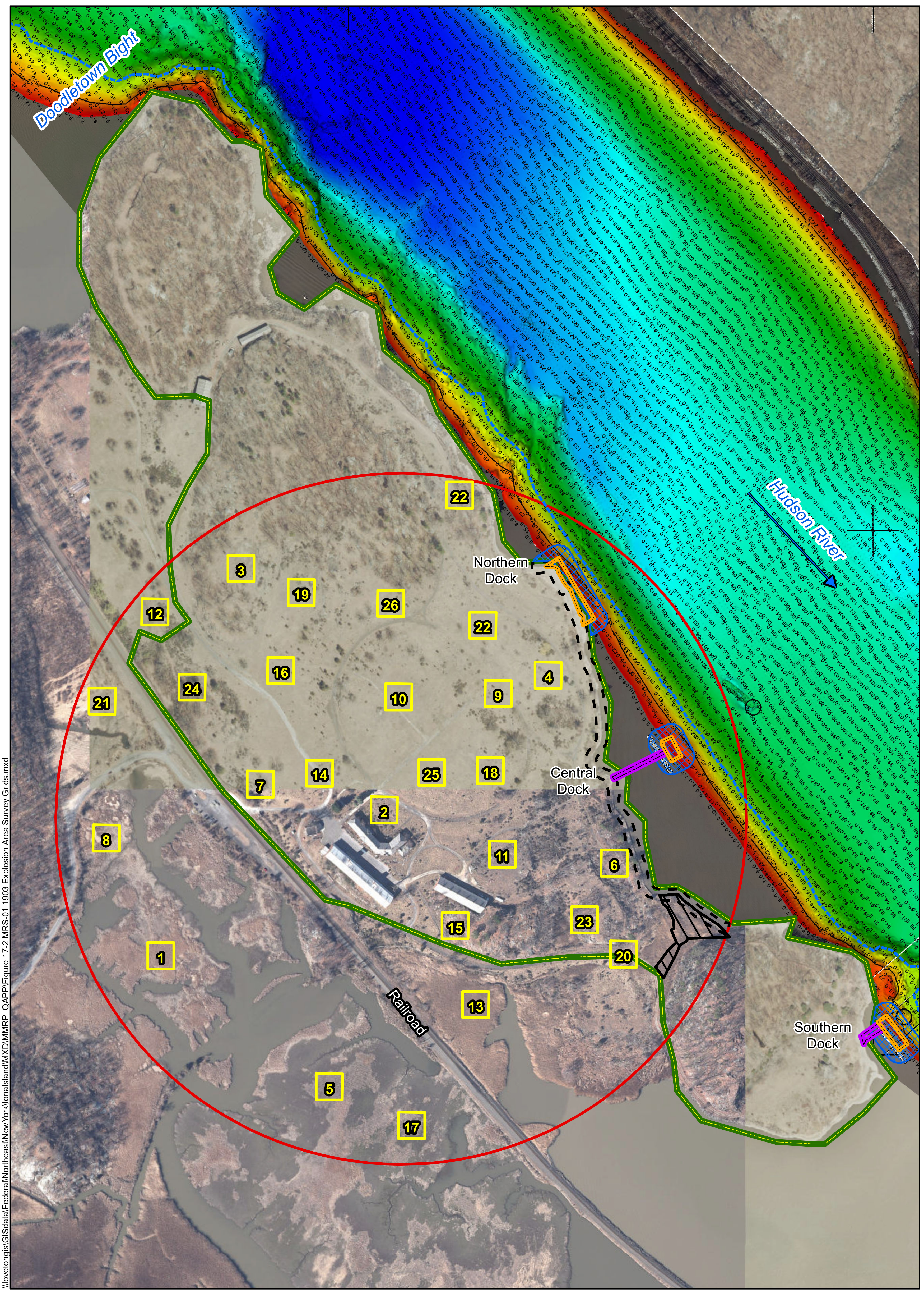
Emergency Contacts: U.S. Coast Guard Station, Sector New York (718) 354-4037;
VHF Channel 16;
Police, Fire, EMS: 911

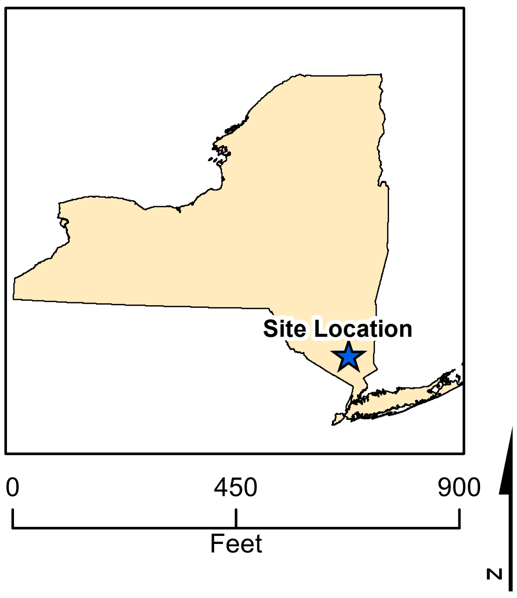
Severe Weather Plan

If no severe weather events are predicted during the survey period, EA personnel will monitor Doppler Radar at least once every three (3) hours. If severe weather is predicted, the interval will be reduced to no less than once every hour. In the event of severe weather, while operating at Iona Island EA personnel will depart the site location at least 1.5 hours before the storm is predicted to reach the work site, transiting south to a safe harbor at the Haverstraw Bay Park Boat Ramp.

Shore Contacting Schedule

Prior to departure from the mobilization site, EA vessel personnel will contact the designated shore contact, detailing the specific survey location(s) and activities as well expected return to shore time. Upon return to shore, vessel personnel will call the shore contact and provide a daily report and disclose any incidents. In the event that vessel personnel do not call the shore contact within one (1) hour of scheduled arrival time, the shore contact will attempt to call vessel personnel via cell phone. If no vessel personnel can be reached, the shore contact will call the U.S. Coast Guard Station Sector New York at (718) 354-4037 to make the station aware that the survey crew and vessel is overdue to the dock.





Legend

- ╌ Approximate 60 Foot Depth Line
- ☐ DGM Grid (100ft x 100ft)
- ▨ Underwater Investigation Area (Former Docks)
- ⌜⌟ DGM Shoreline Area
- ◪ Dump SIte
- ☐ Former Dock
- ☐ Former Causeway
- ☐ FUDS Boundary
- ☐ MRS-01 1903 Explosion Area

Note:
Dives will be limited to 3-60 ft or where the river bottom is less then 20 degree slope or determined acceptable by Direct Person in Charge.
Transects in water depth less then 3 ft will be walked.

FIGURE 17-2
MRS-01 1903 EXPLOSION AREA SURVEY GRIDS

IONA ISLAND NAVAL AMMUNITION DEPOT
FORMERLY USED DEFENSE SITE
ROCKLAND COUNTY, NY

Map Date: 10/03/2018
Dock Aerial - June 18 1948

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Corporate Vessel Operations Manual

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EA Engineering, Science,
and Technology, Inc.

Corporate
Vessel
Operations
Manual

December 2004

CONTENTS

NOTE: Prior to beginning any EA vessel-related activities, copies of the checklists (Chapter 11) should be made available for easy access.

LIST OF TABLES

1. INTRODUCTION

Personnel involved in activities associated with boating and watercraft are potentially exposed to a variety of hazards from activities including operations, maintenance, and transportation.

No person will be required or instructed to work in surroundings or under conditions that are unsafe or dangerous to his or her health.

Each individual employee is responsible for complying with applicable safety requirements, wearing prescribed safety equipment, and preventing avoidable accidents.

Safety and health programs, documents, signs, and tags will be communicated to employees in a language that they understand.

Adequate planning is needed before performing work at these sites to reduce the risk of employee injury or illness.

A partial listing of terms and phrases used during the operation of a vessel is provided in Appendix A. All members of the crew should be familiar with these terms.

1.1 PURPOSE

The purpose of this Manual is to communicate EA's basic policies and procedures regarding safety and health during the performance of work involving boating and watercraft activities. This Manual introduces the reader to EA's Boating and Watercraft Operations Program and critical references and definitions of terms used in this program.

1.2 APPLICABILITY

The procedures and requirements in this section apply to EA and subcontractor personnel involved in the boating and watercraft activities and operations. Visitors are required to follow these requirements.

1.3 DISCLAIMER

This Manual is not a comprehensive overview of all situations an operator may encounter, is not a substitute for common sense or experience, nor is it a substitute for a project- and/or site-specific Safety and Health Plan, as applicable.

1.4 REFERENCES

Maloney, E.S. 1981. Chapman Piloting, Seamanship and Small Boat Handling, 55th Edition. The Hearst Corporation, New York.

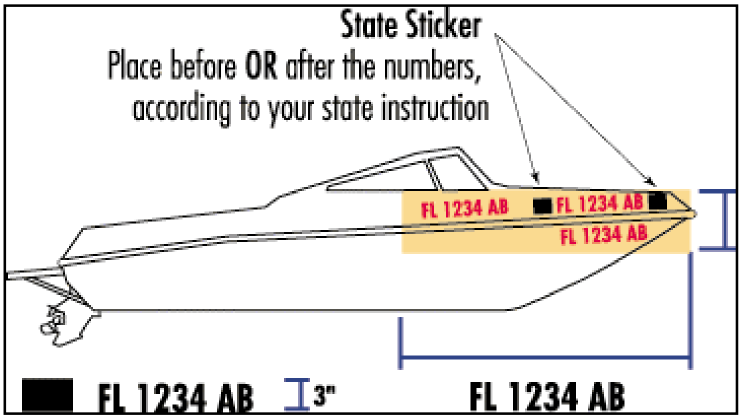
U.S. Coast Guard safe boating website: www.uscgboating.org.

2. BOATING LAWS AND REGULATIONS

The purpose of this section is to acquaint the reader with different types of vessel registrations and numbering, according to the Federal Boat Safety Act of 1971, and adopted by Congress 15 July 1997.

2.1 REGISTRATION, NUMBERING, AND DOCUMENTATION

All undocumented vessels equipped with propulsion machinery must be registered in the state of principal use. A Certificate of Number will be issued upon registering the vessel. These numbers must be displayed on your vessel. The owner/operator of a vessel must carry a valid Certificate of Number whenever the vessel is in use. When moved to a new state of principal use, the certificate is valid for 60 days. Check with your state boating authority for numbering requirements. Some states require all vessels to be numbered.



Some larger recreational vessels may be documented. The certificate of documentation MUST be on board a documented vessel at all times. A document serves as a certificate of nationality and an authorization for a specific trade. A documented vessel is not exempt from applicable state or federal taxes, nor is its operator exempt from compliance with federal or state equipment carriage requirements.

2.1.1 Display of Numbers

Numbers must be painted or permanently attached to each side of the forward half of the vessel. The validation stickers must be affixed within 6 in. of the registration number. With the exception of the vessel fee decal, no other letters or numbers may be displayed nearby.

2.1.2 Notification of Changes to a Numbered Vessel

The owner of a vessel must notify the agency that issued the Certificate of Number within 15 days if:

- The vessel is transferred, destroyed, abandoned, lost, stolen, or recovered
- The Certificate of Number is lost or destroyed, or the owner’s address changes.

If the Certificate of Number becomes invalid for any reason, it must be surrendered in the manner prescribed to the issuing authority within 15 days.

A documented vessel must have the name of the vessel and hailing port plainly marked on the exterior part of the hull in clearly legible letters not less than 4 in. in height. In addition, the documented vessel must have the “Official Number” permanently affixed in block type, Arabic numerals, not less than 3 in. in height on some clearly visible interior structural part of the boat.

Table 2-1 provides a quick reference of vessel length and equipment requirements. The “Rules of the Water” are provided in Appendix B.

TABLE 2-1 QUICK REFERENCE

Vessel Length (in ft)					
<16	16<26	26<40	40<65	Equipment	Requirement
X	X	X	X	Certificate of Number (State Registration)	All undocumented vessels equipped with propulsion machinery must be State registered. Certificate of Number must be on board when vessel is in use. NOTE: Some states require all vessels to be numbered.
X	X	X	X	State Numbering	(a) Plain block letters/numbers not less than 3 in. in height must be affixed on each side of the forward half of the vessel (Contrasting color to boat exterior). (b) State validation sticker must be affixed within 6 in. of the registration number.
	X	X	X	Certificate of Documentation	Applies only to "Documented" vessels: (a) Original and current certificate must be on board. (b) Vessel name/hailing port marked on exterior part of hull - letters not less than 4 in. in height. (c) Official Number permanently affixed to interior structure - numbers not less than 3 in. in height.
X	X	X	X	Life Jackets (personal flotation devices)	(a) One Type I, II, III, or V wearable personal flotation device for each person on board (must be U.S. Coast Guard approved).
	X	X	X		(b) In addition to Paragraph (a), must carry One Type IV (throwable) personal flotation device.
X				Visual Distress Signal	(a) One electric distress light or Three combination (day/night) red flares. NOTE: Only required to be carried on board when operating between sunset and sunrise.
	X	X	X		(b) One orange distress flag or one electric distress light; or three hand-held or floating orange smoke signals and one electric distress light; or three combination (day/night) red flares: hand-held, meteor, or parachute type.
X	X			Fire Extinguishers	(a) One B-I (when enclosed compartment).
		X			(b) One B-II or two B-I. NOTE: Fixed system equals one B-I.
			X		(c) One B-II and one B-I or three B-I. NOTE: Fixed system equals one B-I.
X	X	X	X	Ventilation	(a) All vessels built after 25 April 1940 that use gasoline as their fuel with enclosed engine and/or fuel tank compartments must have natural ventilation (at least two ducts fitted with cowls). (b) In addition to paragraph (a), a vessel built after 31 July 1980 must have rated power exhaust blower.
X	X	X	X	Backfire Flame Arrester	Required on gasoline engines installed after 25 April 1940, except outboard motors.
X	X	X	X	Sound Producing Devices	(a) Some means of making an "efficient" sound signal—audible for 1/2 mi/4-6 seconds (i.e., horn)
		X	X		(b) In addition to Paragraph (a), a vessel 39.4 ft (12 m) or greater, must carry on board a bell with clapper (bell size not less than 7.9 in.—based on the diameter of the mouth).
X	X	X	X	Navigational Lights	Required to be displayed from sunset to sunrise and in or near areas of reduced visibility.
NA	NA	NA	NA	FCC Radio License	Operator of a recreational vessel less than 65.6 ft (20 m) in length is not required to be licensed to operate VHF marine radios, emergency position indicating radio beacons, or any type of radar.
		X	X	Oil Pollution Placard	(a) Placard must be at least 5 × 8 in., made of durable material. (b) Placard must be posted in the machinery space or at the bilge station.
		X	X	Garbage Placard	(a) Placard must be at least 4 × 9 in., made of durable material. (b) Displayed in a conspicuous place notifying all on board the discharge restrictions.
X	X	X	X	Marine Sanitation Device	If installed toilet, vessel must have an operable Marine Sanitation Device Type I, II, or III.
		X	X	Navigational Rules (inland only)	The operator of a vessel 39.4 ft (12 m) or greater must have on board a copy of these rules.

NOTE: NA = Not applicable.

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3. FEDERAL MANDATED SAFETY EQUIPMENT

Federal mandated safety equipment is governed by the U.S. Coast Guard (USCG) Motor Boat Act of 1940 and retained by the Federal Boat Safety Act of 1971, which covers four classes of boats. Table 3-1 provides the minimum required equipment.

3.1 EQUIPMENT REQUIREMENTS – PERSONAL FLOTATION DEVICE

The USCG sets minimum safety standards for recreational boats and associated safety equipment. To meet these standards some of the equipment must be USCG approved. “USCG Approved Equipment” meets USCG specifications and regulations relating to performance, construction, or materials.

3.1.1 Personal Flotation Devices

All recreational boats must carry one wearable personal flotation device (PFD) (Type I, II, III, or V) for each person aboard. A Type V PFD provides performance of either a Type I, II, or III PFD (as marked on its label) and must be used according to the label requirements. Any boat 16 ft and longer (except canoes and kayaks) must also carry one throwable PFD (Type IV PFD).

PFDs must be USCG approved, in good and serviceable condition, and the appropriate size for the intended user.

Accessibility

- Wearable PFDs must be readily accessible

- You must be able to put them on in a reasonable amount of time in an emergency (vessel sinking, on fire, etc.)

- They should not be stowed in plastic bags, in locked or closed compartments, or have other gear stowed on top of them

- The best PFD is the one you will wear

- Though not required, a PFD should be worn at all times when the vessel is underway; a wearable PFD may save your life, but only if you wear it

- Throwable devices must be immediately available for use.

Inflatable Personal Flotation Devices

- Inflatable PFDs may be more comfortable to wear

- The best PFD is the one you will wear
- Inflatable PFDs require the user to pay careful attention to the condition of the device.

- Inflatable PFDs must have a full cylinder and all status indicators on the inflator must be green, or the device is NOT serviceable, and does NOT satisfy the requirement to carry PFDs.

USCG-approved inflatable PFDs are authorized only on recreational boats by a person at least 16 years of age.

Personal Flotation Device Requirements for Certain Boating Activities under State Laws

The USCG recommends, and many states require, wearing PFDs for the following activities:

- Water skiing and other towed activities (use a PFD marked for water skiing)
- While operating personal watercraft (use a PFD marked for water skiing or personal watercraft use)
- During white water boating activities
- While sailboarding (under federal law, sailboards are not “boats”).

Check with your state boating safety officials.

Federal law does not require PFDs on racing shells, rowing sculls, and racing kayaks. State laws vary. Check with your state boating safety officials.

If you are boating in an area under the jurisdiction of the U.S. Army Corps of Engineers, or a federal, state, or local park authority, other rules may apply.

Remember, PFDs will keep you from sinking, but not necessarily from drowning.

- Select a properly-sized PFD to ensure a safe and proper fit
- Test your PFD by wearing it in shallow water or guarded swimming pool to see how it will float you.

U.S. Coast Guard Auxiliary U.S. Power Squadrons Vessel Safety Check Requirements for Personal Flotation Devices

- All boats must be equipped with a wearable PFD for each person on board
- Boats 16 ft and over are required to have a minimum of two PFDs on board, one wearable PFD (Type I, II, III, or V) and one throwable (Type IV); in addition, a wearable PFD is required for each person on board.

Personal Flotation Device Flotation

There are three basic kinds of PFD flotation in the five types of PFDs with the following characteristics:

- **Inherently Buoyant (primarily Foam)**
  - The *most* reliable
  - Adult, youth, child, and infant sizes
  - For swimmers and non-swimmers

- — Wearable and throwable styles
- — Some designed for water sports

Minimum Buoyancy		
Wearable Size	Type	Inherent Buoyancy (Foam)
Adult	I	22 lb
	II and III	15.5 lb
	V	15.5 to 22 lb
Youth	II and III	11 lb
	V	11 to 15.5 lb
Child and Infant	II	7 lb
Throwable:		
Cushion	IV	20 lb
Ring Buoy		16.5 and 32 lb

- **Inflatable**

  - — The most compact
  - — Sizes only for adults
  - — Only recommended for swimmers
  - — Wearable styles only
  - — Some with the best in-water performance

Minimum Buoyancy		
Wearable Size	Type	Inherent Buoyancy
Adult	I and II	34 lb
	III	22.5 lb
	V	22.5-34 lb

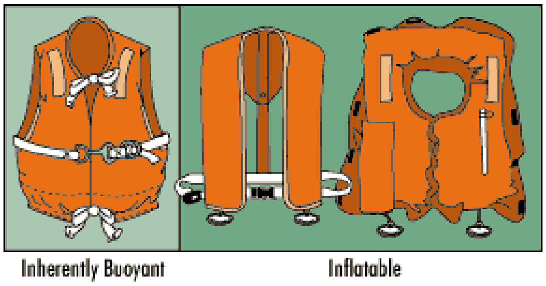
- **Hybrid (Foam and Inflation)**

  - — Reliable
  - — Adult, youth, and child sizes
  - — For swimmers and non-swimmers
  - — Wearable styles only
  - — Some designed for water sports

Hybrid (Foam and Inflation)			
Wearable Size	Type	Inherent Buoyancy	Inflated Total Buoyancy
Adult	II and III	10 lb	22 lb
	V	7.5 lb	22 lb
Youth	II and III	9 lb	15 lb
	V	7.5 lb	15 lb
Child	II	7 lb	12 lb

Types of Personal Flotation Devices

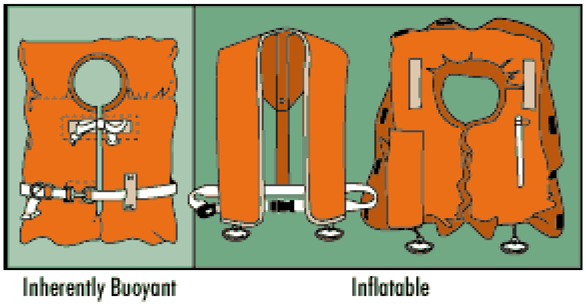
Off-Shore Life Jackets



A Type I PFD, or offshore life jacket, provides the most buoyancy. It is effective for all waters, especially open, rough, or remote waters where rescue may be delayed. It is designed to turn most unconscious wearers in the water to a face-up position.

A Type II PFD, or near-shore buoyancy vest, is intended for calm, inland water or where there is a good chance of quick rescue. Inherent buoyant PFDs of this type will turn *some* unconscious wearers to a face-up position in the water, but the turning is not as pronounced as a Type I. This type of inflatable turns as well as a Type I foam PFD.

Near-shore Buoyancy Vests



A Type III PFD, or flotation aid, is good for conscious users in calm, inland water, or where there is a good chance of quick rescue. It is designed so wearers can place themselves in a face-up position in the water. The wearer may have to tilt their head back to avoid turning face down in the water. The Type III foam vest has the same minimum buoyancy as a Type II PFD. It comes in many styles, colors, and sizes and is generally the most comfortable type for continuous wear. Float coats, fishing vests, and vests designed with features suitable for various sports activities are examples of this type PFD. This type inflatable turns as well as a Type II foam PFD.

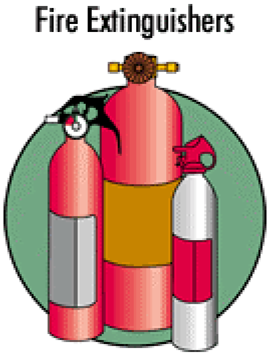
Throwable Devices

A Type IV PFD, or throwable device, is intended for calm, inland water with heavy boat traffic, where help is always present. It is designed to be thrown to a person in the water and grasped and held by the user until rescued—it is *not* designed to be worn. Type IV devices include buoyant cushions, ring buoys, and horseshoe buoys. There are no inflatable Type IV devices.

A Type V PFD, or special use device is intended for specific activities and may be carried instead of another PFD only if used according to the approval condition(s) on its label. A Type V PFD provides performance of either a Type I, II, or III PFD (as marked on its label). If the label says the PFD is "approved only when worn" the PFD must be worn, except for persons in enclosed spaces and used in accordance with the approval label, to meet carriage requirements. Some Type V devices provide significant hypothermia protection. Varieties include deck suits, work vests, and board sailing vests.

3.2 EQUIPMENT REQUIREMENTS – FIRE EXTINGUISHERS

USCG-approved fire extinguishers are required on boats where a fire hazard could be expected from the motors or the fuel system. Extinguishers are classified by a letter and number symbol. The letter indicates the type of fire the unit is designed to extinguish (Type B, for example, are designed to extinguish flammable liquids such as gasoline, oil, and grease fires). The number indicates the relative size of the extinguisher. The higher the number, the larger the extinguisher.



USCG-approved extinguishers required for boats are hand portable, either B-I or B-II classification, and have a specific marine type mounting bracket. The special bracket is required to securely hold the extinguisher in a moving boat. It is recommended the extinguishers be mounted in a readily accessible position, away from the areas where a fire could likely start such as the galley or the engine compartment.

Extinguisher markings can be confusing because extinguishers can be approved for several different types of hazards. For instance, an extinguisher marked "Type A, Size II, Type B:C, Size I" is a B-I extinguisher.

Look for the part of the label that reads "Marine Type USCG."

- Make sure Type B is indicated
- Portable extinguishers will be either size I or II. Size III and larger are too big for use on most recreational boats.

Classes	Foam (gal)	CO_2 (lb)	Dry Chemical (lb)	Halon (lb)
B-I (Type B, Size I)	1.25	4	2	2.5
B-II (Type B, Size II)	2.5	15	10	10

Fire extinguishers are required on boats if any of the following conditions exist:

- Inboard engines are installed.

- There are closed compartments and compartments under seats where portable fuel tanks may be stored.

- There are double bottoms not sealed to the hull or which are not completely filled with flotation materials.

- There are closed living spaces.

- There are closed stowage compartments in which combustible or flammable materials are stored.

- There are permanently installed fuel tanks (fuel tanks secured so they cannot be moved in case of fire or other emergency are considered permanently installed. There are no gallon capacity limits to determine if a fuel tank is portable. If the weight of a fuel tank is such that persons on board cannot move it, the USCG considers it permanently installed).

3.2.1 Fire Extinguisher Maintenance

Inspect extinguishers monthly to make sure that:

- Seals and tamper indicators are not broken or missing

- Pressure gauges or indicators read in the operable range (NOTE: CO_2 extinguishers do not have gauges)

- There is no obvious physical damage, corrosion, leakage, or clogged nozzles
- Weigh extinguishers annually to assure that the minimum weight is as stated on the extinguisher label.

Fire extinguishers that do not satisfy the above requirements or that have been partially emptied must be replaced or taken to a qualified fire extinguisher servicing company for recharge.

3.2.2 Required Number of Fire Extinguishers

The number of fire extinguishers required on a recreational boat is based on the overall length of the boat. The following chart lists the number of extinguishers that are required. In the case where a USCG-approved pre-engineered fire extinguishing system is installed for the protection of the engine compartment, the required number of units may be reduced in accordance with the chart.

Minimum number of hand portable fire extinguishers required:

Vessel Length	No Fixed System	With Approved Fixed Systems
Less than 26 ft	1 B-1	0
26 ft to less than 40 ft	2 B-1 or 1 B-II	1 B-I
40-65 ft	3 B-I or 1 B-II and 1 B-I	2 B-1 or 1 B-II

The pressure gauge alone is not an accurate indicator that Halon extinguishers are full. The weight of the units should be checked regularly. It is recommended that portable extinguishers be mounted in a readily accessible position.

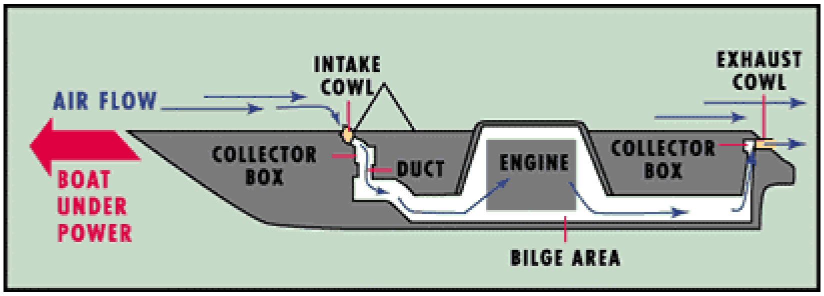
3.3 EQUIPMENT REQUIREMENTS – VENTILATION

All boats that use gasoline for electrical generation, mechanical power, or propulsion are required to be equipped with a ventilation system. A natural ventilation system is required for each compartment in a boat that:

- Contains a permanently installed gasoline engine
- Has openings between it and a compartment that requires ventilation
- Contains a permanently installed fuel tank and an electrical component that is not ignition-protected
- Contains a fuel tank that vents into that compartment (including a portable tank)
- Contains a non-metallic fuel tank.

A natural ventilation system consists of:

- A supply opening (duct/cowl) from the atmosphere (located on the exterior surface of the boat) or from a ventilated compartment or from a compartment that is open to the atmosphere
- An exhaust opening into another ventilated compartment or an exhaust duct to the atmosphere



All blower motors installed in exhaust ducts must be in working condition of date of manufacture.

Each exhaust opening or exhaust duct must originate in the lower one-third of the compartment. Each supply opening or supply duct and each exhaust opening or duct in a compartment must be above the normal accumulation of bilge water.

A powered ventilation system is required for each compartment in a boat that has a permanently installed gasoline engine with a cranking motor for remote starting.

A powered ventilation system consists of one or more exhaust blowers. Each intake duct for an exhaust blower must be in the lower one-third of the compartment and above the normal accumulation of bilge water.
For boats built prior to 1980, there was no requirement for a powered ventilation system; however, some boats were equipped with a blower.

The USCG Ventilation Standard, a manufacturer requirement, applies to all boats built on or after 1 August 1980. Some builders began manufacturing boats in compliance with the Ventilation Standard as early as August 1978. If your boat was built on or after 1 August 1978, it might have been equipped with either: (1) a natural ventilation system, or (2) both a natural ventilation system and a powered ventilation system. If your boat bears a label containing the words “This boat complies with USCG safety standards,” etc., you can assume that the design of your boat’s ventilation system meets applicable regulations.

Manufacturers of boats built after 1980 with remote starters are required to display a label that contains the following information:

> ***WARNING***
> *Gasoline vapors can explode. Before starting engine, operate blower at least 4 minutes and check engine compartment bilge for gasoline vapors.*

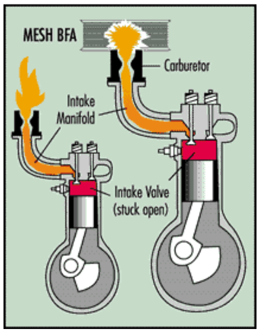
All owners of boats equipped with exhaust blowers are strongly encouraged to take the same precautions before starting a gasoline engine.

All owners are responsible for keeping their boat's ventilation systems in operating condition. This means making sure openings are free of obstructions, ducts are not blocked or torn, blowers operate properly, and worn components are replaced with equivalent marine type equipment.

3.4 EQUIPMENT REQUIREMENTS – BACKFIRE FLAME ARRESTOR

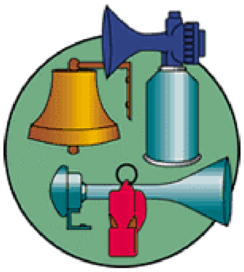
Gasoline engines installed in a vessel after 25 April 1940, except outboard motors, must be equipped with an acceptable means of backfire flame control. The device must be suitably attached to the air intake with a flame tight connection and is required to be USCG approved or comply with SAE J-1928 or UL 1111 standards and marked accordingly.

Flame Arrestor



3.5 EQUIPMENT REQUIREMENTS – SOUND-PRODUCING DEVICES

Signaling Devices



The navigation rules require sound signals to be made under certain circumstances. Meeting, crossing, and overtaking situations described in the Navigation Rules section are examples of when sound signals are required. Recreational vessels are also required to sound signals during periods of reduced visibility.

Vessels 39.4 ft/12 m or more in length are required to carry on board a whistle or horn, and a bell.

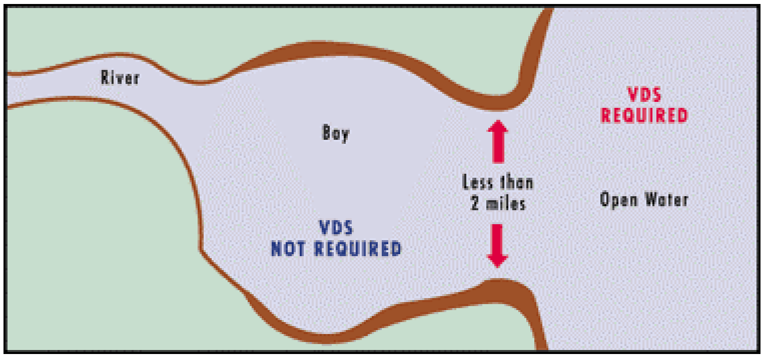
Any vessel less than 39.4 ft/12 m in length may carry a whistle or horn, or some other means to make an efficient sound signal to signal your intentions and to signal your position in periods of reduced visibility.

Therefore, any vessel less than 39.4 ft/12 m in length is required to make an efficient sound signal to signal intentions and to signal your position in periods of reduced visibility.

Vessel operators are required to carry some type of horn or whistle capable of a 4-second blast audible for 0.5 mi for all boats (athletic whistles are not acceptable on boats over 39.4 ft/12 m).

3.5.1 Visual Distress Signals

All vessels used on coastal waters, the Great Lakes, territorial seas, and those waters connected directly to them, up to a point where a body of water is less than 2 mi wide, must be equipped with USCG-approved visual distress signals. Vessels owned in the United States operating on the high seas must be equipped with USCG-approved visual distress signals.



The following vessels are not required to carry day signals but must carry night signals when operating from sunset to sunrise:

- Recreational boats less than 16 ft in length
- Boats participating in organized events such as races, regattas, or marine parades
- Open sailboats less than 26 ft in length not equipped with propulsion machinery
- Manually propelled boats.

3.5.2 Pyrotechnic Devices

Pyrotechnic visual distress signals must be USCG-approved, in serviceable condition, and readily accessible.

- They are marked with an expiration date. Expired signals may be carried as extra equipment, but cannot be counted toward meeting the visual distress signal requirement, since they may be unreliable.

- Launchers manufactured before 1 January 1981, intended for use with approved signals, are not required to be USCG-approved.

- If pyrotechnic devices are selected, a minimum of three is required; that is, three signals for day use and three signals for night. Some pyrotechnic signals meet both day and night use requirements.
- Pyrotechnic devices should be stored in a cool, dry location, if possible.

- A watertight container painted red or orange and prominently marked “DISTRESS SIGNALS” or “FLARES” is recommended.

USCG-approved pyrotechnic visual distress signals and associated devices include:

- Pyrotechnic red flares (hand-held or aerial)
- Pyrotechnic orange smoke (hand-held or floating)
- Launchers for aerial red meteors or parachute flares.

Each of these devices has a different operating (burning) time x seconds to y seconds. Check the label to see how long each pyrotechnic device will actually be illuminated. This will allow you to select a warning device better suited to the conditions where your boat will operate.

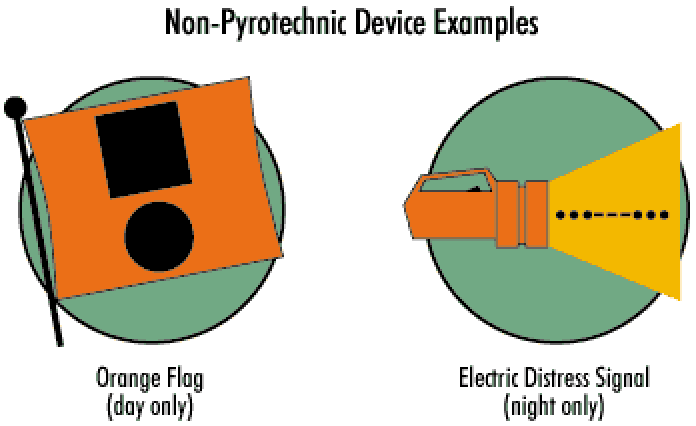
3.5.3 Non-Pyrotechnic Devices

Non-pyrotechnic visual distress signals must be in serviceable condition, readily accessible, and certified by the manufacturer as complying with USCG requirements. They include:

Orange Distress Flag

- Day signal only
- Must be at least 3 × 3 ft with a black square and ball on an orange background

- Must be marked with an indication that it meets USCG requirements in 46 CFR 160.072
- Most distinctive when attached and waved on a paddle, boathook, or flown from a mast
- May also be incorporated as part of devices designed to attract attention in an emergency, such as balloons, kites, or floating streamers.



Electric Distress Light

- Accepted for night use only
- Automatically flashes the international SOS distress signal (... --- ...)
- Must be marked with an indication that it meets USCG requirements in 46 CFR 161.013.

Under Inland Navigation Rules, a high intensity white light flashing at regular intervals from 50-70 times per minute is considered a distress signal. However, such devices do NOT count toward meeting the visual distress signal requirement.

Regulations prohibit display of visual distress signals on the water under any circumstances except when assistance is required to prevent immediate or potential danger to persons on board a vessel.

All distress signals have distinct advantages and disadvantages. No single device is ideal under all conditions or suitable for all purposes. Pyrotechnics are universally recognized as excellent distress signals. However, there is potential for injury and property damage if not properly handled. These devices produce a very hot flame and the residue can cause burns and ignite flammable materials.

Pistol launched and hand-held parachute flares and meteors have many characteristics of a firearm and must be handled with caution. In some states, they are considered a firearm and prohibited from use.

The following are just a few of the variety and combination of devices which can be carried in order to meet the requirements:

- Three hand-held red flares (day and night)
- One hand-held red flare and two parachute flares (day and night)
- One hand-held orange smoke signal, two floating orange smoke signals (day), and one electric distress light (night only).

All boaters should be able to signal for help. Boaters must have current dated USCG-approved day and night signals for all boats operating on coastal and open bodies of water.

3.6 EQUIPMENT REQUIREMENTS – POLLUTION REGULATIONS

The Refuse Act of 1899 prohibits throwing, discharging, or depositing any refuse matter of any kind (including trash, garbage, oil, and other liquid pollutants) into the waters of the United States.

The Federal Water Pollution Control Act prohibits the discharge of oil or hazardous substances which may be harmful into United States navigable waters. Vessels 26 ft in length and over must display a placard at least 5 × 8 in., made of durable material, fixed in a conspicuous place in the machinery spaces, or at the bilge pump control station, stating the following:

Discharge of Oil Prohibited

The Federal Water Pollution Control Act prohibits the discharge of oil or oily waste upon or into any navigable waters of the United States. The prohibition includes any discharge that causes a film or discoloration of the surface of the water or causes a sludge or emulsion beneath the surface of the water. Violators are subject to substantial civil and/or criminal sanctions including fines and imprisonment.

Regulations issued under the Federal Water Pollution Control Act require all vessels with propulsion machinery to have a capacity to retain oil mixtures on board. A fixed or portable means to discharge oily waste to a reception facility is required. A bucket or bailer is suitable as a portable means of discharging oily waste on recreational vessels. No person may intentionally drain oil or oily waste from any source into the bilge of any vessel. You must immediately notify the USCG if your vessel discharges oil or hazardous substances in the water. Call toll-free 800-424-8802 (in Washington, D.C. [202] 267-3675).

Report the following information:

- Location
- Color
- Source
- Substances
- Size
- Time observed.

The Act to Prevent Pollution from Ships (MARPOL ANNEX V) places limitations on the discharge of garbage from vessels. It is illegal to dump plastic trash anywhere in the ocean or navigable waters of the United States. It is also illegal to discharge garbage in the navigable waters of the United States, including the Great Lakes. The discharge of other types of garbage is permitted outside of specific distances offshore as determined by the nature of that garbage.

Garbage Type	Discharge
Plastics- including synthetic ropes, fishing nets, and plastic bags	Prohibited in all areas
Floating dunnage, lining, and packing materials	Prohibited less than 25 mi from nearest land
Food waste, paper, rags, glass, metal, bottles, crockery, and similar refuse	Prohibited less than 12 mi from nearest land
Comminuted or ground food waste, paper, rags, glass, etc.	Prohibited less than 3 mi from nearest land

United States vessels of 26 ft or longer must display, in a prominent location, a durable placard at least 4 × 9 in. notifying the crew and passengers of the discharge restrictions.

United States oceangoing vessels of 40 ft or longer which are engaged in commerce or are equipped with a galley and berthing must have a written Waste Management Plan describing the procedures for collecting, processing, storing, and discharging garbage, and designate the person who is in charge of carrying out the plan.

3.7 EQUIPMENT REQUIREMENTS – MARINE SANITATION DEVICES

All recreational boats with installed toilet facilities must have an operable marine sanitation device (MSD) on board. Vessels 65 ft and under may use a Type I, II, or III MSD. Vessels over 65 ft must install a Type II or III MSD. All installed MSDs must be USCG certified. USCG-certified devices are so labeled, except for some holding tanks, which are certified by definition under the regulations.

When operating a vessel on a body of water where the discharge of treated or untreated sewage is prohibited, the operator must secure the device in a manner which prevents any discharge. Some acceptable methods are: padlocking overboard discharge valves in the closed position, using non-releasable wire tie to hold overboard discharge valves in the closed position, closing overboard discharge values and removing the handle, and locking the door with padlock or keylock to the space enclosing the toilets (for Type I and Type II only.)

3.8 ADDITIONAL RECOMMENDED EQUIPMENT

Besides meeting the legal requirements, prudent boaters should carry additional safety equipment. The following additional items of equipment are suggested depending on the size, location, and use of your boat:

- Very high frequency (VHF) radio
- Boat hook
- Spare anchor
- Heaving line
- Fenders
- First aid kit
- Flashlight
- Mirror
- Searchlight
- Sunburn lotion
- Tool kit
- Ring buoy
- Whistle or horn
- Fuel tanks
- Anchor
- AM/FM radio
- Chart and compass
- Visual distress signals
- Spare propeller
- Mooring line
- Food and water
- Binoculars
- Spare batteries
- Sunglasses
- Marine hardware
- Extra clothing
- Spare parts
- Alternate propulsion (paddles)
- Dewatering device (pump or bailer)
- Spare fuel
- Pumps must work or have manual bailer

TABLE 3-1 MINIMUM REQUIRED EQUIPMENT

Equipment	Class A (Less than 16 ft)	Class 1 (16 ft to less than 26 ft)	Class 2 (26 ft to less than 40 ft)	Class 3 (40 ft to not more than 65 ft)
Personal Flotation Devices	One Type I, II, III, or IV for each person.	One Type I, II, or III for each person on board or being towed on water skis, etc., plus one Type IV available to be thrown.		
Fire Extinguisher-Portable When NO fixed fire extinguishing system is installed in machinery space(s)	At least one B-1 type approved hand portable fire extinguisher (Not required on outboard motorboat less than 26 ft in length and not carrying passengers for hire if the construction of such motorboats will not permit the entrapment of explosive or flammable gases or vapors.)		At least two B-I type approved hand portable fire extinguishers; OR at least one B-II type approved hand portable fire extinguisher.	At least three B-I type approved hand portable fire extinguishers; OR at least one B-I type *Plus* one B-II type approved hand portable fire extinguisher.
Backfire Flame Arrestor	One approved device on each carburetor of all gasoline engines installed after 25 April 1940, except outboard motors.			
Ventilation	At least two ventilator ducts fitted with cowls or their equivalent for the purpose of properly and efficiently ventilating the bilges of every engine and fuel-tank compartment of boats constructed or decked over after 25 April 1940, using gasoline or other fuel having a flashpoint less than 110°F. Boats built after 31 July 1981 must have operable power blowers.			
Whistle	Boats up to 12 m (39.4 ft) – any device capable of making an "efficient sound signal" audible 0.5 mi.	Boats up to 12 m (39.4 ft) – any device capable of making an "efficient sound signal" audible 0.5 mi.	Boats up to 12 m (39.4 ft) – any device capable of making an "efficient sound signal" audible 0.5 mi.	Boats 12 to 20 m (39.4 – 65.7 ft) – device meeting technical specifications of Inland Rules Annex III audible 0.5 mi.
Bell	Boats up to 12 m (39.4 ft) – any device capable of making an "efficient sound signal."	Boats up to 12 m (39.4 ft) – any device capable of making an "efficient sound signal."	Boats up to 12 m (39.4 ft) – any device capable of making an "efficient sound signal."	Boats 12-20 m (39.4 – 65.7 ft) – bell meeting technical specifications of Inland Rules Annex III; mouth diameter of at least 200 m (7.9 in.).
When fixed fire extinguishing system is installed in machinery space(s).	None	None	At least one B-I type approved hand portable fire extinguisher.	At least two B-I type approved hand portable fire extinguishers; OR at least one B-II type approved hand portable fire extinguisher.
	NOTE: Dry chemical and carbon dioxide are the most widely used types, in that order. The others, while acceptable, are seldom seen on boats.			

(a) Not required by the Motorboat Act of 1940; however, the "Rules of the Water" require these vessels to sound proper signals.

NOTE: Fire extinguishers manufactured after 1 January 1965 will be marked, "Marine Type, Size, Approval No. 162.028/EX." Toxic vaporizing-liquid type fire extinguishers, such as those containing carbon tetrachloride or chlorobromomethane, are not accepted as required approved extinguishers on uninspected vessels (private pleasure craft).

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4. NAVIGATION RULES

Navigation rules require vessels to display lights and shapes under certain conditions.

4.1 NAVIGATION LIGHTS

Recreational vessels are required to display navigation lights between sunset and sunrise and other periods of reduced visibility (fog, rain, hazy, etc.). The USCG Navigation Rules, International-Inland, specifies lighting requirements for every description of water craft. The information provided here is intended for power-driven and sailing vessels less than 65.5 ft/20 m in length.

4.2 POWER-DRIVEN VESSELS

If your vessel is less than 65.5 ft/20 m in length, then it must display navigation lights per Figure 4-1.

If your vessel is less than 39.4 ft/12 m in length, then it may display navigation lights per Figure 4-2.

Figure 4-1.

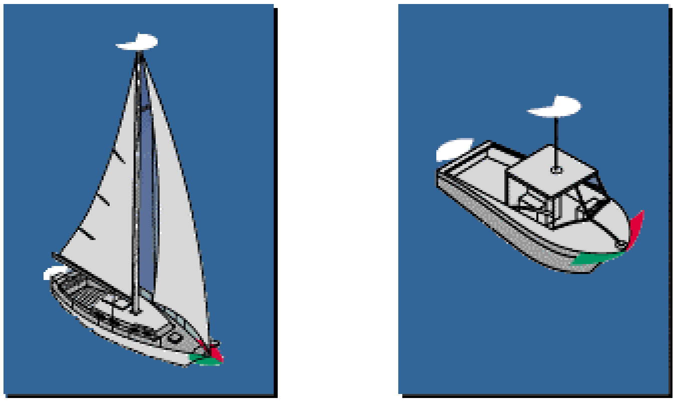
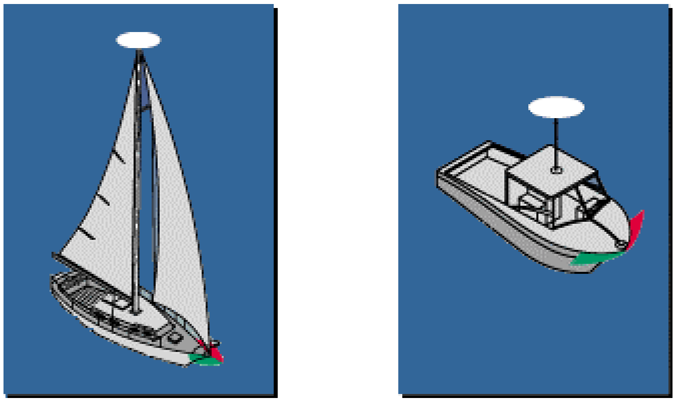


Figure 4-2.



If your vessel is less than 23 ft/7 m in length and its maximum speed cannot exceed 7 knots, then it may display an all-around white light, and if practicable, sidelights instead of the lights prescribed previously (for international rules only).

For vessels less than 39.4 ft/12 m in length, the masthead or all-around white light must be at least 1 m above the sidelights.

Sidelights may be a combination light instead of two separate lights.

4.3 SAILING VESSELS

If your vessel is less than 65.6 ft/20 m in length, then it must display navigation lights shown on Figures 4-3, 4-4, or 4-5.

Figure 4-3.

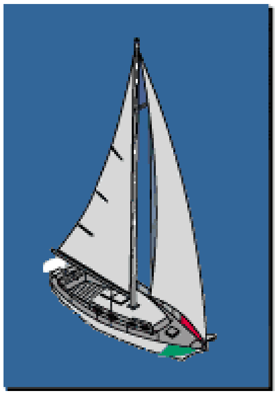


Figure 4-4.

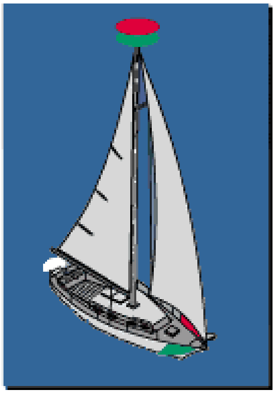
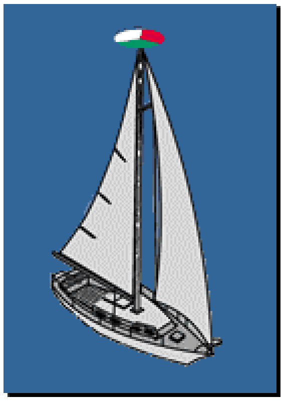


Figure 4-5.



If your vessel is less than 23 ft/7 m in length, then it should display lights for a sailboat (Figure 4-3), if practicable. As an option, your vessel may carry a flashlight or lighted lantern that can show a white light in sufficient time to prevent collision (Figure 4-6).

4.3.1 Vessel under Oars

If your vessels is under oars, then it should display lights for a sailboat (Figures 4-3, 4-4, or 4-5), if practicable. As an option, your vessel may carry an electric torch (flashlight) or lighted lantern that can show a white light in sufficient time to prevent collision (Figure 4-7).

Figure 4-6.

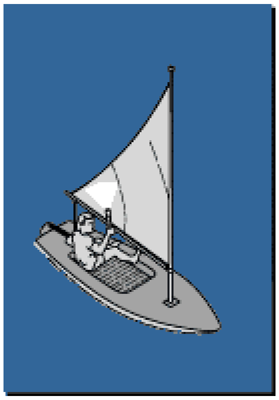
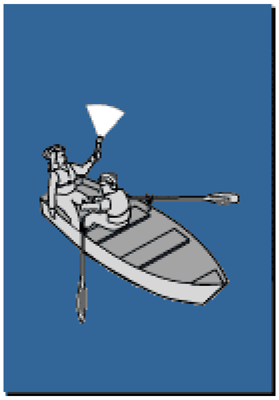


Figure 4-7.



4.3.2 Lights and Shapes

To alert other vessels of conditions that may be hazardous, there are requirements to display lights at night and shapes during the day.

4.3.3 Anchored Vessels

AT NIGHT: All vessels at anchor must display anchor lights. If your vessel is less than 164 ft/50 m in length, then its anchor light is an all-around white light visible where it can best be seen from all directions (Figure 4-8).

DURING THE DAY: All vessels at anchor must display, forward where it can be best seen, a black ball shape conditions (Figure 4-9).

Figure 4-8.

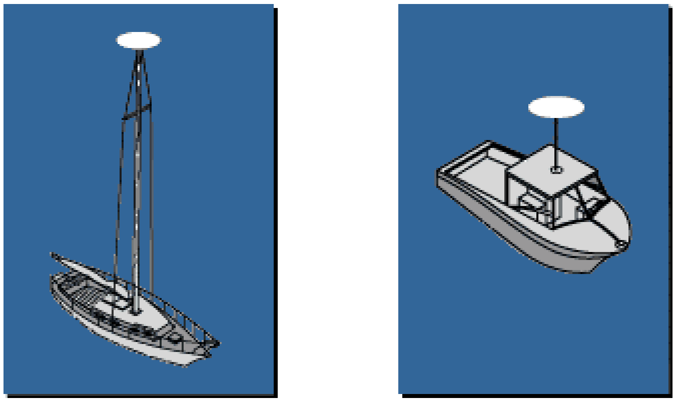
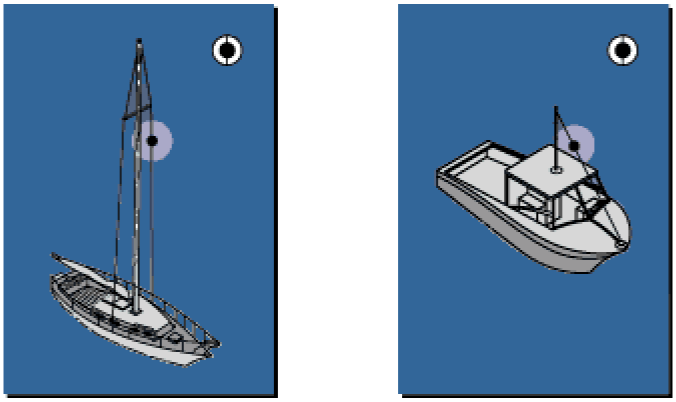


Figure 4-9.



EXCEPTIONS: If your vessel is less than 23 ft/7 m in length, then it is not required to display an anchor light or shape unless it is anchored in or near a narrow channel, fairway or anchorage, or where other vessels normally navigate. If your vessel is less than 65.6 ft/20 m in length, then is not required to display an anchor light if it is anchored in Inland Waters in a special anchorage designated by the Secretary of Transportation.

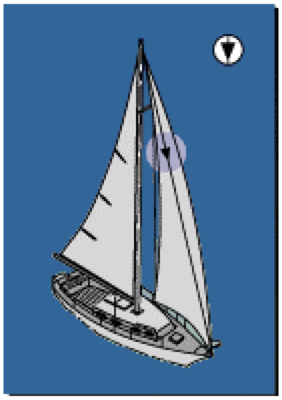
4.3.4 Sailing Vessels under Power (Machinery)

During the day, vessels under sail also being propelled by machinery must exhibit forward, where best seen, a black conical shape with the apex pointing down (Figure 4-10).

EXCEPTION: If your vessel is less than 39.4 ft/12 m in length, then it is not required to display the shape in Inland Waters.

REMINDER: If you are operating your sail vessel at night using machinery or sail and machinery, then your vessel must display lights required for a power-driven vessel (Figures 4-1 or 4-2).

Figure 4-10.



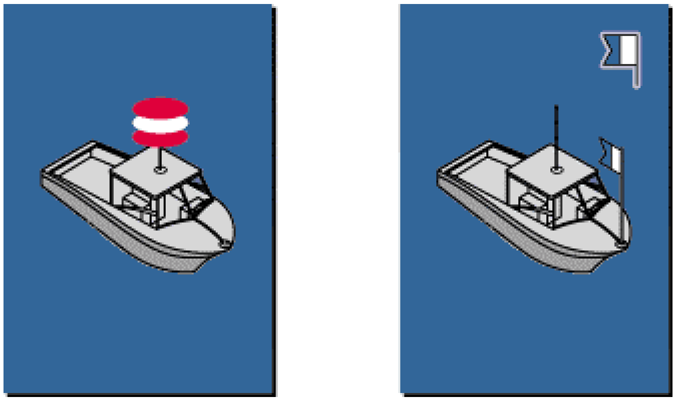
4.3.5 Restricted Maneuverability

The Navigation Rules require vessels restricted in their ability to maneuver to display appropriate day shapes or lights. To meet this requirement, if your vessel is engaged in diving activities during the day, then it must exhibit a rigid replica of the international code flag “Alpha” not less than 3.3 ft/1 m above deck. If diving activities are at night, then your vessel must display the navigation lights shown on

Figure 4-11. This requirement does not affect the use of a red and white divers flag which may be required by state or local law to mark a diver's location. The "A" flag is a navigation signal indicating the vessel's restricted maneuverability and does not pertain to the diver.

All vessels 16 ft or greater must have operable navigation lights and an all around anchor light. Sailboats capable of both power and sail must be able to display navigation lights for both systems.

Figure 4-11.



Tables 4-1 and 4-2 provide the required lights for various types of vessels for inland and international rules, respectively.

TABLE 4-1 LIGHTS FOR VARIOUS TYPES OF VESSELS – 1980 INLAND RULES

No.	Vessel	Masthead (Forward)	Side	Stern	Additional Lights or Remarks
1	Power-driven vessel 12 m but less than 20 m in length	White, 225°, visibility 3 mi; at least 2.5 m above gunwale(a)	Separate red and green 112 ½° or combination, visibility 2 mi; above hull at least 1 m below masthead light(b)	White 135°, visibility 2 mi	---
2	Power-driven vessel less than 12 m in length	White, 225°, visibility 2 mi; can be less than 2.5 m above gunwale, but at least 1 m above side lights(a),(c)	Separate red and green 112 ½° or combination, visibility 1 mi; above hull at least 1 m below masthead light(b),(c)	White 135°, visibility 2 mi	---
3	Sailing vessel under 20 m in length	None	Separate red and green, 112 ½°, or combination, visibility 2 mi(b),(d)	White 135°, visibility 2 mi	Optional—two all-round lights at or near top of mast, red over green, separated at least 1 m, visibility 2 mi
4	Sailing vessel under 12 m in length	None	Separate red and green, 112 ½°, or combination, visibility 1 mi(b),(d),(e)	White 135°, visibility 2 mi(d),(e)	---
5	Vessel propelled by oars	None	Separate red and green, 112 ½°, or combination, visibility 1 mi(f)	May show white, 135°, visibility 2 mi(f)	---
6	Power-driven vessel 20 but less than 50 m in length	White, 225°, visibility 5 mi; not more than ½ of length aft from stem; 6 m or beam (up to 10 m) above hull	Red and green, 112 ½°, visibility 2 mi; at or near sides of vessel; above hull at least 1 m below masthead light	White, 135°, visibility 2 mi	After masthead light may be shown; at least 4.5 m higher than forward masthead light
7	Power-driven vessel 50 m or more in length	White, 225°, visibility 6 mi; not more than ½ of length aft from stem; 6 m or beam (up to 10 m) above hull	Red and green, 112 ½°, visibility 3 mi; at or near sides of vessel; above hull at least 1 m below masthead light	White, 135°, visibility 3 mi	After masthead light required; at least 4.5 m higher and ¼ of vessel length (up to 50 m) aft of forward masthead light
8	Vessel towing: tow less than 200 m overall from stern of towing vessel; (also towing alongside or pushing ahead)	Two white, arranged vertically, 225°, visibility determined by length of vessel (not required pushing ahead or towing alongside on western rivers)	Normal for size of vessel	Normal for size of vessel	Towing astern: towing light(g) over stern light; pushing ahead or towing alongside: two towing lights(g) vertically
9	Vessel towing: tow 200 m or more overall length	Three white, arranged vertically, 225°, visibility determined by length of vessel	Normal for size of vessel	Normal for size of vessel	Towing light: yellow, 135°, above sternlight(g)
10	Vessel being towed astern, if manned	None	Normal for size of vessel	Normal for size of vessel	
11	Vessel being towed alongside or pushed ahead	None	Normal for size of vessel; at forward end	Normal for size of vessel (not used for pushed ahead)	Also "special flashing light" at center or forward end; a group of vessels is lighted as a single vessel

(a) After masthead light may be shown but not required (exception allowed on Great Lakes).
(b) Fitted with inboard screens if necessary to prevent being seen across bow.
(c) Less than 12 m in length, need only have all-round white light, visibility 2 mi but should have side lights.
(d) May be combined into triple combination light at masthead.
(e) Less than 7 m, need only have flashlight or lantern to show.
(f) Need only have flashlight or lantern to show white light.
(g) Visibility 3 mi for vessels 50 m or more in length; 2 mi for shorter vessels.

No.	Vessel	Masthead (Forward)	Side	Stern	Additional Lights or Remarks
12	Vessel engaged in trolling or drift fishing	(h)	(h)	(h)	---
13	Vessel engaged in trawling	None(a)(b)	When making way through the water, normal for size of vessel	When making way through the water, normal for size of vessel	Underway or at anchor, two all-round lights, green over white(g),(i),(j),(k)
14	Vessel engaged in fishing, other than trawling (or trolling)	None(l)	When making way through the water, normal for size of vessel	When making way through the water, normal for size of vessel	Underway or at anchor, two all-round lights, red over white(g),(i),(j),(k)(l); when not actually fishing, show normal masthead lights for vessel its size
15	Vessel at anchor, less than 50 m in length	None	None	None	White, all-round light where can best be seen; visibility 2 mi (not required if less than 7 m in length and not anchored in a narrow channel or where vessels normally navigate)
16	Vessel at anchor; 50 m or more in length	None	None	None	White, all-round light in fore part of vessel not less than 6 m above hull; a second white, all-round light in after part, not less than 4.5 m lower than forward anchor light; visibility 3 mi
17	Vessel aground	None	None		Anchor light(s) as line 15 or 16 plus two red all-round lights of same visibility range(g),(i),(j) (not required if less than 12 m in length)
18	Pilot vessel	None if on pilot duty; normal if underway and not on pilot duty	When underway, normal for size of vessel	When underway, normal for size of vessel	Two all-round lights, white over red, at masthead(g),(i),(j); if at anchor, normal anchor light(s); line 15 or 16
19	Vessel not under command	None	If making way through the water, normal for size of vessel	If making way through the water, normal for size of vessel	Two red all-round lights vertically where best can be seen(g),(i),(j)
20	Vessel restricted in ability to maneuver	None	When making way through the water, normal for size of vessel	When making way through the water, normal for size of vessel	Three all-round lights vertically, red-white-red.(g),(i); if at anchor, normal anchor light(s) (not required if less than 12 m in length)

(h) Show only normal lights of power-driven or sailing vessel.
(i) Vertical spacing 1 m.
(j) Lower light not less than 4 m (2 m if under 20 m in length) above hull.
(k) Lower light above sidelights at least twice vertical spacing.
(l) When not actually fishing, show normal masthead lights for vessel its size.

TABLE 4-2 LIGHTS FOR VARIOUS TYPES OF VESSELS –1972 INTERNATIONAL RULES

	Vessel	Masthead (Forward)	Side	Stern	Additional Lights or Remarks
A	Power-driven vessel 12 m but less than 20 m in length	White, 225°, visibility 3 mi. At least 2.5 m above gunwale(a).	Separate red and green, 112 ½°, or combination, visibility 2 m; above hull at least 1 m below masthead light(b)	White, 135°, visibility 2 mi	---
B	Power-driven vessel less than 12 m in length	White, 225°, visibility 2 mi. Can be less than 2.5 m above gunwale, but at least 1 m above side lights(c)	Separate red and green, 112 ½°, or combination, visibility 1 mi; above hull at least 1 m below masthead light(b)	White, 135°, visibility 2 mi	---
C	Sailing vessel under 20 m in length	None	Separate red and green, 112 ½°, or combination, visibility 2 mi	White, 135°, visibility 2 mi	Optional – two all-round lights at or near top of mast, red over green, separated at least 1 m, visibility 2 mi.
D	Sailing vessel under 12 m in length	None	Separate red and green, 112 ½°, or combination, visibility 1 mi(b)(d)	White, 135°, visibility 2 mi(d)(e)	---
E	Vessel propelled by oars	None	May show separate red and green, 112 ½°, or combination, visibility 1 mi(f)	May show white, 135°, visibility 2 mi(f)	---
F	Power-driven vessel 20m but less than 50 m in length	White, 225°, visibility 5 mi. Not more than ¼ of length aft from stem; 6 m or beam (up to 12 m) above hull.	Red and green, 112 ½°, visibility 2 mi. At or near sides of vessel; not more than ¾ height of masthead light	White, 135°, visibility 2 mi	After masthead light may be shown; at least 4.5 m higher than forward masthead light
G	Power-driven vessel 50 m or more in length	White, 225°, visibility 6 mi. Not more than ¼ of length aft from stem; 6 m or beam (up to 12 m) above hull.	Red and green, 112 ½°, visibility 3 mi. At or near sides of vessel; not more than ¾ height of forward masthead light	White, 135°, visibility 3 mi	After masthead light required; at least 4.5 m higher and half of vessel length (up to 100 m) aft of forward masthead light
H	Vessel towing; tow from stern of towing less than 200 m overall vessel. (Also towing alongside or pushing ahead)	Two white, arranged vertically, 225°, visibility determined by length of vessel.	Normal for size of vessel	Normal for size of vessel	Towing light(g) over sternlight (not shown when towing alongside or pushing ahead)
I	Vessel towing; tow 200 m or more overall length	Three white, arranged vertically, 225°, visibility determined by length of vessel	Normal for size of vessel	Normal for size of vessel	Towing light(g) over stern light

(a) After masthead light may be shown but not required.
(b) Fitted with inboard screens if necessary to prevent being seen across bow.
(c) Less than 7 m and less than 7 kt max speed need only have all-round white light, visibility 2 mi but should have sidelights.
(d) May be combined into triple combination light at masthead.
(e) Less than 7 m need only have flashlight or lantern to show.
(f) Need only have flashlight or lantern to show white light.
(g) Visibility 3 mi for vessels 50 m or more in length; 2 mi for shorter vessels.

	Vessel	Masthead (Forward)	Side	Stern	Additional Lights or Remarks
J	Vessel being towed astern, if manned	None	Normal for size of vessel	Normal for size of vessel	
K	Vessel being towed alongside or pushed ahead	None	Normal for size of vessel; at forward end	Normal for size of vessel (not used for pushed ahead)	A group of vessels is lighted as a single vessel
L	Vessel engaged in trolling or drift fishing	(h)	(h)	(h)	---
M	Vessel engaged in trawling	None(i)	When making way through the water, normal for size of vessel	When making way through the water, normal for size of vessel	Underway or at anchor, two all- round lights, green over white(g)(j)(k)(l)
N	Vessel engaged in fishing, other than trawling (or trolling)	None(i)	When making way through the water, normal for size of vessel	When making way through the water, normal for size of vessel	Underway or at anchor, two all- round lights, red over white(g)(j)(k)(l)
O	Vessel at anchor, less than 50 m in length	None	None	None	White, all-round light where can best be seen; visibility 2 mi (not required if less than 7 m in length and not anchored in a narrow channel or where vessels normally navigate)
P	Vessel at anchor; 50 m or more in length	None	None	None	White, all-round light in fore part of vessel not less than 6 m above hull; a second white all-round light in after part, not less than 4.5 m lower than forward anchor light; visibility 3 mi.
Q	Vessel aground	None	None		Normal anchor light(s) plus two red all-round lights of same visibility range
R	Pilot vessel	None if on pilot duty; normal if underway and not on pilot duty	When underway, normal for size of vessel	When underway, normal for size of vessel	Two all-round lights, white over red, at masthead(g)(j)(k); if at anchor, normal anchor light(s)
S	Vessel not under command	None	If making way through the water, normal for size of vessel	If making way through the water, normal for size of vessel	Two red all-round lights vertically where best can be seen(g)(j)(k)
T	Vessel constrained by her draft	Normal for size of vessel	Normal for size of vessel	Normal for size of vessel	Three red all-round lights, arranged vertically and equally spaced.(g)(j)(k)

(h) Show only normal lights of power-driven or sailing vessel.
(i) When not actually fishing, show normal masthead lights for vessel its size.
(j) Vertical spacing 2 m for vessels 20 m or more in length, 1 m for shorter vessels.
(k) Lower light not less than 4 m (2 m if under 20 m in length) above hull.
(l) Lower light above sidelights at least twice vertical spacing.

5. INLAND "RULES OF THE WATER"

5.1 MEETING SITUATIONS

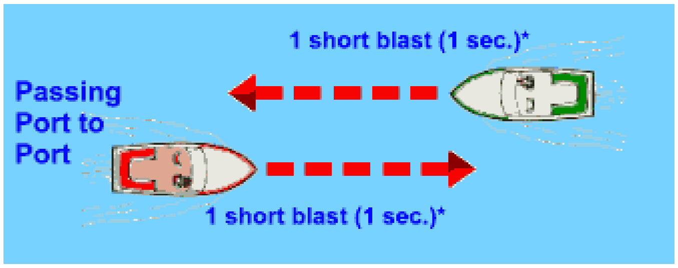
In the following situations, the give-way vessel must take action to keep well clear. The stand-on vessel should maintain its course and speed. If it becomes apparent that the actions taken (or not taken) by the give-way vessel are dangerous or insufficient, you should take action to avoid collision.

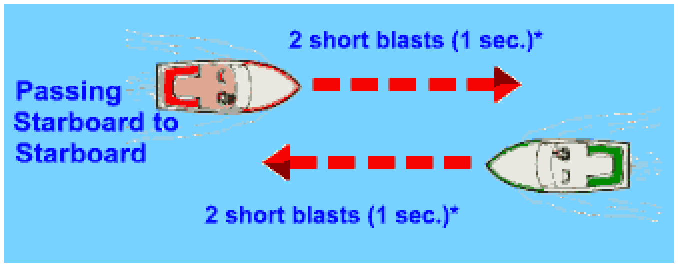
5.1.1 Meeting Head-On

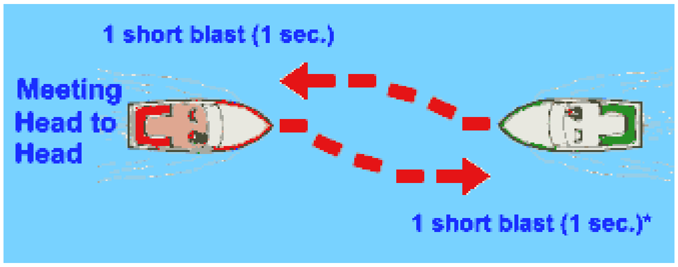
When two power driven vessels are approaching head-on or nearly so, either vessel will indicate its intent which the other vessel will answer promptly. In a meeting situation, neither vessel is the stand-on vessel.

It is generally accepted that you should alter course to starboard and pass port-to-port. The accompanying sound signal is one short blast. If you cannot pass port-to-port due to an obstruction or other vessels, you should sound two short blasts to indicate your intention to pass starboard-to-starboard. Make sure the other vessel understands your intent before proceeding. The other vessel should return your two-short-blast signal.

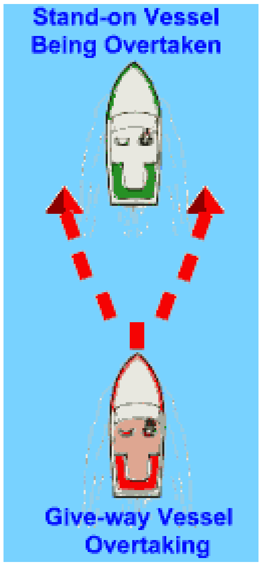
- Not sounded on International Waters







5.1.2 Overtaking

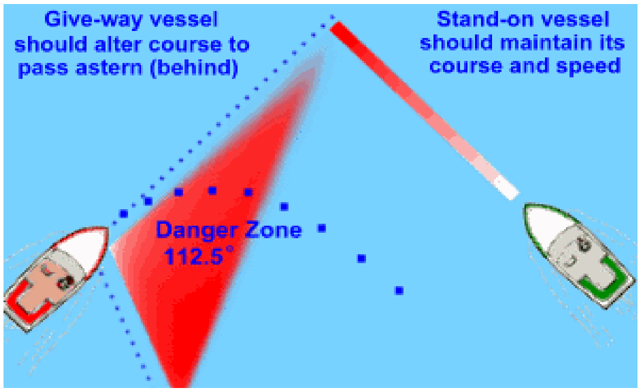


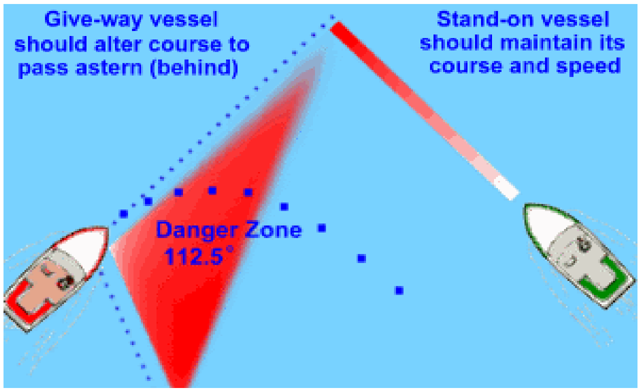
When two vessels are moving in the same direction, and the astern vessel wishes to pass, it must initiate the signal to pass as shown in the diagram. The vessel passing is the give-way vessel and should keep out of the way of the vessel being passed. The vessel being passed is the stand-on vessel and must maintain its course and speed. If the stand-on vessel realizes that the course intended by the give-way vessel is not safe, it should sound the danger or doubt signal.

If you are the overtaking vessel, remember that you are the give-way vessel until well past, and safely clear of, the passed vessel. Do not cut in front, impede, or endanger another vessel.

Inland Rules: "I intend to pass you on your port side" *2 short blasts (1 second)* "Agreement" *2 short blasts (1 second)*	**Inland Rules:** "I intend to pass you on your starboard side" *1 short blast (1 second)* "Agreement" *1 short blast (1 second)*
International Rules: "I intend to pass you on your port side" *2 prolonged blasts/2 short* "Agreement" *1 prolonged/1 short/1 prolonged/1 short*	**International Rules:** "I intend to pass you on your starboard side" *2 prolonged blasts/1 short* "Agreement" *1 prolonged/1 short/1 prolonged/1 short*

5.1.3 Crossing





When two power driven vessels are approaching at right angles or nearly so, and risk of collision exists, the vessel on the right is the stand-on vessel and must hold its course and speed. The other vessel, the give-way vessel, will maneuver to keep clear of the stand-on vessel and will pass it by its stern. If necessary, slow or stop or reverse until the stand-on vessel is clear.

In the example above, the red vessel is the give-way vessel and should alter course and speed to pass behind the green vessel. If the skipper of the green vessel does not observe the red vessel taking action to avoid collision, then he/she must take the required action to avoid a collision.

5.1.4 Sailing Craft and Vessels Propelled by Oars or Paddles

Sailing craft and boats propelled by oars or paddles have the right-of-way over power driven vessels. An exception to this is if the sailing craft or self-propelled vessel is passing a power driven vessel. In an overtaking situation, the overtaking vessel is the give-way vessel, even if it is not propelled by an engine.

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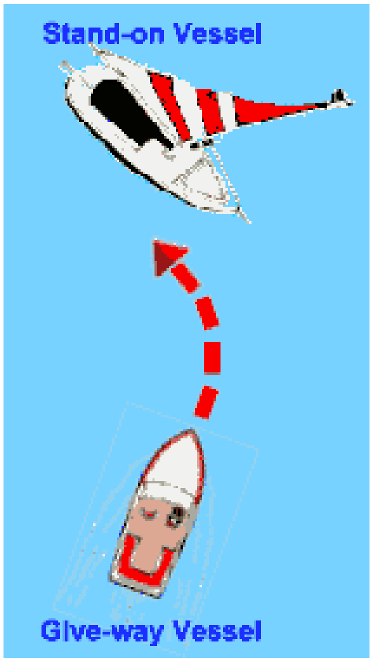


5.1.5 Navigating Narrow Channels

The rules tell you to stay to the starboard side of narrow channels. Make sure that you do not impede a vessel that is constrained by draft, i.e., a large vessel that must operate within the channel in order to make way safely. When crossing a channel, do so at a right angle and in such a way as to avoid causing the traffic in the channel to make course or speed changes. Do not anchor in a channel unless you cannot make way (broken down, etc.).

When operating on the Great Lakes, Western rivers and other designated rivers, the down bound vessel (going with the current) has the right of way over a vessel going upstream. This is because a vessel going upstream can maneuver better than a vessel going downstream.
If you approach a bend in a river around which you cannot see, sound one prolonged blast to alert vessels approaching from the other side of the bend that you are there. If another vessel is around the bend, it should answer with one prolonged blast. Conversely, if you hear a prolonged blast as you approach the bend, answer with a prolonged blast.

5.1.6 Commercial Vessel Situations

If at all possible stay out of areas where there is commercial vessel traffic such as shipping lanes or traffic separation zones. Large ships and barges have special problems in maneuvering and **cannot and will not** get out of your way.

If you must operate around commercial vessels take heed of the following:

- Avoid ship channels; if you must cross, do so at right angles and as quickly as possible
- Be alert; watch for traffic
- Be seen, especially at night
- Know the sound signals, especially the danger or doubt signal
- Keep your VHF radio tuned to Channel 16 and listen carefully
- Order all aboard to wear PFDs
- Be familiar with the area and have current navigation charts
- Do not be a non-survivor of a collision with a large ship.

6. SEAMANSHIP

Seamanship is defined as " the knowledge of and skill in all things pertaining to the operation, navigation, and maintenance of a ship." This knowledge may include; handling and working with rope, wire, and various boat hardware. Basic engine and boat electrical layout maintenance and troubleshooting. Piloting including boat handling, engine operation, proper use of charts, and use of navigation equipment (i.e., depth finders, compass, Global Positioning System (GPS) or loran units, speedometer). A fundamental knowledge of weather (wind, fronts, and cloud types) and the water environment (wave action, tides, and currents). Proper emergency preparation training, basic first aid knowledge, and survival techniques are an integral part of seamanship.

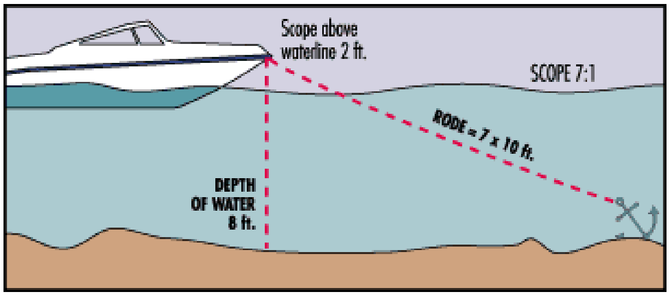
Seamanship skills are developed through training courses, such as the USCG Auxiliary Training course, through training manuals, regulatory handbooks, instructional guides and videos, and most importantly through actual hands on experience and working with people who have developed the skills.

6.1 ANCHORING

Anchoring is done for two principal reasons: first, to stop for fishing, lunch, or an overnight stay and second, to keep you from running aground in bad weather or as a result of engine failure. Anchoring can be a simple task if you follow these guidelines:

- Make sure you have the proper type of anchor (danforth/plow/mushroom).
- A 3- to 6-ft length of galvanized chain should be attached to the anchor. The chain will stand up to the abrasion of sand, rock, or mud on the bottom much better than a fiber line.
- A suitable length of nylon anchor line should be attached to the end of the chain (this combination is called the "Rode"). The nylon will stretch under heavy strain cushioning the impact of the waves or wind on the boat and the anchor.
- Select an area that offers maximum shelter from wind, current, and boat traffic.
- Determine depth of water and type of bottom (preferably sand or mud).
- Calculate the amount of anchor line you will need. General rule: 5-7 times as much anchor line as the depth of water plus the distance from the water to where the anchor will attach to the bow. For example, if the water depth is 8 ft and it is 2 ft from the top of water to your bow cleat, you would multiply 10 ft by 5-7 to get the amount of anchor line to put out (Figure 6-1).

Figure 6-1.



- Secure the anchor line to the bow cleat at the point you want it to stop.
- Bring the bow of the vessel into the wind or current.

- When you get to the spot you want to anchor, place the engine in neutral.
- When the boat comes to a stop, slowly lower the anchor. Do not throw the anchor over, as it will tend to entangle the anchor.
- When all anchor line has been let out, back down on the anchor with engine in idle reverse to help set the anchor.
- When anchor is firmly set, use reference points (landmarks) in relation to the boat to make sure you are not drifting. Check these points frequently.
- Maximum anchoring is achieved at an angle of less than 8 degrees.

The following table provides anchor weights:

Boat Length (Maximum)	Lunch Hook	Working Anchor	Storm Anchor
20 ft	**4** (10)	**5** (20)	**12** (40)
30 ft	**5** (15)	**12** (30)	**18** (60)
40 ft	**12** (20)	**18** (40)	**28** (80)

NOTE: Bold indicates figures based on modern lightweight burial-type anchors of efficient design. Figures in parentheses show how weights would be increased, using a formula of 0.5 lb, 1 lb, and 2 lb per foot for certain kedges.

Table 6-1 provides suggested rode and anchor sizes.

6.2 WEATHER

You should never leave the dock without first checking the local weather forecast. You can get the weather information from the TV, radio, local, newspaper, on-line, or from one of the weather channels on your VHF radio.

At certain times of the year weather can change rapidly and you should continually keep a "weather eye" out. While you are out in a boat, here are a few signs you can look for that indicate an approaching weather change:

- Weather changes generally come from the west. Scan the sky with your weather eye, especially to the west.
- Watch for cloud to build up, especially rapid vertically rising clouds.
- Sudden drop in temperature.
- Sudden change in wind direction and/or speed.

- If you have a barometer on your boat, check it every 2-3 hours. A rising barometer indicates fair weather and rise in wind velocity; a falling barometer indicates stormy or rainy weather.

TABLE 6-1 SUGGESTED RODE AND ANCHOR SIZES(a)

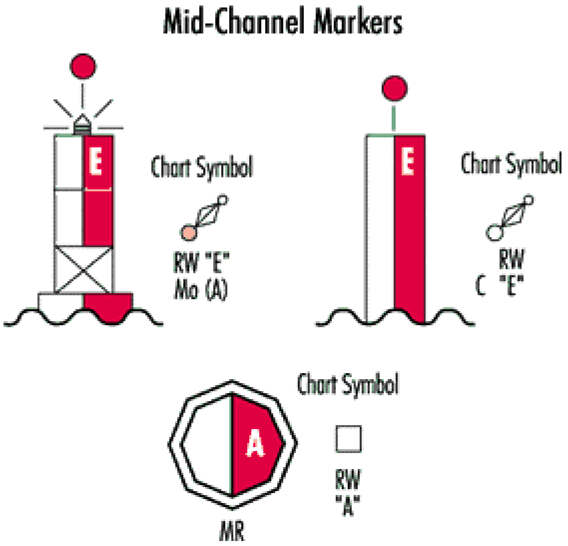
L.O.A.	Beam		Rode		Anchor		
	Sail	Power	Nylon	Chain	Northill	Standard	Hi-Tensile
FOR STORM ANCHOR (WINDS UP TO 60 KNOTS)							
10 ft	5 ft	5 ft	100 ft-1/4 in.	3 ft-3/16 in.	12 lb (6-R)	8-S	5-H
15 ft	7 ft	7 ft	125 ft-1/4 in.	3 ft-3/16 in.	12 lb (6-R)	8-S	5-H
20 ft	8 ft	9 ft	150 ft-3/8 in.	4 ft-1/4 in.	27 lb (12-R)	13-S	12-H
25 ft	9 ft	10 ft	200 ft-3/8 in.	4 ft-1/4 in.	27 lb (12-R)	22-S	12-H
30 ft	10 ft	11ft	250 ft-7/16 in.	5 ft-5/16 in.	46 lb (20-R)	22-S	20-H
35 ft	12 ft	13 ft	300 ft-1/2 in.	6 ft-3/8 in.	46 lb (20-R)	40-S	35-H
40 ft	13 ft	14 ft	400 ft-5/8 in.	8 ft-7/16 in.	80 lb (30-R)	65-S	60-H
50 ft	14 ft	16 ft	500 ft-5/8 in.	8 ft-7/16 in.	105 lb (50-R)	130-S	60-H
60 ft	16 ft	19 ft	500 ft-3/4 in.	8 ft-1/2 in.	105 lb (50-R)	180-S	90-H
FOR WORKING ANCHOR (WINDS UP TO 30 KNOTS)							
10 ft	5 ft	5 ft	80 ft-1/4 in.	3 ft-3/16 in.	6 lb (3-R)	4-S	5-H
15 ft	7 ft	7 ft	100 ft-1/4 in.	3 ft-3/16 in.	6 lb (3-R)	8-S	5-H
20 ft	8 ft	9 ft	120 ft-1/4 in.	3 ft-3/16 in.	12 lb (6-R)	8-S	5-H
25 ft	9 ft	10 ft	150 ft-3/8 in.	3 ft-3/16 in.	12 lb (6-R)	8-S	5-H
30 ft	10 ft	11ft	180 ft-3/8 in.	4 ft-1/4 in.	27 lb (12-R)	13-S	12-H
35 ft	12 ft	13 ft	200 ft-3/8 in.	4 ft-1/4 in.	27 lb (12-R)	22-S	12-H
40 ft	13 ft	14 ft	250 ft-7/16 in.	5 ft-5/16 in.	46 lb (20-R)	22-S	20-H
50 ft	14 ft	16 ft	300 ft-1/2 in.	6 ft-3/8 in.	46 lb (20-R)	40-S	35-H
60 ft	16 ft	19 ft	300 ft-1/2 in.	6 ft-3/8 in.	80 lb (30-R)	65-S	35-H
FOR LUNCH HOOK							
10 ft	5 ft	5 ft	70 ft-1/4 in.	3 ft-3/16 in.	6 lb (3-R)	2 ½ -S	5-H
15 ft	7 ft	7 ft	80 ft-1/4 in.	3 ft-3/16 in.	6 lb (3-R)	2 ½ -S	5-H
20 ft	8 ft	9 ft	90 ft-1/4 in.	3 ft-3/16 in.	6 lb (3-R)	2 ½ -S	5-H
25 ft	9 ft	10 ft	100 ft-1/4 in.	3 ft-3/16 in.	6 lb (3-R)	4-S	5-H
30 ft	10 ft	11ft	125 ft-1/4 in.	3 ft-3/16 in.	6 lb (3-R)	4-S	5-H
35 ft	12 ft	13 ft	150 ft-1/4 in.	3 ft-3/16 in.	12 lb (6-R)	4-S	5-H
40 ft	13 ft	14 ft	175 ft-3/8 in.	4 ft-1/4 in.	12 lb (6-R)	8-S	5-H
50 ft	14 ft	16 ft	200 ft-3/8 in.	4 ft-1/4 in.	12 lb (6-R)	8-S	12-H
60 ft	16 ft	19 ft	200 ft-3/8 in.	4 ft-1/4 in.	27 lb (12-R)	13-S	12-H

(a) Suggested sizes assume fair holding ground, scope of at least 7-to-1 and moderate shelter from heavy seas.

Plow Anchors—Woolsey, manufacturer of the Plowright anchor, makes the following recommendations for winds up to 30 knots: for *working anchors*, 10-21 ft, 6 lb; 22-32 ft, 12 lb; 32-36 ft, 18 lb; 36-39 ft, 22 lb; and 39-44 ft, 35 lb. For *lunch hooks*, they advise stepping down one size. For *storm anchors*, up one size.
Kedges—Holding powers vary widely with the type. Best to consult manufacturer for individual recommendations.

7. AIDS TO NAVIGATION

Aids to navigation are placed along coasts and navigable waters as guides to mark safe water and to assist mariners in determining their position in relation to land and hidden dangers. Each aid to navigation is used to provide specific information.



Several aids to navigation are usually used together to form a local aid to navigation system that helps the mariner follow natural and improved channels. Such aids to navigation also provide a continuous system of charted marks for coastal piloting. Individual aids to navigation are used to mark landfall from seaward, and to mark isolated dangers.

Lateral markers are buoys or beacons that indicate the port and starboard sides of a route to be followed. Virtually all U.S. lateral marks follow the traditional 3R rule of "red, right, returning." This means, when returning from sea, keep red marks on the right-hand (starboard) side of the vessel.

Mariners must NOT rely on buoys alone for determining their position. Storms and wave action can cause buoys to move.

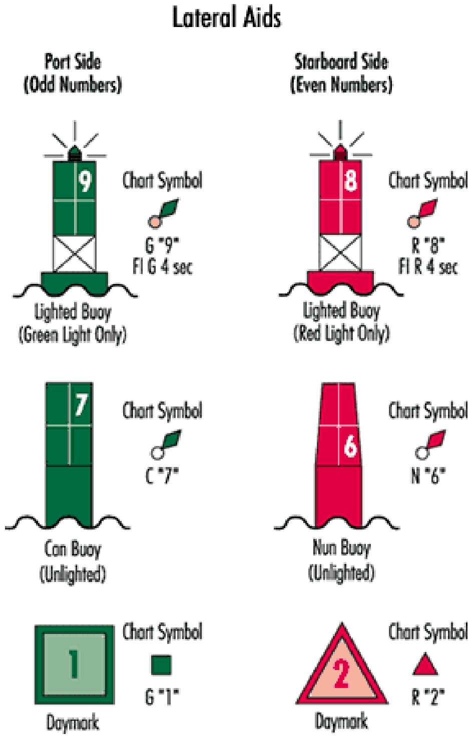
7.1 LATERAL AIDS

Lateral aids marking the sides of channels as seen when entering from seaward.

Do not tie up to Aids to Navigation; it is dangerous and illegal.

7.2 NAUTICAL CHARTS

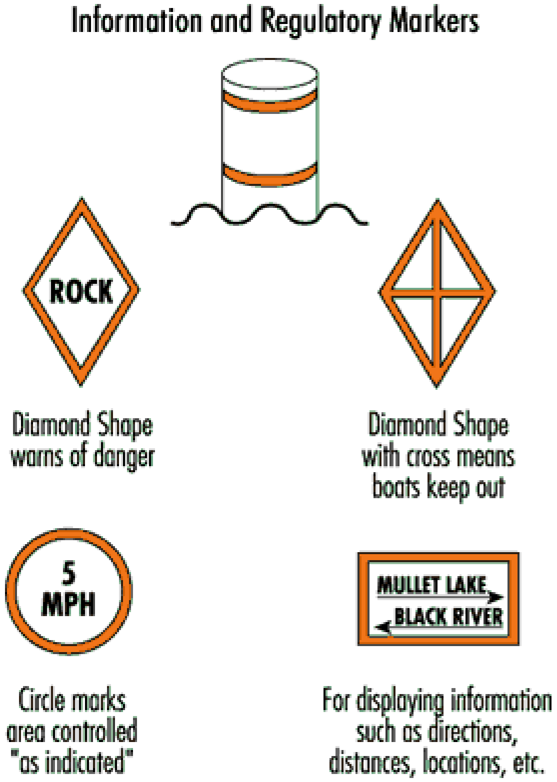
One of the most important tools used for safely navigating waterways are Nautical Charts. Nautical Charts show the nature and shape of the coast, depths of water, general configuration and character of the bottom, prominent landmarks, port facilities, aids to navigation, marine hazards, and other pertinent information. Changes brought about by people and nature require that nautical charts be constantly maintained and updated to aid safe navigation.



To meet the needs of the boaters, the National Ocean Service (NOS) produces a variety of nautical charts and chart products. The date of a nautical chart is critical to the boater. Only up-to-date charts should be used for navigation. Nautical charts vary in scale and format. For coastal navigation, for instance, boaters should use the largest chart scale available. Chart updating information can be obtained from "Local Notice to Mariners" published by the USCG.

NOS nautical charts may be purchased either directly by mail from the NOS Distribution Branch or through an authorized agent. There are more than 1,700 nautical chart agents that sell NOS charts.

Other charts available consist of tide and current charts for various localities and a local notice to mariners. These local charts should be used with NOS Charts.



8. ELECTRONICS

8.1 EQUIPMENT REQUIREMENTS – RADIO REGULATIONS

8.1.1 Carrying a Radio

Most recreational vessels under 65.6 ft/20m in length do not have to carry a marine radio. Any vessel that carries a marine radio must follow the rules of the Federal Communications Commission (FCC).

8.1.2 Radio Licenses

The FCC does not require operators of recreational vessels to carry a radio or to have an individual license to operate VHF marine radios (with or without digital selective calling capability), Emergency Position Indicating Radio Beacons (EPIRBs), or any type of radar. Operators must, however, follow the procedures and courtesies that are required of licensed operators specified in FCC Rules. You may use the name or registration number of your vessel to identify your ship station.

Users of VHF marine radio equipped with digital selective calling will need to obtain a maritime mobile service identity number from the FCC. It is unlawful to use digital selective calling without obtaining this identity.

The following vessels are still required to be licensed:

- Vessels that use medium frequency/high frequency single side-band radio, satellite communications, or telegraphy

- Power driven vessels over 65.6 ft/20 m in length

- Vessels used for commercial purposes including:

    — Vessels documented for commercial use, including commercial fishing vessels
    — CG inspected vessels carrying more than 6 passengers
    — Towboats more than 7.8 m in length
    — Vessels of more than 100 tons certified to carry at least 1 passenger
    — Cargo ships over 300 tons

- Any vessel, including a recreational vessel, on an international voyage.

8.1.3 Radio Listening Watch

Vessels not required to carry a marine radio (e.g., recreational vessels less than 20-m length), but which voluntarily carry a radio, must maintain a watch on Channel 16 (156.800 MHz) whenever the radio is operating and not being used to communicate. Such vessels may alternatively maintain a watch on VHF Channel 9 (156.450 MHz), the boater calling channel.

U.S. vessels required to carry a VHF marine radio, such as commercial fishing vessels, must maintain a watch on Channel 16 (156.800 MHz) while underway whenever the radio is not being used for exchanging communications.

False Distress Alerts

It is unlawful to intentionally transmit a false distress alert, or to unintentionally transmit a false distress alert without taking steps to cancel that alert.

Very High Frequency Marine Radio Channels

The chart below contains a partial listing of channels recreational boaters should be familiar with:

Channel	Type of Message and Use
06	Intership Safety: Used for ship-to-ship safety messages and search messages and ships and aircraft of the USCG.
09	Boater Calling: FCC has established this channel as a supplementary calling channel for non-commercial vessels (recreational boaters). The purpose is to relieve congestion on VHF Channel 16. The USCG announces urgent marine information broadcasts and storm warnings on Channel 9 in the First USCG District (waters off the coast of northern New Jersey, New York, and New England) and USCG Group Grand Haven, Milwaukee and Sault Ste. Maria (Lake Michigan). For that reason, we strongly urge boaters to use Channel 9 in these waters. Use of Channel 9 in other waters is optional, and we recommend boaters keep turned to and use Channel 16 in those waters unless otherwise notified by the USCG.
13,67	Navigation Safety (also known as Bridge-to-Bridge channel): Ships greater than 20 m in length maintain a listening watch on this channel in US waters. This channel is available to all ships. Messages must be about ship navigation (i.e., passing or meeting other ships). You must keep your messages short. Your power output must not be more than 1 watt. This is also the main working channel at most locks and drawbridges. Channel 67 is for lower Mississippi River only.
16	International Distress, Safety and Calling: Use this channel to get the attention of another station (calling) or in emergencies. Ships required to carry a radio maintain a listening watch on this channel. USCG and most coast stations also maintain a listening watch on this channel.
21A, 23A, 83A	USCG only.
22A	USCG Liaison and Maritime Safety Information Broadcasts: Announcements of urgent marine information broadcasts and storm warnings (Broadcasts announced on Channel 16).
24,25,26, 27,28,84, 85,86,87	Public Correspondence (Marine Operator): Use these channels to call the marine operator at a public station. By contacting a public coast station, you can make and receive calls from telephones on shore. Except for distress calls, public coast stations usually charge for this service.
70	Digital Selective Calling: Use this channel for distress and safety calling and for general purpose calling using only digital selective calling techniques. Voice communications not allowed. NOTE: The USCG will not be equipped to respond to digital selective calling distress calls on Channel 70 until 2006 – use Channel 16.

Distress Calls

The radiotelephone distress call consists of:

- Distress signal MAYDAY spoken three times
- Words THIS IS
- Call sign (or vessel registration number or name if no call sign is assigned) of the mobile station in distress, spoken three times.

Other electronic gear available is GPS, fathometer, and radar. The user should refer to individual operator manuals for proper orientation in the use of the gear.

9. TOWING AND LAUNCHING

9.1 TRAILERING YOUR BOAT

Choose the proper trailer for your boat. More damage can be done to a boat by the stress of road travel than by normal water operation. A boat hull is designed to be supported evenly by water. When transported on a trailer, your boat should be supported structurally as evenly across the hull as possible. This will allow for even distribution of the weight of the hull, engine and equipment. It should be long enough to support the whole length of the hull but short enough to allow the lower unit of the boat's engine to extend freely.

- Rollers and bolsters must be kept in good condition to prevent scratching and gouging of the hull.

- Tie-downs and lower unit supports must be adjusted properly to prevent the boat from bouncing on the trailer. The bow eye on the boat should be secured with either rope, chain or turnbuckle in addition to the winch cable. Additional straps may be required across the beam of the boat.

- The capacity of the trailer should be greater than the combined weight of the boat, motor, and equipment.

- The tow vehicle must be capable to handling the weight of the trailer, boat, equipment, as well as weight of the passengers and equipment which will be carried inside. This may require that the tow vehicle may need to be specially equipped with an:

  — Engine of adequate power
  — Transmission designed for towing
  — Larger cooling systems for the engine and transmission
  — Heavy duty brakes
  — Load bearing hitch attached to the frame, not the bumper.

Check your vehicle owners manual for specific information.

9.1.1 Check Before You Go Out on the Highway

- The tow ball and coupler are the same size and bolts with washers are tightly secured. (The vibration of road travel can loosen them.)

- The coupler is completely over the ball and the latching mechanism is locked down.

- The trailer is loaded evenly from front to rear as well as side to side. Too much weight on the hitch will cause the rear wheels of the tow vehicle to drag and may make steering more difficult. Too much weight on the rear of the trailer will cause the trailer to "fishtail" and may reduce traction or even lift the rear wheels of the tow vehicle off the ground. The safety chains are attached crisscrossing under the coupler to the frame of the tow vehicle. If the ball were to break, the trailer would follow in a straight line and prevent the coupler from dragging on the road.

- The lights on the trailer function properly.

- Check the brakes. On a level parking area roll forward and apply the brakes several times at increasing speeds to determine a safe stopping distance.

- The side view mirrors are large enough to provide an unobstructed rear view on both sides of the vehicle.

- Check tires (including spare) and wheel bearings. Improper inflation may cause difficulty in steering. When trailer wheels are immersed in water, (especially salt water) the bearings should be inspected and greased after each use.

- Make certain that water from rain or cleaning has been removed from the boat. Water weighs approximately eight pounds per gallon and can add weight that will shift with the movement of the trailer.

9.1.2 Towing Precautions

- Allow more time to brake, accelerate, pass, and stop.

- Remember the turning radius is also much greater, curbs and roadside barriers must be given a wide berth when negotiating corners.

- Prior to operating on the road, practice turning, backing up, etc. on a level, uncongested parking area.

9.1.3 Pre-Launching Preparations

- For the courtesy of others and to prevent rushing, prepare your boat for launching away from the ramp.

- Check the boat to ensure that no damage was caused by the trip.

- Raise the lower unit (remove supports) to proper height for launching so that it will not hit bottom.

- Remove tie-downs and make sure that the winch is properly attached to the bow eye and locked in position.

- Put the drain plug in securely.

- Disconnect the trailer lights to prevent shorting of electrical system or burning out a bulb.

- Attach a line to the bow and the stern of the boat so that the boat cannot drift away after launching and it can be easily maneuvered to a docking area.
- Visually inspect the launch ramp for hazards such as a steep drop off, slippery area, and sharp objects.

- When everything has been double checked, proceed slowly to the ramp remembering that your boat is just resting on the trailer and attached only at the bow. The ideal situation is to have one person in the boat and one observer at the water's edge to help guide the driver of the tow vehicle.

- Keep the rear wheels of the tow vehicle out of the water. This will generally keep the exhaust pipes out of the water. If the exhaust pipes become immersed in the water, the engine may stall.

- Set the parking brake and place tire chocks behind the rear wheels.

- Make sure someone else on shore is holding the lines attached to the boat.

- Lower the motor and prepare to start the engine (after running blowers and checking for fuel leaks).

- Start the boat motor and make sure that water is passing through the engine cooling system.

- Release the winch and disconnect the winch line from the bow when the boat operator is ready.

- At this point, the boat should be able to be launched with a light shove or by backing off the trailer under power. Finish loading your boat at a sufficient distance from the ramp so that others may use it.

9.1.4 Retrieval

The steps for removing your boat from the water are basically the reverse of those taken to launch it. However, keep in mind that certain conditions may exist during retrieval that did not exist during launching. As you approach the takeout ramp, take special care to note such factors as:

- Change in wind direction and/or velocity
- Change in current and/or tide
- Increase in boating traffic
- Visibility, etc.

First, unload the boat at a dock or mooring if possible. Next, maneuver the boat carefully to the submerged trailer, and raise the lower unit of the engine. Then, winch the boat onto the trailer and secure it. Finally, drive the trailer with the boat aboard carefully out of the ramp to a designated parking area for cleanup, reloading, and an equipment safety check. Practice will make launch and retrieval a simple procedure. The best advise is just, “do it cautiously with safety as your main concern.”

9.1.5 Storage

Since your boat may be sitting on its trailer for quite some time before it is used again, it is important that it be stored properly. To avoid damage from sun and weather, cover the boat with a tarp. To remove weight from the wheels, put cinderblocks or wood beams under the tongue and all four corners of the trailer frame.

The safety chains are attached crisscrossing under the coupler to the frame of the tow vehicle. If the ball were to break, the trailer would follow in a straight line and prevent the coupler from dragging on the road.

- The lights on the trailer function properly.

- Check the brakes. On a level parking area, roll forward and apply the brakes several times at increasing speeds to determine a safe stopping distance.

- The side view mirrors are large enough to provide an unobstructed rear view on both sides of the vehicle.

- Check tires (including spare) and wheel bearings. Improper inflation may cause difficulty in steering. When trailer wheels are immersed in water (especially salt water), the bearings should be inspected and greased after each use.

- Make certain that water from rain or cleaning has been removed from the boat. Water weighs approximately 8 lb per gal and can add weight that will shift with the movement of the trailer.

10. OFFSHORE OPERATION SAFETY EQUIPMENT

10.1 EQUIPMENT REQUIREMENTS – VESSEL OPERATING OFFSHORE

If you operate offshore, you should seriously consider carrying additional equipment beyond the minimum federal requirements. This equipment should include appropriate communications gear, an EPIRB, a means of accurately determining your location, and an inflatable life raft. In cold waters, an immersion suit should be carried for everyone on board.

10.1.1 Communications

Carry communications gear, marine VHF-FM, and/or HF transceiver(s), appropriate to your operating area. Cellular phone coverage is available in many coastal areas. However, cellular phones should not be considered a substitute for VHF-FM marine band radios for emergency purposes.

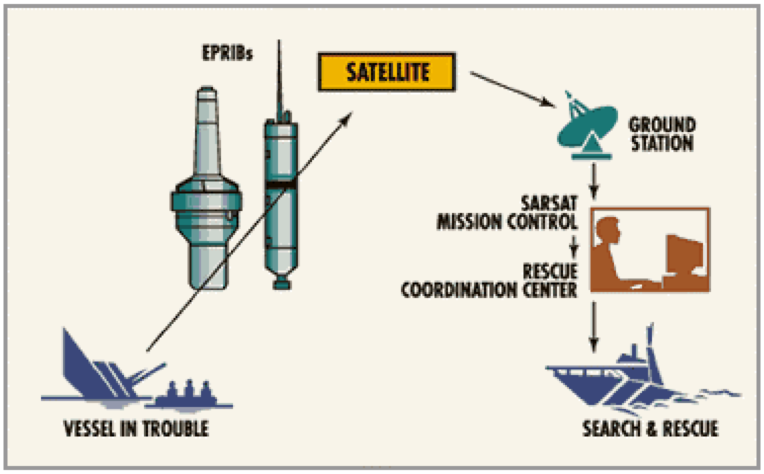
10.1.2 Satellite Emergency Position Indicating Radio Beacons

Satellite EPIRBs (406 MHz) are designed to quickly and reliably alert rescue forces, indicate an accurate distress position, and guide rescue units to the distress scene, even when all other communications fail.

Satellite EPIRBs, operate as part of a worldwide distress system. An international satellite constellation maintains a vigilant, global "listening" watch for satellite EPIRB distress signals. The National Oceanic and Atmospheric Administration operates satellites, ground stations, and an alert distribution system serving the United States and a wide segment of the international community.

When activated, the satellite EPIRB transmits a distress signal with a beacon-unique identifying code. The system detects the signal, calculates an accurate distress position, checks the unique identifying code against the EPIRB registration database (vessel and point-of-contact information supplied by the owner), and routes the distress alert with registration information to the responsible USCG (or international) Rescue Coordination Center, 406 MHz EPIRBs with GPS (internal or attached) also provide an immediate GPS position in the information passed to the Rescue Coordination Center.

How the System Works



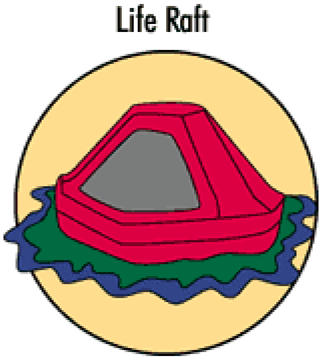
Geostationary satellites make detection almost immediate. If the EPIRB does not have the ability to provide a GPS position, the process to determine a position takes about an hour on average and almost always less than 2 hours. Satellite EPIRBs also include a homing beacon and strobe to help rescue forces quickly locate the distress scene.

Satellite beacons have significant coverage, alerting timeliness, position accuracy, and signaling advantages over other types of EPIRBs (121.5 MHz). Before purchasing or using an other-than-406 MHz EPIRB, be sure you understand its capabilities and limitations.

Mount the EPIRB to float free according to the manufacturer's instructions, if possible. Otherwise, make sure it is **readily accessible.** **Register** the EPIRB with National Oceanic and Atmospheric Administration, according to the instructions provided with the beacon. Registration is mandatory, improves response, and reduces false alarms.

10.1.3 Inflatable Life Rafts

An inflatable life raft can provide a survival platform for an extended period of time. Make sure the life raft is large enough for everyone on board when the boat operates offshore. It should have the appropriate emergency equipment pack, and should be professionally serviced periodically, according to the manufacturer's instructions. USCG approved life rafts must meet a number of stringent material and performance standards.



10.1.4 Immersion Suits

Immersion suits will delay the effects of hypothermia in cold water. They should be stored and maintained according to the manufacturer's instructions. Table 10-1 provides the required or recommended equipment for the vessel safety check decal.

10.2 ELECTROFISHING FIELD MANUAL

The electrofishing field manual and checklist for a safety and health audit are provided in Appendix C.

TABLE 10-1 REQUIRED OR RECOMMENDED EQUIPMENT FOR THE VESSEL SAFETY CHECK DECAL

Numbering	Proper spacing, contrasting color, minimum 3-in. block letters.
Registration/Documentation	Must be on board.
Navigation Lights	Must operate and show proper configuration.
Sound Producing Device	Horn, whistle, or other; bell on boats over 12 m (39.4 ft) or longer.
Personal Flotation Device	One wearable for each passenger, Type IV on boats 16 ft or longer.
Fire Extinguishers	Minimum for size of boat, HALON, FE241/CO_2-current tag.
Visual Distress Signals	INLAND – Visual Distress Signals, Flag, Signal Light, etc.; INT'L - Minimum flares, aerial rockets, or approved signals, not expired.
Backfire Flame Arrestor	Approved, tight, and clean.
Ventilation	For closed compartments with potential for explosive vapors and an ignition source. Blower must work. Warning Posted. Fuel System tanks secure, over 7 gal considered permanent and must be grounded/vented. Hoses in good condition, no leaks.
Anchor and Tackle	Suitable to boat and the area.
Alternate Propulsion	Under 16 ft, paddle or oar; if mechanical, separate fuel tank and starting source.
Dewatering Device	Pumps must work, extra manual bailer.
Overall Vessel Condition	Bilge and equipment area clean, well maintained. Not overloaded, overpowered, or no automotive parts.
Electrical System	Batteries secure, terminals covered, well organized wiring, proper fuses/circuit breakers.
Galley/Heating Systems	Secure system, proper tank installation. No flammable material nearby.
State Requirements	Compiles with state safety requirements. Contact state boating regulators for current state boating regulations.
Marine Sanitation Device	Approved device, overboard discharge sealed.
MARPOL Trash Placard	Boats 26 ft and longer, written plan over 40 ft.
Pollution Placard	Boats 26 ft and longer with machinery compartment.
Navigation Rules	Boats 12 m (39.4 ft) and longer.

11. CHECKLISTS

11.1 EQUIPMENT REQUIREMENTS – SAFETY AND SURVIVAL TIPS

Boater’s Checklist	**Yes**	**No**
State Numbering Displayed		
Certificate of Number (State Registration)		
Certificate of Documentation/Display		
Official Number Displayed		
Personal Flotation Devices		
Throwable Personal Flotation Device		
Visual Distress Signals		
Fire Extinguishers		
Ventilation		
Backfire Flame Arrester		
Sound Producing Device		
Bell		
Navigation/Anchor Lights		
Oil Pollution Placard		
Garbage Placard		
Marine Sanitation Device		
Ring Buoy(a)		
VHF Radio(a)		
Heaving Line(a)		
Fenders(a)		
First Aid Kit(a)		
Flashlight(a)		
Mirror(a)		
Search Light(a)		
Tool Kit(a)		
Chart and Compass(a)		
Boat Hook(a)		
Spare Propeller(a)		
Mooring Line(a)		
Food and Water(a)		
Binoculars(a)		
Spare Batteries(a)		
Marine Hardware(a)		
Sunscreen (SPF 30+)(a)		
Extra Clothing(a)		
Spare Parts(a)		
Spare Fuel(a)		
AM-FM Radio(a)		
Anchor and Tackle(a)		
Dewatering Device(a)		
Alternate Propulsion(a)		
Overall Boat Condition(a)		
Electrical Systems(a)		
Fuel Systems(a)		
Galley/Heating Systems(a)		
State Safety Requirements(a)		
File Float Plan(a)		
Weather Forecast(a)		
(a) Recommended.		

11.2 SMALL CRAFT INSPECTION LIST

	Yes	No
Maintenance Records		
Hull Soundness		
Metal Visual Cracks/Date of Last Ultrasound		
Wood Rot and Loose Planking		
Fiberglass Stress Cracks and Delamination		
Soundness of Deck and Superstructure		
Standing Rigging and Frames		
Stays		
Cleats		
Bits		
Shackles		
Thimbles		
Lines		
Running Rigging		
Lines		
Shackles		
Blocks		
Thimbles		
Engine Compartment		
Belts		
Hoses		
Fuel Lines		
Seacocks		
Bilge Blowers		
Deck Machinery		
Hydraulics		
Wire		
Winches		
OSHA and EA Requirements		

11.3 TRAILER CHECKLIST

Trailer Checklist – Prior to On-Road/Boat Retrieval	Yes	No
Vehicle is appropriate for trailering weight of trailer and boat (e.g., pickup, suburban, or similar)		
Trailer is appropriate for boat		
Tow ball and light system are in good working order		
Safety chains are in good working order		
Vessel tie-downs (if needed) are attached to trailer		
Trailer lights operate (brake and turn signals)		
If outboard engine, engine is in secured up position		
Trailer tires are inflated and suspension in good working order		
Trailer Checklist – Pre-Launch		
Ensure drain plugs are in position		
Trailer lights are disconnected		
Tie-downs removed		
Line attached to bow and is tended		
Inspect ramp for hazards, steep drops, etc.		
Ensure engine starts and cooling system are properly working		

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Appendix A

Nautical Terms

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APPENDIX A

NAUTICAL TERMS

A	
ABAFT	Toward the rear (stern) of the boat; behind.
ABEAM	At right angles to the keel of the boat, but not on the boat.
ABOARD	On or within the boat.
ABOVE DECK	On the deck (not over it – see ALOFT).
AFT	Toward the stern of the boat.
AGROUND	Touching or fast to the bottom.
AHEAD	In a forward direction.
AIDS TO NAVIGATION	Artificial objects to supplement natural landmarks to indicate safe and unsafe waters.
ALOFT	Above the deck of the boat.
AMIDSHIPS	In or toward the center of the boat.
ANCHOR	A heavy metal device, fastened to a chain or line, to hold a vessel in position, partly because of its weight, but chiefly because the designed shape digs into the bottom.
ANCHORAGE	A place suitable for anchoring in relation to the wind, seas, and bottom.
ASTERN	In back of the boat, opposite of ahead.
ATHWARTSHIPS	At right angles to the centerline of the boat; rowboat seats are generally athwartships.
B	
BATTEN DOWN	Secure hatches and loose objects both within the hull and on deck.
BEACON	A lighted or unlighted fixed aid to navigation attached directly to the earth’s surface (lights and day beacons both constitute “beacons”).
BEAM	The greatest width of the boat.
BEARING	The direction of an object expressed either as a true bearing as shown on the chart, or as a bearing relative to the heading of the boat.
BELOW	Beneath the deck.
BIGHT	The part of the rope or line between the end and the standing part on which a knot is formed. A shallow bay.
BILGE	The interior of the hull below the floor boards.
BITTER END	The last part of a rope or chain. The inboard end of the anchor rode.
BLOCK	A wooden or metal case enclosing one or more pulleys and having a hook, eye, or strap by which it may be attached.
BOAT	A fairly indefinite term. A waterborne vehicle smaller than a ship. One definition is a small craft carried aboard a ship.
BOAT HOOK	A short shaft with a fitting at one end shaped to facilitate use in putting a line over a piling, recovering an object dropped overboard, or in pushing or fending off.
BOW	The forward part of a boat.
BOW LINE	A docking line leading from the bow.
BOW SPRING LINE	A bow pivot line used in docking and undocking, or to prevent the boat from moving forward or astern while made fast to a pier.
BOWLINE KNOT	A knot used to form a temporary loop in the end of a line.
BOWSPRIT	A spar extending forward from the bow.
BRIDGE	The location from which a vessel is steered and its speed controlled. “Control Station” is really a more appropriate term for small craft.
BULKHEAD	A vertical partition separating compartments.

BUOY	An anchored float used for marking a position on the water or a hazard or a shoal and for mooring.
C	
CABIN	A compartment for passengers or crew.
CAPSIZE	To turn over.
CAST OFF	To let go.
CATAMARAN	A twin-hulled boat, with hulls side-by-side.
CHAFING GEAR	Tubing or cloth wrapping used to protect a line from chafing on a rough surface.
CHANNEL	1. That part of a body of water deep enough for navigation through an area otherwise not suitable. It is usually marked by a single or double line of buoys and sometimes by range markers. 2. The deepest part of a stream, bay, or strait through which the main current flows. 3. A name given to a large strait, for example, the English Channel.
CHART	A map for use by navigators.
CHINE	The intersection of the bottom and sides of a flat or v-bottomed boat.
CHOCK	A fitting through which anchor or mooring lines are led. Usually U-shaped to reduce chafe.
CLEAT	A fitting to which lines are made fast. The classic cleat to which lines are belayed is approximately anvil-shaped.
CLOVE HITCH	A knot for temporarily fastening a line to a spar or piling.
COAMING	A vertical piece around the edge of a cockpit, hatch, etc. to prevent water on deck from running below.
COCKPIT	An opening in the deck from which the boat is handled.
COIL	To lay a line down in circular turns.
COMPASS	Navigation instrument, either magnetic (showing magnetic north) or gyro (showing true north).
COMPASS CARD	Part of a compass, the card is graduated in degrees, to conform with the magnetic meridian-referenced direction system inscribed with direction which remains constant; the vessel turns, not the card.
COMPASS ROSE	The resulting figure when the complete 360° directional system is developed as a circle with each degree graduated upon it, and with the 000° indicated as True North. True North is also known as true rose. This is printed on nautical charts for determining direction.
CURRENT	The horizontal movement of water.
D	
DAYBEACON	A fixed navigation aid structure used in shallow waters upon which is placed one or more daymarks.
DAYMARK	A signboard attached to a daybeacon to convey navigational information presenting one of several standard shapes (square, triangle, rectangle) and colors (red, green, orange, yellow, or black). Daymarks usually have reflective material indicating the shape, but may also be lighted.
DEAD AHEAD	Directly ahead.
DEAD ASTERN	Directly aft or behind.
DEAD RECKONING	A plot of courses steered and distances traveled through the water.
DECK	A permanent covering over a compartment, hull, or any part of a ship serving as a floor.
DISPLACEMENT	The weight of water displaced by a floating vessel.
DISPLACEMENT HULL	A type of hull that plows through the water, displacing a weight of water equal to its own weight, even when more power is added.

DOCK	A protected water area in which vessels are moored. The term is often used to denote a pier or a wharf.
DRAFT	The depth of water a boat draws.
E	
EASE	To slacken or relieve tension on a line.
EBB TIDE	A receding tide.
EVEN KEEL	When a boat is floating on its designed waterline, it is said to be floating on an even keel.
EYE OF THE WIND	The direction from which the wind is blowing.
EYE SPLICE	A permanent loop spliced in the end of a line.
F	
FAST	Said of an object that is secured to another.
FATHOM	6 ft.
FENDER	A cushion, placed between boats, or between a boat and a pier, to prevent damage.
FIGURE EIGHT KNOT	A knot in the form of a figure eight, placed in the end of a line to prevent the line from passing through a grommet or a block.
FLAME ARRESTER	A safety device, such as a metal mesh protector, to prevent an exhaust backfire from causing an explosion; operates by absorbing heat.
FLARE	The outward curve of a vessel's sides near the bow. A distress signal.
FLYING BRIDGE	An added set of controls above the level of the normal control station for better visibility. Usually open, but may have a collapsible top for shade.
FOLLOWING SEA	An overtaking sea that comes from astern.
FORE AND AFT	In a line parallel to the keel.
FORWARD	Toward the bow of the boat.
FOULED	Any piece of equipment that is jammed or entangled, or dirtied.
FOUNDER	When a vessel fills with water and sinks.
FREEBOARD	The minimum vertical distance from the surface of the water to the gunwale.
G	
GAFF	A spar to support the head of a gaff sail.
GALLEY	The kitchen area of a boat.
GANGWAY	The area of a ship's side where people board and disembark.
GEAR	A general term for ropes, blocks, tackle, and other equipment.
GIVE-WAY VESSEL	A term, from the Navigational Rules, used to describe the vessel which must yield in meeting, crossing, or overtaking situations.
GRAB RAILS	Hand-hold fittings mounted on cabin tops and sides for personal safety when moving around the boat.
GROUND TACKLE	Anchor, anchor rode (line or chain), and all the shackles and other gear used for attachment.
GUNWALE	The upper edge of a boat's sides.
H	
HARBOR	A safe anchorage, protected from most storms; may be natural or man-made, with breakwaters and jetties; a place for docking and loading.
HATCH	An opening in a boat's deck fitted with a watertight cover.
HEAD	A marine toilet. Also the upper corner of a triangular sail.
HEADING	The direction in which a vessel's bow points at any given time.
HEADWAY	The forward motion of a boat. Opposite of sternway.
HEAVE TO	To bring a vessel up in a position where it will maintain little or no headway, usually with the bow into the wind or nearly so.

HEEL	To tip to one side.
HELM	The wheel or tiller controlling the rudder.
HITCH	A knot used to secure a rope to another object or to another rope, or to form a loop or a noose in a rope.
HOLD	A compartment below deck in a large vessel, used solely for carrying cargo.
HULL	The main body of a vessel.
HYPOTHERMIA	A life-threatening condition in which the body's warming mechanisms fail to maintain normal body temperature and the entire body cools.
I	
INBOARD	More toward the center of a vessel; inside; a motor fitted inside the boat.
J	
There are no boating terms under this heading.	
K	
KEDGE	To use an anchor to move a boat by hauling on the anchor rode; a basic anchor type.
KEEL	The centerline of a boat running fore and aft; the backbone of a vessel.
KETCH	A two-masted sailboat with the smaller after mast stepped ahead of the rudder post.
KNOT	A measure of speed equal to one nautical mile (6,076 ft) per hour. A fastening made by interweaving rope to form a stopper, to enclose or bind an object, to form a loop or a noose, to tie a small rope to an object, or to tie the ends of two small ropes together.
L	
LEEWARD	The direction away from the wind. Opposite of windward.
LEEWAY	The sideways movement of the boat caused by either wind or current.
LINE	Rope and cordage used aboard a vessel.
LOG	A record of courses or operation. Also, a device to measure speed.
LUBBER'S LINE	A mark or permanent line on a compass indicating the direction forward; parallel to the keel when properly installed.
M	
MAST	A spar set upright to support rigging and sails.
MONOHULL	A boat with one hull.
MOORING	An arrangement for securing a boat to a mooring buoy or a pier.
MOORING BUOY	A buoy secured to a permanent anchor sunk deeply into the bottom.
N	
NAUTICAL MILE	One minute of latitude; approximately 6,076 ft – about 1/8 longer than the statute mile of 5,280 ft.
NAVIGATION	The art and science of conducting a boat safely from one point to another.
O	
OUTBOARD	Toward or beyond the boat's sides. A detachable engine mounted on a boat's stern.
OUTDRIVE	A propulsion system for boats with an inboard engine operating an exterior drive, with drive shaft, gears, and propeller; also called stern-drive and inboard/outboard.
OVERBOARD	Over the side or out of the boat.
P	
PAINTER	A line attached to the bow of a boat for use in towing or making fast.
PAY OUT	To ease out a line, or let it run in a controlled manner.

PENNANT (sometimes PENDANT)	The line by which a boat is made fast to a mooring buoy.
PERSONAL FLOTATION DEVICE	Personal flotation device (PFD) is official terminology for life jacket. When properly used, the PFD will support a person in the water. Available in several sizes and types.
PIER	A loading/landing platform extending at an angle from the shore.
PILOTING	Navigation by use of visible references, the depth of the water, etc.
PITCH	1. The alternate rise and fall of the bow of a vessel proceeding through waves. 2. The theoretical distance advanced by a propeller in one revolution. 3. Tar and resin used for caulking between the planks of a wooden vessel.
PITCHPOLING	A small boat being thrown end-over-end in very rough seas.
PLANING HULL	A type of hull shaped to glide easily across the water at high speed.
PORT	The left side of a boat looking forward. A harbor.
PROPELLER	A rotating device, with two or more blades, that acts as a screw in propelling a vessel.
Q	
QUARTER	The sides of a boat aft of amidships.
QUARTERING SEA	Sea coming on a boat’s quarter.
R	
REEF	To reduce the sail area.
RIGGING	The general term for all the lines of a vessel.
RODE	The anchor line and/or chain.
ROLL	The alternating motion of a boat, leaning alternately to port and starboard; the motion of a boat about its fore-and-aft axis.
ROPE	In general, cordage as it is purchased at the store. When it comes aboard a vessel and is put to use, it becomes a line.
RUDDER	A vertical plate or board for steering a boat.
RUNNING LIGHTS	Lights required to be shown on boats underway between sundown and sunup.
S	
SCOPE	The ratio of the length of an anchor line, from a vessel’s bow to the anchor, to the depth of the water.
SCREW	A boat’s propeller.
SEA ANCHOR	Any device used to reduce a boat’s drift before the wind.
SECURE	To make fast.
SHACKLE	A U-shaped connector with a pin or bolt across the open end.
SHEAR PIN	A safety device used to fasten a propeller to its shaft; it breaks when the propeller hits a solid object, thus preventing further damage.
SHEET BEND	A knot used to join two ropes. Functionally different from a square knot in that it can be used between lines of different diameters.
SHIP	A larger vessel usually used for ocean travel. A vessel able to carry a “boat” on board.
SHOAL	An offshore hazard to navigation at a depth of 16 fathoms (30 meters or 96 ft) or less, composed of unconsolidated material.
SLACK	Not fastened; loose. Also, to loosen.
SLOOP	A single masted vessel with working sails (main and jib) set fore and aft.
SPLICE	To permanently join two ropes by tucking their strands alternately over and under each other.
SPRING LINE	A pivot line used in docking, undocking, or to prevent the boat from moving forward or astern while made fast to a dock.

SQUALL	A sudden, violent wind often accompanied by rain.
SQUARE KNOT	A knot used to join two lines of similar size. Also called a reef knot.
STANDING PART	That part of a line which is made fast. The main part of a line as distinguished from the bight and the end.
STAND-ON VESSEL	That vessel which continues its course in the same direction at the same speed during a crossing or overtaking situation, unless a collision appears imminent (was formerly called “the privileged vessel”).
STARBOARD	The right side of a boat when looking forward.
STERN	The after part (back) of the boat.
STERN LINE	A docking line leading away from the stern.
STOW	To pack or store away; especially, to pack in an orderly, compact manner.
SWAMP	To fill with water, but not settle to the bottom.
T	
TACKLE	A combination of blocks and line to increase mechanical advantage.
THWART	A seat or brace running laterally across a boat.
TIDE	The periodic rise and fall of water level in the oceans.
TILLER	A bar or handle for turning a boat’s rudder or an outboard motor.
TOPSIDES	The sides of a vessel between the waterline and the deck; sometimes referring to onto or above the deck.
TRANSOM	The stern cross-section of a square-sterned boat.
TRIM	Fore and aft balance of a boat.
TRIMARAN	A boat with three hulls.
TRIPLINE	A line fast to the crown of an anchor by means of which it can be hauled out when dug too deeply or fouled; a similar line used on a sea anchor to bring it aboard.
TRUE NORTH POLE	The north end of the earth’s axis. Also called North Geographic Pole. The direction indicated by 000° (or 360°) on the true compass rose.
TRUE WIND	The actual direction from which the wind is blowing.
TURNBUCKLE	A threaded, adjustable rigging fitting, used for stays, lifelines, and sometimes other rigging.
U	
UNDERWAY	Vessel in motion, i.e., when not moored, at anchor, or aground.
V	
V BOTTOM	A hull with the bottom section in the shape of a “V.”
VARIATION	The angular difference between the magnetic meridian and the geographic meridian at a particular location.
VHF RADIO	A very high frequency electronic communications and direction finding system.
W	
WAKE	Moving waves, track, or path that a boat leaves behind when moving across the waters.
WATERLINE	A line painted on a hull which shows the point to which a boat sinks when it is properly trimmed.
WAY	Movement of a vessel through the water, such as headway, sternway, or leeway.
WHARF	A man-made structure bonding the edge of a dock and built along or at an angle to the shoreline, used for loading, unloading, or tying up vessels.
WINCH	A device used to increase hauling power when raising or trimming sails.
WINDWARD	Toward the direction from which the wind is coming. Opposite of leeward.

X	
There are no boating terms under this heading.	
Y	
YAW	To swing off course, as when due to the impact of a following or quartering sea.
YAWL	A two-masted sailboat with the small mizzen mast stepped abaft the rudder post.
Z	
There are no boating terms under this heading.	

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Appendix B

“Rules of the Water”

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APPENDIX B

"RULES OF THE WATER"

PART A – GENERAL

Rule 1—Application

(a) These Rules shall apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels.

(b) Nothing in these Rules shall interfere in the operation of special rules made by an appropriate authority for roadsteads, harbors, rivers, lakes, or inland waterways connected with the high seas and navigable by seagoing vessels. Such special rules shall conform as closely as possible to these Rules.

(c) Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any State with respect to additional station or signal lights or shapes or whistle signals for ships of war and vessels proceeding under convoy, or with respect to additional station or signal lights for fishing vessels fishing as a fleet. These additional station or signal lights or whistle signals shall, so far as possible, be such that they cannot be mistaken for any light, shape, or signal authorized elsewhere under these Rules.

(d) Traffic separation schemes may be adopted by the Organization for the purpose of these Rules.

(e) Whenever the Government concerned shall have determined that a vessel of special construction or purpose cannot comply fully with the provisions of any of these Rules with respect to number, position, range, or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signaling appliances, such vessel shall comply with such other provisions in regard to number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signaling appliances, as her Government shall have determined to be the closest possible compliance with these Rules in respect to that vessel.

Rule 2—Responsibility

(a) Nothing in these Rules shall exonerate any vessel, or the owner, master, or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

(b) In construing and complying with these Rules, due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger.

Rule 3—General Definitions

For the purpose of these Rules, except where the context otherwise requires:

(a) The word "vessel" includes every description of watercraft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water.

(b) The term "power driven vessel" means any vessel propelled by machinery.

(c) The term "sailing vessel" means any vessel under sail provided that propelling machinery, if fitted, is not being used.

(d) The term "vessel engaged in fishing" means any vessel fishing with nets, lines, trawls, or other fishing apparatus which restrict maneuverability, but does not include a vessel fishing with trolling lines or other fishing apparatus which do not restrict manageability.

(e) The term "seaplane" includes any aircraft designed to maneuver on the water.

(f) The term "vessel not under command" means a vessel which through some exceptional circumstance is unable to maneuver as required by these Rules and is, therefore, unable to keep out of the way of another vessel.

(g) The term "vessel restricted in her ability to maneuver" means a vessel which from the nature of her work is restricted in her ability to maneuver as required by these Rules and is, therefore, unable to keep out of the way of another vessel. The term "vessel restricted in her ability to maneuver" shall include but not be limited to:

    (i) A vessel engaged in laying, servicing, or picking up a navigational mark, submarine cable, or pipeline
    (ii) A vessel engaged in dredging, surveying, or underwater operations
    (iii) A vessel engaged in replenishment or transferring persons, provisions, or cargo while underway
    (iv) A vessel engaged in the launching or recovery of aircraft
    (v) A vessel engaged in mine clearance operations
    (vi) A vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course.

(h) The term "vessel constrained by her draft" means a power-driven vessel which because of her draft in relation to the available depth and width of navigable water is severely restricted in her ability to deviate from the course she is following.

(i) The word "underway" means a vessel is not at anchor, or made fast to the shore, or aground.

(j) The words "length" and "breadth" of a vessel mean her length overall and greatest breadth.

(k) Vessels shall be deemed to be in sight of one another only when one can be observed visually from the other.

(l) The term "restricted visibility" means any condition in which visibility is restricted by fog, mist, falling snow, heavy rainstorms, sandstorms, and any other similar causes.

PART B – STEERING AND SAILING RULES

Section I – Conduct of Vessels in any Condition of Visibility

Rule 4—Application

Rules in this section apply to any condition of visibility.

Rule 5—Look-Out

Every vessel shall at all times maintain a proper look-out by sight as well as by hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

Rule 6—Safe Speed

Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

In determining a safe speed, the following factors shall be among those taken into account:

(a) By all vessels:

  (i) The state of visibility
  (ii) The traffic density including concentrations of fishing vessels or any other vessels
  (iii) The manageability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions
  (iv) At night the presence of background light such as from shore lights or from back scatter from her own lights
  (v) The state of wind, sea, and current, and the proximity of navigational hazards
  (vi) The draft in relation to the available depth of water.

(b) Additionally, by vessels with operational radar:

  (i) The characteristics, efficiency, and limitations of the radar equipment
  (ii) Any constrains imposed by the radar range scale in use
  (iii) The effect on radar detection of the sea state, weather, and other sources of interference
  (iv) The possibility that small vessels, ice, and other floating objects may not be detected by radar at an adequate range
  (v) The number location and movement of vessels detected by radar
  (vi) The more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity.

Rule 7—Risk of Collision

(a) Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt, such risk shall be deemed to exist.

(b) Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.

(c) Assumptions shall not be made on the basis of scanty information, especially scanty radar information.

(d) In determining if risk of collision exists, the following considerations shall be among those taken into account:

(i) Such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change.
(ii) Such risk may sometimes exist even when an appreciable bearing change is evident, particularly when approaching a very large vessel or a tow or when approaching a vessel at close range.

Rule 8—Action to Avoid Collision

(a) Any action taken to avoid collision shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.

(b) Any alteration of course and/or speed to avoid collision shall, if the circumstances of the case admit, be large enough to be readily apparent to another vessel observing visually or by radar; a succession of small alterations of course and/or speed shall be avoided.

(c) If there is sufficient sea room, alteration of course alone may be the most effective action to avoid a close-quarters situation provided that it is made in good time, is substantial and does not result in another close-quarters situation.

(d) Action taken to avoid collision with another vessel shall be such as to result in passing at a safe distance. The effectiveness of the action shall be carefully checked until the other vessel is finally past and clear.

(e) If necessary to avoid collision or allow more time to assess the situation, a vessel may slacken her speed or take all the way off by stopping or reversing her means of propulsion.

(f) (i) A vessel which, by any of these rules, is required not to impede the passage or safe passage of another vessel shall, when required by the circumstances of the case, take early action to allow sufficient sea room for the safe passage of the other vessel.
(ii) A vessel required not to impede the passage or safe passage of another vessel is not relieved of this obligation if approaching the other vessel so as to involve risk of collision and shall, when taking action, have full regard to the action which may be required by the rules of this part.
(iii) A vessel, the passage of which is not to be impeded, remains fully obliged to comply with the rules of this part when the two vessels are approaching one another so as to involve risk of collision.

Rule 9—Narrow Channels

(a) A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.

(b) A vessel of less than 20 m in length or a sailing vessel shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway.

(c) A vessel engaged in fishing shall not impede the passage of any other vessel navigating within a narrow passage or fairway.

(d) A vessel shall not cross a narrow passage or fairway if such crossing impedes the passage of a vessel which can safely navigate only within such channel or fairway. The latter vessel may use the sound signal prescribed in Rule 34(d) if in doubt as to the intention of the crossing vessel.

(e) (i) In a narrow channel or fairway when overtaking can take place only when the vessel to be overtaken has to take action to permit safe passing, the vessel intending to overtake shall indicate her intention by sounding the appropriate signal prescribed in Rule 34(c)(i). The vessel to be overtaken shall, if in agreement, sound the appropriate signal prescribed in Rule 34(c)(ii) and take steps to permit safe passing. If in doubt, she may sound the signals prescribed in Rule 34(d).
(ii) This rule does not relieve the overtaking vessel of her obligation under Rule 13.

(f) A vessel nearing a bend or an area of a narrow channel or fairway where other vessels may be obscured by an intervening obstruction shall navigate with particular alertness and caution and shall sound the appropriate signal prescribed in Rule 34(e).

(g) Any vessel shall, if the circumstances of the case admit, avoid anchoring in a narrow channel.

Rule 10—Traffic Separation Schemes

(a) This rule applies to traffic separation schemes adopted by the Organization and does not relieve any vessel of her obligation under any other rule.

(b) A vessel using a traffic separation scheme shall:

(i) Proceed in the appropriate traffic lane in the general direction of traffic flow for that lane.
(ii) So far as is practicable keep clear of a traffic separation line or separation zone.
(iii) Normally join or leave a traffic lane at the termination of the lane, but when joining or leaving from either side shall do so at as small an angle to the general direction of traffic flow as practicable.

(c) A vessel shall so far as practicable avoid crossing traffic lanes, but if obliged to do so shall cross on a heading as nearly as practicable at right angles to the general direction of traffic flow.

(d) (i) A vessel shall not use an inshore traffic zone when she can safely use the appropriate traffic lane within the adjacent traffic separation scheme. However, vessels of less than 20 m in length, sailing vessels and vessels engaged in fishing may use the inshore traffic zone.
(ii) Notwithstanding subparagraph (d)(i), a vessel may use an inshore traffic Zone when en route to or from a port, offshore installation or structure, pilot station or any other place situated within the inshore traffic zone, or to avoid immediate danger.

(e) A vessel, other than a crossing vessel or a vessel joining or leaving a lane shall not normally enter a separation zone or cross a separation line except:

(i) in cases of emergency to avoid immediate danger
(ii) to engage in fishing within a separation zone.

(f) A vessel navigating in areas near the terminations of traffic separation schemes shall do so with particular caution.

(g) A vessel shall so far as practicable avoid anchoring in a traffic separation scheme or in areas near its terminations.

(h) A vessel not using a traffic separating scheme shall avoid it by as wide a margin as is practicable.

(i) A vessel engaged in fishing shall not impede the passage of any vessel following a traffic lane.

(j) A vessel of less than 20 m in length or a sailing vessel shall not impede the safe passage of a power driven vessel following a traffic lane.

(k) A vessel restricted in her ability to maneuver when engaged in an operation for the maintenance of safety of navigation in a traffic separating scheme is exempted from complying with this Rule to the extent necessary to carry out the operation.

(l) A vessel restricted in her ability to maneuver when engaged in an operation for the laying, servicing or picking up a submarine cable, within a traffic separating scheme, is exempted from complying with this Rule to the extent necessary to carry out the operation.

Section II – Conduct of Vessels in Sight of One Another

Rule 11—Application

Rules in this section apply to vessels in sight of one another.

Rule 12—Sailing Vessels

(a) When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other as follows:

  (i) When each of them has the wind on a different side, the vessel which has the wind on the port side shall keep out of the way of the other
  (ii) When both have the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward
  (iii) If the vessel with the wind on the port side sees a vessel to windward and cannot determine with certainty whether the other vessel has the wind on the port or the starboard side, she shall keep out of the way of the other.

(b) For the purposes of this Rule the windward side shall be deemed to be the side opposite that on which the mainsail is carried or, in the case of a square rigged vessel, the side opposite to that on which the largest fore-and-aft sail is carried.

Rule 13—Overtaking

(a) Notwithstanding anything contained in the Rules of Part B, Sections I and II, any vessel overtaking any other shall keep out of the way of the vessel being overtaken.

(b) A vessel shall be deemed to be overtaking when coming up with a another vessel from a direction more than 22.5 degrees abaft her beam, that is, in such a position with reference to the vessel she is overtaking, that at night she would be able to see only the sternlight of that vessel but neither of her sidelights.

(c) When a vessel is in any doubt as to whether she is overtaking another, she shall assume that this is the case and act accordingly.

(d) Any subsequent alteration of the bearing between the two vessels shall not make the overtaking vessel a crossing vessel within the meaning of these Rules or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

Rule 14—Head-On Situation

(a) When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision, each shall alter her course to starboard so that each shall pass on the port side of the other.

(b) Such a situation shall be deemed to exist when a vessel sees the other ahead or nearly ahead and by night she could see the masthead lights in line or nearly in line and/or both sidelights and by day she observes the corresponding aspect of the other vessel.

(c) When a vessel is in any doubt as to whether such a situation exists, she shall assume that it does exist and act accordingly.

Rule 15—Crossing Situation

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

Rule 16—Action by Give-way Vessel

Every vessel which is directed to keep out of the way of another vessel shall, so far as possible, take early and substantial action to keep well clear.

Rule 17—Action by Stand-on Vessel

(a) (i) Where one of two vessels is to keep out of the way of the other shall keep her course and speed.
    (ii) The latter vessel may, however, take action to avoid collision by her maneuver alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in accordance with these Rules.

(b) When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take such action as will best aid to avoid collision.

(c) A power-driven vessel which takes action in a crossing situation in accordance with subparagraph (a)(ii) of this Rule to avoid collision with another power-driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.

(d) This Rule does not relieve the give-way vessel of her obligation to keep out of the way.

Rule 18—Responsibilities between Vessels

Except where Rules 9, 10, and 13 otherwise require:

(a) A power driven vessel underway shall keep out of the way of:

- (i) a vessel not under command
- (ii) a vessel restricted in her ability to maneuver
- (iii) a vessel engaged in fishing
- (iv) a sailing vessel

(b) A sailing vessel under way shall keep out of the way of:

- (i) a vessel not under command
- (ii) a vessel restricted in her ability to maneuver
- (iii) a vessel engaged in fishing

(c) A vessel engaged in fishing when underway shall, so far as possible, keep out of the way of:

- (i) a vessel not under command
- (ii) a vessel restricted in her ability to maneuver.

(d) (i) Any vessel other than a vessel not under command or a vessel restricted in her ability to maneuver shall, if the circumstances of the case admit, avoid impeding the safe passage of a vessel constrained by her draft, exhibiting the signals in Rule 28.

(ii) A vessel constrained by her draft shall navigate with particular caution having full regard to her special condition.

(e) A seaplane on the water shall, in general, keep well clear of all vessels and avoid impeding their navigation. In circumstances, however, where risk of collision exists, she shall comply with the Rules of this Part.

Section III – Conduct of Vessels in Restricted Visibility

Rule 19—Conduct of Vessels in Restricted Visibility

(a) This rule applies to vessels not in sight of one another when navigating in or near an area of restricted visibility.

(b) Every vessel shall proceed at a safe speed adapted to the prevailing circumstances and condition of restricted visibility. A power-driven vessel shall have her engines ready for immediate maneuver.

(c) Every vessel shall have due regard to the prevailing circumstances and conditions of restricted visibility when complying with the Rules of Section I of this Part.

(d) A vessel which detects by radar alone the presence of another vessel shall determine if a close-quarters situation is developing and/or risk of collision exists. If so, she shall take avoiding action in ample time, provided that when such action consists of an alteration in course, so far as possible the following shall be avoided:

(i) An alteration of course to port for a vessel forward of the beam, other than for a vessel being overtaken
(ii) An alteration of course toward a vessel abeam or abaft the beam.

(e) Except where it has been determined that a risk of collision does not exist, every vessel which hears apparently forward of her beam the fog signal of another vessel, or which cannot avoid a close-quarters situation with another vessel forward of her beam, shall reduce her speed to be the minimum at which she can be kept on her course. She shall if necessary take all her way off and in any event navigate with extreme caution until danger of collision is over.

PART C – LIGHTS AND SHAPES

Rule 20—Application

(a) Rules in this part shall be complied with in all weathers.

(b) The Rules concerning lights shall be complied with from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights which cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out.

(c) The lights prescribed by these rules shall, if carried, also be exhibited from sunrise to sunset in restricted visibility and may be exhibited in all other circumstances when it is deemed necessary.

(d) The Rules concerning shapes shall be complied with by day.

(e) The lights and shapes specified in these Rules shall comply with the provisions of Annex I to these Regulations.

Rule 21—Definitions

(a) "Masthead light" means a white light placed over the fore and aft centerline of the vessel showing an unbroken light over an arc of horizon of 225 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel.

(b) "Sidelights" means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on the respective side. In a vessel of less than 20 m in length the sidelights may be combined in one lantern carried on the fore and aft centerline of the vessel.

(c) "Stern light," means a white light placed as nearly as practicable at the stern showing an unbroken light over an arc of horizon of 135 degrees and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel.

(d) "Towing light" means a yellow light having the same characteristics as the "stern light" defined in paragraph (c) of this Rule.

(e) "All round light" means a light showing an unbroken light over an arc of horizon of 360 degrees.

(f) "Flashing light" means a light flashing at regular intervals at a frequency of 120 flashes or more per minute.

Rule 22—Visibility of Lights

The lights prescribed in these Rules shall have an intensity as specified in Section 8 of Annex I to these Regulations so as to be visible at the following minimum ranges:

(a) In vessels of 50 m or more in length:
- A masthead light, 6 mi
- A sidelight, 3 mi
- A towing light, 3 mi
- A white, red, green, or yellow all-around light, 3 mi.

(b) In vessels of 12 m or more in length but less than 50 m in length
- A masthead light, 5 mi; except that where the length of the vessel is less than 20 m, 3 mi
- A sidelight, 2 mi
- A stern light, 2 mi, A towing light, 2 mi
- A white, red, green or yellow all-round light, 2 mi.

(c) In vessels of less than 12 m in length:
- A masthead light, 2 mi
- A sidelight, 1 mi
- A towing light, 2 mi
- A white, red, green, or yellow all-around light, 2 mi.

(d) In inconspicuous, partly submerged vessels or objects being towed
- A white all-round light; 3 mi.

Rule 23—Power-Driven Vessels Underway

(a) A power-driven vessel underway shall exhibit:

(i) A masthead light forward
(ii) A second masthead light abaft of and higher than the forward one; except that a vessel of less than 50 m in length shall not be obliged to exhibit such a light but may do so;
(iii) Sidelights
(iv) A stern light.

(b) An air-cushion vessel when operating in non-displacement mode shall, in addition to the lights prescribed in paragraph (a) of this Rule, exhibit an all-round flashing yellow light.

(c) (i) A power-driven vessel of less than 12 m in length may in lieu of the lights prescribed in paragraph (a) of this Rule exhibit an all-round white light and sidelights.
(ii) A power-driven vessel of less than 7 m in length whose maximum speed does not exceed 7 knots may in lieu of the lights prescribed in paragraph (a) of this Rule exhibit an all-round white light and shall, if practicable, also exhibit sidelights.

- (iii) The masthead light or all-round white light on a power-driven vessel of less than 12 m in length may be displaced from the fore and aft centerline of the vessel if centerline fitting is not practicable, provided the sidelights are combined in one lantern which shall be carried on the fore and aft centerline of the vessel or located as nearly as practicable in the same fore and aft line as the masthead light or all-round white light.

Rule 24—Towing and Pushing

(a) A power driven vessel when towing shall exhibit:

- (i) Instead of the light prescribed in Rule 23(a)(i) or (a)(ii), two masthead lights in a vertical line. When the length of the tow measuring from the stern of the towing vessel to the after end of the tow exceeds 200 m, three such lights in a vertical line
- (ii) Sidelights
- (iii) A stern light
- (iv) A towing light in a vertical line above the stern light
- (v) When the length of the tow exceeds 200 m, a diamond shape where it can best be seen.

(b) When a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and exhibit the lights prescribed in Rule 23.

(c) A power-driven vessel when pushing ahead or towing alongside, except in the case of a composite unit, shall exhibit:

- (i) Instead of the light prescribed in Rule 23(a)(i) or (a)(ii), two masthead lights in a vertical line. When the length of the tow measuring from the stern of the towing vessel to the after end of the tow exceeds 200 m, three such lights in a vertical line
- (ii) Sidelights
- (iii) A stern light.

(d) A power-driven vessel to which paragraph (a) or (c) of this Rule apply shall also comply with rule 23(a)(ii).

(e) A vessel or object being towed, other than those mentioned in paragraph (g) of this Rule, shall exhibit:

- (i) Sidelights
- (ii) A stern light
- (iii) When the length of the tow exceeds 200 m, a diamond shape where it can best be seen.

(f) Provided that any number of vessels being towed alongside or pushed in a group shall be lighted as one vessel,

- (i) A vessel being pushed ahead, not being part of a composite unit, shall exhibit at the forward end, sidelights
- (ii) A vessel being towed alongside shall exhibit a stern light and at the forward end, sidelights.

(g) An inconspicuous, partly submerged vessel or object, or combination of such vessels or objects being towed, shall exhibit:

- (i) If it is less than 25 m in breadth, one all-round white light at or near the front end and one at or near the after end except that dracones need not exhibit a light at or near the forward end
- (ii) If it is 25 m or more in breadth, two or more additional all-round white lights at or near the extremities of its breadth
- (iii) If it exceeds 100 m in length, additional all-round white lights between the lights prescribed in subparagraphs (i) and (ii) so that the distance between the lights shall not exceed 100 m.
- (iv) A diamond shape at or near the aftermost extremity of the last vessel or object being towed and if the length of the tow exceeds 200 m an additional diamond shape where it can best be seen and located as far forward as is practicable.

(h) When from any sufficient cause it is impracticable for a vessel or object being towed to exhibit the lights or shapes prescribed in paragraph (e) or (g) of this Rule, all possible measures shall be taken to light the vessel or object being towed or at least indicate the presence of such vessel or object.

(i) Where from any sufficient cause it is impracticable for a vessel not normally engaged in towing operations to display the lights prescribed in paragraph (a) or (c) of this Rule, such vessel shall not be required to exhibit those lights when engaged in towing another vessel in distress or otherwise in need of assistance. All possible measures shall be taken to indicate the nature of the relationship between the towing vessel and the vessel being towed as authorized by Rule 36, in particular by illuminating the towline.

Rule 25—Sailing Vessels Underway and Vessels Under Oars

(a) A sailing vessel underway shall exhibit:

- (i) Sidelights
- (ii) A stern light.

(b) In a sailing vessel of less than 20 m in length the lights prescribed in paragraph (a) of this Rule may be combined in one lantern carried at or near the top of the mast where it can best be seen.

(c) A sailing vessel underway may, in addition to the lights prescribed in paragraph (a) of this Rule, exhibit at or near the top of the mast, where they can best be seen, two all-round lights in a vertical line, the upper being red and the lower Green, but these lights shall not be exhibited in conjunction with the combined lantern permitted by paragraph (b) of this Rule.

(d) (i) A sailing vessel of less than 7 m in length shall, if practicable, exhibit the lights prescribed in paragraph (a) or (b) of this Rule, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.

(ii) A vessel under oars may exhibit the lights prescribed in this rule for sailing vessels, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.

(e) A vessel proceeding under sail when also being propelled by machinery shall exhibit forward where it can best be seen a conical shape, apex downwards.

Rule 26—Fishing Vessels

(a) A vessel engaged in fishing, whether underway or at anchor, shall exhibit only the lights and shapes prescribed by this rule.

(b) A vessel when engaged in trawling, by which is meant the dragging through the water of a dredge net or other apparatus used as a fishing appliance, shall exhibit

- (i) Two all-round lights in a vertical line, the upper being green and the lower white, or a shape consisting of two cones with their apexes together in a vertical line one above the other; a vessel of less than 20 m in length may instead of this shape exhibit a basket
- (ii) A masthead light abaft of and higher than the all-round green light; a vessel of less than 50 m in length shall not be obliged to exhibit such a light but may do so
- (iii) When making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a stern light.

(c) A vessel engaged in fishing, other than trawling, shall exhibit:

- (i) Two all-round lights in a vertical line, the upper being red and the lower white, or a shape consisting of two cones with their apexes together in a vertical line one above the other; a vessel of less than 20 m in length may instead of this shape exhibit a basket
- (ii) When there is outlying gear extending more than 150 m horizontally from the vessel, an all-round white light or a cone apex upwards in the direction of the gear
- (iii) When making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a stern light.

(d) A vessel engaged in fishing in close proximity to other vessels engaged in fishing may exhibit the additional signals described in Annex II to these Regulations.

(e) A vessel when not engaged in fishing shall not exhibit the lights or shapes prescribed in this Rule, but only those prescribed for a vessel of her length.

Rule 27—Vessels Not Under Command or Restricted in Their Ability to Maneuver

(a) A vessel not under command shall exhibit:

- (i) Two all-round red lights in a vertical line where they can best be seen
- (ii) Two balls or similar shapes in a vertical line where they can best be seen
- (iii) When making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a stern light.

(b) A vessel restricted in her ability to maneuver, except a vessel engaged in mine clearance operations, shall exhibit:

- (i) Three all-round lights in a vertical line where they can best be seen. The highest and lowest of these lights shall be red and the middle light shall be white
- (ii) Three shapes in a vertical line where they can best be seen. The highest and lowest of these shapes shall be balls and the middle one a diamond.
- (iii) When making way through the water, a masthead light, sidelights and a stern light in addition to the lights prescribed in subparagraph (i)

(iv) When at anchor, in addition to the lights or shapes prescribed in subparagraphs(i) and (ii), the light, lights, or shape prescribed in Rule 30.

(c) A power-driven vessel engaged in a towing operation such as severely restricts the towing vessel and her tow in their ability to deviate from their course shall, in addition to the lights or shapes prescribed in Rule 24(a), exhibit the lights or shapes prescribed in subparagraph (b)(i) and (ii) of this Rule.

(d) A vessel engaged in dredging or underwater operations, when restricted in her ability to maneuver, shall exhibit the lights and shapes prescribed in subparagraphs (b)(i),(ii) and (iii) of this Rule and shall in addition when an obstruction exists, exhibit:

(i) Two all-round red lights or two balls in a vertical line to indicate the side on which the obstruction exists
(ii) Two all-round green lights or two diamonds in a vertical line to indicate the side on which another vessel may pass
(iii) When at anchor, the lights or shapes prescribed in this paragraph instead of the lights or shapes prescribed in Rule 30.

(e) Whenever the size of a vessel engaged in diving operations makes it impracticable to exhibit all lights and shapes prescribed in paragraph (d) of this Rule, the following shall be exhibited:

(i) Three all-round lights in a vertical line where they can best be seen. The highest and lowest of these lights shall be red and the middle light shall be white
(ii) a rigid replica of the code flag "A" not less than 1 m in height. Measures shall be taken to ensure its all-round visibility.

(f) A vessel engaged in mine clearance operations shall in addition to the lights prescribed for a power-driven vessel in Rule 23 or to the light or shape prescribed for a vessel at anchor in Rule 30 as appropriate, exhibit three all-round green lights or three balls. One of these lights or shapes shall be exhibited near the foremast head and one at each end of the fore yard. These lights or shapes indicate that it is dangerous for another vessel to approach within 1,000 m of the mine clearance vessel.

(g) Vessels of less than 12 m in length, except those engaged in diving operations, shall not be required to exhibit the lights prescribed in this Rule.

(h) The signals prescribed in this Rule are not signals of vessels in distress and requiring assistance. Such signals are contained in Annex IV to these Regulations.

Rule 28—Vessels Constrained by their Draft

A vessel constrained by her draft may, in addition to the lights prescribed for power-driven vessels in Rule 23, exhibit where they can best be seen three all-round red lights in a vertical line, or a cylinder.

Rule 29—Pilot Vessels

(a) A vessel engaged on pilotage duty shall exhibit:

(i) At or near the masthead, two all-round lights in a vertical line, the upper being white and the lower red
(ii) When underway, in addition, sidelights and a stern light

- (iii) When at anchor, in addition to the lights prescribed in subparagraph (i), the light, lights, or shape prescribed in Rule 30 for vessels at anchor.

(b) A pilot vessel when not engaged on pilotage duty shall exhibit the lights or shapes prescribed for a similar vessel of her length.

Rule 30—Anchored Vessels and Vessels Aground

(a) A vessel at anchor shall exhibit where it can best be seen:

- (i) In the fore part, an all-round white light or one ball
- (ii) At or near the stern and at a lower level than the light prescribed in subparagraph (i), an all-round white light.

(b) A vessel of less than 50 m in length may exhibit an all-round white light where it can best be seen instead of the lights prescribed in paragraph (a) of this Rule.

(c) A vessel at anchor may, and a vessel of 100 m and more in length shall, also use the available working or equivalent lights to illuminate her decks.

(d) A vessel aground shall exhibit the lights prescribed in paragraph (a) or (b) of this Rule and in addition, where they can best be seen

- (i) Two all-round red lights in a vertical line
- (ii) Three balls in a vertical line.

(e) A vessel of less than 7 m in length, when at anchor not in or near a narrow channel, fairway or where other vessels normally navigate, shall not be required to exhibit the shape prescribed in paragraphs (a) and (b) of this Rule.

(f) A vessel of less than 12 m in length, when aground, shall not be required to exhibit the lights or shapes prescribed in subparagraphs (d)(i) and (ii) of this Rule.

Rule 31—Seaplanes

Where it is impracticable for a seaplane to exhibit lights or shapes of the characteristics or in the positions prescribed in the Rules of this Part she shall exhibit lights and shapes as closely similar in characteristics and position as is possible.

PART D – SOUND AND LIGHT SIGNALS

Rule 32—Definitions

(a) The word “whistle” means any sound signaling appliance capable of producing the prescribed blasts and which complies with the specifications in Annex III to these Regulations.

(b) The term “short blast” means a blast of about one second’s duration.

(c) The term “prolonged blast” means a blast from four to six seconds’ duration.

Rule 33—Equipment for Sound Signals

(a) A vessel of 12 m or more in length shall be provided with a whistle and a bell and a vessel of 100 m or more in length shall, in addition be provided with a gong, the tone and sound of which cannot be confused with that of the bell. The whistle, bell and gong shall comply with the specifications in Annex III to these Regulations. The bell or gong or both may be replaced by other equipment having the same respective sound characteristics, provided that manual sounding of the prescribed signals shall always be possible.

(b) A vessel of less than 12 m in length shall not be obliged to carry the sound signaling appliances prescribed in paragraph (a) of this Rule but if she does not, she shall be provided with some other means of making an efficient signal.

Rule 34—Maneuvering and Warning Signals

(a) When vessels are in sight of one another, a power-driven vessel under way, when maneuvering as authorized or required by these Rules, shall indicate that maneuver by the following signals on her whistle:

- One short blast to mean "I am altering my course to starboard"
- Two short blasts to mean "I am altering my course to port"
- Three short blasts to mean "I am operating astern propulsion."

(b) Any vessel may supplement the whistle signals prescribed in paragraph (a) of this Rule by light signals, repeated as appropriate, whilst the maneuver is being carried out:

(i) These signals shall have the following significance:
  - One flash to mean "I am altering my course to starboard"
  - Two flashes to mean "I am altering my course to port"
  - Three flashes to mean "I am operating astern propulsion."

(ii) The duration of each flash shall be about one second, the interval between flashes shall be about 1 second, and the interval between successive signals shall not be less than 10 seconds.

(iii) The light used for this signal shall, if fitted, be an all-round white light, visible at a minimum range of 5 mi, and shall comply with the provisions of Annex I to these Regulations.

(c) When in sight of one another in a narrow channel or fairway:

(i) A vessel intending to overtake another shall in compliance with Rule 9 (e)(i) indicate her intention by the following signals on her whistle.
  - Two prolonged blasts followed by one short blast to mean "I intend to overtake you on your starboard side"
  - Two prolonged blasts followed by two short blasts to mean "I intend to overtake you on your port side"

(ii) The vessel about to be overtaken when acting in accordance with 9(e)(i) shall indicate her agreement by the following signal on her whistle:
  - One prolonged, one short, one prolonged and one short blast, in that order.

(d) When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signal may be supplemented by at least five short and rapid flashes.

(e) A vessel nearing a bend or an area of a channel or fairway where other vessels may be obscured by an intervening obstruction shall sound one prolonged blast. Such signal shall be answered with a prolonged blast by any approaching vessel that may be within hearing around the bend or behind the intervening obstruction.

(f) If whistles are fitted on a vessel at a distance apart of more than 100 m, one whistle only shall be used for giving maneuvering and warning signals.

Rule 35—Sound Signals in Restricted Visibility

In or near an area of restricted visibility, whether by day or night the signals prescribed in this Rule shall be used as follows:

(a) A power-driven vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast.

(b) A power-driven vessel underway but stopped and making no way through the water shall sound at intervals of no more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them.

(c) A vessel not under command, a vessel restricted in her ability to maneuver, a vessel constrained by her draft, a sailing vessel, a vessel engaged in fishing and a vessel engaged in towing or pushing another vessel shall, instead of the signals prescribed in paragraph (a) or (b) of this Rule, sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.

(d) A vessel engaged in fishing, when at anchor, and a vessel restricted in her ability to maneuver when carrying out her work at anchor, shall instead of the signals prescribed in paragraph (g) of this Rule sound the signal prescribed in paragraph (c) of this Rule.

(e) A vessel towed or if more than one vessel is being towed the last vessel of the tow, if manned, shall at intervals of not more than 2 minutes sound four blasts in succession, namely one prolonged followed by three short blasts. When practicable, this signal shall be made immediately after the signal made by the towing vessel.

(f) When a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and shall give the signals prescribed in paragraphs (a) or (b) of this Rule.

(g) A vessel at anchor shall at intervals of not more than 1 minute ring the bell rapidly for ten seconds. In a vessel 100 m or more in length the bell shall be sounded in the forepart of the vessel and immediately after the ringing of the bell the gong shall be sounded rapidly for about 5 seconds in the after part of the vessel. A vessel at anchor may in addition sound three blasts in succession, namely one short, one long and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel.

(h) A vessel aground shall give the bell signal and if required the gong signal prescribed in paragraph (g) of this Rule and shall, in addition, give three separate and distinct strokes on the bell immediately before and after the rapid ringing of the bell. A vessel aground may in addition sound an appropriate whistle signal.

(i) A vessel of less than 12 m in length shall not be obliged to give the above mentioned signals but, if she does not, shall make some other efficient sound signal at intervals of not more than 2 minutes.

(j) A pilotage vessel when engaged on pilotage duty may in addition to the signals prescribed in paragraph (a), (b) or (g) of this Rule sound an identity signal consisting of four short blasts.

Rule 36—Signals to Attract Attention

If necessary to attract the attention of another vessel, any vessel may make light or sound signals that cannot be mistaken for any signal authorized elsewhere in these Rules, or may direct the beam of her searchlight in the direction of the danger, in such a way as not to embarrass any vessel Any light to attract the attention of another vessel shall be such that it cannot be mistaken for any aid to navigation. For the purpose of this Rule the use of high intensity intermittent or revolving lights, such as strobe lights, shall be avoided.

Rule 37—Distress Signals

When a vessel is in distress and requires assistance she shall use or exhibit the signals described in Annex IV to these Regulations.

PART E – EXEMPTIONS

Rule 38—Exemptions

Any vessel (or class of vessel) provided that she complies with the requirements of the International Regulations for the Preventing of Collisions at Sea, 1960, the keel of which is laid or is at a corresponding stage of construction before the entry into force of these Regulations may be exempted from compliance therewith as follows:

(a) The installation of lights with ranges prescribed in Rule 22, until 4 years after the date of entry into force of these regulations.

(b) The installation of lights with color specifications as prescribed in Section 7 of Annex I to these Regulations, until 4 years after the entry into force of these Regulations.

(c) The repositioning of lights as a result of conversion from Imperial to metric units and rounding off measurement figures, permanent exemption.

(d) (i) The repositioning of masthead lights on vessels of less than 150 m in length, resulting from the prescriptions of Section 3 (a) of Annex I to these regulations, permanent exemption.

(ii) The repositioning of masthead lights on vessels of 150 m or more in length, resulting from the prescriptions of Section 3 (a) of Annex I to these regulations, until 9 years after the date of entry into force of these Regulations.

(e) The repositioning of masthead lights resulting from the prescriptions of Section 2(b) of Annex I to these Regulations, until 9 years after the date of entry into force of these Regulations.

(f) The repositioning of sidelights resulting from the prescriptions of Section 2(g) and 3(b) of Annex I to these Regulations, until 9 years after the date of entry into force of these Regulations.

(g) The requirements for sound signal appliances prescribed in Annex II to these Regulations, until 9 years after the date of entry into force of these Regulations.

(h) The repositioning of all-round lights resulting from the prescription of Section 9(b) of Annex I to these Regulations, permanent exemption.

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Appendix C

Electrofishing Field Manual

C.1 Checklist for Electrofishing Safety and Health Audit

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ELECTROFISHING

FIELD MANUAL

Prepared by

EA Engineering, Science and Technology
1900 Lake Park Drive
Suite 350
Smyrna, Georgia 30080

May 1994

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EA Engineering, Science and Technology
Environmental Assessment and Management
Electrofishing Health and Safety Audit Checklist

Date:
Site name:
Crew:
Boat used:
Generator used:
Motor used:

	Yes	No
Safety Equipment		
Life preservers on-board for each individual?		
Leak-free electrical insulating gloves and boots available for each individual?		
Note: gloves and boots should extend above the knees and elbows.		
Radio available for emergency contacts?		
Radio properly charged?		
First aid kit in boat?		
Burn Jel bandages available in first aid kit?		
Personnel trainned in first aid/CPR		
Fire extinguisher in boat? (type ABC 5lbs)		
Emergency air horn on-board?		
Funnel available for adding gasoline to generator or pump?		
Note: gasoline should not be added to a hot motor.		
Polarized sun glasses		
Boat Safety		
Lights available and working for nightime fishing?		
Boat equipped with an anchor?		
Boat in good repair free from sharp edges and weak or broken areas?		
Fuel tanks positioned a safe distance from the generator and battery?		
Note: gasoline vapors cannot be allowed to contact hot surfaces or sparks.		
Fuel tanks properly capped and lines leak-free?		
Generator/Pump shut-off switch available to eliminate grounding the spark plug?		
Generator/Pump muffler facing outside the boat and shielded to prevent contact in rough seas?		
Foot pedal "dead man" switch controlling the flow of electricity in place in bow of boat?		
Note: device must be operationable for netter(s) to control.		
If no netter foot pedal exists, is there another means of emergency generator shut off?		
Probes used to extend the electrodes to the water made of non-conducting material?		
All electrical connections weather-proof and water tight?		
All electrical conducting surfaces connected to create one circuit on board?		
Note: Separate circuits create "floating metal" which can cause electrocution.		
All surfaces checked with an Ohm meter prior to launching the boat?		
Trailer		
Trailer frame free of significant rust and structurally sound?		
Hitch on trailer solid and working properly with locking hasp?		
Two safety chains present that can be properly connected to the towing vehicle hitch?		
Trailer stand secured properly and can be locked in the vertical and horizontal position?		
Trailer stand and winch handles present and working properly?		
Safety chains present to secure boat to trailer during transportation? (Other than the winch)		
Winch secure and in good working order?		
Winch cable or rope free of broken strands?		

Winch hook a locking type?		
Trailer tires in good shape with adequate tread?		
Trailer wheel bearings been greased (if not sealed)?		
Lights on trailer working properly (brake and turning indicator)?		
Trailer brakes working properly?		
Motor		
Motor bolted to boat with four bolts?		
Motor equipped with proper handles?		
Can the motor be properly locked in the "up" or travel position?		
Emergency motor shut-off connected to operator in case operator falls from boat?		
Post Fishing Checklist		
Generator shut off during rain?		
Boat operated free of sudden turns or changes in direction?		
Comments and items needed for next trip:		
		11/94

TABLE OF CONTENTS

1. INTRODUCTION

This field manual was compiled with available documents which describes basic concepts, proper setup, use, safety, and trouble shooting. The information in this document should reduce the field problems resulting from improper use of our electrofishing equipment. Also, by using proper troubleshooting techniques, it will be possible to make many needed repairs in the field thus salvaging field efforts. The information should also increase understanding of how the systems work and how to properly operate them to increase their effectiveness and reduce unnecessary harm to fish.

Several pages summarize information of EA's available electrofishing equipment based on personal experience and available manufacturers guides. After reviewing these documents, personnel with basic mechanical and electrical skills should be able to properly hook-up, operate and trouble shoot the equipment. If, however for any reason an employee feels uncomfortable with the tasks required, they should not proceed. Safety is always EA's main concern. Electrofishing equipment is **DEADLY** if not handled properly. Do not place yourself in any situation you feel Hazardous. Employees should ask for assistance with any tasks they are hesitant about performing on their own.

2. BASIC CONCEPTS

Electrofishing is in many cases the most effective means of collecting fish for scientific purposes. Electrical current is placed in the water to immobilize fish allowing them to be collected with dip-nets. It involves the use of either AC (alternating current) or DC (direct current) to immobilize fish for capture. These two types of current have very different effects on fish. The choice of which current to use depends on the type of study being performed and the importance of returning healthy fish to the water.

AC And DC Current

AC current typically has the most violent effect on fish. Once in the electrical field a fish will immediately "take a posture transverse to the current in such a way as to receive a minimum of voltage" (Coffelt Electronics). This action is called **oscillotaxis.** Fish will be immobilized quickly and the effect will last longer than that of DC current. Great care must be taken in the collection of fish in this manner. If AC current is applied for too long of a period, the fish may not recover. Another drawback to this type of collection is that since fish usually become immobilized almost immediately when hit by the current, some may be missed because they are shocked while several feet below the surface and out of sight.

DC current will in most cases be the preferred method of collection. Fish react in three ways to DC current. First they line up with the direction of the electrical current, then swim toward the anode (positive electrode). This reaction is called **galvanotaxis.** Finally when fish near the anode they are stunned, roll belly up, and collection becomes possible. The effects of DC current do not last as long as of AC current. When the power is turned off the fish recover quickly. Mortality is far more limited than with the use of AC. This along with the fact that fish actually swim to the anode makes DC current the more effective means of electrofishing.

Control Box

AC or DC current can be selected with electrofishing **control boxes.** In addition to controlling the type of current, a control box allows adjustments to how the current acts. Most equipment will allow you select for standard or pulsed output and to vary the pulse width and frequency of pulses which allows for more efficient collections and limits the risk and stress to fish.

Pulsed output means that the electrical current going from the system into the water comes in pulses or waves. When the pulse rate is low and the width of the field is narrow, less current is required to collect fish. This results in less stress to fish. Since conductivity of water (the ease with which an electrical charge to passes through it) varies it is necessary to have the ability to adjust the pulse rate and width for optimum collection with minimum harm to the fish being collected. EA uses a simple rule of thumb to determine what setting is adequate. Adjustments should be made until the unit output reads **5-6 amps**. Less than 5 is probably below the optimum collection output. More than six is probably inflicting too much damage to fish.

The control box also allows selection of voltage output. This selector should be positioned at the lowest possible setting that allows 5-6 amps to be obtained by adjusting the pulse width and rate.

Types of Equipment

There are several types of electrofishing equipment available. EA typically uses boat, backpack, or pram type units. These units differ in the type of power source used and in their application.

Boat electrofishing is utilized where water depths and characteristics make maneuvering the boat possible. EA primarily uses this type of electroshocking in reservoirs and in navigable rivers. Boat electrofishing usually involves the use of a generator as an electrical power source. The generator sends electricity through a control box which allows the operator to adjust the type of electrical current being placed in the water.

Both pram and back-pack electrofishing are designed for use in areas where boat electrofishing may not be possible or practical. Backpack units consist of a power source (a small generator or battery) and a control box mounted on a backpack frame. Two hand held electrodes (anode and cathode) are utilized by the operator to place electrical current in the water. The user is protected from the current by rubber waders and electrical gloves.

Pram shocking involves the use of a power source and electroshocking unit either placed on the bank or in a barge or small boat. Like backpack electrofishing the operator utilizes two hand held electrodes to place current in the water. The methods differ in that the operator is not required to carry the power source. Cables with up to 50 ft of wire allow mobility over a large section of water.

In all types of electrofishing, current is passed through the water between a positive electrode **(anode)** and a negative electrode **(cathode)**. EA typically uses a boom mounted anode and the boat hull as a cathode when boat electrofishing. You may however, see different arrangements. In back-pack electrofishing both the anode and cathode are the hand-held probes. In pram shocking, the cathode may be the hull of either the barge or boat carrying the equipment or a cable from a bank-mounted power source. Pram shocking may also be performed with the anode and cathode hand-held as in back-pack electrofishing.

Conductivity

Electrofishing works by passing electrical current through a fishes body causing the effects described above. Several factors effect the amount of current passing through the fishes body and thus the effectiveness of electrofishing. If the conductivity of the fishes body is equal to or slightly above the conductivity of the surrounding water, the electricity will choose the path of least resistance and pass through the fish. The greater the conductivity of the fishes body in relation to the surrounding water, the greater the effect of the electricity on the fish. The conductivity of fish flesh differs among species. When shocking you may observe catfish floating up as far as 50 ft from the boat. At the same time scaled fish may not succumb to the current until they actually pass within a few feet of the anode. Also larger fish tend to receive a larger charge of electricity than do smaller fish.

Another factor that influences the effectiveness of electroshocking is the conductivity of the water. Pure distilled water will actually act as an insulator in an electrical current. This is because there are few electrolytes or dissolved solids to conduct the electricity. It would take a great deal of current to pass through this type of water. Conversely the water of a typical lake or river in the South may be very high in dissolved solids. This water will readily conduct very low amounts of current. In all cases the conductivity of the water must be equal to or below the conductivity of the fishes body for electrofishing to be effective. It is not effective to shock in salt water because it is an electrolyte solution. The conductivity of the water is so much higher than that of the fish in it that an electrical current will find that the path of least resistance is actually around the fish rather than through it.

Conductivity of the water being surveyed should always be checked before attempting electrofishing. If it is very low or extremely high, a different type of collection should be considered. When backpack or pram shocking small streams it may actually be possible to increase the conductivity of the water by placing a block of salt upstream of the study area several hours before beginning your survey. This however should only be considered in very controlled conditions.

Equipment Operation

A typical boat shocking survey would be made up of two or three team members. The team leader or an experienced technician will operate the boat and shocking system while the other crew member(s) will stand at a bow mounted railing and collect fish with properly insulated dip nets. Either the operator or the netter will operate a foot switch which will immediately cut the power output if released. This is a very important safety feature and no electroshocking boat should be operated without safety switch.

Backpack and pram shocking are slightly more hazardous than boat shocking because of the users position in the water with the electrical charge. Field training sessions should be completed with an experienced backpack or pram operator before attempting this technique. Basically the system is a miniaturized version of the boat system. At least two operators are required. One person monitors equipment while the other handles the electrodes. One of the electrodes has a dip-net attached to the end. The operator wades through the water holding the electrodes 2-3 feet apart. Thumb switches on the handles of the probes serve the same function as the foot switch on the boat. When a fish is shocked the operator dips it up with the net, releases (turns off) the switches on the handle and places it in a bucket carried by the second crew member. When pram shocking special attention should be paid by all crew members to the size of the electrical field. If the cathode is mounted on a barge, boat, or bank the electrical field will reach from that point to the anode held by the operator. When backpack shocking this field is concentrated only around the two probes.

3. SAFETY RULES

Safety is a matter that should be foremost on all crew members minds when conducting electrofishing operations. The amount of current in the water may at times be in excess of 600 volts. The amount of amperage generated during typical shocking operations averages 6 amps. This is enough to **Kill** you if you come in direct skin contact with an electrical source such as a cathode, anode, or improperly grounded boat or generator. This hazard is compounded by the fact that the boat and other equipment may be wet.

Always follow the manufacturers instructions when installing or operating electrical equipment. Applicable manuals have been included in this binder. It is each crew members responsibility to familiarize themselves with this information. Furthermore it is the responsibility of each crew member to assure that others are following proper procedure. If you are asked to do something that you feel is improper or unsafe, you have the authority to refuse. Don't depend on someone else to look out for you. Look out for yourself. Read through these manuals so that you have a understanding of what is safe and what is not.

Despite all of this, electroshocking surveys can be conducted in a safe manner. All that is required is proper attention to detail and the use of the safety equipment provided to you.

Here are some common sense rules that **Must** be followed by all crew members at all times:

1. Read the available literature; know what you are doing.
2. Take first aid and CPR. Know how to use it and when.
3. Stay alert! Watch out for the other guy.
4. Always wear PFD.
5. Correctly hook up equipment, check for hazards.
6. If wading is involved, be sure waders are in good shape. **No Leaks!**
7. Wear electrical gloves when operating electroshocking equipment.
8. Never touch a loose wire or make an adjustment while unit is in operation.
9. Always use safety switchs.
10. Never over extend yourself when netting fish.
11. Warn observers of danger.
12. Know proper boating safety
13. Communicate hazards to boat operator. The operator has a limited view in front of the boat because of the position of the netters. Don't assume he/she sees what you see. If noise level restricts normal conversation, establish hand signals.
14. Never place your hand in the water.
15. If gloves become wet inside, turn off equipment and dry them.
16. Keep boat deck as dry and clear of obstacles as possible.
17. Look up from the water from time to time to assure that overhanging branches or other items don't pose a risk.

18. Take breaks, fatigue leads to accidents.
19. No Horseplay.
20. If you have a question, Ask...

See the following pages for safety information extracted primarily from Coffelt's manuals.

Some shocking facts about...

Coffelt Electronics

LEADERS IN ELECTROFISHING EQUIPMENT

FACTS AND SAFETY TIPS ON ELECTROFISHING

EMERGENCY MEASURES

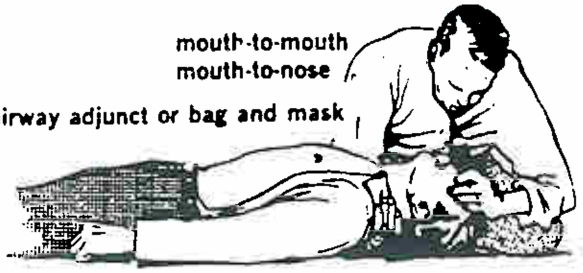
Heart-Lung Resuscitation

IF UNCONSCIOUS

Airway - Open by tilting head back

IF NOT BREATHING

Breathe - Inflate lungs rapidly 3-5 times



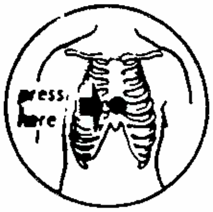
IF CAROTID PULSE IS PRESENT

continue 12 lung inflations per minute

IF PULSE IS ABSENT

Pupils dilated and deathlike appearance

Circulate



Depress Sternum 1½" to 2" once per second

CONTINUE RESUSCITATION until spontaneous pulse returns

ONE OPERATOR – alternate 2 quick inflations with 15 compressions

TWO OPERATORS – interpose one inflation after every fifth compression

YOUR
HEART
ASSOCIATION

produced by the American Heart Association • 44 East 23rd Street, New York, N. Y. 10010

Mouth-to-Mouth (Mouth-to-Nose) Method of ARTIFICIAL RESPIRATION

If there is foreign matter visible in the mouth, wipe it out quickly with your fingers or a cloth wrapped around your fingers.

a. Tilt the head back so the chin is pointing upward (Fig. 1). Pull or push the jaw into a jutting-out position (Fig. 2 and 3).
These maneuvers should relive obstruction of the airway by moving the base of the tongue away from the back of the throat.


Fig. 1


Fig. 2


Fig. 3

b. Open your mouth wide and place it tightly over the victim's mouth. At the same time pinch the victim's nostrils shut (Fig. 4) or close the nostrils with your cheek (Fig. 5). Or close the victim's and place your mouth over the nose (Fig. 6). Blow into the victim's mouth or nose. (Air may be blown through the victim's teeth, even though they may be clenched.)
The first blowing efforts should determine whether or not obstruction exists.

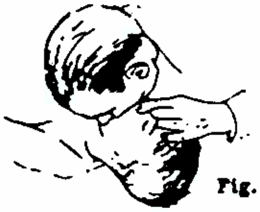


Fig. 4


Fig. 5

c. Remove your mouth, turn your head to the side, and listen for the return rush of air that indicates air exchange. Repeat the blowing effort.
For an adult, blow vigorously at the rate of about 12 breaths per minute. For a child, take relatively shallow breaths appropriate for the child's size, at the rate of about 20 per minute.

d. If you are not getting air exchange, recheck the head and jaw position (Fig. 1 or Fig. 2 and Fig. 3). If you still do not get air exchange, quickly turn the victim on his side and administer several sharp blows between the shoulder blades in the hope of dislodging foreign matter (Fig. 7).
Again sweep your fingers through the victim's mouth to remove foreign matter.

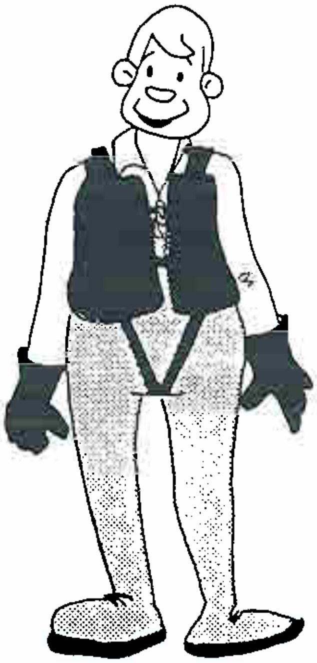

Fig. 6


Fig. 7

Those who do not wish to come in contact with the person may hold a cloth over the victim's mouth or nose and breathe through it. The cloth does not greatly affect the exchange of air.

Don't be shocked - Son

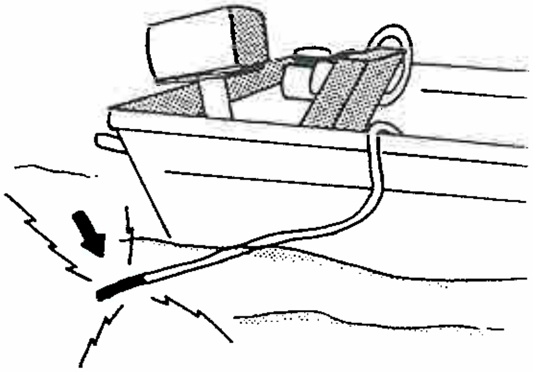
1. WEAR THE PROPER SAFETY ITEMS:



Three basic safety items must be worn by those involved in electrofishing. 1. LIFE JACKET - Even if you are an excellent swimmer or working in shallow water your life may at some time depend on a life jacket. Don't be without it! 2. WADERS - High waders are preferrable. Make sure there are no leaks. (If you have leaks, you'll probably find them when the juice is turned on). 3. RUBBER GLOVES - The easily slipped on gauntlet type are best. Always watch what you touch when working with electricity.

2. NEVER TOUCH THE ANODE OR CATHODE:

Since the business end of an electrofishing unit is its probes, it should be clear they are not to be touched under any circumstances. Make sure you are aware of their location at all times. Also make sure you do not operate any conductive equipment near the probes.

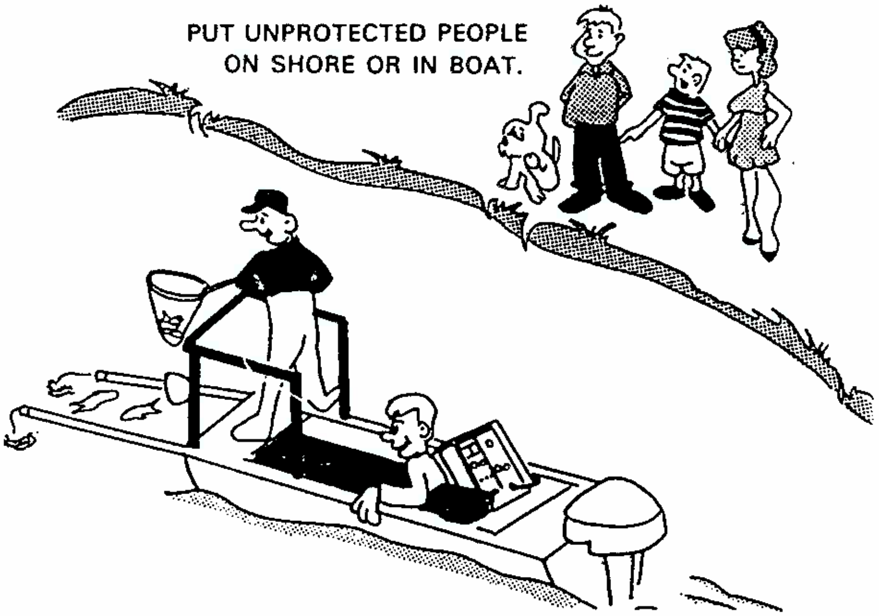


3. KEEP BOOTS AND GLOVES DRY:

If you have leaks in your boots or gloves you run the same risk as the fish. Maintain all protective clothing in a waterproof, shockproof condition. Make sure you are thoroughly dry during an electrofishing operation.

4. KEEP OTHER PEOPLE CLEAR OF AREA:

Before starting an electrofishing operation make sure that everybody, including pets, is in a safe place. Everyone on shore should be kept at a safe distance and only authorized people should participate in the operation. Remember you are using a very powerful force which can be lethal to unprotected persons or animals.

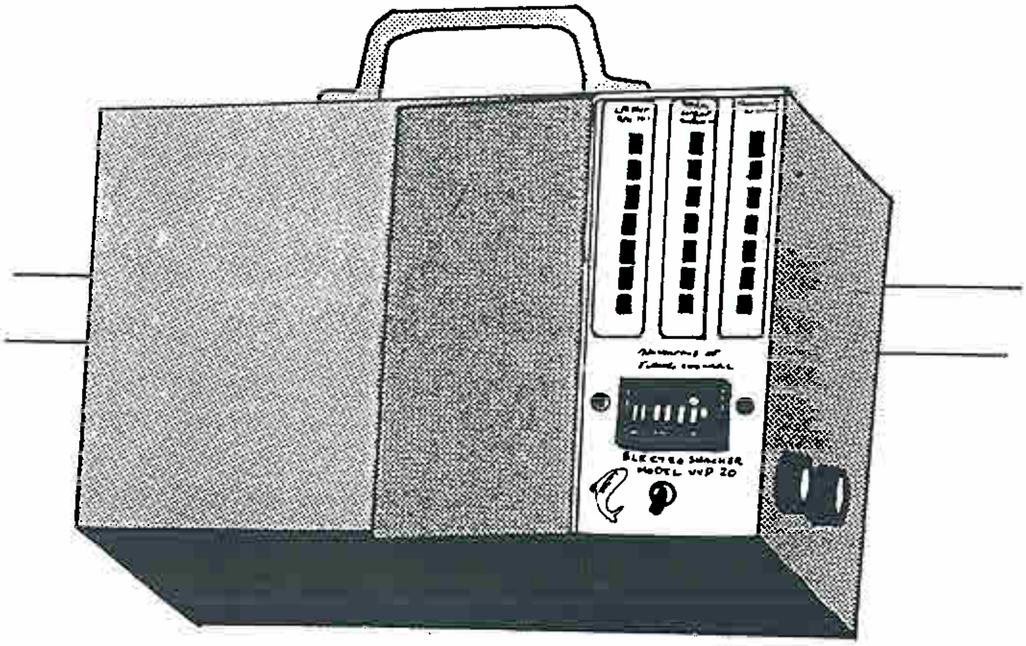


PUT UNPROTECTED PEOPLE
ON SHORE OR IN BOAT.

important safety tips:

5. USE PROPER EQUIPMENT:

As suggested before - make sure you use the appropriate equipment. Commercially designed units have every possible safety feature built into them in the testing stages. Don't take chances with poorly designed, home-made equipment. It just isn't worth the risk!



6. FOLLOW MFRS. OPERATION INSTRUCTIONS:

Reliable professionally designed equipment comes with complete operating, safety and hookup instructions. Even if you think equipment operation is perfectly obvious, read and understand every step; then read it again. It is very important to you.

7. KNOW PROPER FIRST AID PROCEDURES:

If trouble should occur, your life or someone elses may depend on adequate knowledge of first aid. Keep on hand a well equipped kit and check it often. Be especially familiar with the proper techniques for mouth-to-mouth resuscitation.

When all safety and proper operating procedures are followed, electrofishing is a safe operation. Don't allow yourself to be narcotized with the fish by foolishly ignoring basic safety rules and procedures.

Reprinted by Tempo Products Company, Cleveland, Ohio, 44139, in the interest of better boating safety. This article originally appeared in the February 1960 issue of Popular Boating Magazine and is reprinted with their permission.

STATIC ELECTRICITY

Here's how to understand and prevent gasoline explosions that occur due to improper grounding of the fuel system

By Geoffrey Smith

THE BLAST came out of nowhere as far as anyone could see. I came to in ice-cold water fighting to get rid of my rubber hip boots and mackinaw, then swimming up wind to get away from the flames. The score was this: One sailor killed, the total loss of a coastwise schooner and half the pier burnt away. The cause: static electricity.

All this happened 34 years ago on the West Coast of Canada. We knew very little about handling gasoline except that it was considered somewhat dangerous to smoke. There were no dockside pumps at this out-of-the-way harbor and accepted re-fueling practice was to roll drums of gasoline down the pier, hoist them aboard and suspend them from a boom over an out-size funnel fitted into the fill pipe. One man handled the operation on deck, unscrewed the bung, steadied the drum over the funnel and controlled the flow of gasoline by opening and closing the vent. This was the man who was killed—he had spelled me so that I could warm up in the lee of the deck house and catch a smoke.

Our ship and dozens of others had used this method of refueling hundreds of times and nothing had ever gone wrong. It may have been because of the crisp dry weather, it may have been that the drum was hoisted a little higher than usual and the gasoline flowed farther and faster into the funnel. Neither of these explanations was of any great comfort to the captain of the schooner, the owner of the pier or the dead sailor's widow.

In the next couple of years I was involved directly or indirectly with three more gasoline explosions, all of them due to human error. One was when cargo was stowed in an air shaft, reducing ventilation, and a sea-going schooner went up a hundred miles off-shore from the fumes of a leaky beat-up engine. The second time was when we went to the help of an out-of-fuel fishing boat, and gasoline fumes from a now-illegal under-deck vent seeped 30 feet to an open galley fire. The third time was when a deck hand filling a five-gallon can for a light plant moved an oil lantern closer so he could see better. Since then I have learned a lot about gasoline.

Static electricity is generally considered to be frictional electricity generated by two dissimilar materials passing over each other, such as gasoline flowing through a pipe into the air, a car rolling along a highway, or you yourself brushing your hair or walking across a carpet. These and many other actions cause electrical rearrangement. How many times have you reached for a door knob and received an electrical shock, or fondly petted the family dog or cat and had the little animal take off with every hair standing on end? Nylon and other synthetic cloth is particularly conducive to the creation of static electricity and in the dark you can see it. These examples of static occur generally in very dry weather, but when filling your boat's tank it can happen at any time.

Along the coast we generally feel static sparks in the cold weather which a Northwest wind brings in and naturally assume that it is most prevalent in the winter. One reason behind this is that warm weather in coastal waters usually goes with high humidity and the dampness of the air tends to dissipate the electrical discharge.

Your main protection against static electricity while refueling is grounding, also known as bonding, which is direct metal-to-metal contact from the fuel hose nozzle to the water in which your boat is floating.

The first step is to be sure that the hose nozzle is in direct contact with the fill pipe deck fitting. Most fill pipes are metal and consequently you have metal contact to the fuel tank, but in some cases the pipe may be rubber or plastic which, although dangerous, is sometimes used for economy where there are complex curves. If you have such a fill pipe your best bet is to replace it with metal or make a connection with copper wire (8 to 10 gauge or bigger) from the deck fitting to the tank. Should you use solder be very sure that the tank is empty and free from fumes.

Your next concern is the fuel line from tank to engine. If it is metal you have nothing to worry about, but if it is plastic or other non-metallic material you must follow the procedure given above for the fill pipe. Once you are grounded to the engine there is direct metal contact through the engine casing and propeller shaft to the water. In the very rare case where there is a non-metallic gasket on the shaft to allow for play you must set up a metal contact either through it or over it.

Recently fiberglass gasoline tanks have come into being. These pose problems of their own. One method of grounding would be to run a copper wire around the tank from fill pipe to fuel line, but this would not ground the fuel in the tank. An expert on the subject suggests the manufacturers imbed the wire in the fiberglass connected to intake and outlet fittings. This would avoid corrosion which could occur if a wire went through the fuel.

It is not necessary to have a big static spark to set off an explosion—anything you can feel is enough. Even the spark caused by brushing your hair will do it under the right combination of fumes and air.

A disquieting thought is that, under certain atmospheric conditions, you can cause a static explosion yourself, particularly if you are wearing synthetic clothing and the almost certainty if you are insulated by rubber soled shoes. So, for safety's sake and the remote chance, ground yourself before you open the fill pipe deck fitting and release fumes to the air. You can do this by dipping your hand into the water overside, touching the engine block or a metal fitting on the dock connecting to the water.

Diesel fuel is too lean for static electrical explosion under normal conditions, but should it vaporize through contact with hot metal or if a leak in hose or nozzle forms a fine mist, it is potentially dangerous.

Another danger point is water. If there is water mixed with the fuel you are taking aboard the possibility of static spark increases ten to 20 fold.

Gasoline is dangerous unless it is handled properly. Pound for pound, in the right air to vapor mixture, it has more explosive power than T.N.T. But it is a fine efficient fuel and all you need do is treat it as you would the sea itself: with infinite respect. — ⚓

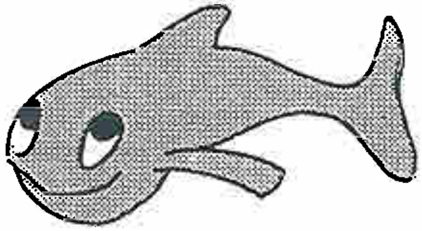
Let's start with the basic elements:

WATER

COMES HARD OR SOFT,
CAN RUN FAST (STREAMS)
OR BE DEEP (LAKES).

The first thing you need is some water. It comes in all types from fast running mountain streams to deep rivers and lakes. It seems almost every location has some different water problem for the electrofisher. The hardness [number of dissolved particles] determines the conductivity of the water, or how well it will carry an electrical current. The conductivity of water is measured by ohms per centimeter. The higher the ohms number the softer the water. Water temperature is another variable affecting the electrofisher.

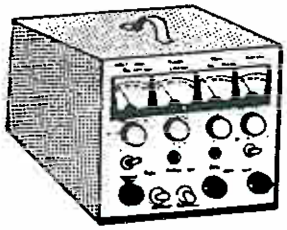
FISH



COMES LARGE AND SMALL
AND IN DIFFERENT KINDS.

Fish come large-small-fat-skinny-handsome-ugly, etc. Various species of fish react differently to electro-shocks. For instance large fish are influenced more quickly and by relatively smaller voltages. Fish also have different densities of flesh which means that conductivity can vary from species to species.

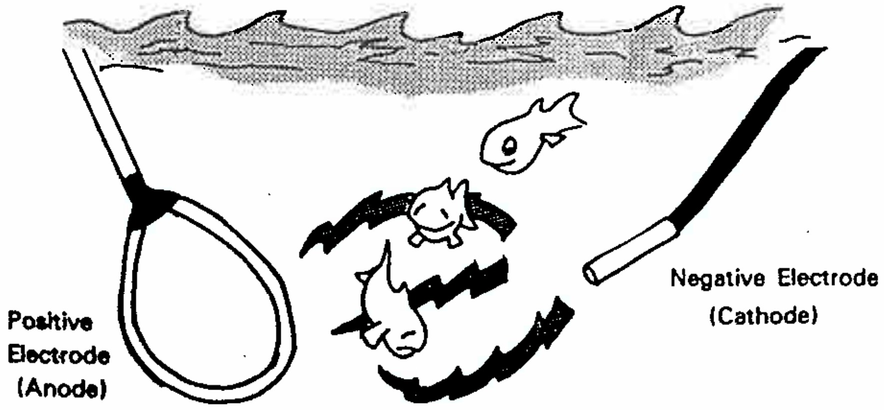
ELECTROSHOCKER



COMES IN A VARIETY OF
SHAPES AND SIZES TO
DO DIFFERENT JOBS.

Our first suggestion is to use an electronic unit which is designed and tested for electrofishing. Home-made units can be very dangerous. Electroshockers basically are designed to put electricity into water. The more control you have over the types of electric current, the more successful you're going to be in dealing with the variables involved. The two basic types of electricity used are AC or DC. [More about that later.] Choose the unit that best suits the physical surroundings, type of water and fish you are going after.

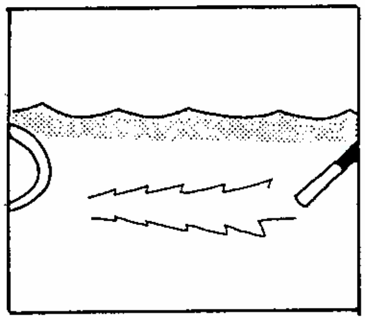
Put them all together and they spell ZAP!



Electricity needs positive and negative electrodes to complete a circuit. In boat electrofishing the negative electrode [cathode] usually hangs over the boat's side. The positive electrode [anode] can dangle from a boom or be hand maneuvered. You put them into the water, aim at the fish, turn on the juice [after following all safety and proper operating procedures] and the result is a bunch of surprised fish.

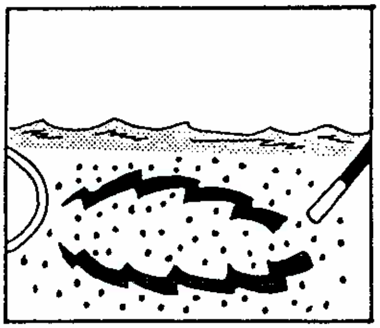
It's the variables that make electrofishing interesting:

Water Conductivity:



LOW CONDUCTIVITY - HARD TO GET ELECTRICITY FROM POS. TO NEG.

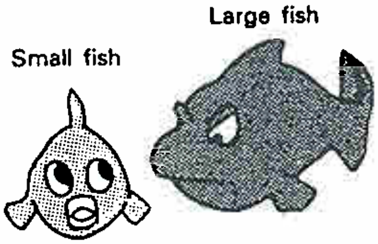
The amount of dissolved solids in the water determines its conductivity. The fewer the dissolved solids the harder it is to pass electrical current from positive to negative electrodes. For instance, distilled water is actually an insulator. Hard water, with lots of dissolved solids is a good conductor and current passes readily between anode and cathode.



HIGH CONDUCTIVITY - EASY TO PASS CURRENT FROM POS. TO NEG.

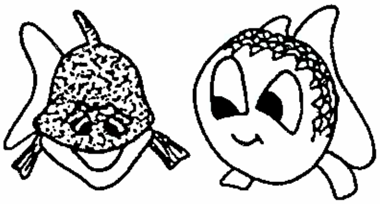
You might think that high water conductivity automatically means really good electrofishing. Not necessarily so. This is where the size of fish and the density of their flesh is important. As an example salt water has very high conductivity, but fish have relatively less conductivity in their bodies and the electrical current sort of slides around them requiring more voltage for a reaction.

When the conductivity of the water is lower than the conductivity of the fish, electrofishing conditions are more favorable. Electrical force lines are drawn to the fish with a resultant satisfactory reaction. Again control of current, pulse, etc. is essential for best results.



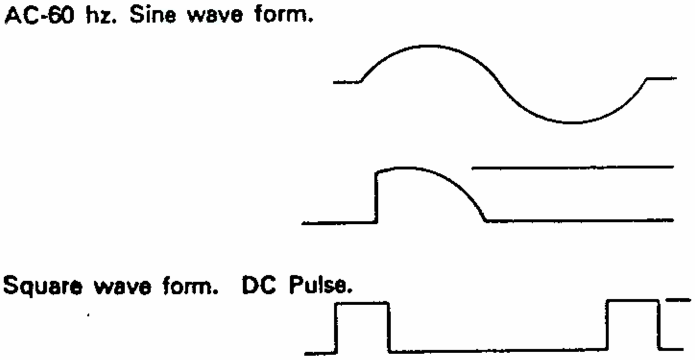
LARGE FISH REACT TO CURRENT MORE THAN SMALL FISH.

Larger fish receive a greater voltage in the water than smaller fish and are influenced more quickly and by relatively smaller voltages. Furthermore, the conductivity of fish flesh varies from species to species and environment to environment.



FISH FLESH OF DIFFERENT SPECIES CAN HAVE DIFFERENT CONDUCTIVITIES.

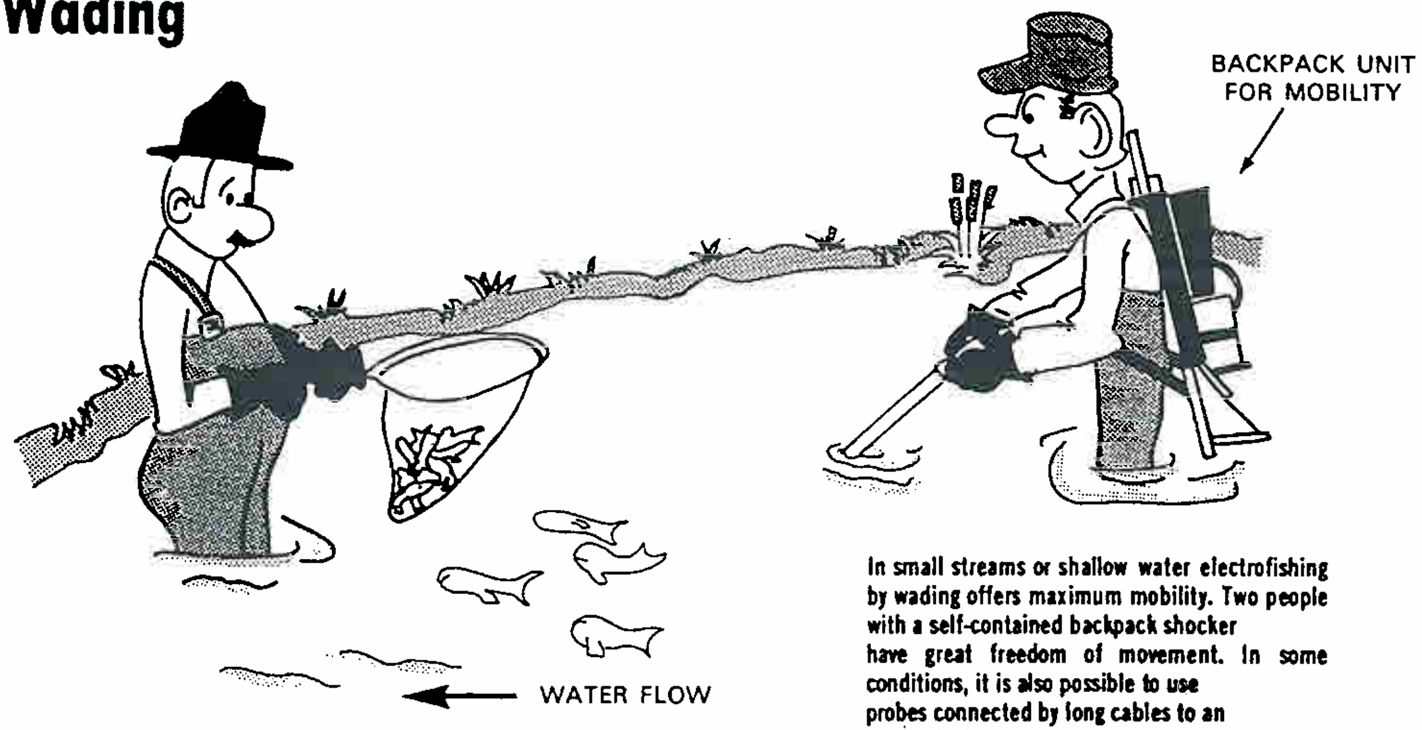
Variable shocking waves & currents help match the right shocking to the water conditions



As we've suggested, the more control over the type of current and pulse rate, etc. the better the chances for successful electrofishing. It's not our intention to get too technical, but to give you some idea of the basic principles of electrofishing. In summation, you can introduce continuous Alternating or Direct currents into the water, or you can break the current by pulsing a certain number of times per second. This is extreme simplification and for more detailed consideration there is an abundance of technical data available.

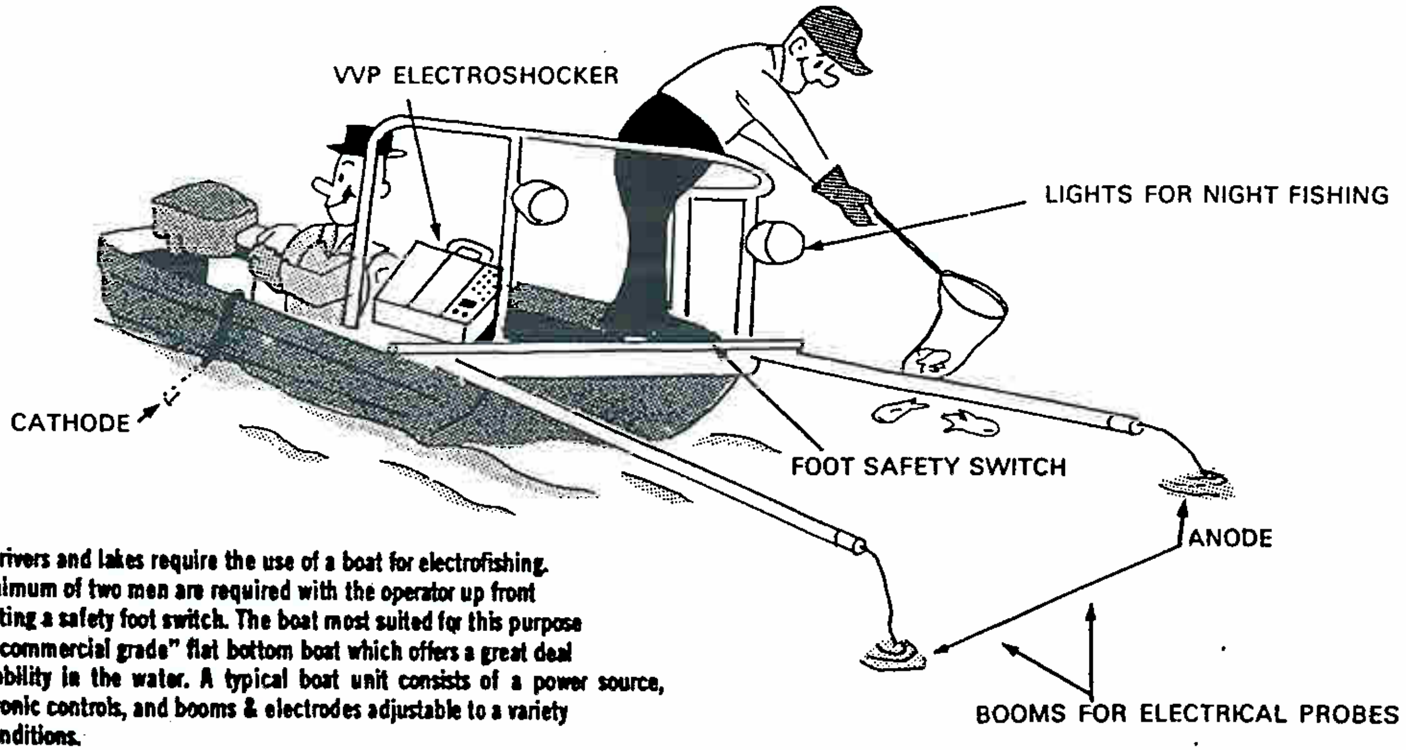
A couple of popular electrofishing set ups:

Wading



In small streams or shallow water electrofishing by wading offers maximum mobility. Two people with a self-contained backpack shocker have great freedom of movement. In some conditions, it is also possible to use probes connected by long cables to an electrofishing unit on the bank or in a boat.

From a boat:



Most rivers and lakes require the use of a boat for electrofishing. A minimum of two men are required with the operator up front operating a safety foot switch. The boat most suited for this purpose is a "commercial grade" flat bottom boat which offers a great deal of stability in the water. A typical boat unit consists of a power source, electronic controls, and booms & electrodes adjustable to a variety of conditions.

A suitable holding tank should be available to contain fish. Several sizes of boat are available with the component equipment outfitted to individual needs.

WARNING

HIGH VOLTAGE

IS USED IN THE OPERATION
OF THIS EQUIPMENT

DEATH ON CONTACT

MAY RESULT IF OPERATING PERSONNEL
FAIL TO OBSERVE SAFETY PRECAUTIONS

BE CAREFUL TO AVOID CONTACT WITH HIGH-VOLTAGE CIRCUITS
OR 115VAC INPUT CONNECTIONS WHILE CHECKING OR
SERVICING THIS EQUIPMENT

DIRECT CURRENT is a flow of current in one direction only. This flow is from the negative cathode to the positive anode.

The reaction of fish to direct current is quite different from their reaction to alternating current. The first reaction of the fish is to turn their heads toward the positive anode and start to swim toward it. This reaction, known as galvanotaxis, will continue until the fish either reaches the anode or encounters a current sufficiently strong enough to cause it to turn on its side and become incapable of any further forward movement. This reaction is known as galvanonarcosis. The severe and often harmful muscle contractions encountered with alternating current do not occur and the fish recover much more quickly from a direct current shock. Thus the mortality rate is much less with direct current than with alternating current. Also, galvanotaxis does not occur with alternating current.

Even greater anode attraction is possible by the use of pulsed direct current. Pulsed direct current is obtained by interrupting a direct current flow with an electronically controlled switch which will give a number of on and off pulses of direct current. Different species of fish differ in the number of pulses per second which will best attract them. Adjustment of pulse frequency and duration are of great importance in electrofishing to produce the desired galvanotaxis reaction.

Experimentation has shown that a fast rising pulse of 325 volts to 425 volts and with a frequency of 40 to 80 pulses per second is the most desireable for optimum results in streams in the range of 35 μmhos to 1000 μmhos per cm^3 conductivity.

The Type VI, Type VII, and the Type VIII electrofishers were designed for use in waters whose conductivity ranges from 20-1350 micromhos, 20-1000 micromhos, and 35-500 micromhos, respectively.* The Type VI is for use in large lakes and rivers and the Type VII is for medium size streams and lakes, and the Type VIII is for use in small fresh water streams. All Smith-Root electrofishers were designed to incorporate the desireable characteristics listed above.

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* These figures correspond to the following resistivity ranges: Type VI - 750 - 50,000 ohms/cm^3; Type VII - 1000-50,000 ohms/cm^3; Type VIII - 2000 - 30,000 ohms/cm^3.

To convert ohms/cm^3 to conductance: $\text{Micromhos} = \dfrac{1 \times 10^6}{\text{ohm}/\text{cm}^3}$

CONSIDERATIONS FOR ELECTROFISHING

The effectiveness of the shocker's output is sometimes effected drastically by environmental and/or biological factors.

Generally speaking, the shocker's output is not greatly modified by the waters resistance or temperature, however, the power that reaches the fish is greatly effected by the water's parameters and the animals physiological make-up.

If these environmental and biological parameters are too far out of line, poor electrofishing will result. Adjustments in the shocker's output can help to reduce erratic actions and the escape of fish.

The following discussion may help to clarify the wide variation of reactions among fish.

INFLUENCE OF RESISTIVITY

The resistivity of the water and of the fish flesh are the main factors that effect electrofishing.

The resistivity of natural water depends on the quantity of dissolved salts and minerals in the water available to carry electric current.

Distilled water is a very good insulator of electric current. If a voltage is applied between two electrodes in distilled water, little or no current would flow through the water and the water would be considered to have extemely high or infinite resistivity.

In the past it was customary to talk in terms of volts per inch required to envoke a given response in a fish. From a theoretical standpoint, it is possible to have many volts per inch and not shock the fish at all.

For example, if a fish were placed in distilled water with high voltage applied, no current would pass through the water and hence, no current would pass through the fish's body even though many volts per inch may be present. What a fish reacts to is the current flowing through its body.

On the other side of the coin if we were able to put a fish in water that had near zero resistance and applied a voltage, a corresponding large current would flow through the water but negligible current would flow through the fish's body because the electric current would find it much easier to pass through the low resistance water than through the fish's flesh of medium to high resistance.

It can be seen from the afore mentioned considerations that a fish will receive the maximum shock (current flow) when a voltage is impressed across water having a resistance per cube equal to the resistance per cube of fish flesh. Typically fish flesh ranges from about 1.5 Kohm per cube to as high as 5 Kohm per cube. Successful electrofishing can be carried out in water with a mismatch ratio or resistance of about 3:1.

Practices which reduce the effects of high resistance water by delivering more useful electrical energy to fish include the use of high frequencies and duration with the use of square waves with peak voltages of 300 to 400 volts; it also helps to maintain a large cathode while keeping the anode medium size (not over 100 sq. in.). The smaller anode has a more intense current field near the anode while a large anode distributes the current over a larger area.

In some areas water resistivity is so high that electrofishing is impractical. The upper limit of resistivity for electrofishing is about 30,000 ohm per cube. In some cases this problem has been helped by adding salt to the water to lower the resistivity to a level more suitable for electrofishing.

In waters of very low resistivity the only solution is to run very heavy current through the water. However, a limit is soon reached where the shocker cannot deliver sufficient current to electrofish successfully. The lower limit on resistivity suitable for electrofishing is about 300 ohms per cube.

Individual variation is notable among fish even though they are of the same species and have similar lengths. However, the longer the individual of a species, generally, the more sensitive it is to electrical shock as fish absorb power as a function of body surface area.

EFFECTS OF TEMPERATURE

Fish flesh has a certain resistivity that decreases with increasing temperature. The success of electrofishing may be enhanced or hindered by this effect depending upon whether the water's resistance is higher or lower than the fish flesh resistance. If it is in a direction to cause a closer resistivity match, the fish will receive a greater shock.

Output energies commonly used in electrofishing are capable of killing fish. Death can occur with or without gross physical damage or by irreversible physiological damage. Mortalities caused by A. C. electrofishing are usually higher than those caused by D. C. or pulsed D. C.. Harmful effects from pulsed D. C. are usually a result of excessive exposure or very intense electrical fields.

ELECTROFISHING TECHNIQUES

One engaged in electrofishing must wade or float, depending upon the depth or swiftness of the water. In suitable waters, the operators wade and can probe the anode into likely fish habitat. Wading upstream eliminates the effects of turbidity caused by bottom sediment. Furthermore, if collections are for food-habit study, stunned prey are not swept downstream and consumed by predators. If turbidity and predication are unimportant, however, collections can be made more efficiently and less strenuously when moving downstream. The fish are normally oriented upstream, or toward the descending electrical field, and the shocked fish initially induced into flight bolt upstream into higher voltage densities, where they are held. Fish that manage to escape are often captured a short distance downstream. The size of the fish captured by wading operations in large streams is usually less than 150 mm., whereas larger fish are taken in deep waters by the floating method.

The floating method of electrofishing is used when the stream is too deep or swift to wade. The anode is clamped rigidly ahead of the boat, extending into the water. One man guides the boat with the oars while one or two operators dip fish as the boat drifts with the river.

Collecting can be improved further by introducing the element of surprise through intermittent fishing. The intensity of the anode's peripheral electric energies only frightens fish, causing them to bolt or penetrate deeper into cover. In either situation, chances of capture are reduced. It is better not to move through a body of water with the power continuously on, but rather to fish only in likely habitat. Fish can be extracted from areas of heavy cover or from under shore ice by inserting the anode, turning the power on, and withdrawing the anode slowly and smoothly. Fish follow the anode under the influence of galvanotaxis into the open, where they can be netted. If the stream velocity is appreciable, the electrical power can be left on during floating without loss of efficiency.

Night fishing with lights has proven to be exceedingly productive in lakes but it is not so in streams. The reflection and refraction of the spotlight beam caused by the ruffled stream surface greatly impairs sighting of the fish. Headlamps are useful for electrofishing by wading at night. For daytime fishing the use of Polaroid sunglasses greatly improves in locating stunned fish.

SAFETY PRECAUTIONS FOR ELECTROFISHING

The operator of an Electrofisher must always keep in mind that his chance of receiving an electrical shock is multiplied when dealing with electric currents in or near water more than any other place. Using an Electrofisher is like using a firearm, if used properly and with good judgement it is perfectly safe. Have respect for electricity and it is easily controlled, lose respect and you could lose your life.

The Smith-Root Electrofishers have a HIGH VOLTAGE OUTPUT and certain safety precautions must be observed to provide safe operation and prevent possible dangerous electric shock.

When operating the Electrofisher NEVER let yourself come in contact with the anode. If this were to happen your body would complete a path for the electric current and a possible lethal shock would result.

The following articles must be worn when using the Electrofisher. They are not just to keep you dry, they are to keep you insulated from the electric currents that may be present.

1. Nonleaking wading boots chest high. If they become wet inside, STOP electrofishing and let them dry out thoroughly. Wet boots can conduct electricity as well as water around them.

2. Nonleaking rubber electricians gloves that reach the elbow or higher. If they become wet inside, STOP electrofishing and let them dry out. Wet gloves conduct electricity.

THE FOLLOWING ARE SOME DO'S AND DON'TS FOR ELECTROFISHING

DO – Always make sure that all personel are clear of the area surrounding the anode before turning on the power. DOUBLE CHECK.

DON'T – Continue to electrofish if your boots or gloves become damp or wet.

DO – Make sure that the anode and cathode electrodes make good connection with the output cable and that both electrodes are in contact with the water.

DON'T – Operate an electrofisher if you have any prior heart ailment history or if you have been under abnormal strain, which may weaken your heart.

DO – Study and know how to administer first aid treatment for electrical shock.

DO – BE CAREFUL!

FRONT PANEL CONTROLS AND PLUGS:

BEFORE ATTEMPTING OPERATION OF THIS EQUIPMENT BE SURE TO READ AND FOLLOW THE INSTRUCTIONS AND SAFETY PRECAUTIONS'

INPUT PLUG – Located lower left. This supplies all power for the Type VI Electrofisher. Do not plug a Type VI that is set up for 220 VAC input into a 110 VAC outlet or a Type VI set up for a 110 VAC into a 220 VAC outlet or serious damage to the unit may result.

POWER SWITCHES – Located lower left. These are circuit breaker switches used to turn on and off the input power and the auxiliary power outlets.

POWER INDICATOR – Located lower left. Will be lighted when input plug has power applied and power switches are in the on position.

OUTPUT MODE SELECTOR SWITCH – Located lower right. Selects actual output waveshape and frequency, 60 HZ A.C. Sine wave, 60 PPS or 120 PPS pulsating D.C.

VOLTAGE SELECTOR SWITCH – Located top left. This switch selects output voltage providing steps of 100 volts per step over the range of 0 to 600 VAC and 0 to 850 volts peak D.C.

HIGH VOLTAGE INDICATOR – Located center right. Indicates when power is being supplied to the anode-cathode electrodes.

PULSE WIDTH CONTROL – Located lower right. Adjusts pulsating D.C. output pulse width within the range of 1 to 7 milliseconds.

AMMETER – Located top center. Indicates the current flowing through the water via the anode-cathode electrodes.

MECHANICAL REGISTER – Located upper left on front panel. Records actual shocking time in seconds. Actuated at one count per second only when high voltage is applied to the anode, and the timer switch, (located just to the right of the mechanical register) is in the on position.

KEY SWITCH – Located lower left. The provided key must be inserted and this switch turned on before the remote switches can be actuated to supply high voltage to the anode. This way high voltage can only be obtained deliberately for obvious safety reasons.

REMOTE INPUT PLUG – Located lower right. Remote switches provided with your Type VI Electrofisher are plugged in here and are used to actuate the circuits supplying high voltage to the anode. With the key switch (lower left panel) in the on position, BOTH remote buttons must be depressed to obtain high voltage at the anode. This is an added safety precaution so there will never be high voltage unless two operators press their respective buttons simultaneously.

OUTPUT PLUG – Located lower right. Both the anode and cathode wires are connected to this plug. Pin "A" goes to the anode and Pin "B" to the cathode. The output cable supplied is wired so that the white wire must be connected to the anode and the black to the cathode.

FUSE, 6 AMP – Located upper right. Limits output to 6 amperes and protects high voltage circuit if anode and cathode should become shorted together.

SECTION 10

GLOSSARY OF ELECTRICAL TERMS

Appendix. Glossary of Electrical Terms.

Conductivity (c) The ratio of the density of the unvarying current in a conductor to the voltage gradient that produces it; common units of measurement are mhos per centimeter or siemens per centimeter.

Conductance (G) The measurement of the ability of a component to conduct electricity; the reciprocal of resistance; unit of measurement is the mho.

Current (I) The rate of electrical charge flow in a circuit. The practical unit is the ampere, which is one coulomb per second.

Current density (J) The ratio of a current to the cross-sectional area of its path in a plane perpendicular to the direction of the current.

Effective fish conductivity (c_f) The apparent electrical conductivity of live fish as determined by statistically fitting electroshock response data to the theoretical curve developed for the concept of constant power.

Electrical charge (Q) A fundamental property of matter that can be classified as a fundamental physical quantity. The practical unit is the coulomb. The electron, the smallest charge identified in nature, has a magnitude of 1.6×10^{-19} coulomb.

Mismatch ratio (q) The ratio of either the two resistance values or two conductivity values determined for adjoining media. For electrofishing, this is the ratio of conductivity of the water to the effective conductivity of the fish.

Power (P) The rate of doing work or the energy per unit of time. The practical unit is the watt, which is one joule per second.

Applied power (P_a) Power incident at an electrical interface separating two media.

Constant transferred power (P_m) The constant value of transferred power desired under all conditions of mismatch.

Maximum output power (P_M) The maximum available power delivered to an external load from a power source having an internal resistance equal to that of the external load.

Reflected power (P_r) The portion of applied power that is not transferred to the second medium.

Transferred power (P_t) The portion of applied power transferred from the first medium to the second medium.

Power density (D) The power or energy per unit of time dissipated in a given volume of material; the unit of measurement is watts per cubic centimeter.

Applied power density (D_a) Power density available for transfer to a fish at a particular location in the water.

Power density in fish (D_m) The desired constant value of power density to be transferred to a fish; also, the threshold of in vivo power density required to produce a specific electroshock response.

Resistance (K) The ability to react to the flow of AC or DC with an opposition to the flow of current. Also, the ratio of the applied voltage to the induced current that it produces. The unit of measurement is the ohm.

Resistivity (r) The reciprocal of conductivity. The common unit of measurement is the ohm-cm.

Volts or Voltage (V) The energy per unit of electrical charge. The volt is the unit of measure where one volt is one joule per coulomb.

Voltage gradient (E) The rate of change of voltage with distance. Also, the force per unit of electrical charge. The common unit of measurement is volt per centimeter.

Appendix C.1

Checklist for Electrofishing Safety and Health Audit

APPENDIX C.1

CHECKLIST FOR ELECTROFISHING SAFETY AND HEALTH AUDIT

Item	Remarks	Yes	No
Safety Equipment	• Life preservers on board for each individual		
	• Leak-free electrical insulating gloves and boots available for each individual (NOTE: Gloves and boots should extend above the knees and elbows)		
	• Radio available for emergency contacts		
	• Radio property charged		
	• First aid kit in boat		
	• Burn Jel bandages available in first aid kit		
	• Personnel trained in first aid/CPR		
	• Fire extinguisher in boat (Type ABC 5 lb)		
	• Emergency air horn on board		
	• Funnel available for adding gasoline to generate or pump (NOTE: Gasoline should not be added to a hot motor)		
	• Polarized sun glasses		
Boat Safety	Lights available and working for night-time fishing		
	Boat equipped with an anchor		
	Boat in good repair free from sharp edges and weak or broken areas		
	Fuel tanks positioned a safe distance from the generator and battery (NOTE: Gasoline vapor cannot be allowed to contact hot surfaces or sparks)		
	Fuel tanks property capped and lines leak-free		
	Generator/pump shut-off switch available to eliminate grounding the spark plug		
	Generator/pump muffler facing outside the boat and shielded to prevent contact in rough seas		
	Foot pedal "dead man" switch controlling the flow of electricity in place in bow of boat (NOTE: Device must be operating for netter[s] to control)		
	If no netter foot pedal exists, is there another means of emergency generator shut off?		
	Probes used to extend the electrodes to the water made of non-conducting material		
	Electrical connections weather-proof and water tight		
	Electrical conducting surfaces connected to create one circuit on board (NOTE: Separate circuits create "floating metal" which can cause electrocution)		
	Surfaces checked with an OHM meter prior to launching the boat		

Item	Remarks	Yes	No
Trailer	• Trailer frame free of significant rust and structurally sound		
	• Hitch on trailer solid and working properly with locking hasp		
	• Two safety chains present that can be properly connected to the towing vehicle hitch		
	• Training stand secured properly and can be locked in the vertical and horizontal position		
	• Trailer stand and winch handles present and working property		
	• Safety chains present to secure boat to trailer during transportation (other than winch)		
	• Winch secure and in good working order		
	• Winch cable or rope free of broken strands		
	• Winch hook a locking type		
	• Trailer tires in good shape with adequate tread		
	• Trailer wheel bearings were greased (if not sealed)		
	• Lights on trailer working properly (brake and turning indicator)		
	• Trailer brakes working properly		
Motor	• Motor bolted to boat with four bolts		
	• Motor equipped with proper handles		
	• Motor can be properly locked in the “up” or travel position		
	• Emergency motor shut-off connected to operator in case operator falls from boat		
Post-Fishing Checklist	• Generator shut off during rain		
	• Boat operated free of sudden turns or changes in direction		
	• Comments and items needed for next trip		

Small Boat Operations SOP

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Standard Operating Procedure No. 035
for
Small Boat Operations

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision: 1
December 2014

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1. BACKGROUND

The threat from working on or near surface water bodies comes from both chemical hazards and physical hazards such as drowning. When there is a need for sampling to be conducted using small boats, EA will provide necessary safety gear, i.e., life vests, nets, and other floating devices and appropriate training.

1.1 PURPOSE

This Standard Operating Procedure (SOP) establishes the operating requirements for small boats conducting inland and coastal marine work.

1.2 SCOPE

This SOP applies to the operation of small boats, including launches, motorboats, working platforms, and skiffs, for inland (rivers, lakes, and bays) and coastal marine work. This SOP applies to EA personnel operating a small boat or working on a subcontractor-operated small boat. This SOP covers small boat requirements, work over or near bodies of water, personal floatation devices (PFDs), lifesaving and safety skiffs, severe weather precautions, and cold water and drowning hazards. This SOP is mandatory for EA personnel. Subcontractors are responsible for analyzing the hazards of activities they control and for preparing job hazard analysis and maintaining equivalent safety requirements.

1.3 DEFINITIONS

Small Boat—Includes dinghies, 1- or 2-man rowboats, up to and including larger vessels typically up to 50 ft in length, and work barges.

Float Plan—A written summary of the details of the trip, including route, type of vessel, persons aboard, and other salient information which may be useful in the event of an emergency.

Job Hazard Analysis—A concise analysis of the specific task considering the body of water, vessel, unique job requirements, training and experience of crew, and other circumstances as may be appropriate.

1.4 REFERENCES

EA Corporate Vessel Operations Manual. 2004. December.

Federal Requirements and Safety Tips for Recreational Boats. 1994. Boating Education Branch. April.

U.S. Army Corps of Engineers. 2003. Safety and Health Requirements Manual. Volume EM 385-1-1. September.

U.S. Coast Guard. 1994. Federal Requirements and Safety Tips for Recreational Boats.

1.5 RESPONSIBILITIES

The Project Health and Safety Officer is responsible for review and approval of small boat operations as described in the Health and Safety Plan. The Project Health and Safety Officer provides any necessary safety requirements to the project team. The Project Health and Safety Officer shall review the job hazard analysis prepared by project personnel.

Onsite Health and Safety Officer—The Health and Safety Officer is responsible for ensuring proper use of small boats at field locations. The Health and Safety Officer ensures that only trained personnel operate small boats, subcontractors implement safety programs, and that all equipment is properly maintained. The Onsite Safety Officer is responsible for filing or maintaining a float plan.

Small Boat Operators—EA personnel working on small boats will follow this procedure and any applicable health and safety procedures identified in the Health and Safety Plan and the vessel rules. Small boat operators will identify any conflicts in procedures or any problems or equipment failures to the Health and Safety Officer. Small boat operators shall demonstrate training, experience, and compliance with state requirements for operator education and licensing prior to operating any vessel. For larger bodies of water, or rapidly moving water, knowledge of local conditions shall be obtained prior to embarkation.

2. SMALL BOAT REQUREMENTS

All small boats used by EA personnel must meet the minimum requirements in the U.S. Army Corps of Engineers Safety and Health Requirements Manual EM 385-1-1 and the applicable Occupational Safety and Health Administration or state plan requirements, as well as meeting applicable U.S. Coast Guard Regulations. These requirements include the following:

- Small boats will meet the minimum floatation requirements of the U.S. Coast Guard, and must have a certification tag affixed to the hull.

- The maximum number of passengers and weight that may be safely transported must be posted on all small boats.

- The number of personnel on the small boat cannot exceed the number of Type I PFDs onboard.

- Each small boat will have sufficient room freeboard, and stability to safely carry the allowable number of personnel and cargo.

- Each motored boat measuring less than 26 ft in length will carry one 1A-10 BC fire extinguisher; motored boats measuring greater than 26 ft will carry two 1A-10 BC fire extinguishers.

Operators and occupants of small craft shall review Federal Requirements and Safety Tips for Recreational Boats (U.S. Coast Guard 1994) before engaging in work from rafts, dinghies, canoes, rowboats, or Jon boats.

2.1 WORK OVER OR NEAR WATER

Work over or near water, where the potential exists for personnel to fall in and possibly drown, will be conducted in accordance with the requirements of applicable Occupational Safety and Health Administration standards and the U.S. Army Corps of Engineers EM 385-1-1 standards. This includes work from shore, bridges, work platforms, and vessels. Work within 15 ft of unobstructed access to water is within the requirements of this section. Personnel will follow the guidelines listed below except where personnel are protected by continuous guardrails, safety belts, or nets, or are conducting work along beaches or similar shorelines:

- Personnel will use the buddy system at all times.

- Swimming is prohibited, with the following exceptions: (1) certified divers performing their duties, and (2) personnel entering water to prevent injury or loss of life.

- All personnel will wear a U.S. Coast Guard-approved PFD of the type able to support an unconscious person (Type 1 with 32-lb floatation).

- At least one Type IV throwable device (ring buoy, horseshoe buoy) will be available on the small boat. Throwable devices should be U.S. Coast Guard-approved and equipped with 150 ft of 600-lb capacity rope.

- If specified in the Health and Safety Plan, at least one person will provide a dedicated safety watch/look-out.

2.2 PERSONAL FLOATATION DEVICES

All EA personnel will wear a U.S. Coast Guard-approved, Type 1 PFD when working over or near bodies of water. PFDs should meet the following requirements:

- Before and after each use, the PFD will be inspected for defects that would alter its strength or buoyancy.

- All PFDs will be equipped with retro reflective tape.

PFDs need not be donned when working on larger craft (>26 ft) except when working over water or outside railing. PFDs should be worn at all times when working on smaller craft.

2.3 SAFETY EMERGENCY DRILL

The vessel operator shall provide a list of crew duties for normal operations and emergencies. Emergencies which shall be covered include man-overboard, vessel fire, and vessel emergency.

The vessel operator shall provide an orientation and emergency drill. An emergency drill shall be conducted at the start of each task, and monthly thereafter, or as provided for in U.S. Coast Guard regulations.

2.4 FLOAT PLAN

A float plan provides essential information to enable the U.S. Coast Guard or other emergency search and rescue teams to initiate a search in the event of personnel not reporting in on schedule. The vessel operator will file a daily float plan with the site representative and with the project health and safety representative listed in the Health and Safety Plan. Upon daily completion of on-water work, the vessel operator will check in with the designated on shore individual. The float plan is provided in Appendix A.

2.5 EMERGENCY PLAN

The emergency plan should list a main dock and an alternate dock, and provide emergency medical support contact for each location.

2.6 COMMUNICATIONS

A marine VHF radio shall be maintained onboard and in operable condition. At least one of the boat personnel shall have a mobile telephone onboard during operations.

2.7 OCEAN REQUIREMENTS

Contact the Corporate Health and Safety Officer and Project Health and Safety Officer prior to planning any work which requires work in open ocean.

2.8 SEVERE WEATHER PRECAUTIONS

During field operations involving small boats, EA personnel will make provisions for severe weather. Severe weather includes sudden and locally severe storms, high winds, hurricanes, and floods. Before beginning work over water, the Health and Safety Officer will evaluate weather reports and conditions to ascertain local weather and prevent personnel exposure to severe weather. In the event that severe weather is encountered, personnel will cease field operations and immediately return to shore.

2.9 COLD WATER AND DROWNING HAZARDS

EA personnel conducting field operations with a small boat may be exposed to cold water and drowning hazards. When water temperature is below 45°F, hypothermia is a serious hazard. A person can lose feeling in extremities within 5 minutes. Under no circumstances will EA personnel enter the water from a small boat unless conducting diving operations or performing a rescue.

Symptoms of hypothermia are discussed during standard first aid training and in the EA Health and Safety Program Plan. If a person who has fallen into the water displays symptoms of hypothermia, he or she should be treated immediately and the field operations canceled. Under no circumstances should the victim be given hot liquids, since they can accelerate shock. Drinks no warmer than body temperature are acceptable. If symptoms are severe and rapid evacuation is not possible, remove the victim's wet clothing and cover the victim with a blanket. Continue to treat the victim for shock.

When a high risk of cold water and drowning hazards exists, all field staff members should be familiar with cold water survival techniques. If a team member falls into the water, he or she should not remove any clothing in the water because all clothing will provide insulation. Although clothing creates added drag while swimming, the added insulation of the clothing outweighs the disadvantage of the additional drag.

If a team member falls into the water, another team member should try to reach the person in the water with an oar, paddle, pole, or similar object. The victim should try to grab the extended item. If the victim is unconscious, the rescuer should try to hook the victim's PFD, clothing, or hair and pull him or her toward the boat. Once the victim is retrieved, the other team members should begin any necessary emergency medical procedures. If no emergency medical procedures are necessary, the victim should change into dry clothing.

2.10 JOB HAZARD ANALYSIS

The requirements for preparing a job hazard analysis apply specifically to all on-water operations. Appendix B provides a sample job hazard analysis; however, an actual job hazard analysis shall consider the specific task including the body of water, vessel type, unique job requirements, training and experience of crew, and other circumstances such as tides, weather, water temperature, access of rescue craft, and other factors as may be appropriate. Job hazard analysis must be prepared specifically for each task and crew in accordance with the U.S. Army Corps of Engineers Safety and Health Requirements Manual EM 385-1-1.

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Appendix A

Float Plan

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APPENDIX A

FLOAT PLAN

1 Name and phone number of person filing plan.

2 Description of boat (type, color, trim, registration number, length, name, make, other).

3 Engine type (horsepower, fuel capacity, number of engines, and fuel [diesel or gasoline]).

4. Survival—Equipment onboard (check):

- Anchor
- Flares
- Flashlight
- Food
- Life ring with 150 ft of line.
- Paddles
- PFDs
- Smoke signals
- Water.

5. Marine Radio onboard (type, frequencies):

6. Automobile (tag number, type, color, make, trailer tag number, where parked)

7. Persons aboard (name, affiliation, and telephone number)

8. Do any of the persons aboard have a medical problem (identify type)

9. Trip plan (depart from @ time, arrive to @ time; via waypoints; expect to return no later than time)

10. Operational area (attach map)

11. If not returned by (a.m./p.m. time), call the U.S. Coast Guard or onshore contact.

12. Onshore contact:

Alternate Other Numbers

Contact	Number

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Appendix B

Job Hazard Analysis Form

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APPENDIX B

JOB HAZARD ANALYSIS FORM

Activity Hazard Analysis		
Task	**Potential Hazards**	**Hazard Control Measures**
MOBILIZATION/ DEMOBILIZATION	Physical Hazards (slips, trips, falls, cuts, etc.)	• Clear walkways/work areas of equipment, tools, and debris. • Watch for accumulation of water work surfaces. • Mark, identify, or barricade obstructions. • Wear cut-resistant work gloves when the possibility of lacerations or other injury caused by sharp or protruding objects occurs.
	Physical Hazards (material handling moving, lifting)	• Observe proper lifting techniques. • Obey sensible lifting limits (60-lb maximum per person manual lifting). • Use mechanical lifting equipment (hand carts, trucks, etc.) to move large awkward loads. • Use two or more persons for heaving bulk lifting.
	Physical Hazards (vehicle and pedestrian traffic)	• Use orange traffic cones where necessary. • Use reflective warning vests if exposed to vehicular traffic. • Locate staging areas in locations with minimal traffic.
	Physical Hazards (cold/heat stress)	• Monitor cold/heat stress as recommended in Section 6 of the Generic Health and Safety Plan.
	Munitions and Explosives of Concern (MEC) Hazard	• Practice site reconnaissance with a trained, experienced MEC specialist capable of recognizing MEC hazards. • If MEC is discovered, use existing access roads to retract from the MEC.
	Biological Hazards (insects, poisonous plants, ticks)	• Wear protective outer clothing and insect repellant to avoid insect bites and ticks. • Wear long sleeve shirts when working in areas with poison ivy or oak. • Workers with allergies should carry antidote kits, if necessary.
SAMPLING ACTIVITIES	Physical Hazards (slips, trips, falls, cuts, etc.)	• Clear walkways/work areas of equipment, tools, and debris. • Watch for accumulation of water work surfaces. • Mark, identify, or barricade obstructions. • Wear cut-resistant work gloves when the possibility of lacerations or other injury caused by sharp or protruding objects occurs.
	Physical Hazards (electrical)	• Identify electrical utility hazards prior to sampling. • Inspect work areas for spark sources, maintain safe distances, properly illuminate work areas, and provide barriers to prevent inadvertent contact. • Maintain minimum clearance distances for overhead energized electrical lines as specified in the Generic Health and Safety Plan.
	Physical Hazards (weather)	• Monitor radio for up-to-date severe weather forecasts. • Discontinue work during thunderstorms and severe weather events.
	Physical Hazards (vehicle and pedestrian traffic)	• Establish an exclusion zone around the drilling location. • Use orange traffic cones (if necessary). • Use reflective warning vests if exposed to vehicular traffic. • Locate staging areas in locations with minimal traffic.

Activity Hazard Analysis		
Task	**Potential Hazards**	**Hazard Control Measures**
SAMPLING ACTIVITIES (continued)	Physical Hazards (cold/heat stress)	• Monitor cold/heat stress as recommended in Section 6 of the Generic Health and Safety Plan.
	MEC Hazards	• Follow established MEC avoidance protocols when performing intrusive sampling activities. • If MEC is discovered or suspected, use existing access roads to retract from the MEC.
	Chemical Hazards (including MEC)	• Perform environmental monitoring as required in the Site-Specific Health and Safety Plan. • Where appropriate, personal protective equipment as indicated in the Site-Specific Health and Safety Plan.
	Biological Hazards (bloodborne pathogens)	• Wear proper personal protective equipment, including nitrile gloves and a face shield or goggles when sampling sludge. • Wash with soap and water as soon as personal protective equipment is removed or when contact or exposure has occurred.
	Biological Hazards (insects, poisonous plants, and ticks)	• Wear protective outer clothing and insect repellant to avoid insect bites and ticks. • Wear long sleeve shirts when working in areas with poison ivy or oak. • Worker with allergies should carry antidote kits, if necessary.
BOATING ACTIVITIES	Physical Hazards (weather)	• Monitor radio for up-to-date severe weather forecasts. • Boat operators will be trained by the site supervisor and/or the senior boat operator. • Discontinue work during thunderstorms and severe weather events.
	Physical Hazard (slips, trips, and falls, including falls overboard)	• Boat operator will inspect the boat prior to operation. The operator will ensure the number of personal floatation devices is equal to or greater than the number of passengers onboard. • No personnel will embark or disembark the vessel without the direction of the vessel operator. Vessel operator will ensure passengers are wearing personal floatation devices while on deck. At the request of the operator, personnel will be seated. • Passengers will stay seated until boat is docked. Ensure three-point contact whenever possible or practical. • A Type IV throwable device will be readily available onboard.

Appendix H

Diving Safety Plan

Military Munitions Response Program
Remedial Investigation, Iona Island Naval Ammunition Depot Formerly Used Defense Site, New York

Diving Operations Plan

Prepared for:

U.S. Army Corps of Engineers
Baltimore District

Prepared for:

EA Engineering, Science, and Technology, Inc. PBC
255 Schilling Circle, Suite 400
Hunt Valley, MD 21031

Prepared by:

AOR International, Inc
3705 N. Courtenay Parkway
Merritt Island, Florida 32953

Military Munitions Response Program
Remedial Investigation, Iona Island Naval Ammunition Depot Formerly Used Defense Site, New York

I hereby certify that the enclosed Dive Operations Work Plan, shown and marked in this submittal, is that proposed to be incorporated with Contract Number W912DR-15-D-0014, Delivery Order W912DR18F0587. This Work Plan is in compliance with contract specifications, Occupational Safety and Health Administration requirements, United States Army Corps of Engineers, Safety and Health Requirements Manual (EM 385-1-1, November 2014), and is submitted for Government approval.

Reviewed by:

Date of Submission: November 19, 2019

Plan prepared by:

Steve Mulholland	
Diving Program Manager	Signature
steve.mulholland@aorintl.com	(619) 559-5888

AOR International, Inc.

Title: Surface/subsurface MEC anomaly operations.

Location of operation: Old Navy loading docks, Hudson River, Iona Island, NY

Dates of field activity: August 2020 (Estimated)

Client: EA Engineering, Science, and Technology, Inc. PBC
U.S. Army Corps of Engineers – Baltimore District.

This Dive Operations Plan is divided into the following sections:

1.0 Dive Plan Overview

Section 1.0 provides names and duties of each member of the dive team and general safety policies.

2.0 Dive Task Operations

Sections 2.0 provide details on task specific operation including the mode of diving, breathing medium, ambient conditions and general sequence of activities and tasks.

Appendices:

Appendix A: Emergency Management Plan
Appendix B: Activity Hazard Analysis
Appendix C: Applicable Dive Tables
Appendix D: Safe Practices Manual
Appendix E: Personnel Certifications (To be provided once personnel are identified but prior to mobilization)
Appendix F: Air Purity (To be provided 1 week prior to mobilization)
Appendix G: Equipment Maintenance Logs (To be provided 1 week prior to mobilization)

"If for any reason the dive mission is altered in mission, dept, personnel, or equipment, the District Dive Coordinator (DDC) will be contacted in order to review and accept the alteration prior to the actual operation."

Table of Contents

Acronym and Abbreviations

ADCI	Association of Diving Contractors International
ACFM	Actual Cubic Feet per Minute
AHA	Activity Hazard Analysis
AOR	AOR International, Inc
ANSI	American National Standards Institute
ATA	Atmospheres Absolute
BC	Buoyancy Compensator
CFR	Code of Federal Regulations
CFM	Cubic Feet per Minute
CO2	Carbon Dioxide
CPR	Cardiopulmonary Resuscitation
DAN	Divers Alert Network
DDC	District Diving Coordinator
DOP	Dive Operations Plan
DPIC	Designated Person In-Charge
DSR	Dive Safety Representative
EAC	Emergency Assistance Checklist
EGS	Emergency Gas Supply
EM	Engineering Manual
EMI	Emergency Management Institute
EMP	Emergency Management Plan
EMS	Emergency Medical Service
EMT	Emergency Medical Technician
FFW	Feet of Fresh Water
FPM	Feet Per Minute
FSW	Feet of Sea Water
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HP	High Pressure
KMDSI	Kirby Morgan Diving Systems Inc.
KTS	Knots
LP	Low Pressure
MEC	Munitions and Explosives of Concern
MPPEH	Material Potentially Presenting and Explosive Hazard
OSHA	Occupational Safety & Health Administration
PMS	Planned Maintenance Systems
PPR	Pre-planned Response
PSIG	Pound Per Square Inch Gauge
RCC	Rescue Coordination Center
SCUBA	Self-Contained Underwater Breathing Apparatus
SPM	Safe Practices Manual

SSA	Surface Supplied Air
TBD	To Be Determined
USACE	United States Army Corp of Engineers
USCG	United States Coast Guard
USNDM	United States Navy Dive Manual
UW	Underwater

Section 1. General Diving Plan

1.1. DIVE PLAN DEVELOPMENT

This dive plan and related underwater operations will strictly conform to all regulations set forth in USACE Safety & Health Requirements Manual (2014), EM 385-1-1; U.S. Navy Diving Manual, Rev. 7. (2016); OSHA 29 CFR 1910, Subpart T; USCG Regulation 46 CFR 197 (Subpart B); and AOR International's Safe Practices Manual (SPM) for Underwater Operations.

AOR dive plans are prepared by the assigned DPIC/Diving Supervisor and reviewed by AOR International's diving program manager. All plans are submitted to the USACE District Diving Coordinator (DDC) for review and acceptance.

- Designated Person in Charge (DPIC)/Diving Supervisor,
- AOR Diving Program Manager Steve Mulholland,
- USACE DDC.

1.2. DIVE TEAM ASSIGNMENTS AND RESPONSIBILITIES

Each dive shift shall consist of a five-man team. Each member will be assigned to perform one or more of the responsibilities listed below. Names of the onsite team for dive operations will be provided.

All diving personnel have current diving certification records including dive logs, fit to dive physicals, and first aid/CPR cards, and oxygen administrator training. Only those individuals who have received approval by the DDC will be used in performance of this contract.

Dive stations will be manned by no less than a DPIC/Diving Supervisor, Diver, Standby Diver, one-Tender, and Boat Coxswain. All diving operations will be conducted during daylight hours.

1.2.1. DPIC/Diving Supervisor

Responsible for safe and efficient conduct of the entire job.

Primary: TBD **Alternate:** TBD

The DPIC/Diving Supervisor will have the following operations, safety and health related responsibilities:

1. Ensure that all diving and support personnel review and are aware of guidelines and procedures reflected in the Activity Hazard Analysis (AHA), Emergency Management Plan (EMP), and SPM for Underwater Operations.
2. Coordinate and supervise all diving and emergency operations.
3. Track diver's bottom time.
4. Liaison with the USACE Dive Safety Represnetative (DSR) and AOR Diving Program Manager and advise of safety and health matters related to the diving operations.

1.2.2. Diver:

Perform tasks as required and directed by DPIC/Diving Supervisor including the following specific tasks. **All divers are qualified to perform Stand-By diver or Tender duties as assigned.**

Divers: TBD TBD TBD TBD

1. Perform all diving duties appropriate to his qualifications as instructed by the DPIC/Diving Supervisor. If the job requires work beyond the experience or capabilities of the diver, the diver shall advise the DPIC/Diving Supervisor.
2. Follow safe diving practices at all times during diving operations, whether on deck or in the water. The diver must bring any points, issues and/or concerns pertaining to the job, dive safety and/or the dive operations to the attention of the DPIC/Diving Supervisor.
3. Comply with all AOR policies, procedures and practices as well as all regulations as they apply to divers' related qualifications or performance.
4. Perform techniques of the assigned diving mode.
5. Use UW tools, equipment and systems relevant to assigned tasks.

Note: *The standby diver will be rested, alert, and capable of performing immediate emergency rescue assistance and recovery. When work is limited to no decompression limits, the standby diver may have a previous dive and shall be sufficiently free of residual nitrogen to allow for 25-minute bottom time at the working depth without exceeding "No Decompression Limits."*

1.2.3. Tender

Assist diver with dressing and undressing, assist diver in and out of water, tend diver umbilical, operate equipment, and assist in topside work as required or directed by the DPIC/Diving Supervisor.

1.3 SAFETY POLICY

The DPIC/Diving Supervisor is ultimately responsible for the safety of all personnel and equipment working on the project and will report directly to the Diving Program Manager on all matters concerning the safety of diving operation.

The DPIC/Diving Supervisor will conduct daily tailgate safety meetings each morning prior to commencement of diving operations. Items of discussion will include coordination of the day's activities and a review of the Activity Hazard Analysis. All involved personnel, including the USACE DSR, shall attend the daily safety meetings. The USACE DSR, will be afforded an opportunity to address daily safety concerns and no work will be allowed to progress without their approval.

The site supervisor, if assigned, will conduct frequent safety inspections of the worksite, equipment and materials. Minor deficiencies will be corrected as soon as possible and discussed at the next tailgate safety meeting. Major deficiencies (imminent danger of harm to personnel of equipment) shall be cause for immediate cessation of work and correction of the issue.

After the completion of each dive, the DPIC/Diving Supervisor shall:

- Debrief each diver as to their physical condition.
- Instruct divers to report any physical problems or adverse physiological effects, including symptoms of decompression sickness or gas embolism.
- Ensure the diver knows the location of the nearest recompression chamber.
- Ensure each diver understands the potential hazards of flying after diving and remains within safe limits. Divers shall not fly within 12 hours of diving.

1.4 DIVING EQUIPMENT

Air certification for breathing air compressor will be available on site for inspection. (All equipment certification will be submitted to the DDC no later than 5 working days prior to start of work)

Equipment	Qty	Comments
KM18 Band Mask / KM37 Helmet	2	Hard wire communications
1st Stage Regulator with hose	2	EGS Bottle
EGS Tank (minimum 30ft^3)	2	Mounted on diver's harness
80-300 ft3 tanks/flasks (Breathing Air)	6	Primary and secondary
Harness (5 point)	2	
Air control box, 2 diver w/communications	1	
Divers Umbilical	2	200' min
Swim fins as required	2	Each diver
Divers knife	2	Each diver
Weight belt – as required	2	Each diver
Handheld magnetometer	2	
AxVIEW 2V-P Video recording system	1	Helmet mounted camera
Shark Navigation system	1	Monitor and assist Diver location
Compressor HP	1	Daily flask charging

1.2.4. Diving Platform

Diving operation will be conducted from a 'flat deck' aluminum pontoon boat or from shore. The dive boat will be a minimum length of 25'. The diving platform includes an operator's console, propulsion, anchoring/mooring, communications, required safety equipment and diver's ladder.

1.2.5. Topside assistance/support

No outside topside support will be required for this operation.

Section 2. Dive Task

2.1. DESCRIPTION OF WORK

AOR International is supporting EA Engineering, Science, and Technology, Inc., PBC with diving services for the MMRP Remedial Investigation at Iona Island Naval Ammunition Depot, Formerly Used Defense Site in Stony Point, Rockland County, New York. AOR will complete an underwater visual and analog detector survey of 3 former loading dock areas

The diving survey will be completed in Surface Supplied Dive Mode. Each diver will be equipped with an Emergency Gas Supply (EGS), a Shark Marine Navigation Tablet, and an underwater (UW) Ebinger 725K analog detector fitted with a 230 mm coil (or similar detector). Transects of each loading dock area will be pre-loaded into the Shark Tablet prior to diving operations. The Shark Tablet will be connected to a global navigation satellite system (GNSS) buoy for locating and tracking divers along transects.

After entering the water, the diver will use the Shark Tablet to navigate and investigate each UW transects. Planned routes will be displayed on the Shark Marine Navigation Tablet in one color for the diver to follow while actual diver's routes are plotted in another color. Route plotting and contact information will be recorded and reviewed daily and provided to USACE. Positioning information obtained through GNSS navigation will be recorded by the Shark Tablet and will allow the diver to visually follow his transect. The diver will investigate anomalies detected along each transect. Anomalies will be investigated by digging up to arms length. Non-munitions related debris will be left in place. Munitions Debris will be recovered. Material Potentially Presenting an Explosive Hazard (MPPEH) will be marked and photographed for evaluation. Following evaluation, MPPEH determined acceptable to move will be raised to the surface and taken to shore. MPPEH determined unacceptable to move will be blown in place in accordance with the Unified Federal Policy - Quality Assurance Project Plan (UFP - QAPP).

The dive contractor has identified the major phases of diving evolution completion as well as an overview of the daily workflow for this project below:

2.1.1. Phases for the project include:

- Mobilization of 5-person dive team and equipment to Iona, NY
- Site preparation/coordination with EA Engineering. Science, and Technology, Inc, PBC field team and USACE diving oversight
- Equipment preparation/inspection by diving inspector/DDC set-up, training, and performing check dives prior to diving operations
- MEC subsurface anomaly RI (details incorporated in QAPP)
- Work completion /debrief to ensure all project deliverable data has been acquired
- Demobilization of the 5-person dive team and equipment to original destination.

2.1.2. Daily Work Schedule

- Daily safety / dive brief (diving assignments, safety information specific to day's activities)
- Dive station and emergency equipment pre-staging

- MEC anomaly RI operations
- Daily debrief.

Dive logs shall be submitted to the DDC as requested.

2.2. DATE, TIME AND LOCATION OF DIVE OPERATIONS

Diving Operations will typically be conducted 0700-1700 each day during daylight hours to allow for work schedule adjustments, as may be required due to inclement weather. In general, it is anticipated that the dive schedule will consist of:

07:00 AOR Team arrive and perform pre-maintenance inspections and checks. The dive sup will ensure all safety and emergency measures are in place, conduct muster and daily tailgate safety brief followed by the dive brief.
07:30 AOR Team underway to the project footprint/dive site and commence MEC anomaly RI diving operations.
16:30 AOR Team secure from diving operations. AOR Team conducts post-dive maintenance inspections and checks, dive sup conducts team de-brief and prepares for the next day's operations.

2.3. DIVING MODE. (INCLUDING A DESCRIPTION OF THE BACKUP AIR SUPPLY.)

The diving mode shall consist of a commercial SSA system utilizing HP air for primary and secondary air supply. Two (2) each, 200-foot or greater, diving umbilical's will be used to provide breathing medium to the divers. All diver umbilical's will be attached via the diver(s) air control manifold to allow for cross connection of primary and secondary supply to the diver(s) as required.

A single dive crew will be used to execute this phase of the work. The dive station will be set up on AOR's dive boat for diving operations. Diver(s) will enter and exit the water via a ladder suspended over the boat(s) side. A 4-pin hardwire communication system will provide communication between the divers and the divers to the dive control station. Divers will be equipped with a helmet mounted underwater color camera which will be displayed on monitors in the video systems console at all times. Digital video recorder will be connected inline and will be recorded as required.

All dives will be planned for No "D". Primary means of selecting the diver's decompression schedule will be conducted by utilizing US NAVY Dive Tables. The DPIC/Diving Supervisor is responsible for tracking the diver's No "D" time remaining via a stopwatch on the surface. Repetitive dives at shallower depths are allowed if for any reason voice communications are lost, the dive must be aborted. Line pull signals will used to communicate during a loss of voice communication.

2.3.1. Backup Air Supply

Divers will utilize a Kirby Morgan Mask/Helmet fitted to accept an EGS bottle. Divers will use a minimum of a 30 ft3 EGS bottle with its own 1st stage regulator attached to the

KM Mask/Helmet side block manifold. The Dive Sup must ensure the back-up air supply is fully charged with a minimum of 2700 psig or at planned depth will provide the diver with a minimum of 12-minutes of air during an emergency with a diver breathing rate of 1.4 ACFM.

2.4. NATURE OF WORK TO BE PERFORMED BY THE DIVERS, INCLUDING TOOLS USED AND MATERIALS TO BE HANDLED OR INSTALLED:

The Dive Team will be conducting subsurface MEC anomaly RI operations utilizing the diver’s handheld magnetometer. The team will mark MEC anomalies location with GPS and if conditions allow a weighted buoy for visual reference and recovery.

If standby diver is utilized as a working diver, the primary diver must report that the worksite is free and clear of obstructions and the diver has free access to the surface. Pre and post-dive maintenance, inspections and checks will be performed on each diving day.

2.5. ANTICIPATED SURFACE AND UNDERWATER CONDITIONS

- Air Temperatures range from a low of 40 degrees F and to highs from 80 degrees F.
- Surface conditions: Winds from the SE @ 1kt.
- Underwater conditions: Foliage and industrial debris
- Currents: 1kt plus
- Visibility: 0 - 1 foot
- Temperature: Water temperatures of 50 - 60 degrees F are expected.

2.6. MAXIMUM SINGLE DIVE BOTTOM TIME FOR THE PLANNED DEPTH OF DIVE FOR EACH DIVER:

Maximum Depth = 60 FFW. Depth measured by pneumofathometer on the console, correction to depth measurement is required.

Elevation at dive site = 08 feet.

Maximum single dive bottom times shall not exceed:

No Decompression Limit for 60’ FFW = 63 minutes.
No Decompression Limit for 45’ FFW = 125 minutes.
No Decompression Limit for 25’ FFW = 1102 minutes
No Decompression Limit for 20’ FFW = unlimited

2.7. MEANS OF DIRECT COMMUNICATION:

The primary mean of communications between AOR DPIC/Diving Supervisor, District Safety Representative, EA PM, SUXOS, UXOSO and USACE PM, and the dive site will be by cellular phone. Secondary means will be either by messenger in the event of an emergency.

2.8. CONTRACTOR INFORMATION

Organization	**Role**	**Name**	**Phone Number**
EA Engineering	Prime Contractor	Tim Reese	410-935-3887
AOR International, Inc	Diving Technical Manager	Brandon Puttroff	619-203-7325
AOR International, Inc	Diving Program Manager / DPIC	Steve Mulholland	619-559-5888

Safe Practices Manual

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2016

SAFE PRACTICES MANUAL FOR UNDERWATER OPERATIONS

PREPARED BY: STEVE MULHOLLAND

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DOCUMENT APPROVALS

Document Number:

Document Title: Safe Practices Manual for Underwater Operations – Revision Approvals

Revision #	Description	Prepared By	Reviewed By	Approved By	Date
0	**Safe Practices Manual**	Cliff Morin	John Hatcher	Trent Milligan	12-20-2016
1	**App. F – Dive and Treatment Tables**	Trent Milligan	John Hatcher	Trent Milligan	03-12-2017

REVISION HISTORY

Rev.	Section	Date	Amendment Description

1.0 INTRODUCTION

1.1 SCOPE AND PURPOSE

Diving operations involve a unique combination of occupational health and safety issues performed in an unforgiving environment where errors can quickly develop into serious incidents. Individual risks must be managed if diving is to be conducted in a safe and efficient manner.

1. This Safe Practices Manual for Underwater Operations defines the principles and requirements of surface diving operations performed by AOR International, INC. (AOR). The purpose of this manual is to define AOR safe practices for diving operations to ensure that these activities are planned, organized, performed, documented, and verified in a safe and efficient manner.

2. This manual replaces and supersedes all previous safe practice manuals and/or safety memorandums. It will be made available at each dive site for reference purposes and is to be used in conjunction with the documents listed below in **Section 1.2**.

3. It should be understood that there may be times when compliance with these rules could cause unsafe conditions and a variance will be necessary. As a minimum standard, such deviations should always be on the side of increasing safety. The reasons for any deviation and steps taken to minimize or eliminate risk shall be documented and approved by the **AOR Diving Operations Manager** and **Compliance, Health & Safety Manager**.

4. Every employee must keep in mind that no safety standard or set of rules will ever exist that will substitute for sound judgment and a continuing concern for optimum safety.

   The Diving Supervisor shall contact the AOR Diving Operations Manager and Compliance, Health & Safety Manager in the event of a situation not covered by procedures described in this manual, or where these procedures cannot be applied due to operational, health, safety, or reasons or due to local legal or contractual requirements.

1.2 REFERENCE DOCUMENTS

The following documents were used as reference for this manual and may be used for further clarification:

A. Occupational Safety and Health Administration (OSHA) Part 1910 – Occupational Safety and Health Standards, Subpart T, Commercial Diving Operations (Current Revision)

B. Occupational Safety and Health Administration (OSHA) Directive Number: CPL 02-00-051 (effective date: January 29, 2016)

C. US Navy Diving Manual Rev. 7 SS521-AG-PRO-010 0910-LP-115-1921, December 01, 2016

D. The Association of Diving Contractors International, Inc. (ADCI) Consensus Standards for Commercial Diving and Underwater Operations Rev. 6.2, Sixth Edition, 2016

E. AOR International, INC. – Health and Safety Standards & Implementations Manual (Current Revision)

F. US Army Corps of Engineers Safety and Health Requirements Manual, Regulation number EM385-1-1, 30 November 2014

G. Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel DDESB TP-18, 01 September 2016
H. Guidance for Diving in Contaminated Waters Revision 1, SS521-AJ-PRO-010, March 15, 2008

1.3 PRESERVATIVE ACTS DISCLOSURE

It is expressly provided and declared that in an emergency situation where personnel or environmental safety is at risk, the company, its officers, directors, agents, or employees may act in variance with the operating procedures and recommendations established in this Safe Practices Manual.

1.4 RESPONSIBILITY FOR ESTABLISHMENT AND MAINTENANCE OF THE MANUAL

A. The AOR Diving Operations Manager is responsible for establishing and maintaining this document.

B. Personnel employed by AOR International are responsible for adhering to the procedures and policy set forth in this manual and for providing feedback aimed at its continual improvement.

1.5 IMPORTANT DEFINITIONS

A. “Shall” is used for mandatory actions and requirements of design, calculations, planning, etc., to comply with specifications. With regard to its use in this manual, “shall” is equivalent to “must.”

B. Important technical definitions are presented in ***Appendix H - Glossary***.

C. He/she – This is a gender-neutral document. Any reference to he or she implies either.

2.0 PERSONNEL REQUIREMENTS

2.1 ASSIGNMENT AND RESPONSIBILITIES

Titles, duties, responsibilities, and capabilities of personnel engaged in commercial diving and underwater operations vary widely across the industry. AOR has established functional descriptions for all positions in its subsea operations. The AOR Diving Operations Manager is responsible for assigning personnel to key positions in the company's underwater diving operations and will ensure all persons are qualified by training and experience to perform the tasks assigned. The following designations indicate the minimum duties and responsibilities of dive team members:

A. Each manager/supervisor is responsible for the health and safety of their employees and all safety/environmental activities within their area of supervision.

B. Each employee shall demonstrate a positive attitude toward injury prevention and protection of the environment and company property. Each employee shall accept that all injuries can be prevented. For more information, refer to the AOR Health and Safety Standards and Implementations Manual.

C. Effective management can be achieved only through good communication and complete understanding of the role of each individual in a project's organization. Therefore, it is essential that each employee is competent and qualified with their individual duties and responsibilities.

D. Job descriptions state the responsibilities and authorities assigned to persons holding a particular position and detail the most important functions relevant to that position. All persons shall have the necessary qualifications for their job assignments.

E. Diving personnel shall have valid documentation of training in relevant subjects, i.e., certificates or documentation from a school that instructs at American National Standards Institute/Association of Commercial Diving Educators (ANSI/ACDE) 01-2009 standards or is approved by the ADCI, a military diving school, or equivalent. Personnel previously employed without meeting these qualifications must be certified by the company as having an equivalent degree of training though a combination of field experience and formal classroom instruction. It is each employee's responsibility to provide all records pertaining to qualifications for their assigned job function(s) to AOR.

F. Persons assigned to specific diving activities shall possess the following knowledge and skills gained through training or experience:

1. Diving procedures and techniques;
2. Emergency procedures;
3. Physiology as it relates to diving;
4. Diving equipment;
5. Basic first aid/CPR (per regulations);
6. Emergency Oxygen provider;
7. Familiarity with procedures and proficiency in the use of tools, equipment, and devices associated with the assigned tasks; and
8. Knowledge of chamber operations (If applicable).

G. A person lacking the required experience and proficiency outlined above may be assigned limited tasks, under the direction of an experienced and qualified individual, in order to obtain the experience and level of proficiency required.

H. Persons engaged as divers or otherwise exposed to hyperbaric conditions shall meet the physical qualifications for such activities as outlined in **Section 4.0 Medical Requirements**. Such physical qualifications shall be documented on an ADCI Medical History and Physical Examination Form or equivalent issued by AOR's Work Care provider.

2.2 ORIENTATION TRAINING

2.2.1 General Orientation Program

A. Each individual shall complete an orientation program when first hired on and prior to commencing work at an AOR worksite. The orientation program is established to ensure that personnel are familiar with all information necessary to conduct the planned operations.

B. The orientation program consists of OSHA, USACE and company-required training, including AOR's H&S specific program standards training. Records including the content of such training, duly signed off, must be maintained in the individual's training file, and relevant records must be accessible to supervisory personnel.

2.2.2 Job Site Orientation

Each job and situation has its own requirements, and reason and logic should normally prevail in the definition of the orientation training. The diving Supervisor is ultimately responsible for assuring that personnel assigned to their respective teams have been given a satisfactory job-site orientation before starting work.

2.3 ENTRY LEVEL QUALIFICATIONS

A. The entry level, minimum skill designation on the diving team is the entry level tender. The entry-level tender shall satisfy the minimum entry qualifications of diving proficiency, technical proficiency, and experience by successfully completing a course of study approved by AOR Diving Operations Manager.

B. A formal course of study for a tender/diver shall be completed at any accredited school, military school or equivalent whose curriculum at a minimum, conforms to ANSI/ACDE- 01-2009 (ANSI American National Standard Institute and ACDE – Association of Commercial Diving Educators). This training for commercial diving is comprised of at least 625 documented hours of academic and practical training components.

C. AOR International recognizes formal training certificates issued from within other nations. Foreign certificates will be evaluated together with presented other documentation to determine if the individual satisfies minimum entry requirements.

D. For persons engaged as divers, or otherwise subjected to hyperbaric conditions, an initial diver medical examination is required. See **Section 4.0 Medical Requirements**.

E. Advancement to higher job skill designations shall require completion of training and experience for all lower designations. Additional required technical qualifications for various job skill designations are detailed separately in **Section 3.0 Individual Qualifications, General Duties, and Responsibilities'**.

F. An individual must demonstrate the following field experience and diving proficiency and be competent and qualified before being promoted from tender to diver:

1. Air divers: Minimum of 60 field days and 20 working dives;

2.4 FIELD EXPERIENCE

Field experience shall be defined as the number of field days an employee has directly participated as a diving supervisor, diver, or tender engaged in diving operations. Individuals must meet the minimum established field experience requirements to obtain various skill designations.

2.5 DIVING PROFICIENCY

Diving proficiency shall be determined by the number of open-water working dives performed by an individual during a 12-month period immediately prior to issuance of a particular job skill designation. Individuals must perform the minimum established number of working dives for each skill designation. Work shall be performed during each dive with proper supervision, and all dives shall have a minimum of 20 minutes of bottom time.

2.6 COMMERCIAL DIVER CERTIFICATION PROGRAM

Persons employed to perform as certified commercial divers must be properly trained in accordance with the current edition of the ADCI International Consensus Standards for Commercial Diving and Underwater Operations. All diving personnel need to hold a current ADCI certification card reflective of the assigned task and experience level.

ADCI Certification Cards can only be obtained through application to ADCI upon company verification of acceptable documentation that the individual has completed the requisite training and on-the-job experience necessary to support the appropriate classification level.

Table 2.1 lists the certification exams, experience level, and pre-requisites for each dive team member category.

Table 2.1 Certifications and Training Matrix

REQUIREMENTS	ENTRY-LEVEL TENDER/DIVER	AIR DIVER	AIR-DIVING SUPERVISOR
Formal Training	625 hours		
Field Days		60	120
Working Dives		20	60
Assistant Supervisor Training Field		30 working days	
Exam			Exam Required

2.7 PERSONAL DIVER LOG BOOKS

2.7.1 Log book Maintenance Responsibilities

A. All divers shall maintain a personal dive log (ADCI Professional diver’s logbook or equivalent) detailing all hyperbaric exposures. The logbook shall include a photograph of, signature, and home address of the diver maintaining the log. This logbook shall be presented for review upon hire and upon request during employment.

B. At a minimum, the following information should be entered in the log book for each dive:

1. Local office name and address;
2. Date of the dive;
3. The name or other designation and location of the dive site or vessel from where the diving operation was carried out;
4. Maximum depth reached during the dive;
5. The time left surface, total bottom time, and the time reached surface for each hyperbaric exposure;
6. Surface interval, if dive includes chamber time for decompression;
7. Type of breathing apparatus and mixture used;
8. Task performed;
9. Type and designation of the decompression table and schedule used;
10. Any decompression illness (DCI) or injury incurred during the dive;
11. Comments section;
12. Diver's signature;
13. Supervisor's signature; and
14. Place for a counter-signature or stamp of the diving company.

C. Divers shall, in addition to the above requirements, maintain a log of any and all maintenance performed on personally owned equipment. Records of this maintenance shall include the following minimum information:

1. Name of person conducting the maintenance;
2. Date of maintenance; and
3. Work performed.

D. All diver personnel shall present their personal logbook to company authorities for verification and stamping at annual intervals, at a minimum.

2.7.2 On-site Verification of Personal Log book

All divers shall present their personal logbook at the work site. The diving supervisor shall verify that all divers assigned a diving role have a current and up-to-date logbook that meets the criteria in **Section 2.7**.

3.0 INDIVIDUAL QUALIFICATIONS, GENERAL DUTIES, AND RESPONSIBILITIES

Table 3.1 Job Titles, Abbreviations, and Descriptions for Surface Diving Personnel

Abbreviation	Job Title	Description
Supervisors		
DST	**Superintendent - Diving**	**Superintendent – Surface-Supplied Diving. Qualified to supervise multiple shifts and vessel operations.**
DS	**Diving Supervisor – Air**	**Diving Supervisor – Surface-Supplied Diving. Qualified to supervise only air diving (completion of Supervisor Training Program for Air Diving).**
Divers/Tenders		
UXOD1	**UXO Diver I**	**In addition to air diving- UXOD1 is able to search and report UXO findings and assist UXOD2 in demolition of UXO**
UXOD2	**UXO Diver II**	**In addition to air diving- UXOD2 is able to evaluate, handle and effect demolition on UXO.**
SSAD	**Air Diver**	**Fully qualified to dive operationally to 165 FSW.**
STBD	**Standby Diver**	**Lowest level of training and experience for Diver classification ("breakout" to SSAD qualifies for promotion by supervisor and management evaluation and requires completion of 20 working dives as a Tender).**
DT	**Tender**	**Tender (apprentice diver): Qualified for surface-supplied air diving. +6 months or +60 days in field.**
Technicians		
Rack Operator	**Rack Operator**	**Dive team experience and qualified to operate the particular breathing manifolds, regulators, and valves, which control the breathing medium to the diver(s). Can monitor depth and pressure gauges for entry into diving log. Works under the direct supervision of the diving supervisor.**
Dive Tech	**Diving Equipment Technician**	**Surface-supplied diving equipment. Qualified to inspect, maintain and repair diving equipment, diving helmets, testing and certifying equipment, regulators, gauges, valves, etc.**

3.1 DESIGNATION OF PERSON-IN-CHARGE OF DIVING OPERATIONS (DPIC)

A. A qualified person in charge of each diving operation shall be designated as the diving supervisor, or designated Person-in-Charge of Diving Operations, by means of written documentation. A copy of the documentation shall be available to competent authorities on arrival at the work site. This notification is provided in accordance with the following regulations:

1. USCG 46 CFR Part 197 Subpart B: Commercial Diving Operations, 197.210 Designation of Diving Supervisor

2. OSHA 29 CFR Part 1910 Subpart T: Commercial Diving Operations,1910.410(c) Designated Person-in Charge

B. The DPIC (Designated Person-in-Charge), commonly referred to as the "Diving Supervisor," is immediately responsible for the safety and health of the dive team. The DPIC is the employer representative chosen by the employer. The DPIC shall be stationed at the dive location, and shall not be stationed at another dive location (i.e., he/she must be stationed at one dive location and be responsible only for the diving operation at that location). The DPIC has the authority to permit the start of diving operations. The DPIC has the ultimate authority to forbid the start and to order the termination of any diving operation on the grounds of safety.

3.2 DIVING SUPERINTENDENT

A. Qualifications

1. The diving superintendent shall have a thorough knowledge of the dive system and relevant equipment, including related operational and emergency procedures; familiarity with relevant regulations applicable to diving venue; familiarity with relevant standards/guidelines applicable to diving venue. He shall also have sound knowledge of the AOR Health and Safety Management System and this Safe Practices Manual for Underwater Operations. Additionally, the diving superintendent must be competent and qualified in the following areas:

   a) Diving procedures and techniques in use at the specific work site;
   b) Management of diving incidents;
   c) Emergency procedures;
   d) Diving-related physiology;
   e) Proper operation and use of all equipment related to diving, including decompression chamber operation;
   f) Hazard recognition and risk assessment; and
   g) Management of Change and Variance processes.

2. In addition, the diving superintendent shall attend scheduled pre-job meetings and/or assist in the risk assessment, as required.

B. General Duties

1. The diving superintendent is in charge of leading the planning and execution of the diving operations and must be competent and qualified.
2. The dive superintendent reports to the project manager and maintains close communication with the client's representative.

C. Responsibilities

The diving superintendent has the responsibility to:

1. Supervise all operational activities, including ship deployment preceding and during any diving, and/or diving equipment on board the ship, barge, or jobsite;
2. Maintain quality control of all operational activities in accordance with the relevant standards and specifications, as required by the client's representative and project documentation requirements;
3. Ensure that all diving operational activities undertaken are in accordance with operational manuals and safety memoranda;
4. Ensure that all employees and/or subcontractors on the diving jobsite follow the EHS policies;
5. Ensure that personnel arriving on the jobsite are fully briefed about the work program, dive systems, and operational and safety requirements;
6. Ensure that any permit-to-work system is fully complied with;
7. Ensure that a safety meeting is convened at the prescribed intervals and a copy of the minutes is sent to the responsible AOR project manager;

8. Coordinate daily pre-shift safety meetings with the diving supervisors;
9. Implement any corrective measures as defined by documented audits and/or inspections pertaining to personnel, the work site, and supporting equipment;
10. Report incidents, near misses, dangerous occurrences and other information to the AOR Compliance, Health and Safety Manager;
11. Prepare or delegate the daily report required by the project manager; and
12. Know the procedures for the Emergency Management Plan for evacuation of the jobsite.

3.3 DIVING SUPERVISOR

A. Qualifications

1. The diving supervisor shall have a thorough knowledge of the system and relevant equipment, including related operational and emergency procedures; familiarity with relevant regulations applicable to diving venue; familiarity with relevant standards/guidelines applicable to diving venue. The diving supervisor shall also have a sound knowledge of the AOR Health and Safety Standards and Implementation Manual and the Safe Practices Manual for Underwater Operations. Additionally, the diving supervisor must competent or qualified in the following areas:

    a) Diving procedures and techniques in use at the specific work site;
    b) Management of diving incidents;
    c) Emergency procedures;
    d) Diving-related physiology;
    e) Proper operation and use of all equipment related to diving, including decompression chamber operation;
    f) Hazard recognition and risk assessment; and
    g) Management of Change and Variance processes.

2. The diving supervisor shall be designated in writing as the Person-in-Charge of Diving Operations.

B. General Duties

1. The diving supervisor has the responsibility for the safe implementation and completion of the diving operations under his command. He must operate within the all regulations and AOR procedures unless an approved variance is in place.
2. The diving supervisor is appointed in writing and reports to the diving superintendent or project superintendent where one is assigned. In the event a Diving or project superintendent is not assigned, the diving supervisor reports to the project manager.

C. Responsibilities

The diving supervisor has the responsibility to:

1. Manage all aspects of the dive site, properly direct the dive team members in the performance of their duties, and remain ready to respond to emergency conditions;
2. While on duty, be in immediate control and available to implement emergency procedures. The diving supervisor shall have no duties other than those set forth in this document and is not permitted to dive unless another qualified diving supervisor is present who has been appointed and designated to assume responsibility;
3. Possess such qualifications that are deemed necessary by AOR and this Safe Practices Manual;
4. Assign the duties of all members of the dive team and ensure they are competent and qualified to carry out their tasks;

5. Verify that all personnel on the dive team are qualified and physically able to perform tasks assigned (i.e., must make an assessment of physical condition of the Divers prior to each dive to determine if any physical impairment is present that would be detrimental to their health and safety in the water or under hyperbaric conditions;
6. Establish a dive plan ensuring that sufficient breathing mixtures, supplies, and proper equipment are available for safe and timely completion of the task;
7. Ensure that an Activity Hazard Analysis (AHA) is performed for each task associated with the diving operations;
8. Be aware of procedures to obtain medical support in the event of an incident (both diving and non-diving);
9. Attend scheduled pre-job meetings and/or assist in risk assessment, as required;
10. Conduct and attend effective pre-shift safety meetings with dive team and support personnel to cover, such as:
    a) Tasks to be undertaken, and
    b) Unusual hazards and environmental conditions

11. Instruct divers to report any illnesses, infections, or anything unusual that would interfere with the safe completion of their dive. Also, instruct divers to report any symptoms that might indicate DCS or injury following a dive;
12. Ensure that the diver's pneumo hose does not become clogged with sand or mud while working in such conditions on bottom. It is a recommended practice to do a slow purge of the pneumo hose after an accurate depth is established. This practice should be addressed and taken into account when performing the pre-dive AHA;
13. Report all injuries and incidents involving personnel as required by AOR and the client;
14. Inform the diving superintendent or project manager of his intentions in order to maintain effective liaison between all interested parties;
15. Complete all records and documentation, regularly and in full, as required by relevant industrial standards, AOR procedures, and this Safe Practices Manual, including requirements for diving operations, equipment maintenance, testing, and repair;
16. Assure adequate turnover and fully brief his relief on the operation, regardless of the period of absence from the supervising position;
17. Keep an accurate personal diving supervisor log book as well as review and ensure accuracy of divers' log books and sign to properly record activities;
18. Review and implement emergency contingency procedures;
19. Conduct routine diving emergency drills and record accordingly;
20. Facilitate "pre and post" dive checklists for the operations;
21. Brief diving teams before each dive;
22. Ensure that all relevant operating instructions, manuals, decompression tables, and treatment schedules are available at the dive location and are maintained to reflect current changes;
23. Ensure that all equipment is placed at the work site with regard to ease of operation and safety;
24. Ensure that all necessary supplies and equipment have been provided, are suitable for purpose, and are inspected prior to dive;
25. Ensure that the diving operations are conducted from a suitable and safe location on the surface;
26. Ensure that each diver is continuously tended in the water;
27. Determine deepest depth of dive prior to leaving bottom.
28. Ensure that the dive is terminated when:
    a) the diver requests termination;
    b) the diver fails to respond to communication or communication is lost;
    c) the diver goes on bailout (diver-carried emergency gas system); or
    d) weather conditions or site conditions degrade to the extent that diver safety is in jeopardy.
29. Ensure each diver surfacing from a dive requiring decompression is assessed for the following:

   a) The physical condition and well-being of the diver is checked by visual observation and verbal questioning;
   b) The diver is instructed to report any physical problems or symptoms of DCS.

30. Ensure that after any treatment or dive outside of the no-decompression limits:
    a) The diver is instructed to remain awake and in the vicinity of a decompression chamber for at least 2 hours, and
    b) A trained dive team member is available to operate the decompression chamber;

31. Ensure each diver's personal equipment is inspected and is safe for use. Personal gear that is not within specifications or is deemed "unfit for use" shall not be used;
32. Maintain required medical certification (i.e., first aid CPR, and O2 administrator);
33. Ensure instruction is given to tenders while making dives to allow them to gain much needed knowledge and experience on their way to becoming divers.

3.4 NON-DIVING SUPERVISOR

A Non-diving supervisor is an experienced diving supervisor not currently participating in the diving rotation. In the event the diving supervisor will dive in the rotation, he must appoint another person to act as diving supervisor who has adequate qualifications of a diving supervisor.

3.5 UXO DIVER I

A. Qualifications

1. Divers shall have a thorough understanding regarding the equipment and tools to be used during the work. They shall have a sound knowledge of the operational and emergency procedures relevant to their work. Additionally, divers shall have training or experience in the following areas:

   a) Air diving procedures and techniques, and, if applicable, mixed gas diving procedures and techniques;
   b) Emergency procedures;
   c) Management of diving incidents; and
   d) Proper operation and use of all equipment related to air diving, including decompression chambers.

2. All divers must meet the required standards from an ACDE accredited school, a school that instructs at ANSI standards level or is approved by the ADCI, a military school, or equivalent approved by AOR.
3. Completed the underwater portion of NAVSCOLEOD (or foreign equivalent)

B. General Duties

1. The diver must read and comply with all AOR policies, procedures and practices as well as all regulations as they apply to divers' related qualifications or performance.
2. The diver must possess an ADCI/or local equivalent-approved current medical clearance to dive and a current logbook ADCI Professional Diver's log book or equivalent). This logbook is to be kept up-to-date.
3. The diver is expected to perform all diving duties appropriate to his qualifications as instructed by the diving supervisor. If the job requires work beyond the experience or capabilities of the diver, the diver shall advise the diving supervisor.
4. The diver is expected to follow safe diving practices at all times during diving operations, whether on deck or in the water. The diver must bring any points, issues and/or concerns

pertaining to the job, dive safety and/or the dive operations to the attention of the diving supervisor.

C. Responsibilities

The diver has the responsibility to:

1. Keep in good physical condition;
2. Comply with all policies, procedures and/or practices of AOR and any applicable government agency;
3. Inform the diving supervisor if he is unfit, has a condition and/or or if there is any other reason why he should not go or remain under water or in a decompression chamber. He must report any recent illness or medical treatment and advise the diving supervisor of any prescription drugs or medication he is taking so that a determination can be made to his ability to dive safely; any current/ongoing symptoms/illnesses are to be made known when diver reports to the jobsite and immediately before a dive.
4. Report any illnesses, symptoms or injury pre and post dive immediately to the diving supervisor;
5. Check all basic diving equipment that he would normally use on a dive, including any emergency equipment, ancillary equipment, or personal protective equipment (PPE). Before entering the water, and he should be satisfied that his equipment is functional and in proper working order;
6. Report to the diving supervisor any defective or malfunctioning diving equipment provided for the diving operation;
7. As required, assist in the setup, maintenance, and repair of all diving equipment on the job;
8. Comply with regulations or instructions concerning the use, repair, maintenance, and testing of all diving equipment provided for the operation;
9. Act as standby diver when required and following all requirements found in *Section 3.8;*
10. Ensure that he is fully briefed prior to a dive and fully understands the task to be carried out;
11. Report the exact condition of the work site to the diving supervisor, including any hazards that might exist for the divers who follow in rotation;
12. Make certain the deepest depth of dive has been established prior to leaving bottom;
13. Obey the diving supervisor when instructed to depart the work site for a return to the surface or the first water stop;
14. Safely exit the water and make a timely transition into the decompression chamber within the prescribed time limit, as noted in the air/gas surface diving tables;
15. Remain awake in the vicinity of the decompression chamber for a minimum of 2 hours after the completion of each dive, decompression, or treatment;
16. Ensure, on completion of a dive, that his equipment is cleaned and stowed and that any equipment faults are brought to the attention of the diving supervisor;
17. Review the dive sheet within the calendar day of the dive and ensure correctness. Any discrepancies are to be reported to the diving supervisor for appropriate action. The diver is to sign the dive sheet after review;
18. Comply with the facility safety requirements;
19. Be able to apply the routine emergency procedures that are detailed in the relevant manuals on board;
20. Immediately report any incident, injury, illness, symptom and/or feeling unwell to the diving supervisor and/or dive superintendent before dive, during dive, during surface interval and post dive;
21. Know and observe the rules for time limitations of flying after diving;
22. Not to do heavy lifting with an hour of surfacing from a decompression dive;
23. Maintain a diver's log book that details all dives, medical examinations, courses taken, certification level achieved, and personal equipment maintenance;
24. Ensure medical certifications are up-to-date and recorded in a personal log book;

25. Present their log book to the diving supervisor on every job for his signature following a dive;
26. Maintain certification in first aid, CPR, and O2 administration;
27. Have experience in the use of diving equipment;
28. Be familiar with the type of work at hand; and
29. Assist in the training and mentoring of new diver/tenders and entry level tenders

3.6 UXO DIVER II

A. Qualifications

1. Divers shall have a thorough understanding regarding the equipment and tools to be used during the work. They shall have a sound knowledge of the operational and emergency procedures relevant to their work. Additionally, divers shall have training or experience in the following areas:

    a) Air diving procedures and techniques, and, if applicable, mixed gas diving procedures and techniques;
    b) Emergency procedures;
    c) Management of diving incidents; and
    d) Proper operation and use of all equipment related to air diving, including decompression chambers.

2. All divers must meet the required standards from an ACDE accredited school, a school that instructs at ANSI standards level or is approved by the ADCI, a military school, or equivalent approved by AOR.
3. Completed a UXO technician certification' 29491 UXO-TI' course IAW DDESB TP-18

B. General Duties

1. The diver must read and comply with all AOR policies, procedures and practices as well as all regulations as they apply to divers' related qualifications or performance.
2. The diver must possess an ADCI/or local equivalent-approved current medical clearance to dive and a current logbook (ADCI Professional Diver's logbook or equivalent). This logbook is to be kept up-to-date.
3. The diver is expected to perform all diving duties appropriate to his qualifications as instructed by the diving supervisor. If the job requires work beyond the experience or capabilities of the diver, the diver shall advise the diving supervisor.
4. The diver is expected to follow safe diving practices at all times during diving operations, whether on deck or in the water. The diver must bring any points, issues, and/or concerns pertaining to the job, dive safety and/or the dive operations to the attention of the diving supervisor.

C. Responsibilities

The diver has the responsibility to:

1. Keep in good physical condition;
2. Comply with all policies, procedures and/or practices of AOR and any applicable government agency;
3. Inform the diving supervisor if he is unfit, has a condition and/or or if there is any other reason why he should not go or remain under water or in a decompression chamber. He must report any recent illness or medical treatment and advise the diving supervisor of any prescription drugs or medication he is taking so that a determination can be made to his ability to dive safely; any current/ongoing symptoms/illnesses are to be made known when diver reports to the jobsite and immediately before a dive.

4. Report any illnesses, symptoms or injury pre and post dive immediately to the diving supervisor;
5. Check all basic diving equipment that he would normally use on a dive, including any emergency equipment, ancillary equipment, or personal protective equipment (PPE). Before entering the water, and he should be satisfied that his equipment is functional and in proper working order;
6. Report to the diving supervisor any defective or malfunctioning diving equipment provided for the diving operation;
7. As required, assist in the setup, maintenance, and repair of all diving equipment on the job;
8. Comply with regulations or instructions concerning the use, repair, maintenance, and testing of all diving equipment provided for the operation;
9. Act as standby diver when required and following all requirements found in *Section 3.8;*
10. Ensure that he is fully briefed prior to a dive and fully understands the task to be carried out;
11. Report the exact condition of the work site to the diving supervisor, including any hazards that might exist for the divers who follow in rotation;
12. Make certain the deepest depth of dive has been established prior to leaving bottom;
13. Obey the diving supervisor when instructed to depart the work site for a return to the surface or the first water stop;
14. Safely exit the water and make a timely transition into the decompression chamber within the prescribed time limit, as noted in the air/gas surface diving tables;
15. Remain awake in the vicinity of the decompression chamber for a minimum of 2 hours after the completion of each dive, decompression, or treatment;
16. Ensure, on completion of a dive, that his equipment is cleaned and stowed and that any equipment faults are brought to the attention of the diving supervisor;
17. Review the dive sheet within the calendar day of the dive and ensure correctness. Any discrepancies are to be reported to the diving supervisor for appropriate action. The diver is to sign the dive sheet after review;
18. Comply with the facility safety requirements;
19. Be able to apply the routine emergency procedures that are detailed in the relevant manuals on board;
20. Immediately report any incident, injury, illness, symptom and/or feeling unwell to the diving supervisor and/or dive superintendent before dive, during dive, during surface interval and post dive;
21. Know and observe the rules for time limitations of flying after diving;
22. Not to do heavy lifting with an hour of surfacing from a decompression dive;
23. Maintain a diver's logbook that details all dives, medical examinations, courses taken, certification level achieved, and personal equipment maintenance;
24. Ensure medical certifications are up-to-date and recorded in a personal log book;
25. Present their log book to the diving supervisor on every job for his signature following a dive;
26. Maintain certification in first aid, CPR and O2 administration;
27. Have experience in the use of diving equipment;
28. Be familiar with the type of work at hand; and
29. Assist in the training and mentoring of new diver/tenders and entry level tenders

3.7 AIR DIVER

A. Qualifications

1. Divers shall have a thorough understanding regarding the equipment and tools to be used during the work. They shall have a sound knowledge of the operational and emergency procedures relevant to their work. Additionally, divers shall have training or experience in the following areas:

    a) Air diving procedures and techniques, and, if applicable, mixed gas diving procedures and techniques;
    b) Emergency procedures;
    c) Management of diving incidents; and
    d) Proper operation and use of all equipment related to air diving, including decompression chambers.
2. All divers must meet the required standards from an ACDE accredited school, a school that instructs at ANSI standards level or is approved by the ADCI, a military school, or equivalent approved by AOR.

B. General Duties

1. The diver must read and comply with all AOR policies, procedures and practices as well as all regulations as they apply to divers' related qualifications or performance.
2. The diver must possess an ADCI/or local equivalent-approved current medical clearance to dive and a current logbook (ADCI Professional Diver's logbook or equivalent). This logbook is to be kept up-to-date.
3. The diver is expected to perform all diving duties appropriate to his qualifications as instructed by the diving supervisor. If the job requires work beyond the experience or capabilities of the diver, the diver shall advise the diving supervisor.
4. The diver is expected to follow safe diving practices at all times during diving operations, whether on deck or in the water. The diver must bring any points, issues and/or concerns pertaining to the job, dive safety and/or the dive operations to the attention of the diving supervisor.

C. Responsibilities

The diver has the responsibility to:

1. Keep in good physical condition;
2. Comply with all policies, procedures and/or practices of AOR and any applicable government agency;
3. Inform the diving supervisor if he is unfit, has a condition and/or or if there is any other reason why he should not go or remain under water or in a decompression chamber. He must report any recent illness or medical treatment and advise the diving supervisor of any prescription drugs or medication he is taking so that a determination can be made to his ability to dive safely; any current/ongoing symptoms/illnesses are to be made known when diver reports to the jobsite and immediately before a dive.
4. Report any illnesses, symptoms or injury pre and post dive immediately to the diving supervisor;
5. Check all basic diving equipment that he would normally use on a dive, including any emergency equipment, ancillary equipment, or personal protective equipment (PPE). Before entering the water, and he should be satisfied that his equipment is functional and in proper working order;
6. Report to the diving supervisor any defective or malfunctioning diving equipment provided for the diving operation;
7. As required, assist in the setup, maintenance, and repair of all diving equipment on the job;
8. Comply with regulations or instructions concerning the use, repair, maintenance, and testing of all diving equipment provided for the operation;
9. Act as standby diver when required and following all requirements found in *Section 3.8;*
10. Ensure that he is fully briefed prior to a dive and fully understands the task to be carried out;
11. Report the exact condition of the work site to the diving supervisor, including any hazards

that might exist for the divers who follow in rotation;
12. Make certain the deepest depth of dive has been established prior to leaving bottom;
13. Obey the diving supervisor when instructed to depart the work site for a return to the surface or the first water stop;
14. Safely exit the water and make a timely transition into the decompression chamber within the prescribed time limit, as noted in the air/gas surface diving tables;
15. Remain awake in the vicinity of the decompression chamber for a minimum of 2 hours after the completion of each dive, decompression, or treatment;
16. Ensure, on completion of a dive, that his equipment is cleaned and stowed and that any equipment faults are brought to the attention of the diving supervisor;
17. Review the dive sheet within the calendar day of the dive and ensure correctness. Any discrepancies are to be reported to the diving supervisor for appropriate action. The diver is to sign the dive sheet after review;
18. Comply with the facility safety requirements;
19. Be able to apply the routine emergency procedures that are detailed in the relevant manuals on board;
20. Immediately report any incident, injury, illness, symptom and/or feeling unwell to the diving supervisor and/or dive superintendent before dive, during dive, during surface interval and post dive;
21. Know and observe the rules for time limitations of flying after diving;
22. Not to do heavy lifting with an hour of surfacing from a decompression dive;
23. Maintain a diver’s log book that details all dives, medical examinations, courses taken, certification level achieved, and personal equipment maintenance;
24. Ensure medical certifications are up-to-date and recorded in a personal log book;
25. Present their log book to the diving supervisor on every job for his signature following a dive;
26. Maintain certification in first aid and CPR;
27. Have experience in the use of diving equipment;
28. Be familiar with the type of work at hand; and
29. Assist in the training and mentoring of new diver/tenders and entry level tenders.

3.8 STANDBY DIVER

A. Qualifications

The standby diver is a qualified diver to act as a rescue diver in the event the diver experiences and emergency requiring in-water assistance. The standby diver shall be appointed by diving supervisor prior to the dive. The standby diver shall have a thorough understanding of the equipment and tools the diver intends to use during the work, and shall ensure his diving equipment is readily deployable.

The standby diver should be able to listen to all communications between the working diver and the diving supervisor during the diver. Additionally, the standby diver must have training or experience in the following areas:

1. Emergency procedures and diver rescue techniques;
2. Management of diving incidents; and
3. Proper operation and use of all equipment related to air diving, including decompression chambers.

B. General Duties

The standby diver reports to the diving supervisor. The standby diver must be capable and qualified to carry out the duties and responsibilities of the diver as set forth in Section 3.7.

C. Responsibilities

The standby diver has the responsibility to:

1. Ensure standby hat is properly fitted to standby umbilical and check for proper flow of breathing medium and adequate communications;
2. Monitor the dressing of the primary diver by the tender to verify the diver is properly dressed to enter the water and the diver's hat is cam locked (locked in place) properly;
3. Be adequately dressed to allow quick entry into the water and stay at depth as long as circumstances require;
4. Remain at the appointed station throughout the dive and in-water decompression;
5. Monitor the diving radio to remain abreast of events as they happen and the status of the project;
6. Present possible emergency situations to the diver and diving supervisor and suggest what actions to take in response to each possibility; and
7. Not be assigned any task or duty that might interfere with the duties as standby diver while there is a diver in the water.

3.9 TENDER

A. Qualifications

Lead tenders shall have a thorough understanding of the equipment and tools that they will use as well as a sound knowledge of the operational and emergency procedures relevant to their work. Lead tenders must have training or experience in the following areas:

1. Same qualifications as a diver, with a lower level of required experience;
2. Familiarity with air diving and, if applicable, mixed-gas diving equipment; and
3. Have training from an approved diving school/program.

B. General Duties

The lead tender reports directly to the diving supervisor and assists the divers in the general work and maintenance during diving operations.

C. Responsibilities

The lead tender has the responsibility to:

1. Run, test, and load out the equipment assigned to the job. The lead tender will ensure that all items are complete and equipment is tested as required, and will double-check the tie-downs on the work platform, barge, vessel, etc.
2. Ensure that the chamber, volume tanks, and gas cylinders used on jobs have current certification and proper paper work;
3. Ensure that any mechanical problem or equipment deficiency is immediately reported to the diving supervisor. The deficient equipment should be "red tagged" with the full explanation of the problem or immediately repaired;
   Assist the diver in dressing and undressing of diving equipment;
4. Tend the diver's umbilical (keeping at least one hand on the umbilical at all times);
5. Assist other crew members in loading out equipment on vehicles or ships;
6. Assist with deck work and tool handling;
7. Clean and maintain auxiliary tools and equipment;
8. Set up and operate all equipment, as directed;
9. Immediately report any conditions that are unsafe or potentially hazardous;

10. Properly tend the surface diver, taking in or paying out such umbilical as may be required, transmit and receive such signals as may be directed or required, and remain alert to the amount of slack paid out or for any unusual or potentially hazardous circumstances;
11. Become familiar with the line signals;
12. Properly operate a decompression chamber required for decompression or treatment, if assigned to operate a decompression chamber;
13. Notify supervisor of any changes in diver’s condition, or issues with equipment;
14. Never leave his tending position until properly relieved;
15. Maintain proper ascent rate when operating winch to recover a stage;
16. Fully brief his relief if the diver is still deployed in the water or in the decompression chamber;
17. Properly complete all paperwork required; and
18. Maintain medical certification and training (i.e. first aid, CPR, and O2 administrator.)

4.0 MEDICAL REQUIREMENTS

All divers and tenders who are exposed to hyperbaric conditions shall be medically fit for diving and hold a valid diving medical clearance. The purpose of these guidelines is to outline recommendations concerning the extent and frequency of examinations, and define the medical requirements to be met by occupational divers and tenders who dive and/or exposed to hyperbaric conditions.

Medical exam protocols should align with the ADCI (Association of Diving Contractors International) Consensus Standards for Commercial Diving and Underwater Operations (6.2 Edition) standards for Medical Requirements (2.3) and Medical Standards and Recommendations (2.4). In addition, minimum requirements for diving shall meet the standards of OSHA 29 CFR Subpart T (Commercial Diving Operations) and dictated national or local laws.

4.1 GENERAL REQUIREMENTS

For persons engaged as divers, or otherwise subjected to hyperbaric conditions, the following ADCI medical examinations (or equivalent) are required:

1. An initial medical examination.
2. Periodic examinations are recommended on an annual basis.
3. A re-examination after a diving-related injury or illness as needed to determine fitness to return to diving duty.

4.2 PHYSICIAN’S WRITTEN REPORT

1. For persons engaged as divers or otherwise subjected to hyperbaric conditions, the initial exam and periodic medical re-examination include the following:

   a) Work history. The tests required in ADCI Consensus Standards as appropriate.
   b) Any tests deemed necessary to establish the presence of any of the disqualifying conditions listed in this section.
   c) Any additional tests the physician deems necessary.

2. All persons engaged as divers or otherwise subjected to hyperbaric conditions are required to get an annual exam. More frequent or extensive examination(s), including a complete medical re-examination, should be required if there have been any incidents (illness, accidents, etc.) during the course of that year that may have caused a change in the individual’s medical condition.

4.3 RE-EXAMINATION AFTER INJURY OR ILLNESS

Any person engaged as a diver, or otherwise exposed to hyperbaric conditions, will have a medical examination following an injury or illness that requires hospitalization of 72 hours or more (unless national or local laws dictate otherwise) or known decompression sickness with audio-vestibular, central nervous system dysfunction, or arterial gas embolism.

The person should not be permitted to return to work as a diver, or otherwise be subjected to hyperbaric conditions, until he is released by a physician to do so. The examining physician should determine the scope of the examination in light of the nature of the injury or illness.

4.4 TEMPORARY IMPAIRMENT OR CONDITION

Divers shall not dive or be exposed to hyperbaric conditions, other than treatment procedures, for the duration of any known temporary impairment or condition if such is likely to adversely affect health or interfere with the person's ability to perform a specific diving task or safely be exposed to hyperbaric conditions. These include, but are not limited to:

1. Colds;
2. Alcoholic intoxication or its after-effects (hangover);
3. Being under the influence of drugs;
4. Pregnancy;
5. Respiratory diseases;
6. Middle ear diseases;
7. Skin infections;
8. External ear infections; and
9. Excessive fatigue or emotional distress.

It is the diver's responsibility to inform the diving supervisor of any impairment or condition. In no case shall the diver be required to dive or be exposed to hyperbaric conditions against his will, except for treatment procedures.

4.5 MEDICAL RECORDKEEPING

An accurate medical record for each person subject to the medical specifications of this section should be established and maintained. The record should include those physical examinations specified herein including the ADCI Medical History / Physical Examination Forms and the physician's written report.

The medical record shall be maintained for a minimum of five years from the date of the last hyperbaric exposure unless otherwise prescribed by law.

4.6 WITHDRAWAL FROM HYPERBARIC CONDITIONS

An individual's fitness to dive in ongoing operations will be determined by the AOR Compliance, Health & Safety Manager and Operations Managers based on the history of the case, physician's examination, and whether a person's health will be impaired by continued exposure to hyperbaric conditions. Ultimate ruling on a diver's condition to dive will be signed by the AOR Diving Operations Manager.

For additional medical examination guidance, refer to ***Appendix G – AOR Guidelines for Medical Examinations for Divers.***

5.0 OPERATIONAL PLANNING AND SAFETY

5.1 INTRODUCTION

A. AOR has developed and maintains this Safe Practices Manual for Underwater Operations for the safety and health of divers and as required by government regulations. This manual shall be made available at all dive locations for each dive team member to review.

B. AOR's safe working practices are based on operational experience and meet or exceed the requirements of OSHA, USACE, and the ADCI Consensus Standards.

5.2 PLANNING AND SAFETY CONSIDERATIONS AND PROCEDURES

A. Planning and Safety go hand in glove and both are essential to a successful operation. All personnel involved in each operation should be involved in planning and hazard identification/assessment to the maximum extent possible. Thorough planning should identify all safety issues. While no amount of planning and assessing can eliminate all risk, no diving at AOR shall be continued with unidentified risk. Changing conditions may present unforeseen circumstance not previously addressed. In this case, stop work and assess the hazards. No safety concern communicated by any team member shall be dismissed.

B. The following shall be available at the dive site to all dive team members:

1. Safe Practices Manual for Underwater Operations;
2. Dive Operations Plan
3. Activity Hazard Analysis;
4. Emergency Management Plan;

C. The following subsections list minimum guidelines for specific safety checklists and equipment confirmations. These minimum guidelines may require modification, depending on the specific diving mode or work site needs.

5.2.1 General Company Safety Procedures

For general safety procedures and safety rules, refer to *AOR Health and Safety Standards and Implementations Manual.* Diving Superintendents and diving supervisors, and project managers and coordinators are responsible for knowledge and compliance with customer and facility safety requirements in addition to AOR policy.

5.2.2 Planning and Assessment

At a minimum, Planning shall include:

A. Work tasks and schedule.
   1. Include daily and weekly schedule with dive cycle times.

B. Site assessment, including:
   1. Surface and underwater conditions;
   2. Operational and environmental Hazards;
   3. Means of water entry and normal and emergency water exit;

C. Risk assessment:

1. Hazard identification;
2. Hazard analysis;
3. Hazard mitigation

D. Personnel assessment:
   1. Dive team capability and assignments;
   2. Team certifications;

E. Dive equipment assessment:
   1. Diving mode;
   2. Breathing gas supply duration, including reserves;
   3. Dive station set-up, pre-dive checklists (equipment, helmets, chamber, etc.)
   4. Thermal protection;

F. Decompression requirements:
   1. Repetitive diving procedures;
   2. Decompression procedure:
   3. Altitude corrections;

G. Emergency procedures;
   1. Site emergencies (fire, flooding, extreme weather);
   2. Equipment/systems failure;
   3. Personnel casualty (diving and non-diving)

H. Communication Plan

5.2.3 Risk Management

A. All operations planning shall employ risk management and include a site specific Activity Hazard Analysis (AHA.) Risk management is a long term overall program that assesses risk to personnel, risk to equipment, risk to the company, and risk to the mission. AHAs are specific to a job and a site and assess and eliminate or mitigate hazards to the lowest possible level of risk.

   1. Risk assessment is a formal process for identifying hazards associated with all possible job tasks/methods that may be undertaken by AOR. It identifies potential hazards associated with job tasks and environmental conditions and identifies control measures to mitigate or eliminate hazards. Risk assessment provides the foundation for AHAs.

   2. Risk assessments shall be undertaken when:

      a) Performing any non-routine activity;
      b) Performing a new task;
      c) New personnel are involved;
      d) Third party personnel are involved; or
      e) Major changes to the job plan are considerations

5.2.4 Activity Hazard Analysis (AHA)

AHAs shall be carried out as part of planning and during shift changes. The AHA Worksheet Form shall be used and names of participants shall be listed on the form.

A. The purpose of an AHA is to identify hazards associated with each step of a job and develop solutions that will either eliminate or mitigate the hazards. The relevant job/task plan and relevant

Work Permits shall be included in the AHA. The basic steps to performing a AHA are as follows:

1. Break the job into planned steps;
2. Identify possible hazards associated with each step;
3. Develop solutions or controls to mitigate each potential hazard;
4. Identify personnel involved;
5. Revise or modify as appropriate; and
6. All affect personnel shall sign the AHA.

B. The order of precedence and effectiveness of hazard control is the following:

1. Engineering controls.
2. Administrative controls.
3. Personal protective equipment.

C. Engineering controls include the following:

1. Elimination/minimization of the hazard - Designing the facility, equipment, or process to remove the hazard, or substituting processes, equipment, materials, or other factors to lessen the hazard;
2. Enclosure of the hazard using enclosed cabs, enclosures for noisy equipment, or other means;
3. Isolation of the hazard with interlocks, machine guards, blast shields, welding curtains, or other means; and
4. Removal or redirection of the hazard.

D. Administrative controls include the following:

1. Written operating procedures, work permits, and safe work practices;
2. Exposure time limitations (used most commonly to control temperature extremes and ergonomic hazards);
3. Monitoring the use of highly hazardous materials;
4. Alarms, signs, and warnings;
5. Buddy system; and
6. Training

E. Personal Protective Equipment - such as respirators, hearing protection, protective clothing, safety glasses, and hardhats—is acceptable as a control method in the following circumstances:

1. When engineering controls are not feasible or do not totally eliminate the hazard;
2. While engineering controls are being developed;
3. When safe work practices do not provide sufficient additional protection; and
4. During emergencies when engineering controls may not be feasible.

Use of one hazard control method over another higher in the control precedence may be appropriate for providing interim protection until the hazard is abated permanently. In reality, if the hazard cannot be eliminated, the adopted control measures will likely be a combination of all three items instituted simultaneously.

5.2.5 Hazards to Diving Operations

A. Identification of hazards is the cornerstone of safe diving operations. Unidentified hazards cannot be controlled and therefore impart unmitigated risk into an operation. At a minimum, every diving operation shall be assessed for the following inherent hazards:

1. Personnel readiness;
2. Use and storage of high and low-pressure air;
3. Water entry and exit;
4. Hazards contributing to pulmonary over inflation and decompression sickness risk;
5. Site hazards;
6. Simultaneous operations which may affect diving operations

B. See **appendix A** for a comprehensive list of hazards and controls.

5.3 EMERGENCY ASSISTANCE

A. AOR maintains a list of available sources of emergency aid, equipment, and professional assistance. The emergency contact list, which includes phone numbers and contact instructions, shall be readily available at all principal places of business, operating locations, in order to fulfill the company's Emergency Management Plan.

B. The Emergency Management Plan at the jobsite shall include information necessary for the requisition of, or access to, the following types of emergency aid appropriate for the specific diving operation:

1. Location of nearest operational recompression chamber (if not on site);
2. Hospital or emergency treatment facility;
3. Hospital or emergency treatment facility with a Burn Trauma Unit;
4. Air or ground evacuation;
5. On-call physician;
6. USCG Rescue Coordination Centers; and
7. Company contacts for the Crisis Communication Plan.

F. First Aid Supplies

First aid supplies, appropriate to the type of operation being conducted, shall be readily accessible at the work site. First aid supplies should be adequately stocked sufficient for the crew size. The first aid kit shall be inspected monthly. If a recompression chamber is on the jobsite, a first aid jump kit shall be available suitable for hyperbaric use. In addition to this first aid kit, the supplies at the dive location shall include:

1. An American Red Cross standard first aid handbook (or equivalent);
2. A bag-type manual resuscitator with transparent mask and tubing;
3. A backboard suitable for patient transport;
4. An eyewash bottle or access to an eyewash station; and
5. An emergency O_2 administration kit.

G. Recompression Chamber Availability

A recompression chamber may be required on dive locations, dependent upon the hazards of the dive, OSHA and USACE regulations. On all AOR dive locations, a dual-lock recompression chamber having a minimum capacity of 6 ATA (equivalent to 165 fsw) shall be available and ready for use for:

1. Any diving in excess of 100 fsw;
2. Dives deeper than 60 fsw when live boating;
3. For any dive with planned decompression, regardless of depth;
4. For any dive requiring in-water decompression.

5. Dives to water depths which require no planned decompression should be evaluated to determine if a decompression chamber is necessary. Factors that should be taken into account when conducting the risk assessment to determine the need for a recompression chamber include:

   a) Dive site location with respect to a known location of a recompression chamber that will be available under emergency circumstances;
   b) Multi-day and/or repetitive diving operations;
   c) Potential for diver fouling or entrapment;
   d) Potential for diver blow up;
   e) Potential hazards that contribute to decompression sickness.

5.4 COMMUNICATIONS PLAN

A. A sound communications plan supports daily operations and the Emergency Management Plan. The communications plan identifies lines of communication and authority between AOR, the prime contractor, the customer, local facility, emergency resources, and local authorities in the following cases:

   1. Normal operations;
   2. Activation of the Emergency Management Plan;
   3. Contractual conflict;

B. There shall be an operating two-way audio-communications system to enable contact between the diver and the diving supervisor at all times during the dive. If communications are lost and cannot be restored in a short period of time, the dive shall be aborted.

C. Two-way communications shall be available on site and tested to ensure normal flow of communication and communication to emergency resources in the event of an emergency.

D. See *Appendix B Commercial Diving Checklists* for a sample Emergency Assistance Checklist.

6.0 OPERATION SPECIFIC REQUIREMENTS

6.1 INTRODUCTION

A. Projects involving dive operations conducted by or on behalf of AOR shall have documented operational procedures to ensure safe and effective operations. The following procedures and plans shall be prepared in compliance with the AOR EHS Management System:

   1. Onboard operational procedures describing the required operation and handling of the diving system;
   2. Operational checklists for all relevant equipment and all actions to be taken during a normal operation; and
   3. Procedures to ensure a safe and practical means of entry and egress for the primary and standby divers.

B. Specific operations procedures will vary with the type of diving mode employed. Prior to mobilization of operations, a risk assessment and/or AHA shall be performed to determine the appropriate diving mode, equipment, and job manning requirements

C. Deviation from normal operations procedures may take place only after the appropriate deviation has been approved and a Management-of-Change has been issued.

D. Equipment modification performed on any part of the diving system or associated tools used in the operations shall be accompanied by updated operational procedures, including any necessary drawings, figures, and tables.

6.2 Remotely Operated Vehicle (ROV)

ROVs are a valuable asset and their use should be considered for every operation. ROVs can be used in situations or conditions which may be otherwise harmful to humans such as contaminated water, hot or very cold water, and potential or actual differential pressure situations.

ROVs should be considered even if for only an initial assessment or to confirm bottom conditions. ROVs may also be utilized to locate objects or a work site. Once located, a diver can follow the ROV tether to the object or work site which minimizes the duration of human exposure to otherwise hazardous conditions.

No AOR employee shall operate company ROVs without proper training. ROV shall be treated with the same care and concern as diver life support equipment to ensure safety and to prevent damage to valuable equipment.

More information on the size, capability, and procedures for launch, operation, and recovery of ROVs may be found in ADCI Consensus Standard section nine.

Company ROVs shall be maintained by trained and competent personnel only in accordance with the manufactures recommendation.

6.3 SELF-CONTAINED DIVING (SCUBA)

Though SCUBA is not a standard method of diving in the commercial industry, AOR promotes the use of SCUBA where it can be shown to be more safe and efficient than the alternate modes of diving. AOR recommends that Surface-supplied equipment be used in most diving operations. As with all dives conducted by AOR, a full risk assessment of the operations shall be carried out, and approval from the Diving Operations Manager and the C/H&S Manager will be required.

A. SCUBA diving operations shall comply with applicable statutory regulations and industry standards, in particular:

    1. OSHA Part 1910 – Occupational Safety and Health Standards, Subpart T, Commercial Diving Operations
    2. Occupational Safety and Health Administration (OSHA) Directive Number: CPL 02-00- 051 (effective date: January 29, 2016)
    3. The Association of Diving Contractors International, Inc. (ADCI) Consensus Standards for Commercial Diving and Underwater Operations Rev. 6.2, Sixth Edition, 2016
    4. US Navy Diving Manual Rev. 7 SS521-AG-PRO-010 0910-LP-115-1921, December 01 2016
    5. US Army Corps of Engineers Safety and Health Requirements Manual, Regulation number EM385-1-1, 30 November 2014

B. The following are minimum requirements for SCUBA diving operations:

    1. The maximum planned depth and bottom time of each dive shall be determined prior to the start of operations;
    2. A weight belt appropriate for the suit and depth of the dive shall be worn, except when conditions dictate otherwise for the safety of the diver;

3. When diving from a pier or in a location where the tenders cannot reach diver while he is in the water, a separate safety harness with a positive buckling device shall be worn. The harness shall distribute the load of the diver's body evenly and maintain the diver in a head ups position during lifting. When needed, a retrieving line shall be attached to the lift ring on the harness to pull the diver from the water. The harnesses should be worn under all other types of equipment;
4. Each dive team member shall be continuously monitored and, if required, tended while in the water;
5. No dives shall be conducted deeper than 100 fsw.
6. All dives will be planned for No-Decompression.
7. At a minimum, one diver or tender assigned to each crew must be competent and qualified to perform the duties of a standby diver in order to render emergency assistance to the assigned diver;
8. There shall be a plan for recovery of an unconscious or disabled diver from the water.

6.3.1 SCUBA Diving – General Requirements

A. All equipment and manning levels should be considered the recommended minimum for approaching SCUBA diving based on one dive. Increased manning levels and additional equipment may be required. Proper job planning shall be conducted to ensure that the necessary levels of personnel and equipment are available for diving operations and an adequate response to emergencies.

B. At no time, shall any member of the dive team be asked to perform an activity that prevents that person from the immediate and continuous performance of the diving supervisor's assigned responsibilities.

C. At least one qualified dive team member assigned to each dive crew must be fully competent, equipped and designated to perform the duties of a standby diver in order to render emergency assistance to the assigned diver.

D. The minimum number of personnel comprising a dive team shall never be less than (4) four. Minimum personnel requirements should take into consideration not only the direct requirements of the work to be performed but also additional factors known or suspected that may lead to complications during the conduct of the intended operations.

E. Additional crew member may be required for diving operations with an increased likelihood of diver entrapment, deployment and recovery of the diver from the water, recovery of an unconscious or incapacitated diver, or working in higher risk environments.

F. All dives conducted during live boat operations shall follow the guidelines of *Section 6.5.*

G. A Full-Face Mask (FFM) may be used with an approved single hose first-stage regulator with and octopus, to the maximum approved depth of the regulator not to exceed 100 ft.

H. In open water, the diver shall be line-tended from the surface, or accompanied by another diver in the water in continuous visual contact during the diving operations.

I. Divers shall terminate their dive so that they reach the surface with a minimum of 500psig or anytime that any diver is required to go on secondary/reserve air.

J. A diver-carried reserve breathing gas supply shall be provided for each diver consisting of: A manual reserve (J valve); or an independent reserve cylinder with a separate regulator or connected to the underwater breathing apparatus

K. SCUBA operations shall NOT be conducted:

1. At depths greater than 100 ft
2. Against currents exceeding one knot
3. In enclosed or physically confining spaces
4. In areas where pressure differentials exist and it cannot be positively verified that all potential leaks have been eliminated
5. Where the dive does not have direct access to the surface

The following subsections describe minimum requirements for specific SCUBA operations.

6.3.2 SCUBA Diving (0 to 100 fsw) with No Planned Decompression

A. Minimum Required Equipment. All equipment must be within certification date:

1. 2 sets of SCUBA equipment consisting of:

    a) SCUBA cylinder (should consist of a minimum of 80cuft)
    b) Regulator with octopus
    c) Buoyancy Compensation Device (BCD)
    d) Pressure gauge
    e) Harness as required in *Section 6.3.B.3*
    f) Reserved gas supply: J valve or secondary cylinder with regulator.
    g) FFM (as required)
    h) Thru water comms (as required)

2. 1 set of air decompression and treatment tables;
3. 1 Safe Practices Manual for Underwater Operations;
4. 1 diving ladder or other safe means of getting a diver out of the water;
5. 2 tending lines
6. 1 buddy line
7. 1 retraction line for emergency extraction of diver, as required in *Section 6.3.B.3*
8. 1 set first aid supplies;
9. 1 emergency O_2 administration kit;
10. 2 timekeeping devices;

11. 2 sets of diver’s personal diving equipment consisting of;

    a) mask
    b) weights as required
    c) protective clothing
    d) tools, as required
    e) safety harness
    f) fins
    g) knife
    h) watch with timing device or dive computer
    i) depth gauge or dive computer

12. Log book and dive sheets.

B. Minimum Required Personnel (4)

1. 1 Dive Supervisor
2. 1 Diver
3. 1 Standby Diver (qualified to dive and capable of performing the duties of standby diver)
4. 1 Tender

C. Minimum Qualifications of Personnel

Personnel qualifications are described in *Section 3.0.*

6.4 SURFACE-SUPPLIED DIVING

A. Surface-supplied diving operations shall comply with applicable statutory regulations and industry standards, in particular:

1. OSHA Part 1910 – Occupational Safety and Health Standards, Subpart T, Commercial Diving Operations
2. Occupational Safety and Health Administration (OSHA) Directive Number: CPL 02-00- 051 (effective date: January 29, 2016)
3. The Association of Diving Contractors International, Inc. (ADCI) Consensus Standards for Commercial Diving and Underwater Operations Rev. 6.2, Sixth Edition, 2016
4. US Navy Diving Manual Rev. 7 SS521-AG-PRO-010 0910-LP-115-1921, December 01, 2016
5. US Army Corps of Engineers Safety and Health Requirements Manual, Regulation number EM385-1-1, 30 November 2014

B. The following are minimum requirements for surface-supplied diving operations:

1. The maximum planned depth and bottom time of each dive shall be determined prior to the start of operations;
2. A weight belt appropriate for the suit and depth of the dive shall be worn, except when conditions dictate otherwise for the safety of the diver;
3. A separate safety harness with a positive buckling device shall be worn. The harness shall distribute the load of the diver’s body and prevent any strain from being placed on the diver’s mask or helmet when the umbilical attached to the lift ring on the harness is pulled. Except for heavy gear diving, harnesses should be worn under all other types of equipment;
4. Each dive team member shall be continuously tended while in the water;
5. For dives, deeper than 100 fsw, a separate dive team member shall tend each diver in the water;
6. At a minimum, one diver or tender assigned to each crew must be competent and qualified to perform the duties of a standby diver in order to render emergency assistance to the assigned diver;
7. Each diving operation shall have a primary and secondary breathing gas supply sufficient to support the diver for the duration of the planned dive, one emergency dive by the standby diver, including decompression;
8. When diving through an air gap that exceeds 15 feet, a stage and a man-rated lifting system shall be used to accommodate the primary diver and standby diver;
9. There shall be a plan for recovery of an unconscious or disabled diver from the water; and
10. A diver-carried reserve breathing supply (bailout bottle) shall be worn on all dives, regardless of depth, and provide a physiologically appropriate mixture (bottom mix) for the depths involved. In all cases, the reserve breathing supply also shall be of sufficient duration, to allow the diver to reach the surface or another source of breathing supply (stage, open bell, etc.) or be reached by the standby diver, who is equipped with another

source of breathing supply.

a) For surface diving operations, the diver-carried reserve breathing supply shall have a minimum capacity of 30 cu. ft. that is maintained at a pressure to enable a minimum of five (5) minutes supply at the anticipated depth.
b) Use of a bailout bottle smaller than 30 cu. ft. on any dive job shall require approval by the Manager of Diving Operations.
c) In all cases, activation of the diver's reserve shall cause the dive to be aborted. The reason for activation of the reserve must be ascertained and corrected prior to continuation of diving activities.
d) Bail-out bottles filled with any mixture other than air, shall be analyzed and that analysis shall be clearly marked and initialed on the cylinder.

6.4.1 Surface-Supplied Air Diving – General Requirements

A. All equipment and manning levels should be considered the recommended minimum for approaching surface-supplied air diving based on one dive and any applicable decompression required. Increased manning levels and additional equipment may be required. Proper job planning shall be conducted to ensure that the necessary levels of personnel and equipment are available for diving operations and an adequate response to emergencies.

B. At no time, shall any member of the dive team be asked to perform an activity that prevents that person from the immediate and continuous performance of the diving supervisor's assigned responsibilities.

C. At least one qualified dive team member assigned to each dive crew must be fully competent, equipped and designated to perform the duties of a standby diver in order to render emergency assistance to the assigned diver.

D. The minimum number of personnel comprising a dive team shall never be less than (4) four. Minimum personnel requirements should take into consideration not only the direct requirements of the work to be performed but also additional factors known or suspected that may lead to complications during the conduct of the intended operations.

E. Additional crew member may be required for diving operations with an increased likelihood of diver entrapment, deployment and recovery of the diver from the water, recovery of an unconscious or incapacitated diver, or working in higher risk environments.

The following subsections describe minimum requirements for specific surface-supplied air diving operations.

6.4.2 Shallow Air (0 to 100 fsw) with No Planned Decompression

A. Minimum Required Equipment. All equipment must be within certification date.

1. 1 air sources with 1 volume tank to support two divers;
2. 1 onsite secondary (emergency) air source;
3. 2 diving hose groups, each consisting of;
    a) air hose
    b) strength member (the strength member may be the entire hose assembly, if so designed)
    c) communications cable
    d) pneumofathometer hose

4. 1 set of air decompression and treatment tables;
5. 1 Safe Practices Manual for Underwater Operations;
6. 1 control station consisting of;
   a) communications system
   b) depth gauges and gas distribution system with the capability to supply and control two divers at the maximum planned depth
7. 1 diving ladder or other safe means of getting a diver out of the water;
8. 1 set first aid supplies;
9. 1 emergency O_2 administration kit;
10. 2 timekeeping devices;
11. 2 sets of diver's personal diving equipment consisting of;
    j) helmet or band mask
    k) weights as required
    l) protective clothing
    m) tools, as required
    n) safety harness
    o) bail-out bottle (diver worn EGS)
    p) knife?

12. Log book and dive sheets.

B. Minimum Required Personnel 4)

1. 1 Diving Supervisor
2. 1 Diver
3. 1 Stand-by Diver
4. 1 Tender (qualified to dive and capable of performing the duties of standby diver)

C. Minimum Qualifications of Personnel

Personnel qualifications are described in *Section 3.0.*

6.4.3 Deep Air (0 to 100 fsw) with Planned Decompression

A. Minimum Required Equipment

1. 2 independent air sources with 2 independent volume tanks to support 2 divers and decompression chamber;
2. 1 onsite secondary (emergency) air source;
3. 1 double-lock decompression chamber which has adequate air supply to recompress the chamber to 165 fsw;
4. Adequate supply of gases for the planned dive profiles, one emergency dive, and a potential treatment (using Treatment Table 6A);
5. 1 stage or work platform for any planned in-water decompression greater than 30 minutes;
6. 2 diving hose groups, each consisting of;
   a) air hose
   b) strength member (the strength member may be the entire hose assembly, if so designed)
   c) communications cable
   d) pneumofathometer hose
7. 1 set of air decompression and treatment tables;
8. 1 Safe Practices Manual for Underwater Operations;
9. 1 control station consisting of;
   a) communications system;

   b) depth gauges and gas distribution system with the capability to supply and control two divers at the maximum planned depth
10. 1 diving ladder or other safe means of getting a diver out of the water;
11. 1 set first aid supplies;
12. 1 emergency O_2 administration kit;
13. 2 timekeeping devices;
14. 2 sets of diver's personal diving equipment consisting of;
    a) helmet or band mask
    b) weight belt, if appropriate
    c) protective clothing
    d) tools, as required
    e) safety harness
    f) bail-out bottle (diver worn EGS)
    g) knife (to be carried only by the diver and standby diver while working underwater)
15. Log book and dive sheets;
16. Neurological Exam Check sheets and DCI Treatment sheets.

B. Minimum Required Personnel (5)

1. 1 Diving Supervisor
2. 1 Diver
3. 1 Standby Diver
4. 2 Tenders

C. Minimum Qualifications of Personnel

Personnel qualifications are described in *Section 3.0.*

6.4.4 Deep Air (101 fsw to 190 fsw) with Planned Decompression

A. Minimum Required Equipment

1. 2 independent air sources with 2 independent volume tanks to support 2 divers and decompression chamber;
2. 1 onsite secondary (emergency) air source;
3. 1 double-lock decompression chamber which has adequate air supply to recompress the chamber to 165 fsw;
4. Adequate supply of gases for the planned dive profiles, one emergency dive, and a potential treatment (using Treatment Table 6A);
5. 1 stage or work platform for planned in-water decompression greater than 30 minutes;
6. 2 diving hose groups, each consisting of;
   a) air hose
   b) strength member (the strength member may be the entire hose assembly, if so designed)
   c) communications cable
   d) pneumofathometer hose
7. 1 set of air decompression and treatment tables;
8. 1 Safe Practices Manual for Underwater Operations;
9. 1 control station consisting of;
   a) communications system
   b) depth gauges and gas distribution system with the capability to supply and control two divers at the maximum planned depth
10. 1 diving ladder or other safe means of getting a diver out of the water;
11. 1 set first aid supplies;
12. 1 emergency O_2 administration kit;

13. 2 timekeeping devices;
14. 2 sets of diver's personal diving equipment consisting of;
    a) helmet or bank mask
    b) weight belt, if appropriate
    c) protective clothing
    d) tools, as required
    e) safety harness
    f) bail-out bottle (diver worn EGS)
    g) knife (to be carried only by the diver and standby diver while working underwater)
15. Log book and dive sheets;
16. Neurological Exam Check sheets and DCI Treatment sheets.

B. Minimum Required Personnel (5)

1. 1 Diving Supervisor (not in dive rotation)
2. 1 Diver
3. 1 Standby Diver
4. 2 Tenders

C. Minimum Qualifications of Personnel

Personnel qualifications are described in *Section 3.0.*

6.5 Live boating – General Requirements

Live boating is defined as diving during vessel movement (under power or drifting) in support of diving operations. This method of diving is preferred in instances where anchoring is difficult, under conditions with high currents, when the dive plan makes it likely that divers will move away from the initial dive location, and in locations where divers may need to be shielded from other vessel traffic.

A. Depth Limits: The maximum depth for live boating operations is 165 fsw.

B. In all cases, personnel manning equipment shall be selected to ensure maximum safety during operation. Depending on the water depth, the minimum manning requirements for the dive team shall be five (5) persons. On small boats/vessels of less than 33 feet in length, and while diving to limited water depths, it may be permissible for the dive team to consist of three (3) persons (diving supervisor, diver, standby diver, and a tender) due to space limitations on deck.

C. No live boating will be conducted without a job procedure, dive plan and risk assessment approved by the AOR Diving Operations Manager.

D. There will be constant and easily understandable verbal communications available between the dive station and wheelhouse (bridge) at all times.

E. The vessel will be maneuvered in such a manner so as to permit the tender or diving supervisor to continuously monitor the direction of the diver's umbilical with respect to the diving control station and the position of the vessel.

F. The propellers of the vessel are to be stopped before the diver enters or exits the water.

G. A means will be used to prevent the diver's hose from becoming entangled in the propellers of the vessel.

H. Live boating shall not be done:

1. In seas that impede the station-keeping ability of the vessel;
2. In non-daylight hours;
3. During other periods of restricted visibility; and
4. Any time existing conditions make live boating unsafe in the opinion of the boat captain or diving supervisor.

I. The Standby Diver shall be dressed in and be continuously prepared to enter the water when directed by the diving supervisor.

J. All live boating operations shall be tended from the bow and the vessel shall be operated from the wheelhouse or flying bridge.

K. A “kill switch” shall be in the immediate vicinity of the operator of the vessel for instantaneous shutdown of the engines.

6.5.1 Air Diving While Live boating – Air Diving (0 to 60 fsw)

A. Minimum Required Equipment

In addition to Minimum Required Equipment for the planned diving depth and diving mode, the following is also required:

1. On all live boating operations, a third diving hose connected to the manifold shall be available for emergency use, except in the case of small boats or vessels where sufficient space for a third diving hose and associated equipment may not be available.
2. A free-floating decompression buoy or equivalent may be used in liveboating operations whenever in-water decompression may become necessary.

B. Minimum Required Personnel (5)

1. 1 Diving Supervisor (not in dive rotation)
2. 1 Diver
3. 1 Standby Diver
4. 2 Tenders

C. Minimum Qualifications of Personnel

In addition to minimum personnel qualifications described in *Section 3.0,* personnel working on live boating operations, including the vessel captain/master shall be sufficiently experienced in such operations for the dive being conducted.

6.5.2 Live boating – Air Diving (61 to 165 fsw)

A. Minimum Required Equipment

In addition to Minimum Required Equipment in *Section 6.3.1* for the planned diving depth and diving mode, the following is also required:

1. On all liveboating operations, a third diving hose connected to the manifold shall be available for emergency use except in the case of small boats or vessels where sufficient space for a third diving hose and associated equipment may not be available.
2. A free-floating decompression buoy or equivalent may be used in liveboating operations whenever in water decompression may become necessary.

B. Minimum Required Personnel (6)

1. 1 Diving Supervisor (not in dive rotation)
2. 1 Diver
3. 1 Standby Diver
4. 3 Tenders

C. Minimum Qualifications of Personnel

In addition to minimum personnel qualifications described in *Section 3.0,* personnel working on liveboating operations, including the vessel captain/master, shall be sufficiently experienced in liveboating operations for the dive being conducted.

6.6 Diving at Altitude

Divers may be required to dive in bodies of water at high altitudes. Planning shall address the effects of atmospheric pressures that may be much lower than those at sea level. Transporting divers out of the diving area, which may include movement into even higher elevations, either overland or by plane, requires special consideration and planning.

When a dive takes place at altitude higher than 1,000 feet above sea level, it is necessary to make appropriate corrections in the decompression tables. In order to determine an equivalent depth in fresh water at a mountainous location, calculations need to be performed and applied to the sea level/saltwater dive table information. Depths and rate of ascent are affected and should be modified to ensure that the diver is protected against decompression illness.

Appendix E: Dive and Treatment Tables contains altitude dive worksheets.

For specific procedures and guidelines, refer to the *U.S. Navy Diving Manual (Revision 7), Section 9-13, Diving at Altitude.*

6.7 Rigging Work

Subsea activities may include both underwater and surface-mounted rigging and lifting gear for launching and retrieval of tools and equipment.

A. Deck-mounted lifting gear shall comply with relevant safe practices.

B. Rigging and lifting gear used on the subsea work site shall be certified in accordance with a recognized standard and used in accordance with recognized practices.

C. During complex lift operations involving special subsea rigging gear, multiple crane lifts, or any lift over 75% of the crane's maximum lifting capacity, a Critical lift plan shall be prepared and require management approval.

D. The diving supervisor shall maintain a system for briefing ongoing shifts (both topside personnel and the divers) concerning the actual rigging situation on the subsea work site. During such briefings, emphasis shall be given to systems under tension, and the following procedures will be discussed:

1. Establish the weight and size of the load;
2. Ensure that lifting equipment and all straps, shackles, and associated hardware are tested and approved for the load to be handled;
3. During handling, keep diver(s) and diving bell at safe distance from the load;

4. Never handle a dangerous load over a diver;
5. Ensure clear communication between the crane/winch operator and diving supervisor, and
6. The crane/winch operator shall never move a load unless clearly instructed by the diving supervisor, or his designee.

6.8 Electrical Hazards

Working activities can include electrical tools, specifically designed for underwater use, such as:

A. Electrical pumps, NDT inspection equipment, and cathodic protection measuring equipment shall comply with manufacturer's specifications for use, GFCI requirements, and any relevant regulations.

B. Remotely operated vehicles (ROVs) used in combination with divers shall comply with the *ADCI Consensus Standards for Commercial Diving Operations – 6.2 Edition.*

6.9 Hand-Held Power Tools

Power tools such as hydraulic and pneumatic drills, chainsaws, grinders, and bolt/nut tensioners are often used in subsea work activities. Consideration should be given to using:

A. Tools to be used on sensitive breakable items, as well as nuts/bolts to be set with a required torque, shall be deployed in such a manner that damage to the actual items is avoided. This situation may be achieved by introducing power limitations or other means to prevent excessive forces being applied by the tools in question.

B. Tools that can cause bodily harm to divers during use shall be fitted with the appropriate and manufacturer's recommended safety guards around potentially dangerous parts.

6.10 Welding and Burning (Oxy-Arc Cutting)

Underwater burning processes involve several potential hazards, including electrical currents and gases which may explode in the presence of spark. These processes include:

1. Oxy-Arc burning using exothermic electrodes;
2. Oxy-Arc burning using tubular steel electrodes; and
3. Shielded metal arc burning and cutting (welding rods).

Some underwater cutting processes can produce sparks (grinding) and should follow these same guidelines. Personnel required to perform underwater burning and cutting shall be familiar and equipped to perform routine underwater cutting and burning.

Actual procedures for underwater burning and cutting should be carried out in conformance with the *U.S. Navy Underwater Cutting & Welding Manual, NAVSHIPS S0300- BB-MAN-010 (1 June 2002).*

6.11 High Pressure Water Blasting

High-pressure water jets are used to clear hard and soft marine growth from structures and equipment, to clean surfaces prior to repair or inspection, and, in combination with grit, to cut or remove concrete and other material. These units typically operate at pressures of 1,000 to 40,000 psi.

Water blasters can cause serious injuries. Recommended practices and procedures do not replace the proper training necessary to operate high-pressure water blasting equipment. For underwater use, refer to *ADCI Consensus Standards (6.2 Edition), Section 5.35, High-Pressure Water Blasting.*

6.12 Explosives

Explosives are used underwater for a variety of purposes, including Unexploded Ordnance (UXO) disposal, rock clearance, cutting, deepening or widening channels, clearing local rock or debris, pile cutting, removing abandoned oil/gas well heads, pipe cutting or demolition of mass concrete, and demolition prior to salvage of wrecks or structures, or other

A. Prior to the use of explosives, a risk assessment and/or AHA shall be performed and approved by the Diving Operations Manager and the Compliance/Health and Safety Manager.

B. Procedures for the deployment of explosives shall be established in compliance with 29 CFR 1910.109, 29 CFR 1926.912, and other applicable regulations (e.g., state and local) and will include:

   1. Transport to load-out site (i.e., single component explosives shall be transported and stored in magazine boxes, and blasting caps will not be stored with explosives);
   2. Procedures for handling on the jobsite;
   3. Personnel qualifications and previous experience;
   4. Electrical continuity of explosive circuits shall not be tested with divers in the water;
   5. Line of communication between personnel involved;
   6. Blasting cap shall not be tied in until divers are safely out of the water;
   7. Dive Supervisor shall maintain custody of firing device until all personnel are in the safety location;
   8. Actions in case of misfire and/or other incidents; and
   9. Return/disposal of remaining equipment/explosives after terminating work.
   10. Detonators shall not be stored in the same magazine in which other explosives.

C. A checklist shall be prepared, followed, and signed off by the diving supervisor and project manager prior to detonation of explosives.

D. It is unlawful for any person to use, possess and control, manufacture, purchase store, transport or dispose of any explosive material without possessing a valid license issued by the proper controlling authority.

E. Unexploded Ordnance, (or UXO), are explosive weapons (bombs, bullets, shells, grenades, land mines, etc.) that did not explode when they were employed and still pose a threat of detonation, potentially many decades after they were used or discarded. If they are encountered, they should not be disturbed by untrained personnel and appropriate authorities should be notified. The location of the UXO should be recorded.

6.13 Contaminated Water Diving Operations

Diving in contaminated water increases the risk and complexity of an operation. Prior to diving in any known contaminated water, planning shall thoroughly address all aspects of the operation to protect personnel from adverse acute and chronic health effects. If while diving, a previously unknown contaminated water condition arises, diving shall be suspended until the issue is addressed appropriately in accordance with this manual. The diving supervisor shall take all precautions and mitigations available to safely recover the diver while protecting the topside crew from the suspected contaminants.

See *Appendix F: Contaminated Water Diving Operations* for further information.

6.14 Penetration Diving and Limited Access Situations

A diver entering a confining structure, other than a habitat, that is both a physically confining space and one in which there is no direct access to the surface for recovery of the diver from the water by the tender. Penetrations may include:

1. Pipelines, outfalls, tunnels, tanks, etc.
2. Entry into hatchways on sunken vessels, barges;
3. Limit access tasks under bridges, piers, pile caps, etc.

Generally, working under a vessel of barge would not be considered a penetration dive, as the diver can usually be easily pulled to the surface at the location of the topside tender. There is a clear and distinct difference between working beneath a vessel or barge, and working inside a tunnel or pipeline. In the former case, the diver may be directly retrieved by the surface tender without danger of entrapment or entanglement as the umbilical is generally maintained in a horizontal direct line to the diver. In the case of a diver entering an underwater pipeline, the umbilical will often turn a corner at the entrance to the pipeline, or even within the pipeline, and therefore must be tended at such points by another diver acting as in-water tender.

When performing any penetration requiring an in-water tender, the length of the in-water tender's umbilical should be a minimum of 10 feet longer than the diver making the penetration.

6.15 Current and Tidal Considerations and Limitations

Currents and tides produce forces that affect the diver, his umbilical, and various lines and pieces of equipment at the work site. Effects of currents on divers vary with the individual, the work being done, and the diving method being used, so it is not possible to define fixed limits. Special consideration shall be given to the following:

1. Length and buoyancy of umbilical;
2. Method of deployment;
3. Type of task being performed;
4. Diver orientation during task; and
5. Work site conditions (e.g., location, type of seabed, etc.)

6.16 Diver Entering and Leaving the Water

A. Entering and leaving the water shall be conducted in a controlled manner. There shall be a safe means for entering and leaving the water from the diving platform, such as a ladder, stage, or other appropriate device. This device shall extend a minimum of 3 feet below the water's surface. Additionally, the means of entering and leaving the water shall be adequate to facilitate rescue of personnel.

B. Ladders shall extend at least 3 feet below the water and have sufficient hand-holds above water to allow the diver to step easily onto the deck.

C. When deploying a diver through an air gap that exceeds 15 feet, a stage and a man- rated lifting system shall be used to accommodate the primary diver and standby diver.

7.0 EQUIPMENT AND SYSTEMS

7.1 GENERAL REQUIREMENTS

A wide range and variety of equipment may be required to support commercial diving and underwater operations. Equipment utilized shall be that necessary to assure the safe conduct of operations under the conditions in which it will be employed. The equipment described in this chapter shall meet the requirements as contained in the:

1. OSHA Part 1910 – Occupational Safety and Health Standards, Subpart T, Commercial Diving Operations
2. Occupational Safety and Health Administration (OSHA) Directive Number: CPL 02-00- 051 (effective date: January 29, 2016)
3. The Association of Diving Contractors International, Inc. (ADCI) Consensus Standards for Commercial Diving and Underwater Operations Rev. 6.2, Sixth Edition, 2016
4. US Navy Diving Manual Rev. 7 SS521-AG-PRO-010 0910-LP-115-1921, December 01 2016
5. US Army Corps of Engineers Safety and Health Requirements Manual, Regulation number EM385-1-1, 30 November 2014

These documents set forth the minimum jurisdictional requirements for equipment and operations.

Due to the life support nature of diving, personnel involved in the operation, maintenance, and repair of diving systems and equipment shall have appropriate training and experience in the type of equipment and how it is used. Equipment such as helmets, masks, bail-out bottles and emergency gas systems, regulators, etc. that provides direct life support shall be of the type familiar to the diver and subject to a planned maintenance system.

The diving supervisor shall ensure that all diving systems and equipment have been examined and tested to the extent necessary to determine their condition and suitability for service. Diving operations shall not be permitted to commence until all systems and equipment have been tested for proper functionality. Equipment designated as “necessary” must be able to continue operating in the event of loss of primary power through the use of batteries, stored energy (hydraulic or air power), or connection to an emergency generator.

7.2 MAINTENANCE RECORDS

A. Suitable equipment logs shall be established and maintained;
B. All equipment shall have a unique identity traceable to the equipment log;
C. Entries made in the equipment log shall describe the nature of the work performed, including the dates of modification, repair, or testing, the name of the individual performing the work or test, and the particular piece of equipment involved;
D. Individual persons performing maintenance, repair, calibration, testing, or modification to any diving equipment shall print and sign their name in the equipment log; and
E. Each diving helmet and mask will follow criteria established in *Section 7.3.7.*

7.3 DIVER’S DRESS

7.3.1 General

Diver’s dress shall be suitable for the job intended, with consideration given to environmental exposure.

7.3.2 Dry Suits

Dry suits shall:

1. Have a device to prevent over-inflation (except in cases of diving in contaminated environments);
2. Be constructed of material suitable to the environment in which it is to be used;
3. Protect the diver from the environmental effects of temperature and hazardous material;
4. Not be used without pre-dive inspection.

7.3.3 Hot Water Suits

Hot water suits shall:

1. Provide a sufficient flow of water to maintain the desired temperature;
2. Be capable of withstanding an operating temperature of 110° F (44° C.); and
3. Allow the diver to bypass incoming water prior to it entering the suit.

7.3.4 Harnesses

Harnesses shall:

1. Be made of material strong enough to lift the diver and his equipment from the water; with an overall breaking strength of no less than 2,000 pounds;
2. Have a mechanical quick-release between the harness and the umbilical;
3. Be constructed and fitted to prevent an unconscious diver from slipping through; and is fitted with at least one recovery ring suitable for diver recovery from the water in an emergency;
4. Be designed to prevent restriction of the diver’s breathing when his full weight is supported by the harness; and
5. Be equipped with adjustable leg straps.

7.3.5 Weight Belts

Weight belts shall:

1. Be of sufficient weight to keep the diver at working depth;
2. Not be used as an attachment for the diving umbilical;
3. Be equipped with an approved release buckle; and
4. Be attached to the diver so as to avoid accidental release.

7.3.6 Bail-out Bottle and EGS (diver-carried emergency air/gas cylinder)

Bail-out Bottle and Emergency Gas System shall:

1. Have a cylinder meeting the requirements of *Section 7.10.3*;
2. Have a regulator on the cylinder capable of delivering the proper pressure and flow to the diver’s helmet or mask in accordance with the flow characteristics recommended by the helmet or mask manufacturer;
3. Have a means of attachment to the harness to prevent accidental disengagement;
4. Have a bail-out connection must meet the AOR-approved standard fitting configuration;
5. Be visually inspected annually by a AOR manufacturer-approved person or vendor;
6. Be hydrostatically tested before the required inspection expiration date every 5 years by a AOR manufacturer-approved vendor; and
7. Be clearly marked for contents and pressure.

7.3.7 Helmets

A. Dive helmets and their associated diver-carried regulators are components of a critical life support system that, if not functioning properly, can expose the diver to significant hazards. As such, all helmets and their associated diver-carried regulators shall be maintained and inspected in strict compliance with AOR and manufacturer recommendations. Logs shall be maintained.

B. It is the responsibility of the user of the helmets and associated diver-carried equipment (i.e., the diver) to ensure that these life support critical elements are functioning properly prior to the start of each and every dive; this should be logged on the pre-dive inspection.

C. Helmets used for surface-supplied diving operations shall:

1. Be of a type approved by the AOR Diving Operations Manager. Band masks shall not be used on hand jetting diving jobs. The use of a band mask must be approved by the Diving Operations Manager.
2. Be capable of ventilating up to at least 4.5 actual cubic feet per minute (ACFM) of gas when supplied at the manufacturer-recommended pressure;
3. Be capable of maintaining the diver’s inspired carbon dioxide partial pressure below 0.02 ATA when the diver is producing carbon dioxide at the rate of 1.6 standard liters per minute;
4. Be fitted with a two-way audio communications system;
5. Be equipped with a non-return valve in the main gas supply that closes readily and positively;
6. Have non-return valves with springs not exceeding 3 psi cracking pressure;
7. Be made of corrosion-resistant materials;
8. Be protected from over-pressurization;
9. Be maintained in accordance with manufacturer specifications;
10. Be annually inspected by a AOR approved person or vendor; and

7.3.7.1 Lightweight Diving Helmets

Lightweight diving helmets shall:

1. Meet requirements of Section 7.3.8.
2. Be fitted to accept a bail-out bottle supply; and
3. Be fitted to allow for positive and ready removal from the diver in all uses.

7.3.7.2 Specialized Application Helmets

Helmets and masks used for specialized applications shall:

1. Meet the requirements of Section 7.3.8;
2. Be inspected for deterioration prior to and after extended use in applications where elements of destructive and varied environments are known to exist (i.e., contaminated water, underwater burning, or welding); and
3. Be equipped to prevent entry of contaminants to the diver.

7.3.8 Built-in Breathing Systems (BIBS)

Built-in Breathing Systems (BIBS) utilized in recompression chambers and other types of pressure vessels for human occupancy (PVHOs) shall:

1. Be suitable for purpose and cleaned for use with oxygen;
2. Be held in place by adjustable straps, hood, or other suitable means that frees the diver's hands;
3. Be capable of providing 2.0 ACFM at maximum depth;
4. Be equipped to allow the user to adjust for ease of breathing or constant free flow;
5. Be equipped with an exhaust valve;
6. Be equipped to prevent over-pressurization or rapid negative pressure from endangering the user;
7. Be maintained in accordance with manufacturer specifications; and
8. Be disinfected prior to each use.

7.4 HOSES

7.4.1 General

Flexible hoses used with diving systems or equipment shall:

1. Have a minimum burst pressure equal to four times the maximum allowable working pressure (MAWP);
2. Have an MAWP and flow rating not less than the system in which it is installed or used, and be suitable for the use intended;
3. Have connectors with pressure capability equal to or greater than the hoses on which they are installed;
4. Have fittings of corrosion-resistant material that cannot be accidentally disengaged;
5. Be kink-resistant or arranged to prevent kinking;
6. Have suitable temperature rating when used for hot water service;
7. Be subjected to annual visual examination and tested to 1.5 times the design working pressure for 10 minutes, without loss of pressure, when corrected for temperature; and
8. Be visually examined and pressure tested after each repair or alteration.

7.4.2 Breathing Gas Hoses

Breathing gas hose assemblies shall:

1. Met the general requirements for hoses (Section 7.4.1);
2. Be suitable for breathing gas service;
3. Have an MAWP equal to or greater than maximum depth of dive relative to the supply source, plus 150 psig;
4. Be subjected to an annual hydrostatic test to 1.5 times the design working pressure with a 200-lb axial load applied on fittings while test pressure is applied for 10 minutes, without loss of pressure, when corrected for temperature or creep of end fittings; and
5. Be of suitable design to prevent collapse when used for operation with higher external pressure than internal pressure.

7.4.3 Umbilical

Diver umbilical and dive hose assemblies shall:

1. Meet the general requirements for hoses *Section 7.4.1;*
2. Be marked from the diver/bell end in 10-ft intervals up to 100 feet and marked in 50-ft intervals thereafter as shown in Table 7.1. Markings must be marked with a unique identity and be subjected to a planned maintenance program;
3. Consist of a breathing gas hose, communications cable, a means of determining the diver's depth, and include a strength member or other, such as video or hot water;

4. Have a strength member made of material unaffected by prolonged immersion in water; and
5. Have minimum break strength of the hose assembly, including terminating hardware of 1,000 lbs.

Table 7.1 Dive hose/umbilical banding color code.

Depth (feet)	Depth (meters)	Marking
10	3.05	One white band
20	6.10	Two white bands
30	9.15	Three white bands
40	12.20	Four white bands
50	15.25	One yellow bands
60	18.29	One yellow/one white band
70	21.34	One yellow/two white bands
80	24.39	One yellow/three white bands
90	27.44	One yellow/four white bands
100	30.49	One red band
150	45.73	One red/one yellow band
200	60.98	Two red bands
250	76.22	Two red/one yellow band
300	91.46	Three red bands

7.4.4 Oxygen Hoses

A. Oxygen hoses shall:

1. Meet the general requirements for hoses *(Section 7.4.1);* and
2. Meet the requirements for breathing gas hoses *Section 7.4.2.*

B. In addition, if used for oxygen service:

1. Hose assemblies used in systems containing greater than 40% oxygen are to be cleaned for oxygen service;
2. Hoses used for oxygen service shall be identified by a consistent color code or tagged “FOR OXYGEN USE ONLY”; and
3. Lubricants used to assemble fittings on hoses for oxygen service shall be compatible with oxygen.

7.5 COMPRESSOR SYSTEMS

7.5.1 Compressor and Gas Pumps

Compressors, boosters, gas transfer pumps, and filters used to provide breathing air/gas for diving shall:

1. Have suitable personnel protection around rotating machinery that meets OSHA standard for rotating machinery (29 CFR 1910.219), as well as applicable jurisdictional requirements;
2. Have the necessary instruments to facilitate operations;
3. Be of the proper type, pressure, and flow rate, and suitable for the service intended;
4. Have air intake arranged to be clear of exhaust fumes and other contaminants;
5. Have piping in accordance with ANSI Code B31.1;
6. Have flexible hoses in accordance with *Section 7.4.1;*

7. Have electrical controls, wiring, and drive units meeting jurisdictional requirements, when so equipped;
8. Not be used to pump or transfer oxygen, unless designed for oxygen service;
9. Be cleaned for oxygen service when used with mixtures of greater than 40% oxygen and equipped with slow opening valves;

7.5.2 Recording of Maintenance and Repairs

1. Entries shall be made in the equipment log for all maintenance and repairs performed on the compressor and gas system.
2. Results of air quality tests shall be kept in the equipment maintenance log.
3. Compressors shall have a unique identity incorporating manufacturer, model, serial number, and maximum-rated outlet pressure, rated capacity, and safety valve settings.
4. Compressor units shall be subject to planned maintenance.

7.5.3 Volume Tanks

Volume tanks or receivers used on compressor or breathing gas systems shall comply with *Section 7.10.1.*

7.5.4 Filtration

Filters, when installed to prevent contamination, must meet or exceed the flow rate and pressure rating of the compressor or piping system in which they are installed.

7.5.5 Testing

Compressors used for breathing gas shall be functionally tested per the following schedule and conform to design specifications and air purity requirements described in *Section 7.5.6;*

1. Prior to being put into service;
2. Periodically, in accordance with manufacturer recommendations and planned maintenance schedule;
3. During annual inspection; and
4. After any repairs that may affect compressor performance.

7.5.6 Air Purity Requirements

A. Compressors, transfer pumps or booster pumps used for breathing-air service will be subjected to an air quality test annually. Compressors with a discharge pressure of 500 psig or less shall meet the standards of ANSI CGA 7.1-1989 for Grade D air as a minimum, and shall contain a maximum of 25 ppm of total hydrocarbon content (as methane). Compressors with a discharge pressure that exceeds 500 psig shall meet the requirements of ANSI CGA 7.1-1989 for Grade E air.

B. Tests in accordance with Compressed Gas Association (CGA) shall be taken at the discharge point that would normally supply the breathing gas system, the diver’s hose, or cylinder fill point.

C. Compressors, transfer pumps or booster pumps used for breathing-air service will be subjected to an air quality test following any repair or modification which may affect air quality. Air quality test shall also follow any report or incident when air quality is in doubt which cannot with certainty be attributed to another cause.

D. Documentation of these tests shall be kept on file for a minimum of 3 years.

E. Compressors used for breathing-gas transfer other than atmospheric air shall be checked annually to ensure they do not introduce contaminants into the gas being processed.

7.6 DIVE ENTRY AND EGRESS SYSTEMS

All water entries shall be controlled entries. NO JUMPING IS PERMITTED.

7.6.1 Diving Ladders

Diving ladders shall:

1. Be capable of supporting the weight of two divers plus their gear;
2. Be made of corrosion-resistant material;
3. Be suitable for the purpose intended;
4. Be positioned a minimum of 3 feet below water surface when in use and extend beyond the deck a minimum of 3 feet when in use; and
5. Be free of sharp edges or pinch points.

7.6.2 Diving Stages

Diving stages shall:

1. Be capable of supporting the weight of two divers plus their gear;
2. Be made of corrosion-resistant material;
3. Be provided with a safety chain and internal hand-holds for dive safety during launch and recovery;
4. Be suitable for the purpose intended;
5. Make provisions for mounting of breathing gas cylinder and regulator for emergency breathing at all depths of intended operation; and
6. Have a “man-rated” lifting system

7.7 PRESSURE VESSELS FOR HUMAN OCCUPANCY (PVHOs)

7.7.1 Diving Pressure Vessels

The following are minimum requirements for PVHOs:

A. Equipment shall be constructed in accordance with USCG regulations, ASME PVHO-1, and/or a classing society competent in PVHO diving systems and shall be subject to planned maintenance system;

B. Each pressure Vessel, including each volume tank, cylinder, PVHO, and pressure Vessel piping, shall be examined and tested annually for mechanical damage or deterioration and shall likewise be examined and tested after any repair, modification, or alteration, with results of the examinations entered into the log;

C. The following tests shall be conducted at least every 3 years:

  1. All piping permanently installed on a PVHO,
  2. A leak test at the MAWP using the breathing mixture normally used at service, and

D. Be subject to and pass:

  1. A pneumatic test to MAWP annually.
  2. Hydro test to the code to which it was built every fifth year or after an alteration or repair to the pressure boundary.
  3. Unless otherwise noted, pressure tests conducted in accordance with this section shall be either hydrostatically tested or pneumatically tested.

E. When a hydrostatic test is conducted on a pressure Vessel, the test pressure shall be less than 1.25 times the MAWP;

F. When a pneumatic test is conducted on a pressure Vessel, the test pressure shall be the maximum stamped on the nameplate;

G. When a pneumatic test is conducted on piping, the test pressure shall be no less than 90% of the setting of the relief device;

H. Pressure tests shall be conducted only after suitable precautions are taken to protect personnel and equipment;

I. Pressure tests shall be maintained for a period of time sufficient to allow examination of all joints, connections, and high stress areas;

J. All test results must be entered in the equipment maintenance log;

K. PVHOs shall have acrylic windows that are designed, manufactured, inspected, tested, maintained, repaired, and replaced in according to ASME PVHO-1-2012 Safety Standards for Pressure Vessels for Human Occupancy, 2012 Edition.

7.7.2 Recompression Chambers

Recompression chambers shall:

1. Be dual-lock and multi-place, except emergency rescue chambers or chambers designed to mate with another PVHO;
2. Have sufficient internal dimensions to accommodate a person lying in a horizontal position with another person attending (except in designated diving bells, transfer-locks and emergency rescue chambers);
3. Allow ingress and egress of personnel and equipment while the occupants remain pressurized;
4. Have all doors that are fitted with integral locking/dogging mechanisms, other than shipping dogs, operable from both sides of the door;
5. Have sufficient exterior illumination to allow operation of any internal controls and allow for visual observation, diagnosis, and/or medical treatment;
6. Have a visible capability that allows the interior to be observed from the exterior;
7. Have a minimum pressure capability of 6 ATA (165 fsw) or the maximum depth for the dive for dives deeper than 9 ATA (264 fsw);
8. Be capable of a minimum pressurization rate of 2 ATA per minute to 60 fsw and at least 1 ATA per minute thereafter;
9. Be capable of a decompression rate of 1 ATA per minute to 33 fsw;
10. Have a means to maintain an atmosphere below a level of 25% oxygen by volume;
11. Have a means of maintaining an atmosphere below 2% surface equivalent carbon dioxide by volume;
12. Have monitors if no means is available to maintain an atmosphere below a level of 25% oxygen and 2% carbon dioxide;

13. Have mufflers/silencers on blow-down and exhaust outlets;
14. Have suction guards on exhaust line openings inside each compartment;
15. Have piping arranged to ensure adequate circulation to ensure non-strata;
16. Have all installed flexible hoses meet the requirements of *Section 7.4.1;*
17. Have all penetrations clearly marked as to service;
18. Have piping in accordance with ANSI Code B31.1 and/or ASME/PVHO 1990 or classification society to which it was built;
19. Have a dedicated pressure gauge indicating depth for each pressurized compartment;
20. Have a calibration of each depth gauge within 6 months;
21. Be arranged so as to allow comparison with another gauge while in operation;
22. Have a pressure relief device as per ASME/PVHO-1 or the code of construction;
23. Have the pressure relief valve setting tested annually and the test recorded in the equipment log;
24. Have an installed breathing system with a minimum of one mask per occupant, per lock plus one spare mask per lock;
25. Have a non-return valve on through-hull penetrators supplying any BIBS;
26. Have a two-way voice communications system between the occupants and the operator, as well as between other occupants in separate compartments of the same PVHO or an attached PVHO; this may be a sound-powered phone system;
27. Have a speech descrambler when used with mixed gas;
28. Be equipped with a readily available means for extinguishing a fire;
29. Chamber exhaust should not vent into an enclosed space;
30. The chamber, its general area and controls should be adequately illuminated for operations at night;
31. When fitted, have electrical systems designed for the environment in which they will operate;
32. If external lights are used to illuminate the chamber internally, they shall not be placed in a manner that would subject viewports to heat build-up;
33. If the chamber is located away from dive control station, there must be a suitable means of communications between the two locations;
34. Have hearing muffs provided in chamber for hearing protection.

7.8 GAUGES

A. Gauges used with diving equipment or systems shall:

  1. Be suitable for the purpose intended; and
  2. Be rated as cleaned for oxygen use when installed in oxygen systems.

B. When used to indicate a diver’s depth, gauges shall:

  1. Be of the appropriate range and gradation;
  2. Be gradated in units consistent with the decompression tables;
  3. Be checked for calibration every 6 months;
  4. Be marked with a label, tag, or sticker indicating date of last calibration and due date that will not interfere with full-scale visibility;
  5. Have a tag or label indicating amount of deviation (±) to the calibration standard;
  6. Have calibrations documented in the equipment cal log; and
  7. A pressure-limiting device may be fitted to avoid gauges being over-pressurized.

7.9 TIMEKEEPING DEVICES

Devices used to monitor a diver’s exposure time under pressure shall:

1. Be suitable for purpose and easily read;
2. Be consistently used during the course of an operation.
3. Be compared against known standard every 6 months;
4. Not be used when there is an error exceeding 15 seconds in 4 hours.

7.10 COMPRESSED GAS EQUIPMENT

7.10.1 Volume Tanks/Air Receivers

Volume tanks used in diving systems shall:

1. Be designed, fabricated, inspected, tested, and certified in accordance with American Society of Mechanical Engineers (ASME) Boiler and Pressure Ship Code Section VIII, Div. I “Unfired Pressure Ships,” and/or other statutory classification society requirements;
2. Be equipped with a pressure gauge;
3. Be equipped with a non-return valve on the inlet side;
4. Be equipped with a relief valve as required by code of the manufacturer;
5. Be equipped with condensate drain valve located at its lowest point;
6. Be equipped with slow opening valves when used with design pressures exceeding 500 psig;
7. Be cleaned for oxygen service and have slow opening valves when used in systems containing greater than 40% oxygen;
8. Be inspected internally and externally at least annually for damage or corrosion;
9. Be pneumatically tested to MAWP annually, using the normal breathing mixture;
10. Be hydro tested to 1.5 MAWP every 5 years or after any repair, modification, or alteration to the pressure boundary and stamped with the test date; and
11. Have a unique identity with results of all tests being recorded in the equipment log.

7.10.2 Gas Storage Cylinders and Tubes

High pressure gas cylinders or tubes shall:

1. Be manufactured to recognized code of standard;
2. Be equipped with an over- pressure relief device;
3. Be visually examined annually for damage or corrosion;
4. If rack-mounted into banks of cylinders or tubes, have valves and regulators protected from damage caused by impact of falling items;
5. Be hydrostatically tested to 1.5 times MAWP every 5 years and stamped with the test date;
6. If used underwater, be inspected internally and externally, at least annually, for damage or corrosion;
7. Have contents labeled. Fire hazard warning signs should be erected in vicinity of stored oxygen;
8. Be stored in a well-ventilated area, protected from overheating;
9. Be positively secured from falling; and
10. All single cylinder manifolds shall be capped when not in use.

7.10.3 Bail-out Bottles

High-pressure bottles used for bail-out shall:

1. Be manufactured to recognized standard or code;
2. Be equipped with an over-pressure relief device;
3. Be visually inspected by diver prior to use.
4. Be inspected internally and externally at least annually for damage and corrosion; and
5. Be hydrostatically tested every 5 years to the requirements of the code of manufacture by an authorized test facility and stamped with the date of test.

8.0 EMERGENCY PROCEDURES

8.1 GENERAL REQUIREMENTS

All AOR operations shall have documented procedures to ensure that immediate and effective actions are taken in emergency situations. The following procedures and plans shall be prepared:

A. Worksite specific emergency procedures (emergency procedures may be found in Appendix E);

B. A medical emergency plan describing the interrelation between the shore-based health services and the onboard team;

C. An overall contingency plan describing actions required to support the vessel or work site in case of a hazardous situation that cannot be solved directly on board; and

D. A contingency training plan describing the actions required to train all relevant personnel in order to maintain a high level of contingency preparedness.

8.2 CONTINGENCY PLANNING

A. All work sites shall have a documented contingency plan that describes all measures taken to prepare for any foreseeable incident requiring assistance not available on the Vessel or work site. This plan shall describe the organization, watch systems, medical support, and logistics of hyperbaric evacuation and of transporting sick or injured personnel ashore and/or qualified medical personnel on board.

B. The contingency plan shall also include contact numbers for all relevant persons and/or institutions capable of assisting in emergency situations. These contact numbers shall be current.

9.0 MANAGEMENT OF DIVING AND DECOMPRESSION INCIDENTS

9.1 PHYSIOLOCIGAL PROBLEMS IN DIVING

Physiological problems often occur when divers are exposed to the pressures of depth. Some of these problems may be the result of pressure and decompression, or related to equipment failures, workload, and environmental causes. Some of these problems include:

1. Hypoxia

2. Hypercapnia
3. Asphyxia
4. Drowning
5. Carbon Monoxide Poisoning
6. Middle Ear / Sinus Squeeze
7. Nitrogen Narcosis
8. Dehydration
9. Thermal Problems
10. Oxygen Toxicity
11. Pulmonary Over-Inflation Syndromes
12. Decompression Sickness (DCS)

9.1.1 Hypoxia

Hypoxia is an abnormal deficiency of oxygen (O2) in the arterial blood.

Causes:

- Improper breathing gases or low oxygen in the breathing gas supply.
- Collapse of lung due to pneumothorax.
- Excessive breath holding.

Symptoms:

- Loss of judgment.
- Lack of concentration.
- Lack of muscle control.
- Drowsiness.
- Loss of consciousness.

Treatment:

- If on surface, administer 100% oxygen.
- If in water, ventilate and/or switch gas supply.

9.1.2 Hypercapnia

An abnormally high level of carbon dioxide (CO2) in the blood and tissues.

Causes:

- Inadequate helmet ventilation.
- Excessive over-breathing of the gas supply by the diver.

Symptoms:

- Increased breathing rate.
- Shortness of breath, sensation of difficulty breathing or suffocation.
- Confusion.
- Inability to concentrate.
- Headache.
- Cyanosis (bluish hue of skin and lips)
- Loss of consciousness.

Treatment:

- Decrease level of exertion to reduce CO2 production.
- Increase helmet ventilation (a long vent of 1 or 2 minutes)
- Shift to an alternate breathing source if equipment cause is suspected.

9.1.3 Asphyxia

A condition where breathing stops and both hypoxia and hypercapnia occur simultaneously. Asphyxia will occur when there is no gas to breathe or when the airway is completely obstructed.

9.1.4 Drowning

Fluid induced asphyxia. Drowning while in a helmet is rare but can happen if the helmet is not properly secured and comes off, or if the diver is trapped in a head-down position with a water leak into the helmet. Rescue breathing should be started on a drowning victim as soon as possible.

9.1.5 Carbon Monoxide Poisoning

Occurs when carbon monoxide (CO) in the blood exceeds normal levels. CO is taken up by the red blood cells in preference to oxygen, thereby blocking the cells ability to deliver oxygen to the body tissues.

Causes:

- Contaminated breathing gas usually due to the compressor intake being contaminated by engine exhaust fumes.
- Breathing CO produced by welding rods in a dry habitat.

Symptoms:

- Headache.
- Nausea.
- Dizziness /confusion.
- Cherry red coloration of the skin, tongue, and lips.
- Loss of consciousness without warning.

Treatment:

- Switch to a clean air or gas source.
- Breathe fresh air.
- Administer 100% O2 and transport to hyperbaric chamber.
- Consider Treatment Table 5 after consulting hyperbaric physician.

9.1.6 Middle Ear / Sinus Squeeze

Pain and barotrauma cause by pressure differentials in middle ear and/or sinus cavities. This squeeze or barotrauma usually occurs during descent, but may occur during ascent. Middle ear squeeze is the most common and is caused by a blockage of the Eustachian tubes and inability of pressure to equalize with the pressure on the outside of the eardrum caused by depth and pressure.

If squeeze is noticed during the descent, the diver shall stop, ascend a few feet and gently perform a Valsalva maneuver (closing his mouth and nose and then exhaling). If clearing cannot be accomplished after a few attempts, abort the dive. NEVER descend if squeeze of any type occurs and cannot be resolved.

Caution must be exercised during descent (blow down) in a decompression chamber. the chamber operator should visually monitor the diver during descent and prepare to stop descent if the diver experiences squeeze.

9.1.7 Nitrogen Narcosis

A state of stupor or euphoria caused by diving air at deep depths. The high partial pressure of nitrogen (N_2) in the air produces a narcotic effect in susceptible individuals. The effects may first become noticeable at a depth of 100 fsw, but become more pronounced at depths greater than 150 fsw. The diver usually experiences a sensation of euphoria with apprehension, confusion, impaired judgment, and a false sense of well-being. Concentration or performance of even simple tasks is difficult. Therefore, the diving supervisor should closely monitor the dive and the effects of possible nitrogen narcosis on the diver in order to ensure safety.

9.1.8 Dehydration

Excessive loss of water in the body tissues and resulting electrolyte imbalance. Dehydration is a concern to divers, particularly in hotter climates, while diving hot water suits, or diving in high temperature water environments. the diver may experience lightheadedness or faint while attempting to climb out of the water or feel fatigued and less alert. Divers should monitor their fluid intake and ensure they keep themselves well hydrated.

9.1.9 Thermal Problems

In diving, can be either hypothermia (excessive heat loss) or hyperthermia (excessive heat gain). These thermal problems, arising from exposure to various temperatures pose a major consideration when planning operational dives and selecting equipment.

Hypothermia is a lowering of the core temperature of the body. In mild cases, the victim will experience uncontrolled shivering, slurred speech, imbalance, and poor judgment. Severe cases are considered a medical emergency.

Treatment:

- Remove all wet clothing.
- Wrap victim in a blanket.
- If possible, place in a warm area (galley, engine room, etc.)
- For severe cases, seek immediate medical attention.

Hyperthermia is an excessive raising of the core temperature of the body. Hyperthermia should be considered a potential risk any time the air temperature exceeds 90ºF or water temperature is above 82ºF. The most common signs and symptoms are high breathing rate, feeling of being hot, low urine output, fatigue and nausea. Severe cases are considered a medical emergency.

The treatment of all cases of hyperthermia shall include cooling the victim to reduce core temperature. Removing clothing and spraying with a fine mist of cool water, and then fanning should be initiated. Avoid whole body immersion in cold water or packing the body in ice as this will cause vasoconstriction which may slow the loss of heat.

9.1.10 Oxygen Toxicity

Can be a concern whenever exposed to a partial pressure of oxygen (ppO_2) greater than that in normal daily living. The extent of the toxicity is dependent on both the oxygen partial pressure and the exposure time. Pulmonary toxicity can occur whenever the ppO_2 exceeds 0.5 ata. Long exposures exceeding 12 hours at .5 ata may produce symptoms of a burning sensation in the lungs progressing to pain and coughing upon inhalation. The only method of resolving these symptoms is to reduce the ppO_2 in mixed gas or NITROX, and to reduce exposure times.

Central Nervous System (CNS) oxygen toxicity can occur whenever the ppO_2 exceeds 1.3 ata in a wet diver and 2.4 ata in a dry diver, as in a decompression chamber.

Symptoms (CNS oxygen toxicity):

- **V**isual disturbances: tunnel vision, blurred vision, loss of peripheral vision.
- **E**ar Symptoms: ringing, roaring, or pulsing sound in the ears.
- **N**ausea
- **T**witching: of small muscles, especially the facial muscles, lips, etc.
- **I**rritability
- **D**izziness
- **C**onvulsions. This may be the first sign which occurs with little or no warning.

A convulsion is the most serious consequence of CNS oxygen toxicity. This can occur in the decompression chamber without warning. The chamber operator should be aware of signs of oxygen toxicity of a decompressing diver. During this type of convulsion, the individual loses consciousness and a tonic phase seizure followed by a clonic phase seizure usually occurs. The treatment for any oxygen toxicity symptom is to ascend or shift to a breathing mixture with a lower ppO_2, if in the water. Do not attempt to ascend a diver in the water during a clonic phase seizure. During this phase, the victim is probably not breathing, and any change in depth may result in an arterial gas embolism (AGE). In a recompression chamber, the BIBS masks should be removed as soon as possible and breathing of oxygen switched to air.

9.1.11 Pulmonary Over-Inflation Syndromes

Pulmonary over-inflation syndromes are a group of pressure related diseases caused by the expansion of gas trapped in the lung during ascent or over pressurization of the lung with subsequent rupture of the alveolar sacs. When the alveolar sacs rupture, the route that the escaping gas takes determines which of the three main over-inflation syndromes develop in the diver:

A. Arterial Gas Embolism (AGE)
B. Pneumothorax
C. Mediastinal and Subcutaneous Emphysema

Arterial Gas Embolism (AGE)

AGE is caused by entry of gas bubbles into the arterial circulation as a result of pulmonary over-inflation and rupture of the alveolar sacs in the lungs. These gas bubbles enter the blood stream, which go directly to the heart and up the main arteries to the brain and/or central nervous system. At the brain, the bubbles lodge in smaller vessels and halt blood flow. The onset of symptoms is very rapid and occurs normally within 10 minutes after surfacing, but the onset can manifest itself within 20 minutes. AGE is a medical emergency.

Symptoms:

- Unconsciousness.
- Convulsions.
- Stroke-like symptoms (paralysis in extremities).
- Pain in chest.
- Extreme fatigue.
- Dizziness.
- Coughing up blood.
- Leibermeister’s sign (a sharp defined area of pallor on the tongue).

Treatment:

- IMMEDIATE RECOMPRESSION (use treatment flowchart Figure 20-1 Treatment of Arterial Gas Embolism or Serious Decompression Sickness).
- Keep patient inclined lying with head lower than feet if possible.
- If chamber is not available, administer 100% O_2 and transport to nearest hyperbaric chamber.

Pneumothorax

A pneumothorax is gas trapped in the pleural space between the lungs and chest wall. The gas trapped in this space will cause an organ (lung and/or heart) shift causing the lung to collapse and impair heart function. It may occur without the associated arterial gas embolism. During ascent (in the water or decompression chamber) the gas will expand exponentially placing more pressure on the lungs and heart. If a pneumothorax occurs under pressure, halt the ascent immediately.

Symptoms:

- Sudden sharp chest pain.
- Shortness of breath and labored breathing (rapid shallow breaths).
- Weak pulse.
- Absence of breathing sounds on the injured side.
- Leaning toward the injured side and supporting the chest (splinting).

Treatment:

- Recompression is NOT indicated, unless associated with gas embolism.
- Prepare the patient for medical evacuation and higher medical care.
- If pneumothorax occurs in a decompression chamber, halt the ascent immediately. Failure to do so may result in a fatality.
- Contact hyperbaric physician immediately for further guidance.

Mediastinal and Subcutaneous Emphysema

Emphysema refers to misplaced gas in the body resulting rupture within the lung due to over-inflation. Mediastinal emphysema occurs when gas is forced through torn lung tissue into the middle of the chest. Mild cases are often unnoticed by the diver but sever cases are indicated by a moderate or dull ache under the breastbone. Subcutaneous emphysema occurs when gas subsequently migrates into tissues under the skin, usually in the neck area. Signs and symptoms include swelling around the neck, a voice change due to pressure. Pressing on the skin around the neck may produce a cracking or crunching sound (crepitation).

Treatment:

- Rule out the coexistence of arterial gas embolism or pneumothorax.
- Recompression is usually not indicated, unless associated with gas embolism.
- Administer 100% O_2 on the surface. 1 hour of breathing oxygen should be sufficient for resolution.
- Shallow treatment in the chamber may be used if the diver is in respiratory distress. Usually 1 hour of oxygen breathing at 10 fsw is sufficient for resolution.
- Following any treatment for emphysema requires further medical evaluation.

9.1.12 Decompression Sickness (DCS)

Decompression sickness (DCS) results from the formation of bubbles in the blood or body tissues and is caused by inadequate decompression following a dive or other exposure to high pressure. Inadequate decompression may occur even when normal safe decompression regimes are followed and all precautions are observed. Abnormal conditions in the diver or his surroundings, sometimes impossible to detect or prevent may cause him to absorb excess gas or inhibit natural elimination of dissolved gas during normal decompression. Any decompression sickness that occurs MUST be treated by recompression.

For the purpose of deciding the appropriate treatment, symptoms of decompression sickness are generally divided into two categories, Type I and Type II.

Onset of Symptoms

DSC symptoms usually occur shortly following the dive or pressure exposure. If the controlled decompression during ascent is omitted, DCS symptoms can occur in the water prior to reaching the surface. In analyzing several thousand air dives, the U.S. Navy calculated the time of onset of symptoms after surfacing:

- 42% occurred within 1 hour.
- 18% occurred between 1 hour and 3 hours.
- 23% occurred between 3 hours and 8 hours.
- 15% occurred between 8 hours and 24 hours.
- 2% occurred after 24 hours.

Type I Decompression Sickness Symptoms

Symptoms:

- Skin bends (itching, skin rash, marbled skin).
- Joint pain (localized and pain only), most commonly a deep, dull ache in a shoulder joint, elbow, wrist, hand, knee or ankle.
- Swelling or pain in lymph nodes.

Treatment:

- Administer Rapid Neurological Exam Check prior to recompression.
- Follow treatment flowchart Figure 20-2 Treatment of Type I Decompression Sickness.

Type II Decompression Sickness Symptoms

1. Neurological Symptoms (Central Nervous System)

- Numbness in an extremity.
- Muscle weakness, paralysis of any body part.
- Pain that radiates down an extremity.
- Pain in two or more joints.
- Tingling sensation (pins and needles).
- Severe pain of the abdomen and around the trunk of the body.
- Visual disturbances.

2. Cardiopulmonary Symptoms (the “chokes”)

- Begins as chest pain.
- Increasing breathing rate.
- Increasing lung congestion.
- Complete circulatory collapse, loss of consciousness.

Treat all cases of DCS IAW paragraph 9.4

DECOMPRESSION SICKNESS PREVENTION

Although decompression tables have evolved to a point where the risk of decompression sickness has been considerably reduced, it cannot be completely ruled out. Even when following standard diving profiles, due to variations in individual physiology and work conditions, a diver may develop symptoms following any dive. Diving supervisors and divers should be aware of some of the factors which may affect decompression:

- Pneumofathometer gauge error.
- Improper decompression profile planning.
- Sea state / heavy seas.
- Diver fatigue.
- Excessive work load.
- Age / physical condition of the diver.
- Dehydration in the diver.
- Exercise/ work during decompression in water.
- Exercise during decompression in the chamber.
- Body position which may restrict blood flow while in decompression chamber (e.g. sitting on

hands, etc.)

- Recent soft tissue injury.
- Alcohol intake or the aftereffects of recent alcohol intake.

9.2 DECOMPRESSION SICKNESS ASSESSEMENT

It is the diving supervisor's responsibilities to assess the condition of each diver following a dive for signs of decompression sickness and pulmonary over-inflation syndromes. The diver has the responsibility to report all symptoms to the diving supervisor no matter how minor they may appear. The diver shall report all symptoms early, which may avoid more serious symptoms appearing later. For all symptoms and all suspected symptoms, the Manager of Diving Operations and the EHS Manager shall be contacted.

It is important that in every case of suspected Type I DCS, an *Initial Neurological Examination Check* (see *Appendix F – Dive and Treatment Tables*) shall be performed to assess the diver's condition prior to treatment. If a neurological examination is not conducted the diver will be considered as having Type II DCS. All signs and symptoms should be reported promptly to the diving supervisor.

The *Rapid Neurological Examination Check* is intended as a quick examination to identify any potential signs of decompression sickness. This examination is suggested following any decompression dive and required following chamber decompression for any mixed-gas dive.

The *Rapid Neurological Examination Check* should also be used for periodic examination of a diver undergoing treatment for decompression illness in the chamber. Periodic exams should be administered prior to and following each depth change, upon surfacing from the chamber and, one to two hours following completion of the treatment.

In all cases of suspected TYPE II DCS or Pulmonary Over-Inflation Syndromes, recompress the diver immediately. The inside tender shall perform a Rapid Neurological Exam at depth in the chamber and prior to any change in depth. It is recommended that the exam be conducted at 30-minute intervals during treatment.

If the reason for post dive symptoms is FIRMLY established due to other causes other than decompression sickness or arterial gas embolism (e.g. injury, sprain, etc.), then recompression is not necessary. If the diving supervisor cannot rule out decompression sickness or arterial gas embolism with 100% certainty, then treatment shall commence.

9.3 ASYMPTOMATIC OMITTED DECOMPRESSION

Certain emergencies, such as uncontrolled ascents, an exhausted air supply, or bodily injury may interrupt or prevent required decompression. In some unplanned omitted decompression omitted decompression, the diver may suddenly appear on the surface without warning or communication to the diving supervisor. Even if the diver shows no symptoms, omitted decompression must be addressed in some manner to avert later difficulty.

Table 9-3 summarizes management of asymptomatic omitted decompression.

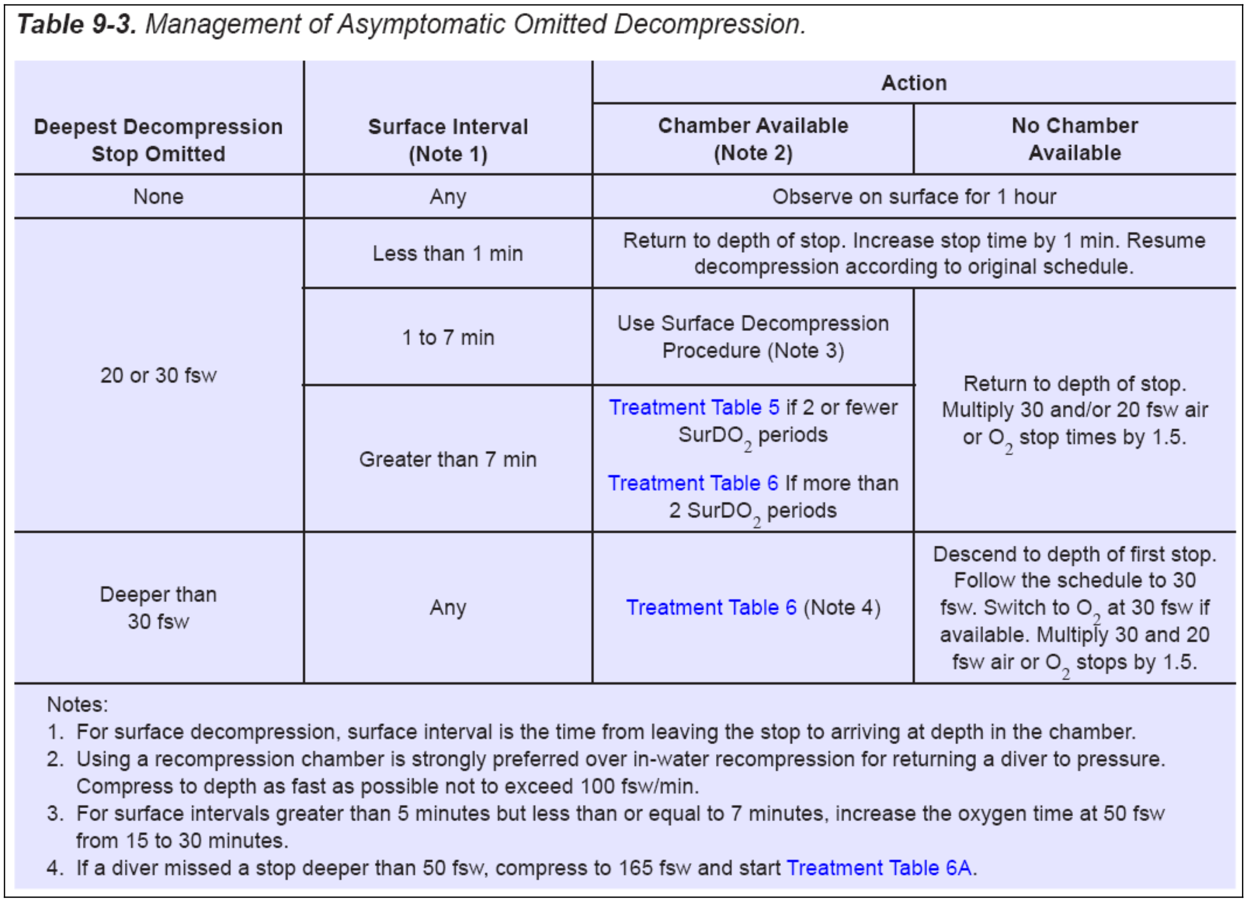

Table 9-3. *Management of Asymptomatic Omitted Decompression.*

Deepest Decompression Stop Omitted	Surface Interval (Note 1)	Action: Chamber Available (Note 2)	Action: No Chamber Available
None	Any	Observe on surface for 1 hour	
20 or 30 fsw	Less than 1 min	Return to depth of stop. Increase stop time by 1 min. Resume decompression according to original schedule.	
	1 to 7 min	Use Surface Decompression Procedure (Note 3)	Return to depth of stop. Multiply 30 and/or 20 fsw air or O_2 stop times by 1.5.
	Greater than 7 min	Treatment Table 5 if 2 or fewer $SurDO_2$ periods Treatment Table 6 If more than 2 $SurDO_2$ periods	
Deeper than 30 fsw	Any	Treatment Table 6 (Note 4)	Descend to depth of first stop. Follow the schedule to 30 fsw. Switch to O_2 at 30 fsw if available. Multiply 30 and 20 fsw air or O_2 stops by 1.5.

Notes:

1. For surface decompression, surface interval is the time from leaving the stop to arriving at depth in the chamber.
2. Using a recompression chamber is strongly preferred over in-water recompression for returning a diver to pressure. Compress to depth as fast as possible not to exceed 100 fsw/min.
3. For surface intervals greater than 5 minutes but less than or equal to 7 minutes, increase the oxygen time at 50 fsw from 15 to 30 minutes.
4. If a diver missed a stop deeper than 50 fsw, compress to 165 fsw and start Treatment Table 6A.

If the diver makes an uncontrolled ascent to the surface at a rate greater than 30 fsw/min, but the dive itself is within no-decompression limits, the diver should be observed on the surface for 1 hour to ensure that symptoms of decompression sickness or arterial gas embolism do not develop. Recompression is not necessary unless symptoms develop. For omitted decompression stops of 20 fsw or deeper, refer to *Table 9-3.*

9.4 DECOMPRESSION SICKNESS TREATMENT

Based on the diagnosis, the diving supervisor shall choose a treatment scheme and follow guidelines in the decompression sickness flowcharts provided (See *Appendix E - Dive and Treatment Tables*.) It should be noted that the treatment schemes rely exclusively on U.S. Navy treatment tables and protocols. Never deviate from the flowchart paths or schedules and do not attempt to shorten or modify them without the guidance of a hyperbaric physician. For any planned treatment, the Manager of Diving Operations and EHS Manager shall be contacted. It is also noted that a hyperbaric physician should be contacted when treating decompression sickness.

For all treatments, an inside tender (qualified to work in hyperbaric environments) shall remain in the chamber for the entire course of the treatment. The supervisor shall follow the decompression protocols specified in the treatment table and applicable flow chart(s).

Dive and Treatment tables are in Appendix F:

Decompression Sickness Treatment Flowcharts

Figure 20-1: Treatment of Arterial Gas Embolism or Serious Decompression Sickness.
Figure 20-2: Treatment of Type I Decompression Sickness.
Figure 20-3: Treatment of Recurrence of Symptoms.

Decompression Sickness Treatment Tables

Figure 20-4: Treatment Table 5.
Figure 20-5: Treatment Table 6.
Figure 20-6: Treatment Table 6A.
Figure 20-7: Treatment Table 4.
Figure 20-8: Treatment Table 7.

9.5 EMERGENCY CONSULTATION

In all cases, contact the Diving Operations Manager and C/H&S Manager as soon as possible.

Emergency consultation is available 24 hours a day via:

Primary: Diver's Alert Network - 919-684-9111

Secondary: Navy Experimental Diving Unit (NEDU)
Commercial (850) 230-3100 or (850) 235-1668

9.6 POST DIVE REQUIREMENTS

After surfacing from a dive, divers remain at risk decompression sickness for at least 24 hours. Divers must therefore follow the post-dive/post chamber requirements shown in Table 9.1.

As a precautionary measure against the occurrence of decompression sickness, a diver must remain awake and within the vicinity of the chamber for a minimum period of 1 hour following a decompression dive.

Table 9.1 Post-dive requirements.

Type of Hyperbaric Exposure	Time (Hours) Diver Must Remain In…	
	Immediate Vicinity [1]	General Vicinity [2]
Any surface dive requiring decompression	**1**	**12**
Any saturation dive	**24**	**N/A**

[1] Direct access to the chamber (e.g., on the vessel or at the jobsite).
[2] Within 30 minutes' travel time to a chamber.

9.6.1 Flying in a Pressurize Aircraft after Diving

Due to pressures in commercial aircraft (less than sea-level pressures), flying after diving has wait time limits. Table 9.2 lists the minimum required surface interval prior to flying in a pressurized aircraft following hyperbaric exposure.

Table 9.2 Required Surface Interval for flying in a pressurized aircraft after diving

Diving Mode	Highest Repet Group Letter obtained in previous 24 hours	Time (Hours)
Air diving w/ no-decompression	**A - H**	**12**
Air diving w/ no-decompression	**I - Z**	**24**
Air diving with decompression	**All**	**24**
Mixed-gas surface diving	**n/a**	**24**
Heliox (HeO2) saturation diving	**n/a**	**24**
Any decompression sickness	**n/a**	**48**
Extreme Exposure (Emergency) dive	**n/a**	**48**

9.6.2 Flying in an Unpressurized Aircraft After Diving

Flying in an unpressurized helicopter or other aircraft after diving also requires a surface interval following hyperbaric exposure. This includes flying after diving in any unpressured aircraft above and altitude of 1000 feet, or any land travel to altitudes in excess of 1000 feet above sea level. For all scenarios, refer to U.S. Navy Diving Manual – Rev. 7, *Table 9-6 Required Surface Interval Before Ascent to Altitude.*

9.6.3 Diving After Decompression Sickness

Assessing fitness to return to diving after decompression sickness shall be in accordance with *Section 4.5.*

10.0 OPERATIONAL REPORTING REQUIREMENTS

10.1 GENERAL REPORTING REQUIREMENTS

A. The structure of the AOR reporting system is based on the following:

1. Statutory requirements;
2. AOR internal requirements;
3. Client requirements; and
4. Project procedures and reporting requirements.

B. The following reports may be generated during the course of any project:

1. Dive sheets;
2. Chamber logs;
3. 24-hour job log;
4. Pre-shift safety meeting;
5. Activity Hazard Analysis (AHA);
6. Incident/injury reports;
7. DCI treatment sheet; and
8. Rapid Neurological Exam Checklist

10.1.1 Recordkeeping and Reporting Requirements

At a minimum, the Recordkeeping and Reporting Requirements shall include the following:

1. Project description / work scope;
2. Task and/or accomplishment record of completion with timeline;
3. Dive log and decompression records;
4. Incident/injury reports, including any report of decompression illness and treatment;

10.2 DIVING REPORTS AND RESPONSIBILITIES

10.2.1 Dive Log / Sheet

A dive log (dive sheet) is required for every dive, regardless of depth or bottom time. The dive sheet is differentiated from the required diver maintained dive log in that the dive sheet is a company record of diving activity. Requirement of the dive log and blank dive sheets may be found in *Appendix B: Dive Briefs, and Logs*.

A. The diving supervisor on watch is responsible for the dive and, as such, shall sign the Dive Sheet. If a dive is in progress at the time when supervisors change shifts, the outgoing supervisor shall sign the logs and record the time of the handover. The incoming supervisor shall also sign the logs at the completion of the dive. A note of the shift changes and names of the diving supervisors shall be recorded on the Dive Sheet, as well as recorded in the Diving Operations Log.

B. When mixed-gas diving operations are conducted, the logs shall detail various environmental parameters, such as stage depth, on-board gas supply, and diver on-line and reserve breathing gas mixtures and pressures.

10.2.2 Chamber Log

The Chamber Log shall provide a record of the divers' exposure to the hyperbaric environment in the chamber. It is used to record specific information regarding the time and depths of exposure in the chamber, the names of the persons responsible for the operation of the chamber system, and the specified oxygen exposure times. Blank chamber log sheets are included in *Appendix B: Dive Briefs, and Logs*.

In surface diving, the chamber log, or chamber sheet, is filled out by the diving supervisor or qualified chamber operator. The diving supervisor is responsible for the accuracy of the decompression table or treatment table.

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Appendix A: JOB HAZARDS AND CONTROLS

Job Hazards and Controls

This appendix lists operation and environmental hazards and possible controls to mitigate risk. Use this appendix when performing Activity Hazard Analysis for the specific hazards of a particular jobsite and work task(s). The AHA Worksheet Form shall be used, and names of participants shall be listed on the form.

The order of precedence and effectiveness of hazard control is:

1. Engineering controls.
2. Administrative controls.
3. Personal protective equipment.

A. Engineering controls include the following:

- Elimination/minimization of the hazard—Designing the facility, equipment, or process to remove the hazard, or substituting processes, equipment, materials, or other factors to lessen the hazard;
- Enclosure of the hazard using enclosed cabs, enclosures for noisy equipment, or other means;
- Isolation of the hazard with interlocks, machine guards, blast shields, welding curtains, or other means; and
- Removal or redirection of the hazard

B. Administrative controls include the following:

- Written operating procedures, work permits, and safe work practices;
- Exposure time limitations (used most commonly to control temperature extremes and ergonomic hazards);
- Monitoring the use of highly hazardous materials;
- Alarms, signs, and warnings;
- Buddy system; and
- Training

C. Personal Protective Equipment—such as respirators, hearing protection, protective clothing, safety glasses, and hardhats—is acceptable as a control method in the following circumstances:

- When engineering controls are not feasible or do not totally eliminate the hazard;
- While engineering controls are being developed;
- When safe work practices do not provide sufficient additional protection; and
- During emergencies when engineering controls may not be feasible.

Must consider the cumulative effects of multiple hazards on the team’s ability to function. Also, must consider the potential supportive or canceling effects of multiple controls.

ENVIRONMENTAL HAZARDS AND CONTROLS

SURFACE WEATHER / CONDITIONS.

Surface conditions affect both the divers and topside team members. Conditions for the area of operations can be determined from special charts that show seasonal variations in temperature and wind. Weather reports and long-range weather forecasts should be studied to determine likely conditions. Extreme conditions are generally a greater problem for topside personnel than for the diver. Any reduction in the effectiveness of the topside personnel may endanger the safety of the diver.

Surface weather hazards to topside personnel:

Hazard	Effect(s)	Control(s)
Altitude	Altitude sickness	Acclimatization. Reduce activity. Limit exposure.
Sun	Sunburn, sun poisoning, eye damage.	Provide shelter/awnings. Wear sunscreen, long shirts, pants, hats, sun glasses.
Wind	windburn, flying debris, wind chill	Provide shelter. Wear lib and face balm, long shirts, pants, eyewear
Cold	Chilling, hypothermia, frostbite. Frozen equipment	Provide shelter/heating. Wear appropriate thermal protection. Rotate personnel. Ensure winterization, preparation of equipment for use in cold environment IAW manufacture recommendations.
Heat	Heat exhaustion, Hyperthermia	Provide shelter with cooling, dive early or late in the day. Wear light, loose clothing. Hydrate.
Reduced surface visibility (night operations, rain, fog, haze…)	Loss of situational awareness, lack of visibility to other craft. Surface craft running over diver on the surface.	Use of radar reflector, surface flood/area lights, suspend/limit operations,
Lightning	Electrical shock,	Plan operations around known severe weather periods. Suspend operations.
Wet, slippery surfaces	Slips, falls	Use sand or mats to increase traction. Tenders control dressed divers
Uneven surfaces, hoses / cables on the ground	Trips, falls	Provide dunnage or other material to cover uneven surfaces. Provide handrails on or near uneven surfaces. Plan dive site setup to minimize hoses / cable on the ground. Use cable trays, route hoses in overhead. Tenders control dressed divers
Marine life	Injury, venomous/poisonous sting	Use of trappers / local experts. Limit exposure during know feeding/ breeding times. Situation awareness. PPE / Physical barriers (shark cage).

Notes on surface weather / conditions:

Cold conditions pose a unique stress on a dive team and often the topside personnel are at more risk for cold injuries than the diver. Adequate thermal protection for the divers is a given. Due care and concern for the protection of topside personnel must be planned to avoid a distracted workforce.

- Protection of equipment from freeze damage during and post dive must be taken to ensure

continued diving. All personnel should be on guard for the symptoms of cold injuries and take appropriate precautions.
- Adequate hydration of divers is just as important in cold climates as in hot.

Refer to the USN Dive Manual for additional guidance for diving in cold or ice-covered water.

Diving in hot climates generally brings the threat of thunderstorms and lightning as well as heat injuries. Diving supervisors should monitor storms via weather radio or available technology.

- Every five (5) seconds from the sight of lightning until the audible thunder equals one (1) mile. Diving should be suspended if lightening is with six (6) miles or 30 seconds (10 miles or 50 seconds for USACE operations), until the lightning has passed for 30 minutes (30 – 30 rule.)
- All personnel should be on guard for the symptoms of heat injuries and take appropriate precautions. Divers should drink electrolytes and avoid caffeinated beverages and avoiding overhydrating while diving in warm water.

Refer to the USN Dive Manual for additional guidance for diving in warm water.

Aquatic Environment Hazards to the diver:

Hazard	Effect	Control(s)
Increased depth	DCS, narcosis, dyspnea	Use of remotely operated vehicles. Use of SSA. Match work rate to breathing. Use decompression tables conservatively. Use surface decompression or in-water oxygen.
Cold water	Chilling, hypothermia, dehydration, DCS	Provide / review training for diving in cold/ice covered water. Provide shelter/heating. Wear appropriate thermal protection for the water temperature. Use cold water diving procedures (keep equipment dry, do not purge or breathe on the surface.) Rotate divers. Adequate hydration, food and rest. Limit Caffeine. Use surface decompression.
Warm water	Heat exhaustion, Hyperthermia, DCS, Pulmonary Edema	Use of cooling packs, Rotate divers (limit stay times to reduce exposure)
Ocean or river currents and tides	Increased exertion – DCS. loss of stability, displacement from dive site, entrapment	Plan diving during slack water or times when seasonal water flows are reduced. Plan work to move with current if possible. Use additional weights.
Bottom composition (Mud, debris)	Increased exertion -DCS, diver fouling / entrapment	Use swimming mode if possible. Match work rate to breathing. Use floating umbilical. Plan routes to avoid obstacles.
Low or no visibility	Trapped or lost diver. Diver injury (contact with bottom debris, dangerous aquatic life, pinch / crush	Plan diving in periods with seasonably clear water (low rainfall periods). Use slow deliberate motions. Use PPE (gloves, wetsuit, coveralls)

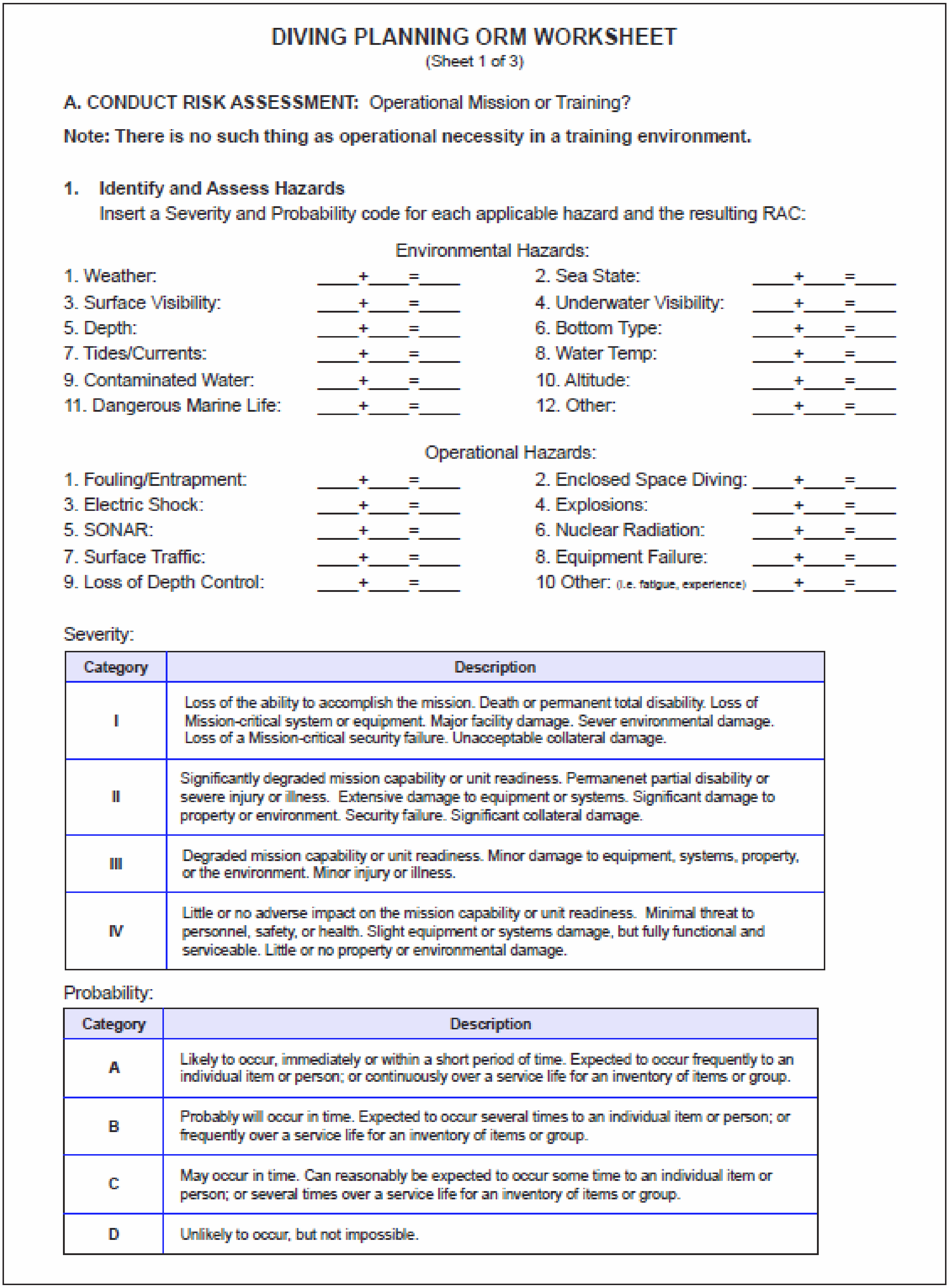
	injury)	
Wave action	Loss of decompression stop. Pinch / crushing Injury due to hard object contact while entering/ leaving water. Loss of mooring.	Use surface decompression. Plan diving in periods with low or no surface waves. Suspend operations. Use diver stage to enter / leave water. Maintain situational awareness. Use adequate ground tackle to secure mooring.
Contaminated water	Sickness or illness	Proper training on procedures and equipment. Diving in contaminated water requires extensive procedures and equipment. Any diving performed in contaminated water shall be performed with a detailed contaminated water diving plan IAW *Appendix F Contaminated Water Diving Operations*
Altitude	DCS	Use non-diving techniques, ROV. Use altitude table corrections. Limit repetitive diving. Limit deep diving. Adhere to post-dive flying nor driving (over mountains) at altitude.

OPERATIONAL HAZARDS AND CONTROLS

Hazard	Effect	Control(s)
Differential Pressure	Entrapment	Lock out / Tag out. Use of ROV. Use screens, guards over intakes, drains and excavation equipment suction hoses. Situational Awareness for changing conditions that may create a differential pressure situation. Proper training on procedures.
Confined space / penetration	Entrapment	Use of ROV. Use of SSA with/adequate secondary air supply and bailout bottle. Use of tender at the point of entry. Proper training on procedures and equipment
Working with electrically powered equipment	Electric shock	Use lockout / tag out when diving on or near electrical equipment. Use GFCI with A/C powered equipment and ROVs. Proper training on procedures and equipment.
Munitions and Explosives of Concern (MEC)	Overpressure related injury,	Working with and in search of MEC poses a serious risk to topside and underwater personnel. Use only trained personnel. Any diving performed with or in search of MEC shall be performed IAW an approved explosives safety plan IAW *EM 385-1-97.* Proper training on procedures and equipment.
Surface traffic	Diver injury	Notice to mariners, Dive in periods of good visibility, post diver down and alpha signal flags. Post picket boat to ward off traffic. Proper training on procedures and equipment.
Dive Equipment Failure	Loss of air, loss of communications, inability to read depth	Effective maintenance and inspection. Use of secondary air supply and bail out bottles. Know emergency procedures. Know line pull signals. Mark umbilical IAW EM 385-1-1 section 30. Proper training on procedures and equipment.
Working in mid-water column	Loss of depth control – falling; barotrauma.	Proper tending technique. Use staging / hogging line. Avoid using excessive weight. Proper training on procedures and equipment.
Use of lift bags	Loss of depth control – blow up	Proper training. Maintain equipment in good condition. Use remote filling and or lifting. Use of toppling line. Use multiple small lift bags vice one large bag. Use yard and stay technique to limit lift bag travel. Proper umbilical management. Verify umbilical prior to filling. Proper training on procedures and equipment.
Use of dry suits	Loss of depth control: blow up and falling – barotrauma/pulmonary over-inflation.	Proper training. Proper equipment maintenance. Work up dives. Do not carry tools and or equipment - use lift line to lower tools / equipment. Avoid task overload. Avoid use of dry suits in and around debris with sharp edges or puncture possibility. Proper training on procedures and equipment.
Live boating	Diver entanglement - injury, Loss of depth control (pulling diver to surface)	Limit operations to conditions as specified in: ??? Do not perform in rough seas. Perform only during daylight hours. Proper training on procedures and equipment.
Burning / welding operations	Electric shock. Explosion, differential pressure, diver injury due to hot/falling debris	Only use only properly maintained equipment. Use PPE in excellent condition. Do not perform underwater cutting/welding without training. Use proper procedures when using underwater cutting and welding. See ADCI burning and welding SOP. Proper training on

		procedures and equipment.
Lifting / crane operation	Crushing, pinching injury	Use critical lift plan. Establish direct communications between dive supervisor and crane operator. Use hard hat dive rig. Keep diver out from in between rigging – proper umbilical management. Perform lift with diver on the surface.
Use of hydraulic or pneumatic power tools	Fouling of diver umbilical. Physical soft tissue injury.	Use of appropriate manufacturer's recommended safety guards and positive communications with diver. Practice proper umbilical management. Proper training on procedures and equipment.
High – pressure water blasting	Physical soft tissue injury	Use of appropriate manufacturer's recommended safety guards and positive communications with diver. Practice proper umbilical management. Proper training on procedures and equipment.
Welding and burning	Electrocution, burns, flash burns to eyes. Crushing injury due to falling debris. Explosions from trapped gases	Use of proper and well-maintained equipment. Use of proper procedure – keeping the ground close to the work and between diver and electrode. Use of positive communications with diver. Properly secure structure prior to cutting away. Adequate venting of compartments. Proper training on procedures and equipment.
Use of explosives	Crushing injury, over pressurization injury.	Proper training on procedures and equipment. Use of approved blasting plan. Remove divers from water during detonation. Use of ROV for post blast assessments.
Contaminated water	Acute or chronic adverse health reactions/concerns.	Identification of toxins/contaminants. PPE. Proper training on procedures and equipment. Any diving performed in contaminated water shall be performed with a detailed contaminated water diving plan IAW *Appendix F Contaminated Water Diving Operations*

Dive Planning Risk Management Worksheet



DIVING PLANNING ORM WORKSHEET

(Sheet 1 of 3)

A. CONDUCT RISK ASSESSMENT: Operational Mission or Training?

Note: There is no such thing as operational necessity in a training environment.

1. Identify and Assess Hazards

Insert a Severity and Probability code for each applicable hazard and the resulting RAC:

Environmental Hazards:

1. Weather:	____+____=____	2. Sea State:	____+____=____
3. Surface Visibility:	____+____=____	4. Underwater Visibility:	____+____=____
5. Depth:	____+____=____	6. Bottom Type:	____+____=____
7. Tides/Currents:	____+____=____	8. Water Temp:	____+____=____
9. Contaminated Water:	____+____=____	10. Altitude:	____+____=____
11. Dangerous Marine Life:	____+____=____	12. Other:	____+____=____

Operational Hazards:

1. Fouling/Entrapment:	____+____=____	2. Enclosed Space Diving:	____+____=____
3. Electric Shock:	____+____=____	4. Explosions:	____+____=____
5. SONAR:	____+____=____	6. Nuclear Radiation:	____+____=____
7. Surface Traffic:	____+____=____	8. Equipment Failure:	____+____=____
9. Loss of Depth Control:	____+____=____	10 Other: (i.e. fatigue, experience)	____+____=____

Severity:

Category	Description
I	Loss of the ability to accomplish the mission. Death or permanent total disability. Loss of Mission-critical system or equipment. Major facility damage. Sever environmental damage. Loss of a Mission-critical security failure. Unacceptable collateral damage.
II	Significantly degraded mission capability or unit readiness. Permanenet partial disability or severe injury or illness. Extensive damage to equipment or systems. Significant damage to property or environment. Security failure. Significant collateral damage.
III	Degraded mission capability or unit readiness. Minor damage to equipment, systems, property, or the environment. Minor injury or illness.
IV	Little or no adverse impact on the mission capability or unit readiness. Minimal threat to personnel, safety, or health. Slight equipment or systems damage, but fully functional and serviceable. Little or no property or environmental damage.

Probability:

Category	Description
A	Likely to occur, immediately or within a short period of time. Expected to occur frequently to an individual item or person; or continuously over a service life for an inventory of items or group.
B	Probably will occur in time. Expected to occur several times to an individual item or person; or frequently over a service life for an inventory of items or group.
C	May occur in time. Can reasonably be expected to occur some time to an individual item or person; or several times over a service life for an inventory of items or group.
D	Unlikely to occur, but not impossible.

DIVING PLANNING ORM WORKSHEET

(Sheet 2 of 3)

2. Identify Control Options

Environmental Hazards:

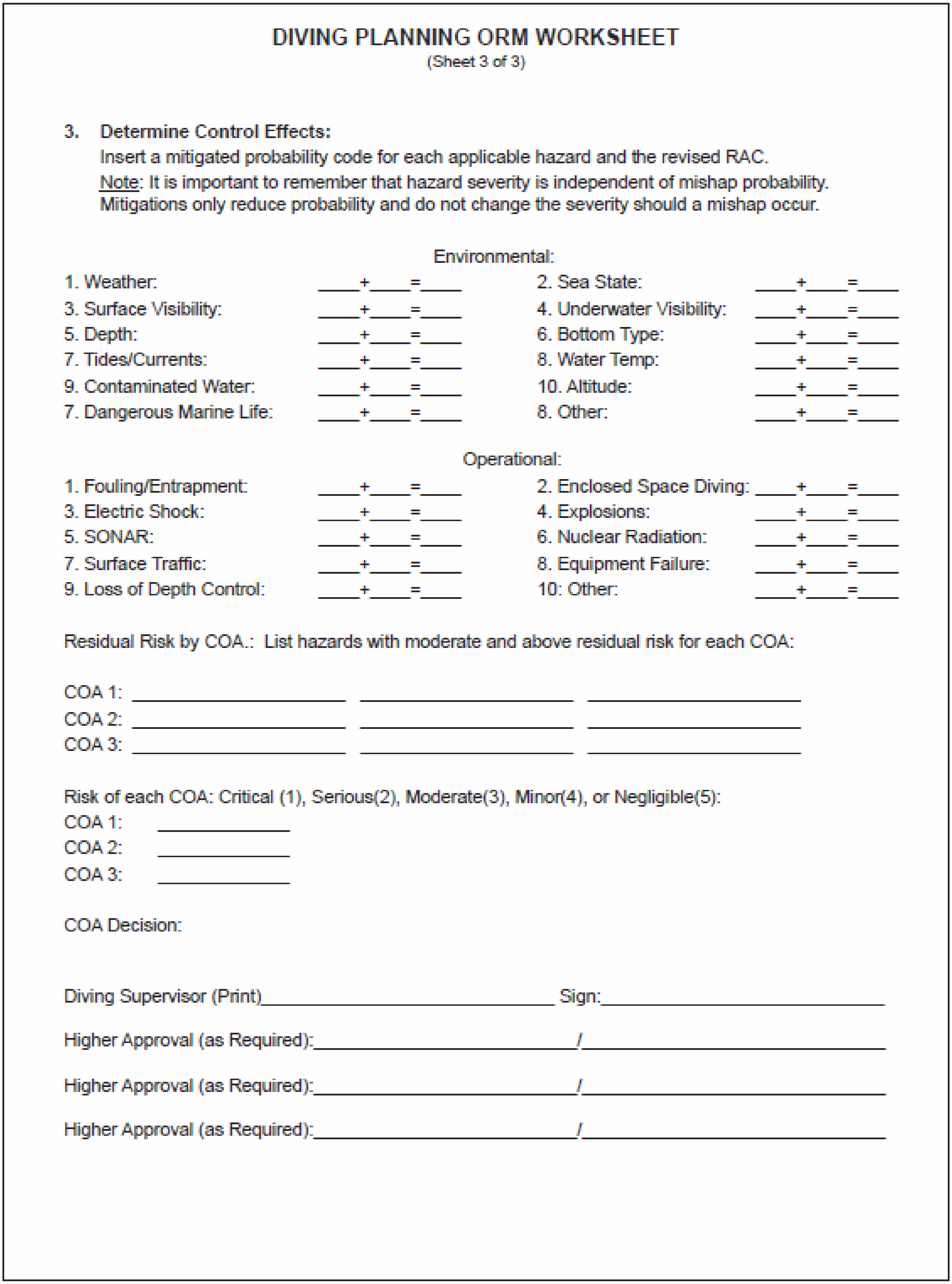
1. Weather: __________
2. Sea State: __________
3. Surface Visibility: __________
4. Underwater Visibility: __________
5. Depth: __________
6. Bottom Type: __________
7. Tides/Currents: __________
8. Water Temp: __________
9. Contaminated Water: __________
10. Altitude: __________
7. Dangerous Marine Life: __________
8. Other: __________

Operational Hazards:

1. Fouling/Entrapment: __________
2. Enclosed Space Diving: __________
3. Electric Shock: __________
4. Explosions: __________
5. SONAR: __________
6. Nuclear Radiation: __________
7. Surface Traffic: __________
8. Equipment Failure: __________
9. Loss of Depth Control: __________
10: Other: __________

Risk Assessment Matrix				Probability			
				Frequency of Occurrence Over Time			
				A Likely	B Probable	C May	D Unlikely
SEVERITY	Effect of Hazard	I	Loss of Mission Capability, Unit Readiness or Asset; Death	1	1	2	3
		II	Significantly Degraded Mission Capability or Unit Readiness; Severe Injury or Damage	1	2	3	4
		III	Degraded Mission Capability or Unit Readiness; Minor Injury or Damage	2	3	4	5
		IV	Little or No Impact to Mission Capability or Unit Readiness; Minimal Injury or Damage	3	4	5	5
Risk Assessment Codes **1 - Critical 2 - Serious 3 - Moderate 4 - Minor 5 - Negligible**							

Note: It is important to remember that severity is independent of probability and reducing probability does not change mishap severity.



DIVING PLANNING ORM WORKSHEET

(Sheet 3 of 3)

3. Determine Control Effects:

Insert a mitigated probability code for each applicable hazard and the revised RAC.

Note: It is important to remember that hazard severity is independent of mishap probability. Mitigations only reduce probability and do not change the severity should a mishap occur.

Environmental:

1. Weather: ____+____=____
2. Sea State: ____+____=____
3. Surface Visibility: ____+____=____
4. Underwater Visibility: ____+____=____
5. Depth: ____+____=____
6. Bottom Type: ____+____=____
7. Tides/Currents: ____+____=____
8. Water Temp: ____+____=____
9. Contaminated Water: ____+____=____
10. Altitude: ____+____=____
7. Dangerous Marine Life: ____+____=____
8. Other: ____+____=____

Operational:

1. Fouling/Entrapment: ____+____=____
2. Enclosed Space Diving: ____+____=____
3. Electric Shock: ____+____=____
4. Explosions: ____+____=____
5. SONAR: ____+____=____
6. Nuclear Radiation: ____+____=____
7. Surface Traffic: ____+____=____
8. Equipment Failure: ____+____=____
9. Loss of Depth Control: ____+____=____
10: Other: ____+____=____

Residual Risk by COA.: List hazards with moderate and above residual risk for each COA:

COA 1: ______________________ ______________________ ______________________
COA 2: ______________________ ______________________ ______________________
COA 3: ______________________ ______________________ ______________________

Risk of each COA: Critical (1), Serious(2), Moderate(3), Minor(4), or Negligible(5):
COA 1: ______________
COA 2: ______________
COA 3: ______________

COA Decision:

Diving Supervisor (Print)______________________________ Sign:______________________________

Higher Approval (as Required):__________________________/______________________________

Higher Approval (as Required):__________________________/______________________________

Higher Approval (as Required):__________________________/______________________________

SAMPLE: Activity HAZARD ANALYSIS Format

Activity Hazard Analysis (AHA)

Activity/Work Task:	Overall Risk Assessment Code (RAC) (Use highest code)	

Project Location:

Contract Number:

Date Prepared:

Prepared by (Name/Title):

Reviewed by (Name/Title):

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Notes: (Field Notes, Review Comments, etc.)

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

	RAC Chart
"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.	
"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible	**E = Extremely High Risk** **H = High Risk**
Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.	**M = Moderate Risk** **L = Low Risk**

Job Steps	Hazards	Controls	RAC
Equipment to be Used	**Training Requirements/Competent or Qualified Personnel name(s)**	**Inspection Requirements**	

2016

Appendix B: Dive Briefs and Logs

Emergency Assistance Checklist

EMERGENCY MEDICAL SERVICE (EMS) Location: Phone Number: Remarks:	RECOMPRESSION CHAMBER Location: Phone Number: Remarks:
DIVING MEDICAL OFFICER Location: Name: Phone Number: Response Time:	LAW ENFORCEMENT: Location: Phone Number: Remarks:
FIRE DEPARTMENT Location: Phone Number: Remarks:	EMERGENCY CONSULTATION Divers Alert Network 919-684-9111 Navy Experimental Dive Unit (NEDU) Phone Numbers 24 Hours a Day (850) 234-4351 (850) 230-3100

SUPERVISOR____________________________________ **DATE**_________________

Pre-Operational Dive Briefing

AOR International
Dive Brief

CHECK THE SIDE

DIVE SUPERVISORS CHECKLIST COMPLETE _______ LOADLIST COMPLETED _________

CALL SIGN ____

ROLL CALL

ASSUME THE SIDE

1. PM _______________ QC/Safety _________________ Field Sup _________________ DDC__________________

DIVE BILL

2. OPERATION IN DETAIL/TIME LINE____

____

ANTICIPATED CONDITIONS

WEATHER _____________ AIR TEMP _____ WIND DIRECTION/SPEED _____/_____ SUN RISE/SET_____/_____

WAVE HEIGHT ______ CURRENT DIRECTION/SPEED _____/_____ VIS SURFACE/BOTTOM _____/______

OCEAN TEMP________ BOTTOM TYPE____________ BOTTOM HAZARDS_____________________________

SHORE TYPE______________________ ONSITE/MISSION HAZARDS ______________________________

DEPTH/BT _____/_____ NO D LIMITS ____/_____ NTE ____/____ NTE NO D LIMITS _____/_____

BRIEF EMERGENCY MISHAP PLAN

PRIMARY RECOMPRESSION CHAMBER

LOCATION __________________ TRANSIT TIME__________ RESPONSE TEAM # _______________________

TRANSPORTATION/EVACUATION TO MEDICAL FACILITY POV/TRUCK/SMALL CRAFT
CONTACTS FOR TRANSPORTATION ____

ROUTE TO MEDICAL FACILITY ____

ISOLATE GEAR ON DIVE STATION ____

COMMUNICATIONS __________________________ SAFETY DRIVER __________________________________

BRIEF DIVE TEAM

DIVERS – ANY PROBLEMS MAKING THIS DIVE, LAST TIME IN RIG, LINE PULLS, HAND SIGNALS, EP's FOR THE RIG, GO ON RESERVE/TERMINATE DIVE, (500 psi SINGLE/250 psi TWINS) STAY TOGETHER, ABORT DIVE IF

CONDITIONS CHANGE OR YOU EXPERIENCE ANY ADVERSE PHYSIOLOGICAL SYMPTOMS OR RIG MALFUNCTIONS, DIVERS FULLY UNDERSTAND OPERATION. ANY QUESTIONS?
ALL DIVERS CLEAR OK/CLEAR NOW, ANY DIVES LAST 12 HOURS, ANY MEDICATIONS, FALSE TEETH, CONTACTS, ACHES, PAINS, WEAKNESS, ANY NEUROLOGICAL DEFICIETS, I SHOULD KNOW ABOUT.

"NOTE HOW YOU FEEL RIGHT NOW, IF YOU FEEL ANY DIFFERENT FROM THE TIME YOU LS TO RS LET ME KNOW. ASAP"

STANDBY DIVER – DRESS OUT (OCTOPUS RIG), DOWN DRESS AT MY DISCRETION, STAY ALERT, I WILL BRIEF YOU FULLY BEFORE DEPLOYING, ASSESS SITUATION, EYES ON THE BOTTOM, LET ME KNOW HOW I CAN HELP, FOLLOW EP's. ANY QUESTIONS?

TENDERS – ASSIST DRESSING DIVERS, CHECK RED/GREEN/STANDBY, MAINTAIN POSITIVE CONTROL AT ALL TIMES, IF SURFACE TENDED FISH THE DIVERS, REPORT ALL LINE PULLS, TRACK BUBBLES, WITNESS FLOAT, WATCH FOR BOAT TRAFFIC, STAY ALERT. ANY QUESTIONS?

DIVE PROCEDURES

<u>EXPLAIN IN DETAIL</u>

WATER ENTRY ______________________________ WATER EXIT ___________________________________

DESCENT – NTE 75 fpm, STAY AHEAD OF THE PRESSURE, SQUEEZE HALT DESCENT ASCEND TIL DOR, CLEAR AND CONTINUE DESCENT, DON'T PUSH IT.

ASCENT – NTE 30 fpm, BREATHE NORMAL, HAND OVER HEAD, 360 SWEEP DURING ASCENT CHECKING FOR SMALL CRAFT, ON SURFACE REPORT OK MAX DEPTH/BT.

RECALL DEVICES – PRIMARY – COMMS, TENDING LINE, 4 REVS/RAPS, STICKS
(CIRCLE ONE) SECONDARY – TENDING LINE, STDBY, 4 REVS/RAPS, STICKS

EMERGENCY PROCEDURES

LOST/SEPARTED DIVER – 360 SWEEP, LOOK FOR BUBBLES, TAP ON TANKS, SLOWLY ASCEND, SURFACE REPORT TO SUP (OK MAX DEPTH/BT/psi), MARK SPOT, INITIATE RECALL, DEPLOY LOST DIVER BOUY, and CONDUCT CIRCLE SEARCH.

FOULED/TRAPPED DIVER – REMAIN CALM EVALUTE SITUATION, UNFOUL/CUT YOURSELF FREE - BUDDY DIVER ASSIST FOULED/TRAPPED DIVER, (CHECK EGS AIR SUPPLY), ATTACH TENDING LINE/WITNESS FLOAT, SURFACE IF ASSISTANCE IS NEEDED FROM TOPSIDE. LINE PULLS (2-2-2 I NEED U, 3-3-3 I WILL BE FREE)

LOSS OF AIR – TURN ON EGS AT SIDE BLOCK, SIGNAL BUDDY/LEAD DIVER, BUDDY BREATHE, ABORT DIVE MAKE A CONTROLLED ASCENT. DITCH GEAR AS LAST RESORT, BLOW AND GO.

INJURED/ UNCONSCIOUS – GET POSITIVE CONTROL OF DIVER, DITCH WEIGHT BELT, PRESSING ON DIAPHRAM, CHECK VITALS, INFORM SUPERVISOR.
NO VITALS COMMENCE RESCUE BREATHING, 2 QUICK BREATHS/1 EVERY 5 SECONDS TILL DIVER IS ON PLATFORM, COMMENCE CPR.

EXTRACTION BRIEF – MAINTAIN POSITIVE CONTROL OF DIVER, STRIP/ISOLATE GEAR, CHECK ABC's ON DECK, ADMINISTOR O2, INITIATE EMERGENCY MEDICAL PLAN, TRANSPORT.

DIVING RELATED DISORDERS/DISEASES

TYPE I – PISS/PMS
TYPE II – (PARALYSIS/WEAKNESS, NUMBNESS/TINGLING, MENTAL STATUS, COORDINATION, NAUSEA, CONVULSIONS ETC.)
POIS – AGE - SAME SYMPTOMS AS TYPE II TIME ONSET IS THE KEY.
PNEUMO – (SHARP PAIN, SHORTNESS OF BREATH, RAPID BREATHING)
MEDIASTINAL - (MILD/MOD PAIN BREASTBONE, DULL ACHE, WORSE DEEP INSPIRATION, RADIATE TO NECK, BACK, SHOULDER)
SUBCUTANEOUS - (FULLNESS AROUND NECK, DIFFICULTY SWALLOWING, VOICE CHANGE, RICE CRISPIES)
SQUEEZES – MIDDLE EAR/SINUS (PAIN, DIZZINESS, VERTIGO, NAUSEA) REVERSE SQUEEZE - ASCENT (PAIN ABV)
CO POISONING – (HEAD ACHE MILD/SEVERE, NAUSEA, MENTAL CONFUSION, TIGHTNESS ACROSS FOREHEAD)
CO2 TOXICITY – (SHORTNESS OF BREATH, MENTAL CONFUSION, RAPID PULSE, HEADACHE, DIZZINESS, ETC.)

ANY QUESTIONS, COMMENTS, PROBLEMS, UNDERSTAND OPERATION.

LOAD UP/UNDERWAY, DRESS DIVERS, STAND BY FOR PRE-DIVE CHECKS

Dive Supervisor (Print / Sign):	Date:

Rough Diving Log

ROUGH DIVE LOG

NAME:	L/S	L/B	BT	MAX DEPTH	SI	RNT

Dive Supervisor________________________ **Date of Dive:**________________

DIVE LOG

Dive Date:

Company: AOR International LLC

Location:

Equipment

Platform:

Gas Source: Air

Apparatus:

Dress:

Environment

Dive Location:

Air Temp:

Current:

Visibility:

Altitude:

Water Temp:

Wave Ht.:

Bottom Type:

Dive Data

Diver	LS	BT	LB	TDT	RS	TTD	Depth	T/S	SI	RNT	NOTES
Hatcher	9:05	0:12	9:17	0:01	9:18	0:13:00	53'	53/12			Example

Dive Description

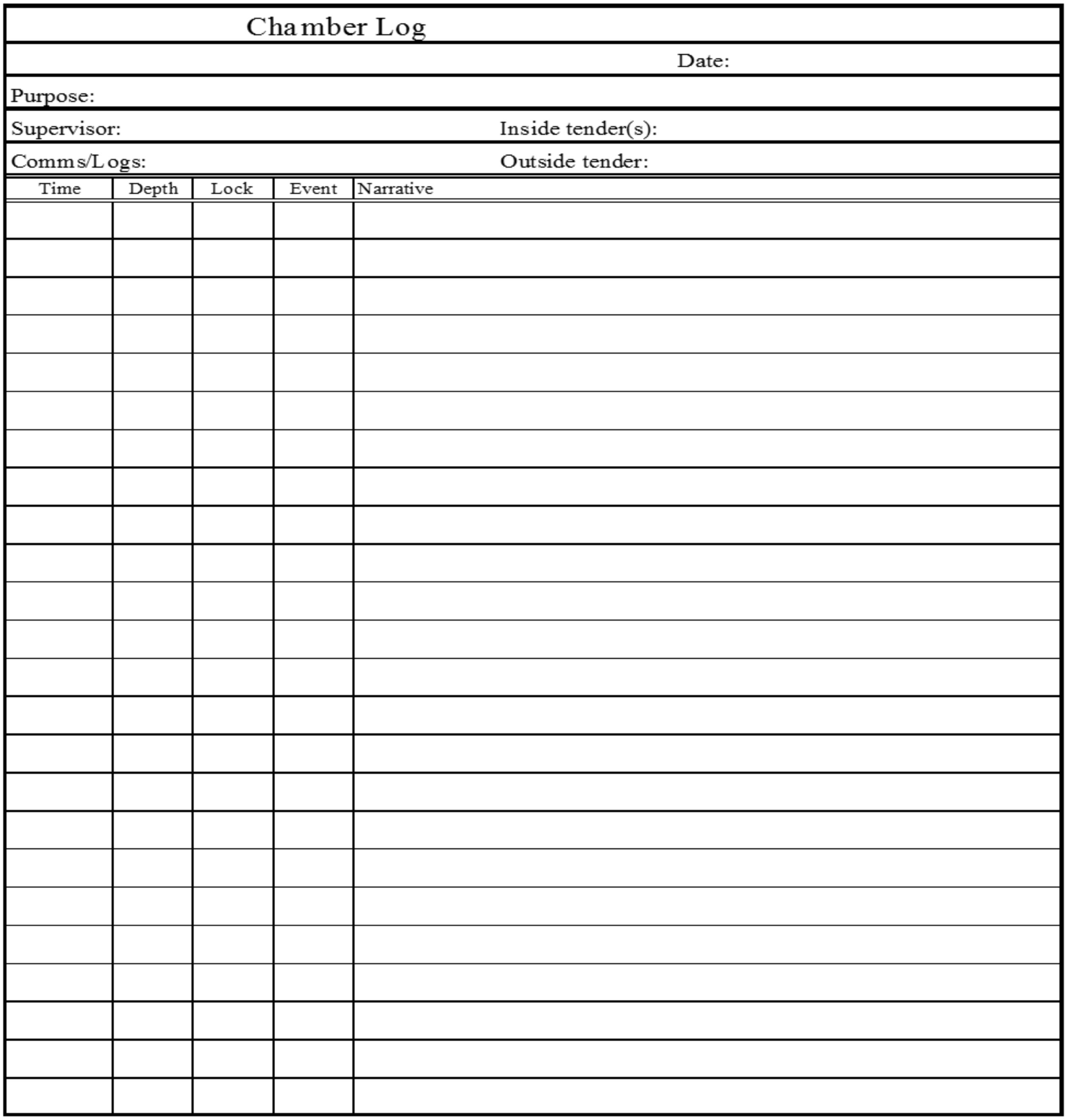
Purpose:

Description:

Dive Supervisor:

Date:

Chamber Log



Chamber Log

Date:

Purpose:

Supervisor: Inside tender(s):

Comms/Logs: Outside tender:

Time	Depth	Lock	Event	Narrative

2016

Appendix C – SSA Diving Checklists

Dive Site Checklist

Pre-Dive			
Planning		On Station Items	
	NOAA Weather Forecast		Dive Brief
	Small Boat Advisory (Yes or No)		SPM (approved and signed)
	Sea State (0 – 9) _________		Diver Certification Docs
	Wind Speed _________		Dive Plan (approved and signed)
	Current ______kts		EMP
	Water Temp ______		AHA’s (approved and signed)
	OP’s in the area (i.e. boat traffic, sonar)		Dive Manual / Logs / Charts
	Manning Level, IAW EM 385-1-1		OP’s / EP’s (System and Chamber)
	Dive Coordinator Notified		Missions and Pre-Dives
	Chamber Notified		Supervisor Checklist
	Dive Manifest / Sailing List Posted		Cell Phone / Radio (marine band/VHF)
	O_2 Requirements ____________ SCFT		
	Air Requirements ____________ SCFT		

Station Checks			
	Code Alpha / Day Shapes		Diver Ready / Knives / Shackle
	Lights / Tools for the job		Standby EGS (most PSI)
	Side Clean / Organized		Communication Power Supply
	Mooring Reference Point		Air Lined Up to Divers
	Ladder secured and stable		Metal Detector / Batteries
	O_2 / First Aid Kit _____________psi		Stretcher / Head Support / Straps
	Extraction Line		AED on Station (Green light)
	ACLS travel time_____________		Fuel (boat, generator, etc.)
	Life Jackets (all personnel)		Leak Test (Snoop)
	Sanizide and Fresh Water Rinse		Boat USCG Approved

Dive Supervisor (Print / Sign):	Date:

Full Face Mask (FFM) Supervisor Pre-Entry Check sheets

Date: ____________________ **Job:** ____

Helmet Type	Serial No.	Checked By:	Supervisor Name	Supervisor Signature
1.				
2.				

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the FFM.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Dive Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Pre-missions / pre-dives complete**			
2	**Don thermal protection: (if needed)**			
3	**Don harness and weights / pull test fins**			
4	**Connect umbilical shackle: (left side) Tuck pneumo.**			
5	**Send air to the hats**			
6	**Tenders do surface checks on the hats**			
7	**Record Air Bank Pressure 1.____________________ 2.___________________**			
8	**Record Minimum Manifold Pressure. (115psig minimum) PSIG ________________**			
9	**Open EGS and record pressure**			
10	**Ensure valve is secured at side block**			
11	**Purge and test pneumo (1st Dive ONLY)**			
12	**Don mask and activate air flow**			
13	**Verify rig breaths fine**			
14	**Check comms (round robin)**			
15	**Leak test back to console (1st dive ONLY)**			
16	**Physically check divers and rig (check knobs and screws)**			
17	**Have Standby diver remove mask once divers are on the bottom.**			

Pre-Dive: AGA / Guardian Checkoff Sheet

Date: ____________________ **Job:** ______________________________________

Diver 1/ Tender 1:_________________________/_________________________

Diver 2/ Tender 2:_________________________/_________________________

Mask Type	Serial No.	Checked By:	Checked By Signature	Supervisor Signature
1.				
2.				

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the AGA to be pre-dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Visually inspect the rubber for signs of damage. Visually inspect face plate to be secure and undamaged.**			
2	**Check the screws that hold the comm port cover are hand tight. Do not over tighten.**			
3	**Inspect the oral nasal for cracks or other defects.**			
4	**Inspect the Spider to ensure there are no tears and/or cracks in the material. Ensure all five legs are present. If it is worn and/or cracked, it must be replaced.**			
5	**Ensure the Earphones and the Microphone are installed correctly.**			
6	**Ensure the One-Way Valve is operational** **WARNING: The One-Way Valve must be tested daily prior to commencing diving operations.**			
7	**Inspect the hoses attached to the block assembly and check valve**			
8	**Connect the First Stage Regulator to the EGS Cylinder and the Mask Emergency Supply Valve. With the Cylinder turned OFF, open and close the Side Block Auxiliary Valve (EGS) to check for smooth operation. Then depress purge button on FFM.**			
9	**Visually inspect all EGS hoses for signs of damage.**			
10	**Check to ensure the cylinder is within the VIP and the hydro dates.**			
11	**Ensure the First Stage Regulator pressure setting and the Over Pressure Bleed/Relief Valve settings have been checked within the past month. (Maintenance Log).**			
12	**Inspect the Safety Harness and Cylinder Retainer for wear and damage. Repair/replace as necessary.**			
13	**Open the EGS Supply Valve on the cylinder. Then open the Emergency Supply Valve on the Side Block.**			

14	**Momentarily depress the purge button on the FFM. Check for a strong flow of gas, then secure.**			
15	**Blow down the Umbilical and attach it to the Umbilical Adapter on the One-Way Valve.**			
16	**Depress the Purge Button all the way, verify a strong surge of gas.**			
17	**Ensure the Side Block Emergency Valve is closed, and the Bail Out Cylinder Valve is open. Log the cylinder pressure psig.**			**1. PSIG _____________** **2. PSIG _____________**
18	**Perform communications check.**			
19	**Soap and leak check the Mask gas fittings and connections including the EGS.**			
20	**Check Diver's Safety Harness**			
21	**Check Umbilical Strain Release**			
22	**Check EGS Hose Quick Disconnect**			
23	**Check to ensure the Mask is breathing easily**			

POST-DIVE: AGA / Guardian FFM CHECKOFF SHEET

Date: ____________________ **Job:** ______________________________________

Helmet Type	Serial No.	Checked By:	Check By Signature	Supervisor Signature
1.				
2.				

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the FFM to be post-dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Secure and bleed down gas supplies.**			
2	**Disconnect and cap air connections and disconnect the communication wires.**			
3	**Immerse the face mask and the breathing valve into Sanizide solution, then rinse with fresh water. Inspect for signs of damage.**			
4	**Press the purge button and allow the air to flow through the valve until the valve is dry.**			
Perform the following after prolonged use or diving in dirty water				
5	**Remove Mic cover by unscrewing the two screws and pulling the cover off.**			
6	**Turn the breathing valve clock-wise so that it comes away from the bayonet coupling and pull the valve outwards.**			
7	**Unscrew the locking ring and remove the positive pressure unit from the valve housing.**			
8	**Hold the positive pressure unit and loosen the diaphragm assembly by squeezing the thread of the cover. Separate the components carefully.**			
9	**Remove the positive pressure spring and the guide disc from the positive pressure unit cover.**			
10	**Remove the sealing disc and the exhalation diaphragm from the diaphragm assembly. Do not dismantle the diaphragm assembly any further.**			
11	**Wash parts with soap and warm water, then rinse in clean water.**			
12	**Let parts dry before assembly**			

KMB-18B Supervisor Pre-Entry Dive Check sheet

Date: ____________________ **Job:** ______________________________________

Diver 1/ Tender 1:_________________________/__________________________

Diver 2/ Tender 2:_________________________/__________________________

Mask Type	Serial No.	Checked By:	Check By Signature	Supervisor Signature
1.				
2.				

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the Band Mask be post dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Open and close Steady Flow Valve to ensure proper operation.**			
2	**Check breathing resistance, adjust Demand Regulator Adjustment Knob for minimum inhalation effort.**			
3	**Press Purge Button to check gas purge function.**			
4	**Ensure Nose Block Device slides freely.**			
5	**Ensure Emergency Valve opens and closes properly, then verify Emergency Valve is shut and the Bail Out Cylinder Valve is open.**			
6	**Perform communications check.**			
7	**Soap and leak check the Mask gas fittings and connections, including the EGS.**			
8	**Diver's Safety Harness**			
9	**Umbilical Strain Release**			
10	**EGS Hose Quick Disconnect**			
11	**Boots or fins, gloves, knife, and other accessories**			
12	**Helmet supply pressure, minimum 115 psig.**			
13	**Check to ensure helmet is breathing easily.**			

Pre-Dive: KMB 18 (Band Mask) Checkoff Sheet

Date: ____________________ **Job:** ______________________________________

Diver 1/ Tender 1:_________________________/__________________________

Diver 2/ Tender 2:_________________________/__________________________

Mask Type	Serial No.	Checked By:	Signature	Supervisor Signature

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the Dive Helmet be pre-dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Visually inspect the Hood and Face Seal for signs of damage. Check the Hood for tears, holes, and/or cuts. Ensure the Face Seal is properly glued to the Hood.**			
2	**Check the screws that hold the Bands in position. They must be properly torque to *26-inch pounds (28 kg cm)***			
3	**Inspect the Bands. Ensure the welds exhibit no signs of cracking and/or parting. Inspect all band keeper components**			
4	**Inspect the Spider to ensure there are no tears and/or cracks in the material. Ensure all five legs are present. If it is worn and/or cracked, it must be replaced.**			
5	**Visually inspect the interior/exterior of the Band Mask for any obvious signs of damage. Check to make sure the Oral Nasal Valve is correctly installed and the Oral Nasal Mask is installed on the Regulator Mount Nut. Ensure the Nose Clearing Device operates smoothly. Lubricate as necessary. Guidance O & M Manual.**			
6	**Ensure the Earphones and the Microphone are installed correctly. Check the Wire Lugs to ensure they are not touching each other. Guidance O & M Manual.**			
7	**Ensure the Demand Regulator Cover is not excessively dented, with dents deeper than ¼ inch.**			
8	**Inspect the Regulator Hose Assembly on the KMB-18A. The Hose(s) and fittings must be in good shape. On the KMB-18B, the Bent Tube must not have any dents and/or compressed areas exceeding 1/8”**			
9	**Check all moving parts to ensure smooth and proper operation. 1) Defogger Control Knob 2) Auxiliary Knob (EGS) 3) Nose Block Device 4) Regulator Adjustment Knob**			

10	**Ensure the One-Way Valve is operational** **WARNING: The One-Way Valve must be tested daily prior to commencing diving operations.**			
11	**Connect the First Stage Regulator to the EGS Cylinder and the Mask Emergency Supply Valve. With the Cylinder turned OFF, open and close the Side Block Auxiliary Valve (EGS) to check for smooth operation. Then open and close the Defogger Valve to check for smooth operation.**			
12	**Visually inspect all EGS hoses for signs of damage.**			
13	**Check to ensure the cylinder is within the VIP and the hydro dates.**			
14	**Ensure the First Stage Regulator pressure setting and the Over Pressure Bleed/Relief Valve settings have been checked within the past month. (Maintenance Log).**			
15	**Inspect the Safety Harness and Cylinder Retainer for wear and damage. Repair/replace as necessary.**			
16	**Document inspection/maintenance in Maintenance Log**			
17	**Rotate the Regulator Adjustment Knob in fully (clockwise), then rotate out (counterclockwise) 3 – 4 rotations to check for smooth operation.**			
18	**Open the EGS Supply Valve on the cylinder. Log the pressure. Then open the Emergency Supply Valve on the Side Block.**			**1. PSIG ________** **2. PSIG ________**
19	**Momentarily open the Mask Defogger ¾ to 1 full turn. Check for a strong flow of gas out of the Defogging Train, and then close.**			
20	**Check for gas escaping from the One-Way Valve.**			
21	**Blow down the Umbilical and attach it to the Umbilical Adapter on the One-Way Valve.**			
22	**Rotate out (counterclockwise) on the Demand Regulator Adjustment Knob until a slight free flow develops. Then rotate in (clockwise) until the free flow stops.**			
23	**For masks equipped with a SuperFlow or SuperFlow 350 regulator, slowly depress the purge button to check for excessive travel. The purge button should travel in no less that 1/16" and out no more than 1/8" before gas flow is heard. For masks equipped with a 450 or 455 balanced regulator depressing the flexible cover the cover should travel 1/16" to 1/8" before gas starts to flow.**			
24	**Depress the Purge Button all the way, verify a surge of gas. Pressing the flexible cover of the 450 and 455 further than 1/4" should result in a strong flow of gas.**			

25	**Ensure the Side Block Emergency Valve is closed, and the Bail Out Cylinder Valve is open. Log the cylinder pressure psig.**			**1. PSIG _______** **2. PSIG ________**
26	**Perform communications check.**			
27	**Soap and leak check the Mask gas fittings and connections including the EGS.**			
28	**Check Diver's Safety Harness**			
29	**Check Umbilical Strain Release**			
30	**Check EGS Hose Quick Disconnect**			
31	**Check to ensure the Mask is breathing easily**			

Post Dive: KMB 18 (Band Mask) Checkoff Sheet

Date: ____________________ Job: ______________________________________

Diver 1/ Tender 1:_________________________/_________________________

Diver 2/ Tender 2:_________________________/_________________________

Mask Type	Serial No.	Checked By:	Check By Signature	Supervisor Signature
1.				
2.				

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the Band Mask be post dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Secure and bleed down gas supplies.**			
2	**Disconnect and cap the Mask Gas Connections and disconnect the communication wires. Cap the Umbilical End.**			
3	**Wash the exterior surface of the Mask with a solution of mild detergent and fresh water, then rinse. Inspect for signs of damage.**			
4	**Dislodge the Earphones from their pockets in the Hood. Remove the Earphone protective covers, clean and rinse to allow to dry.**			
5	**Clean Hood Assembly. Rinse with fresh water and inspect for damage. Hang-up for drying or airing.**			
6	**Remove the Demand Regulator Clamp, Cover, and Diaphragm Assembly. Wash the interior of the Demand Regulator with mild detergent and fresh water, then rinse thoroughly.**			
7	**Remove the Microphone from the Oral Nasal Mask. Avoid getting water on the Oral Nasal Mask, Microphone and Earphones.**			
8	**Wipe down interior of the Mask, including the Oral Nasal Mask with Sanizide and fresh water solution. Thoroughly rinse with fresh water while cycling the Defogger Knob, Auxiliary Gas Knob (EGS) and Regulator Adjustment Knob.**			
9	**Fully back out on the Regulator Adjustment Knob, counterclockwise (this will prolong the life of the Inlet Valve Seat). Shut the Auxiliary Supply (EGS) and Steady Flow Valves.**			
10	**Wipe all surfaces with a clean dry towel to remove water droplets. Allow to air dry.**			
11	**Cap the Emergency Gas Whip on the First Stage Regulator. Wash the exterior of all EGS components, the First Stage Regulator, the Gas Cylinder, the submersible pressure gauge, and the Harness Assembly with a mild detergent solution and rinse with fresh water. Hang-up Harness Assembly for drying or airing.**			

KM-37 Supervisor Pre-entry Check sheets

Date: ____________________ **Job:** ______________________________________

Helmet Type	Serial No.	Checked By:	Signature	Supervisor Signature

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the Dive Helmet be pre-dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Ensure gas to the diver**			
2	**Log the EGS cylinder pressure**			**1. PSIG____________** **2. PSIG____________**
3	**Divers open and close the Steady-Flow Valve to ensure proper operation.**			
4	**Divers check breathing resistance. Set Demand Regulator Adjustment Knob for minimum inhalation effort**			
5	**Divers press Purge Button to check gas purge function.**			
6	**Divers ensure Nose Block Device slides freely.**			
7	**Divers ensure Emergency Valve opens and closes properly. Then, ensure Emergency Valve is closed and the Bail Out Cylinder Valve is open.**			
8	**Perform communications check.**			
9	**Soap and leak check Helmet/Mask gas fittings and connections, including Emergency Gas System.**			
10	**Ensure the sealed Pull Pins are fully engaged on the base of the Helmet Ring into the Locking Collar/Neck Pad Assembly.**			**Attempt to rotate pull pins, if pin rotates this is an indication that pin is not correctly engaged**
11	**Check the Diver's Safety Harness.**			
12	**Check the Umbilical strain release.**			
13	**Check the EGS Hose Quick Disconnect**			
14	**Check boots, gloves, knife, and other accessories**			
15	**Helmet supply pressure, minimum 115 psig (7.93 bar).**			
16	**Diver ensure helmet is breathing properly**			

PRE-DIVE: DEMAND DIVE HELMET CHECKOFF SHEET

Date: ____________________ **Job:** ______________________________________

Diver 1/ Tender 1:_________________________/__________________________

Diver 2/ Tender 2:_________________________/__________________________

Helmet Type	Serial No.	Checked By:	Signature	Supervisor Signature

Note: All items will be checked in appropriate blocks as follows:

1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the Dive Helmet be pre-dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Visually inspect the Neck Dam Ring Assembly for signs of damage. Check the Neck for tears, holes, and/or cuts. Ensure the Neck Dam is of the proper size and fit.**			
2	**Test-mate the Neck Dam Ring Assembly to the Helmet and check for proper adjustment.**			
3	**Ensure the sealed Pull Pins work properly.**			
4	**Visually inspect Helmet Shell interior and exterior for damage and/or contamination. Check that the Oral Nasal Valve is correctly installed and the Oral Nasal Mask is installed on the Regulator Mount Nut. Ensure the Nose Clearing Device operates smoothly. Lubricate as necessary.**			
5	**Ensure the Earphones and Microphones are installed correctly.**			
6	**Inspect the Head Cushion for proper fit, broken snaps, tears, and/or rips. Lightly lubricate male snaps with silicone 111.**			
7	**Visually inspect all EGS Hoses for signs of damage.**			
8	**Check the hydro date and ensure the cylinder is within the VIP and the hydrostatic date. Visually inspect the cylinder and valve for obvious signs of damage.**			
9	**Ensure the First Stage Regulator pressure and the Over-Pressure Bleed/Relief Valve settings have been checked within the past month.**			
10	**Inspect the Safety Harness and Cylinder Retainer for wear and/or damage. Repair/replace as necessary.**			
11	**Orally check the One-Way Valve. (blow and suck)**			
12	**Connect the First Stage Regulator to the EGS Cylinder and the Helmet Emergency Supply Valve. With the cylinder turned OFF, open and close the Side Block Emergency Valve to check for smooth operation. Then open and close the Steady flow.**			

13	**Rotate the Regulator Adjustment Knob in fully (clockwise), then rotate out (counterclockwise) 3 – 4 rotations to check for smooth operation.**			
14	**Open the EGS Supply Valve on the cylinder. Next open the Emergency Supply Valve on the Side Block.**			
15	**Momentarily open the Helmet Steady Flow 3/4 to 1 full turn. Check for a strong flow of gas out of the Defogging Train, and then close.**			
16	**Check for gas escaping from the One-Way Valve.**			
17	**Adjust dial-a-breath**			
18	**Check free-flow**			
19	**Check purge**			
20	**Ensure the Side Block Emergency Valve is shut and the Bail Out Cylinder Valve is open.** **PSIG ________________ PSIG________________**			
21	**Connect Umbilical to air source. Blow down umbilical then attach to side block one-way valve.**			
22	**Connect communications. Perform communications check.**			
23	**Leak check all gas fittings and EGS connections.**			

POST-DIVE: DEMAND DIVE HELMET CHECKOFF SHEET

Date: ____________________ **Job:** ______________________________________

Helmet Type	Serial No.	Checked By:	Signature	Supervisor Signature

Note: All items will be checked in appropriate blocks as follows:
1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the Dive Helmet be pre-dove.
3. When complete, person completing the checks will sign as appropriate (blocks 1 or 2) and then return to Diving Supervisor for final review and check.

Task	Procedures	1	2	Remarks
1	**Secure and bleed down gas supplies.**			
2	**Disconnect and cap or tape the Helmet Gas Connections and disconnect the communication wires. Cap or tape the Umbilical End.**			
3	**Wash the exterior surface of the Helmet with a solution of mild detergent and fresh water, then rinse. Inspect for signs of damage.**			
4	**Remove the Head Cushion Assembly. Inspect for damage. If the Head Cushion has gotten wet with perspiration or water, clean and hang-up for drying or airing.**			
5	**Remove the Demand Regulator Clamp, Cover, and Diaphragm Assembly. Wash the interior of the Demand Regulator with mild detergent and fresh water, then rinse thoroughly.**			
6	**Dislodge the earphones. If the interior of the Helmet and Liner has gotten wet, remove the earphone protective covers, wash with mild detergent solution, rinse with fresh water and allow to dry.**			
7	**Remove the microphone from the Oral Nasal Mask. Wash with a mild detergent solution and rinse with fresh water.**			
8	**Wipe interior of the Helmet, including the Oral Nasal Mask. Wash with Sanizide and rinse with fresh water.**			
9	**Rotate the Regulator Adjustment Knob fully out (counter clockwise). Close the Emergency Supply and Steady Flow Valves.**			
10	**Clean the Neck Ring, and Pull Pin Assemblies with mild detergent solution, thoroughly rinse with fresh water.**			
11	**Wipe all surfaces with a clean, dry towel to remove water droplets. Allow to air dry.**			
12	**Cap the Emergency Gas Whip on the First Stage Regulator. Wash the exterior of all EGS components, with a mild detergent solution and rinse with fresh water.**			
13	**Note any damage or discrepancies found during cleaning.**			

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Appendix D – SCUBA Diving Checklists (with or without FFM)

SCUBA Dive Site Checklist

Pre-Dive			
Planning		On Station Items	
	NOAA Weather Forecast		Dive Brief
*	Small Boat Advisory (Yes or No)		SPM (approved and signed)
*	Sea State (0 – 9) ________		Diver Certification Docs
	Wind Speed ________		Dive Plan (approved and signed)
	Current ______kts		Emergency Management Plan
	Water Temp ______		AHA's (approved and signed)
	OP's in the area (i.e. boat traffic, sonar)		Dive Manual / Logs / Charts
	Manning Level, IAW EM 385-1-1	*	OP's / EP's (Chamber, as required)
	Dive Coordinator Notified		Maintenance and Pre-Dives
	Chamber Notified		Supervisor Checklist
	Dive Manifest / Sailing List Posted		Cell Phone / Radio (marine band/VHF)
	O_2 Requirements ____________ SCFT	*	Pre missions conducted on Full Face Mask (as Required)
	Air available for depth_______ SCFT		

Station Checks			
	Code Alpha / Day Shapes		Recall device
	Lights / Tools for the job		Standby (most PSI)
	Tending lines / buddy line		Comms Power Supply (as required)
*	Mooring Reference Point		Proper diver protection
*	Ladder secured and stable		Metal Detector / Batteries
	O_2 / First Aid Kit _____________psi		Stretcher / Head Support / Straps
*	Extraction Line		AED on Station (Green light)
	ACLS travel time_____________	*	Fuel (boat, generator, etc.)
	Life Jackets (all personnel)		Leak Test (Snoop)
	Sanizide and Fresh Water Rinse	*	Boat USCG Approved

* Blocks may not be required on some dives

Dive Supervisor (Print / Sign):	Date:

SCUBA Supervisor Pre-Entry Check sheets
(with or without FFM)

Date: ____________________ **Job:** ____

Note: All items will be checked in appropriate blocks as follows:
1. Initial for each completed and satisfactory check.
2. An N/A for each item not applicable to the FFM.
3. When complete, Dive Supervisor will sign and date appropriate blocks

Task	Procedures	DV 1	DV 2	STBY
1	MINIMUM EQUIPMENT: 1. Tanks / Regulator / Pressure Gauge 2. Buoyancy compensator 3. Depth gauge / watch (or dive computer) 4. Mask, fins, knife 5. Weights (as required) 6. Proper thermal protection			
2	Fully open cylinder valve (back a ¼ turn)			
3	Cycle reserve, leave in up position			
4	Cylinder pressures / max time at depth________			
5	Quick releases / buckles properly rigged			
6	Check BC: Not Constrained / manual inflator / power inflator / dump valves			
7	Weights properly installed / belt outside of all equipment			
8	* Lifeline attached / buddy line ready (as required)			
9	Ensure knife cannot be jettisoned			
10	Tuck pressured gauge			
11	Zero depth gauge / set watch to zero			
12	Purge and breath all regulators / Secure octopus			
13	* Don FFM / adjust: nose clear device; bands (as required)			
14	* Check communications (as required)			
15	Physically check divers			
16	Sign:	Date:		

* Blocks may not be required on some dives

Appendix E –Emergency Procedures

EMERGENCY PROCEDURES (EP's)

1. Fire

a. Extinguish fire; secure equipment.
b. Determine damage and effect on Diver.
c. If required, terminate dive; commence decompression.
d. Each chamber must have a means of extinguishing a fire in the interior.

2. Equipment failure

a. Evaluate effect on Diver and dive team
b. Inform Diver of problem and action planned.
c. Alert Standby Diver, prepare to deploy.
d. Alert deck crew.
e. Diver informs topside of his readiness.
f. Activate plan, and if necessary, terminate dive.

3. Adverse weather

Warning: Lightning is cause for termination of the dive and diving will not be resumed for 30 minutes post last sighting.

If adverse weather arises:

a. Evaluate effect on the diver and dive team
b. Inform Diver of problem and action planned.
c. Alert Standby Diver.
d. Alert deck crew.
e. Diver informs topside of his readiness.
f. Activate plan, and if necessary, terminate dive.

4. Medical illness/injury of crew member

a. Initiate emergency response and evacuation as required.
b. Inform the diver of the situation and abort the dive.
c. Evaluate the effect of loss of personnel on the dive.
d. The dive may continue if there was no loss to critical surface support
e. Resume diving after diving supervisor reevaluates the impact to the dive team and proper notifications to PM and others as required.

5. Decompression Sickness without a Chamber on Site

a. Perform Rapid Neurological Exam Check on the diver and record results.
b. Contact local hyperbaric facility or hospital with hyperbaric facility noted in Emergency Action Plan.
c. Patient should be transported on back with legs slightly elevated and administered O_2.
d. The record of dive (dive sheet) and the diving supervisor shall accompany the patient to the medical facility.
e. Contact the Diving Operations Manager and C/H&S Manager as soon as possible.

6. Oxygen Toxicity in Water

a. Supervisor notes signs, or diver reports symptoms to Dive Control;
b. Immediately deploy the standby diver to assist and report on diver condition;
c. If CNS symptoms are present, do not attempt to ascend the diver until symptoms subside and it is

verified that the diver is breathing.
- d. Ascend 10 FSW and reduce oxygen partial pressure (switch to air).
- e. Add missed time to this next stop while breathing air.
- f. Upon arrival at next shallower stop, return diver to the decompression gas.
- g. Continue decompression according to procedure.
- h. Contact the Manager of Diving Operations and EHS Manager for further direction.

7. Oxygen Toxicity in the Decompression Chamber

- a. If possible, the diver reports symptoms to the chamber operator or the chamber operator notes signs.
- b. Symptoms and signs are noted and logged by chamber operator.
- c. Instruct the diver to remove oxygen mask, secure oxygen, and vent chamber.
- d. Lock in a qualified tender to assist.
- e. Wait 15 minutes after symptoms subside, and then continue decompression at point stopped.
- f. If symptoms reoccur, repeat step e**.**

8. Severance of Diver’s umbilical (Breathing Hose Only)

- a. Put breathing media to diver’s pneumofathometer hose.
- b. Diver activates bail-out bottle.
- c. Alert and prepare standby diver, prepare to deploy.
- d. If required, diver inserts pneumofathometer hose inside helmet under the neck dam.
- e. Diver returns to down line or stage.
- f. Diver activates and uses emergency breathing supply on stage, if applicable.
- g. If required, deploy the standby diver to assist.
- h. Terminate dive and follow proper decompression procedures.

9. Severance of Complete Umbilical

- a. Diver activates bail-out bottle and immediately deploy standby diver.
- b. Diver returns to down line.
- c. Diver activates and uses emergency breathing supply on stage, if applicable.
- d. If umbilical is severed on deck and the end of the umbilical is still on deck, send standby diver down umbilical with hose/bail-out bottle. Otherwise, send standby diver down the down line or stage cable.
- e. Terminate dive and follow proper decompression procedure.

10. Fouling and Entrapment.

- a. The first and most important action that a trapped diver can take is to stop and think.
- b. Inform topside of the situation
- c. The diver shall remain calm, analyze the situation, and carefully try to 2C-12 U.S. Navy Diving Manual — Volume 2 work free. Panic and overexertion are the greatest dangers to the trapped diver.
- d. Alert and prepare standby diver; prepare to deploy.
- e. Diver attempts to free himself.
- f. If required, send standby diver down to assist diver; standby diver to stay with diver.
- g. Monitor breathing; if necessary, standby diver shall open diver’s free-flow.
- h. Standby diver assists injured diver to surface, following proper decompression procedures, except when severity of injuries indicates a greater risk than omitting decompression.
- i. When diver is free, if unable or unwilling to continue the dive, or if the standby diver was deployed, terminate the dive.

11. Loss of vital support equipment

a. Evaluate effect on Diver.
b. Inform Diver of problem and action planned.
c. Alert Standby Diver.
d. Alert deck crew.
e. Diver informs topside of his readiness.
f. Activate plan, terminate dive.

12. Loss of gas supply

a. Re-establish breathing media supply by:
b. Activating topside Secondary air supply, or
c. Diver goes on bailout bottle, or
d. Put constant purge on Diver's pneumo hose then have Diver insert the hose into helmet/mask.
e. Alert Standby Diver.
f. Diver goes to descent line or stage.
g. If required, deploy Standby Diver for assistance.
h. Terminate dive.

13. Loss of communications

a. Use line-pull signals at once. Depth, current, bottom or work site conditions may interfere.
b. Check for rising bubbles of air.
c. A cessation or marked decrease of bubbles could be a sign of trouble.
d. Listen for sounds from the diving helmet. If no sound is heard, the circuit may be out of order.
e. If the flow of bubbles seems normal, the diver may be all right.
f. If sounds are heard and the diver does not respond to signals, assume the diver is in trouble.
g. Have divers already on the bottom investigate, or send down the standby diver to do so.

WARNING If only one diver is in the water and no response is received from the diver.
The possibility of contaminated breathing supply should be considered
and a shift to secondary may be required.

h. Bring Diver to first stop or surface once line-pull signals are established.
i. Terminate dive.

14. Injured Diver in Water

a. Diver informs Dive Control of injury and dive is aborted.
b. Alert and prepare standby diver; prepare to deploy.
c. Diver reports nature and extent of injury.
d. If required, send standby diver to assist diver; standby diver should remain with diver.
e. Monitoring breathing. If necessary, standby diver opens diver's free-flow. If breathing stops, overpressure diver's regulator.
f. Standby diver assists injured diver to surface, following proper decompression procedures, except when severity of injury indicates a greater risk than omitting decompression.
g. Institute planned diver recovery procedure.
h. Request required medical assistance and emergency evacuation, if required.

15. Diver Blow Up/Exceeded Ascent Rate to Surface

a. If a Diver appears on the surface unexpectedly, quickly determine if the Diver is okay.

b. Recover the Diver, and deploy Standby Diver if required.
c. Determine amount of decompression missed and treat accordingly.
d. Terminate the dive and recover all Divers. Monitor all Divers thorough clean time and one hour.

16. Diver Loss of Consciousness

a. Unconscious diver during dive
   i. Alert dive team and deploy Standby Diver if necessary.
   ii. Recover Diver to dive station and check for vital signs; administer CPR if required.
   iii. Notify emergency services and transport to recompression chamber.
   iv. Recompression treatment shall be started immediately. A Diver who surfaces unconscious and recovers when exposed to fresh air shall receive a neurological evaluation to rule out arterial gas embolism.

b. Unconscious diver on surface after dive:
   i. Notify emergency services and transport to recompression chamber.

   ii. Recompression treatment shall be started immediately. A Diver who surfaces unconscious and recovers when exposed to fresh air shall receive a neurological evaluation to rule out arterial gas embolism.

17. Injury/Illness of Topside Personnel with Diver in Water

a. Evaluate effect on Diver.
b. Inform Diver of problem and action planned if possible.
c. Alert Standby Diver.
d. Alert deck crew.
e. The Diving Supervisor will direct first Aid/CPR as necessary, determine the course of action, utilize the EAC, and terminate the dive if required.

Table 8.4 Emergency Line-Pull Signals

Signal	From Tender to Diver	From Diver to Tender
4-4-4 Pulls	**n/a**	***"Haul me up immediately"***
3-3-3 Pulls	**n/a**	***"I am fouled but can clear myself"***
2-2-2 Pulls	**n/a**	***"I am fouled and need assistance"***
4 Pulls	***"Come up."***	***"Haul me up."***
3 Pulls	***"Stand by to come up."***	***"Take up my slack."***
2 Pulls	***"Going down."*** **During ascent, 2 pulls mean *"You have come up to far; go back down until we stop you."***	***"Lower."*** **Or *"Give me slack."***
1 Pull	***"Are you all right?"*** **Or when diver is descending, 1 pull means *"Stop."***	***"I am all right."*** **When descending, 1 pull means *"Stop"* or *"I am on the bottom."***

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Appendix F: DIVE and TREATMENT TABLES

No-Decompression Limits and Repetitive Groups

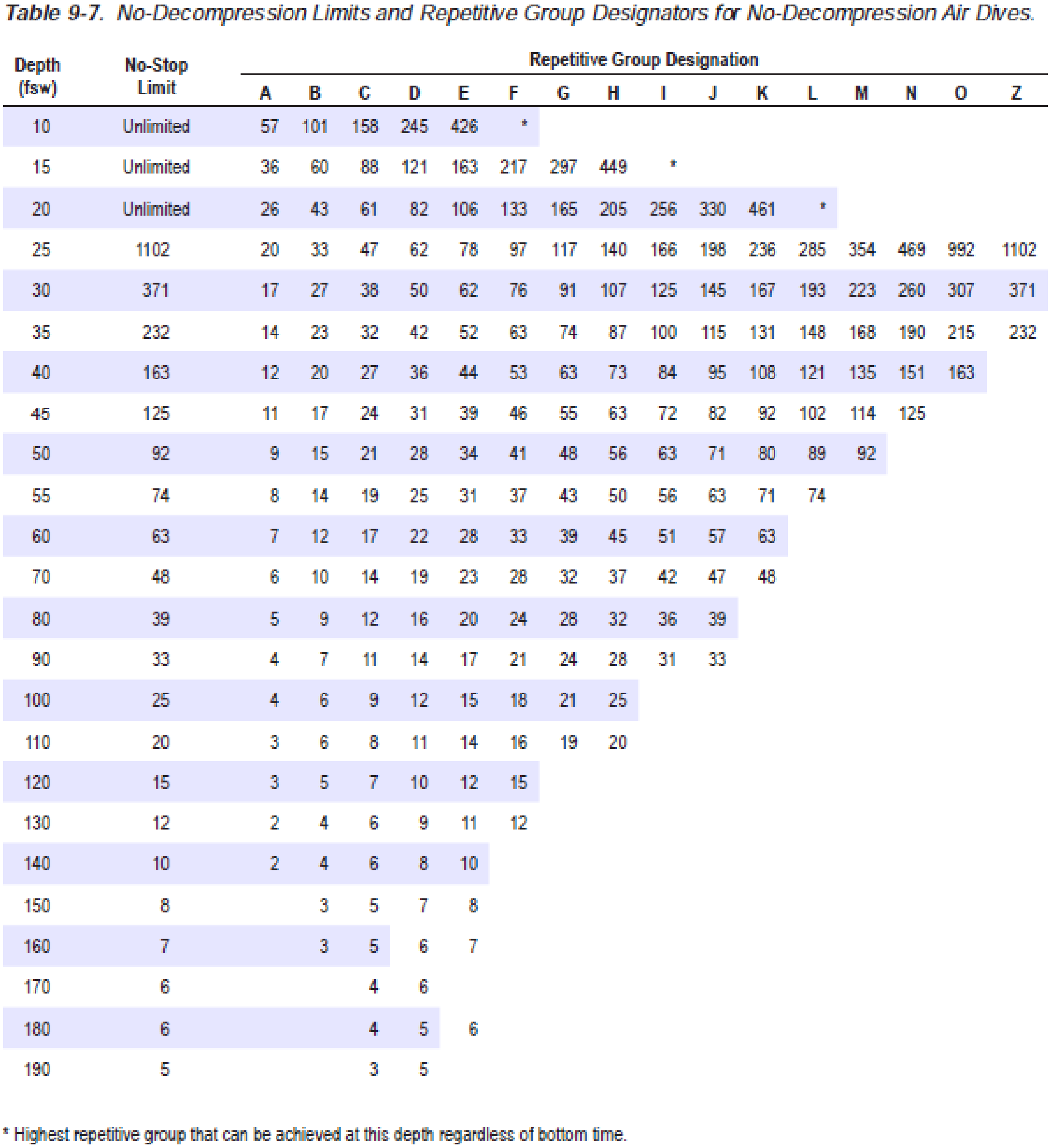


Table 9-7. No-Decompression Limits and Repetitive Group Designators for No-Decompression Air Dives.

Depth (fsw)	No-Stop Limit	Repetitive Group Designation															
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
10	Unlimited	57	101	158	245	426	*										
15	Unlimited	36	60	88	121	163	217	297	449	*							
20	Unlimited	26	43	61	82	106	133	165	205	256	330	461	*				
25	1102	20	33	47	62	78	97	117	140	166	198	236	285	354	469	992	1102
30	371	17	27	38	50	62	76	91	107	125	145	167	193	223	260	307	371
35	232	14	23	32	42	52	63	74	87	100	115	131	148	168	190	215	232
40	163	12	20	27	36	44	53	63	73	84	95	108	121	135	151	163	
45	125	11	17	24	31	39	46	55	63	72	82	92	102	114	125		
50	92	9	15	21	28	34	41	48	56	63	71	80	89	92			
55	74	8	14	19	25	31	37	43	50	56	63	71	74				
60	63	7	12	17	22	28	33	39	45	51	57	63					
70	48	6	10	14	19	23	28	32	37	42	47	48					
80	39	5	9	12	16	20	24	28	32	36	39						
90	33	4	7	11	14	17	21	24	28	31	33						
100	25	4	6	9	12	15	18	21	25								
110	20	3	6	8	11	14	16	19	20								
120	15	3	5	7	10	12	15										
130	12	2	4	6	9	11	12										
140	10	2	4	6	8	10											
150	8		3	5	7	8											
160	7		3	5	6	7											
170	6			4	6												
180	6			4	5	6											
190	5			3	5												

* Highest repetitive group that can be achieved at this depth regardless of bottom time.

Table 9-8. Residual Nitrogen Time Table for Repetitive Air Dives.

Locate the diver's repetitive group designation from his previous dive along the diagonal line above the table. Read horizontally to the interval in which the diver's surface interval lies.

Next, read vertically downward to the new repetitive group designation. Continue downward in this same column to the row that represents the depth of the repetitive dive. The time given at the intersection is residual nitrogen time, in minutes, to be applied to the repetitive dive.

* Dives following surface intervals longer than this are not repetitive dives. Use actual bottom times in the Air Decompression Tables to compute decompression for such dives.

Repetitive Group at Beginning of Surface Interval

	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
A																:10 2:20 *
B															:10 1:16	1:17 3:36 *
C														:10 :55	:56 2:11	2:12 4:31 *
D													:10 :52	:53 1:47	1:48 3:03	3:04 5:23 *
E												:10 :52	:53 1:44	1:45 2:39	2:40 3:55	3:56 6:15 *
F											:10 :52	:53 1:44	1:45 2:37	2:38 3:31	3:32 4:48	4:49 7:08 *
G										:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:23	4:24 5:40	5:41 8:00 *
H									:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:16	5:17 6:32	6:33 8:52 *
I								:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:08	6:09 7:24	7:25 9:44 *
J							:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 7:00	7:01 8:16	8:17 10:36 *
K						:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:52	7:53 9:09	9:10 11:29 *
L					:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:44	8:45 10:01	10:02 12:21 *
M				:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:37	9:38 10:53	10:54 13:13 *
N			:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:29	10:30 11:45	11:46 14:05 *
O		:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:21	11:22 12:37	12:38 14:58 *
Z	:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:19	11:20 12:13	12:14 13:30	13:31 15:50 *

Repetitive Group at the End of the Surface Interval

Dive Depth	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
10	**	**	**	**	**	**	**	**	**	**	**	427	246	159	101	58
15	**	**	**	**	**	**	**	**	450	298	218	164	122	89	61	37
20	**	**	**	**	**	462	331	257	206	166	134	106	83	62	44	27
25	†	†	470	354	286	237	198	167	141	118	98	79	63	48	34	21
30	372	308	261	224	194	168	146	126	108	92	77	63	51	39	28	18
35	245	216	191	169	149	132	116	101	88	75	64	53	43	33	24	15
40	188	169	152	136	122	109	97	85	74	64	55	45	37	29	21	13
45	154	140	127	115	104	93	83	73	64	56	48	40	32	25	18	12
50	131	120	109	99	90	81	73	65	57	49	42	35	29	23	17	11
55	114	105	96	88	80	72	65	58	51	44	38	32	26	20	15	10
60	101	93	86	79	72	65	58	52	46	40	35	29	24	19	14	9
70	83	77	71	65	59	54	49	44	39	34	29	25	20	16	12	8
80	70	65	60	55	51	46	42	38	33	29	25	22	18	14	10	7
90	61	57	52	48	44	41	37	33	29	26	22	19	16	12	9	6
100	54	50	47	43	40	36	33	30	26	23	20	17	14	11	8	5
110	48	45	42	39	36	33	30	27	24	21	18	16	13	10	8	5
120	44	41	38	35	32	30	27	24	22	19	17	14	12	9	7	5
130	40	37	35	32	30	27	25	22	20	18	15	13	11	9	6	4
140	37	34	32	30	27	25	23	21	19	16	14	12	10	8	6	4
150	34	32	30	28	26	23	21	19	17	15	13	11	9	8	6	4
160	32	30	28	26	24	22	20	18	16	14	13	11	9	7	5	4
170	30	28	26	24	22	21	19	17	15	14	12	10	8	7	5	3
180	28	26	25	23	21	19	18	16	14	13	11	10	8	6	5	3
190	26	25	23	22	20	18	17	15	14	12	11	9	8	6	5	3

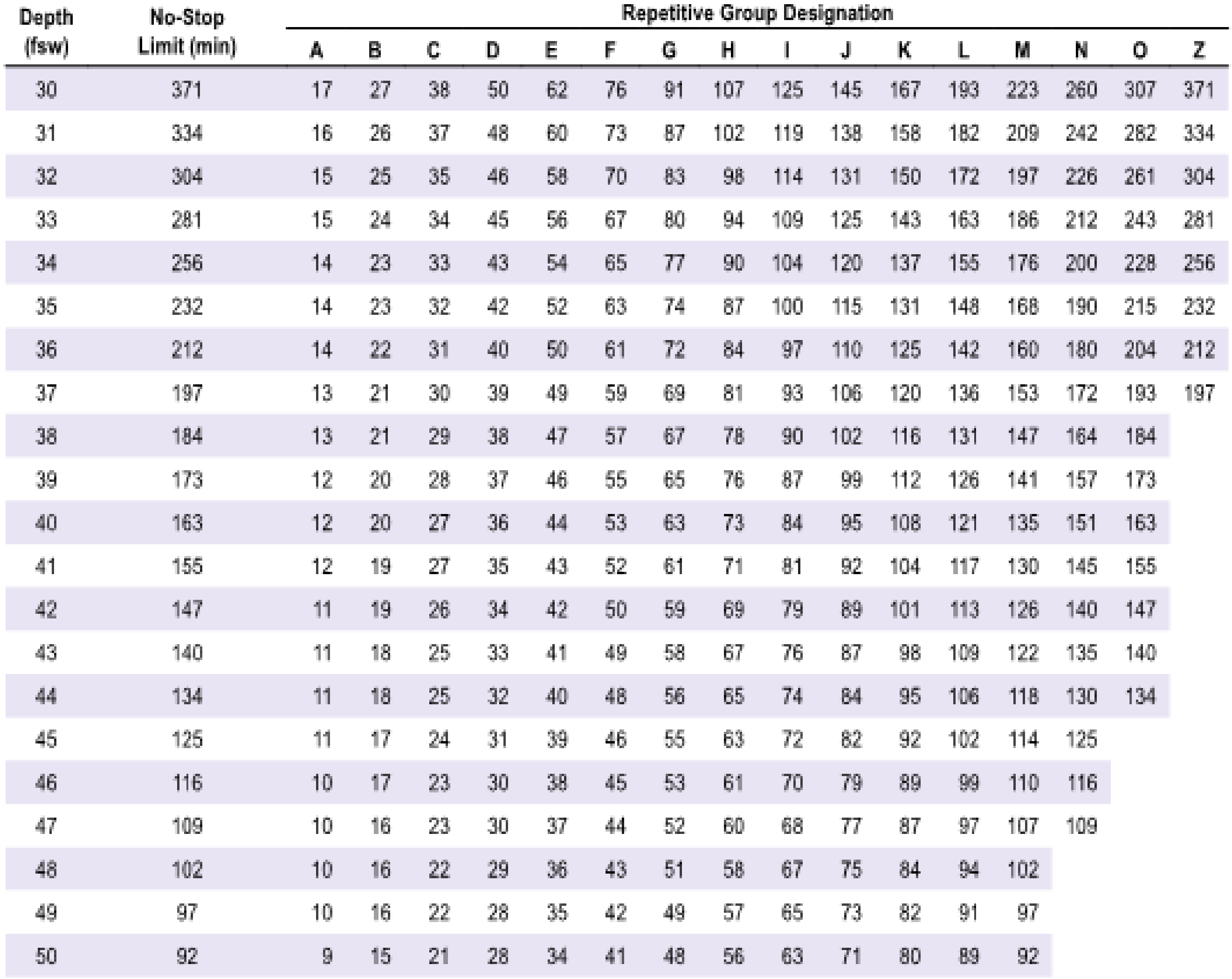
Residual Nitrogen Times (Minutes)

** Residual Nitrogen Time cannot be determined using this table (see paragraph 9-9.1 subparagraph 8 for instructions).

† Read vertically downward to the 30 fsw repetitive dive depth. Use the corresponding residual nitrogen times to compute the equivalent single dive time. Decompress using the 30 fsw air decompression table.

No-Decompression Limit and Repetitive Group for Shallow Water Dives

Table 2A-1. *No-Decompression Limits and Repetitive Group Designators for Shallow Water Air No-Decompression Dives.*



Depth (fsw)	No-Stop Limit (min)	Repetitive Group Designation															
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
30	371	17	27	38	50	62	76	91	107	125	145	167	193	223	260	307	371
31	334	16	26	37	48	60	73	87	102	119	138	158	182	209	242	282	334
32	304	15	25	35	46	58	70	83	98	114	131	150	172	197	226	261	304
33	281	15	24	34	45	56	67	80	94	109	125	143	163	186	212	243	281
34	256	14	23	33	43	54	65	77	90	104	120	137	155	176	200	228	256
35	232	14	23	32	42	52	63	74	87	100	115	131	148	168	190	215	232
36	212	14	22	31	40	50	61	72	84	97	110	125	142	160	180	204	212
37	197	13	21	30	39	49	59	69	81	93	106	120	136	153	172	193	197
38	184	13	21	29	38	47	57	67	78	90	102	116	131	147	164	184	
39	173	12	20	28	37	46	55	65	76	87	99	112	126	141	157	173	
40	163	12	20	27	36	44	53	63	73	84	95	108	121	135	151	163	
41	155	12	19	27	35	43	52	61	71	81	92	104	117	130	145	155	
42	147	11	19	26	34	42	50	59	69	79	89	101	113	126	140	147	
43	140	11	18	25	33	41	49	58	67	76	87	98	109	122	135	140	
44	134	11	18	25	32	40	48	56	65	74	84	95	106	118	130	134	
45	125	11	17	24	31	39	46	55	63	72	82	92	102	114	125		
46	116	10	17	23	30	38	45	53	61	70	79	89	99	110	116		
47	109	10	16	23	30	37	44	52	60	68	77	87	97	107	109		
48	102	10	16	22	29	36	43	51	58	67	75	84	94	102			
49	97	10	16	22	28	35	42	49	57	65	73	82	91	97			
50	92	9	15	21	28	34	41	48	56	63	71	80	89	92			

Table 2A-2. *Residual Nitrogen Time Table for Repetitive Shallow Water Air Dives.*

Locate the diver's repetitive group designation from his previous dive along the diagonal line above the table. Read horizontally to the interval in which the diver's surface interval lies.

Next, read vertically downward to the new repetitive group designation. Continue downward in this same column to the row that represents the depth of the repetitive dive. The time given at the intersection is residual nitrogen time, in minutes, to be applied to the repetitive dive.

* Dives following surface intervals longer than this are not repetitive dives. Use actual bottom times in the Air Decompression Tables to compute decompression for such dives.

Repetitive Group at Beginning of Surface Interval	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
A																:10 2:20 *
B															:10 1:16	1:17 3:36 *
C														:10 :55	:56 2:11	2:12 4:31 *
D													:10 :52	:53 1:47	1:48 3:03	3:04 5:23 *
E												:10 :52	:53 1:44	1:45 2:39	2:40 3:55	3:56 6:15 *
F											:10 :52	:53 1:44	1:45 2:37	2:38 3:31	3:32 4:48	4:49 7:08 *
G										:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:23	4:24 5:40	5:41 8:00 *
H									:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:16	5:17 6:32	6:33 8:52 *
I								:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:08	6:09 7:24	7:25 9:44 *
J							:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 7:00	7:01 8:16	8:17 10:36 *
K						:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:52	7:53 9:09	9:10 11:29 *
L					:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:44	8:45 10:01	10:02 12:21 *
M				:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:37	9:38 10:53	10:54 13:13 *
N			:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:29	10:30 11:45	11:46 14:05 *
O		:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:21	11:22 12:37	12:38 14:58 *
Z	:10 :52	:53 1:44	1:45 2:37	2:38 3:29	3:30 4:21	4:22 5:13	5:14 6:06	6:07 6:58	6:59 7:50	7:51 8:42	8:43 9:34	9:35 10:27	10:28 11:19	11:20 12:13	12:14 13:30	13:31 15:50 *

Repetitive Group at the End of the Surface Interval

Dive Depth	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
30	372	308	261	224	194	168	146	126	108	92	77	63	51	39	28	18
31	334	282	243	210	183	159	139	120	103	88	74	61	49	38	27	17
32	306	262	227	198	173	151	132	115	99	85	71	59	47	36	26	17
33	282	244	213	187	164	144	126	110	95	81	69	57	46	35	25	16
34	262	229	201	177	156	138	121	105	91	78	66	55	44	34	25	16
35	245	216	191	169	149	132	116	101	88	75	64	53	43	33	24	15
36	231	204	181	161	143	126	111	98	85	73	62	51	41	32	23	15
37	218	194	173	154	137	122	107	94	82	70	60	50	40	31	23	14
38	207	185	165	148	132	117	103	91	79	68	58	48	39	30	22	14
39	197	177	158	142	127	113	100	88	77	66	56	47	38	29	21	14
40	188	169	152	136	122	109	97	85	74	64	55	45	37	29	21	13
41	180	163	146	132	118	105	93	82	72	62	53	44	36	28	20	13
42	173	156	141	127	114	102	91	80	70	61	52	43	35	27	20	13
43	166	150	136	123	110	99	88	78	68	59	50	42	34	26	19	12
44	160	145	131	119	107	96	85	75	66	57	49	41	33	26	19	12
45	154	140	127	115	104	93	83	73	64	56	48	40	32	25	18	12
46	149	136	123	111	101	90	81	71	63	54	46	39	32	25	18	12
47	144	131	119	108	98	88	78	70	61	53	45	38	31	24	18	11
48	139	127	116	105	95	85	76	68	60	52	44	37	30	24	17	11
49	135	123	112	102	92	83	74	66	58	51	43	36	30	23	17	11
50	131	120	109	99	90	81	73	65	57	49	42	35	29	23	17	11

Residual Nitrogen Times (Minutes)

Repetitive Dive Worksheet

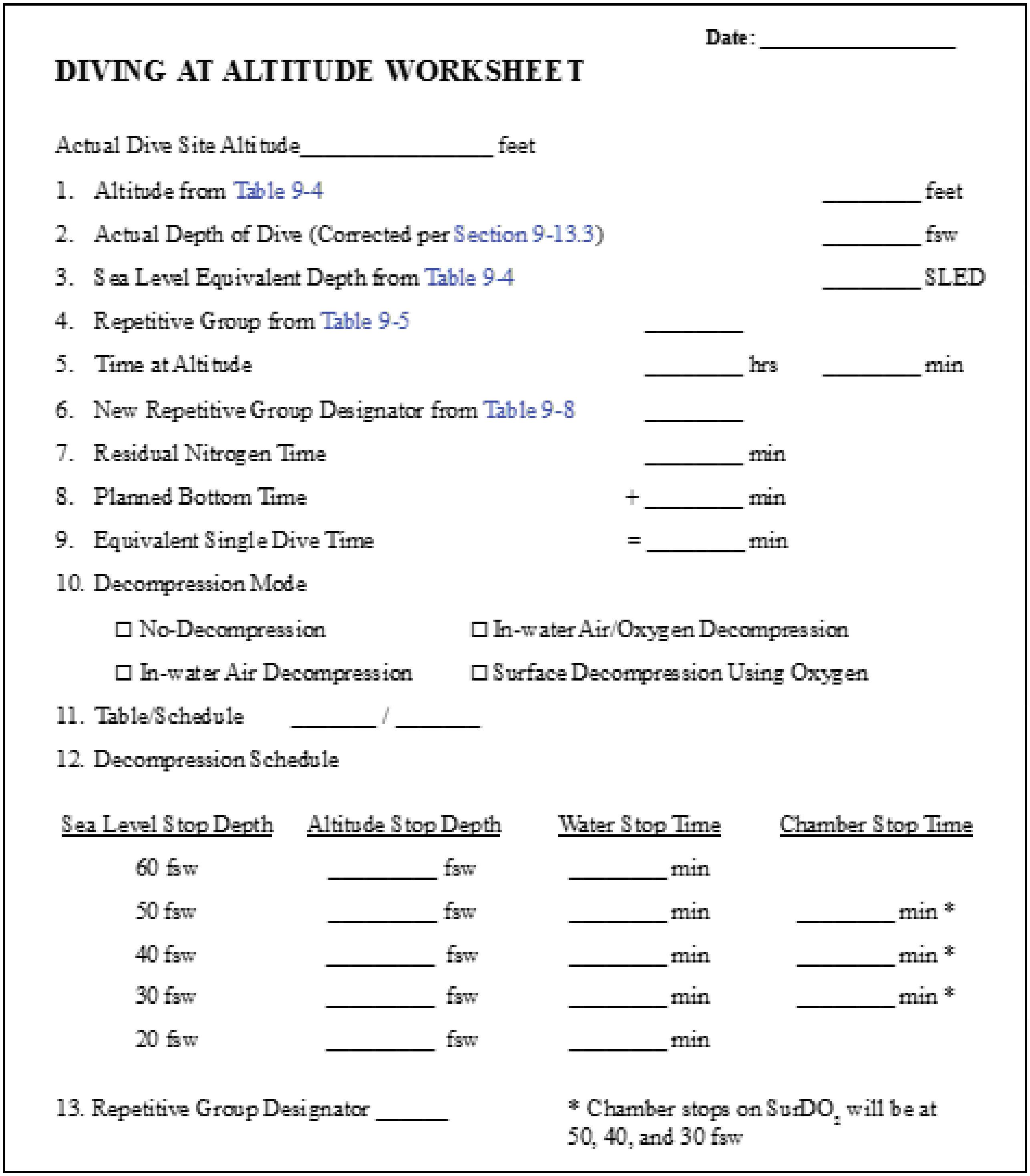
REPETITIVE DIVE WORKSHEET

Date:

1st DIVE							
Max Depth							
Bottom Time							
Table & Schedule						REPET Group	
Surface Interval						New Group	
2nd DIVE							
Max Depth			MD + ESDT = Table & Schedule				
Bottom Time	+	RNT	=	ESDT	=	Table & Schedule	REPET Group
	+		=		=		
Ensure the RNT Exception Rule does not apply							
Surface Interval						New Group	
3rd DIVE							
Max Depth			MD + ESDT = Table & Schedule				
Bottom Time	+	RNT	=	ESDT	=	Table & Schedule	REPET Group
	+		=		=		
Ensure the RNT Exception Rule does not apply							
Surface Interval						New Group	
4th DIVE							
Max Depth			MD + ESDT = Table & Schedule				
Bottom Time	+	RNT	=	ESDT	=	Table & Schedule	REPET Group
	+		=		=		
Ensure the RNT Exception Rule does not apply							
Surface Interval						New Group	

Figure 9-9. Repetitive Dive Worksheet.

Diving at Altitude Worksheet and Equivalency Tables



Date: ________________

DIVING AT ALTITUDE WORKSHEET

Actual Dive Site Altitude ________________ feet

1. Altitude from Table 9-4 ________ feet
2. Actual Depth of Dive (Corrected per Section 9-13.3) ________ fsw
3. Sea Level Equivalent Depth from Table 9-4 ________ SLED
4. Repetitive Group from Table 9-5 ________
5. Time at Altitude ________ hrs ________ min
6. New Repetitive Group Designator from Table 9-8 ________
7. Residual Nitrogen Time ________ min
8. Planned Bottom Time + ________ min
9. Equivalent Single Dive Time = ________ min
10. Decompression Mode

☐ No-Decompression

☐ In-water Air Decompression

☐ In-water Air/Oxygen Decompression

☐ Surface Decompression Using Oxygen

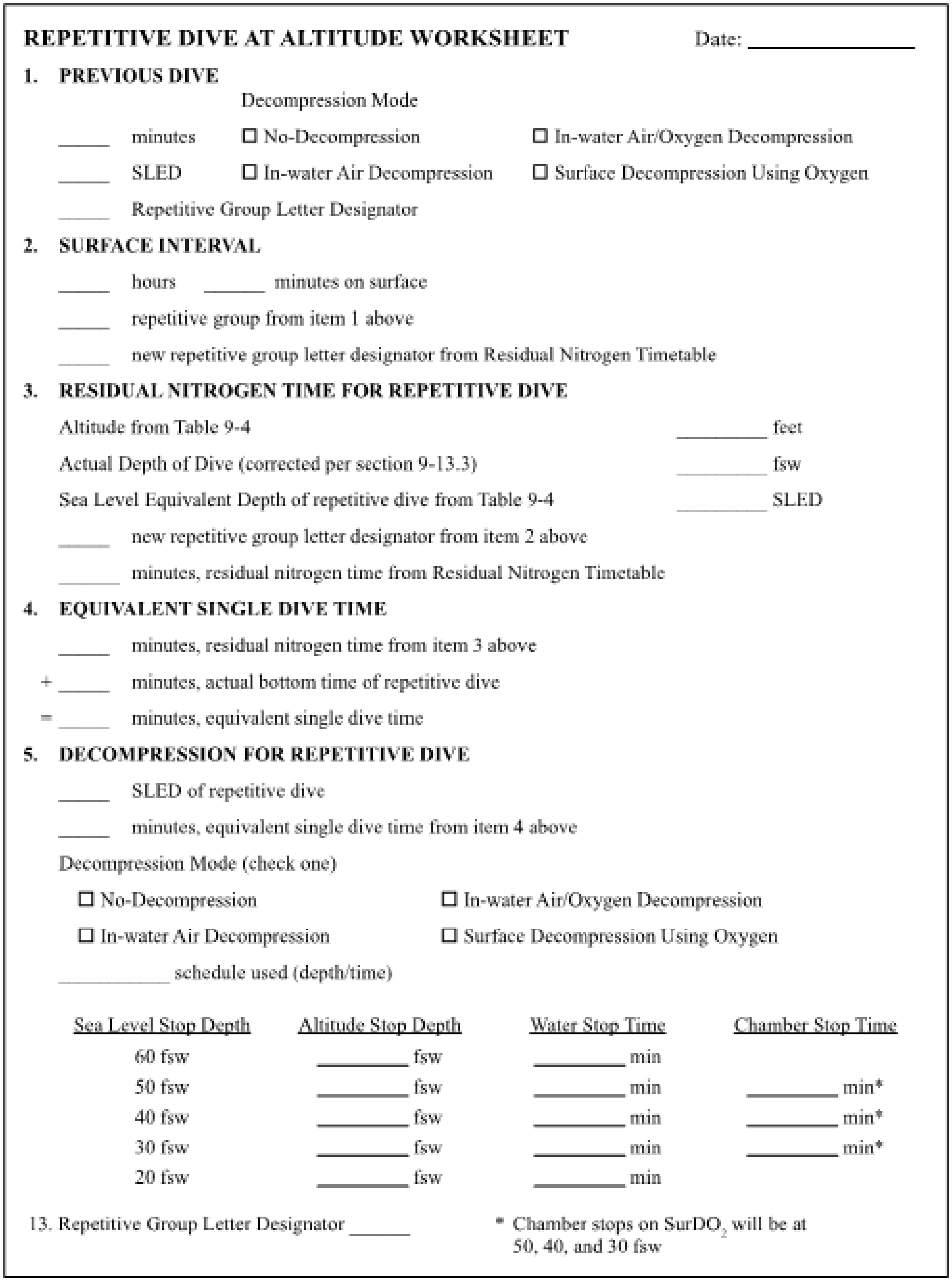
11. Table/Schedule ________ / ________
12. Decompression Schedule

Sea Level Stop Depth	Altitude Stop Depth	Water Stop Time	Chamber Stop Time
60 fsw	________ fsw	________ min	
50 fsw	________ fsw	________ min	________ min *
40 fsw	________ fsw	________ min	________ min *
30 fsw	________ fsw	________ min	________ min *
20 fsw	________ fsw	________ min	

13. Repetitive Group Designator ______

* Chamber stops on SurDO$_2$ will be at 50, 40, and 30 fsw

Figure 9-15. Diving at Altitude Worksheet



REPETITIVE DIVE AT ALTITUDE WORKSHEET Date: ________________

1. PREVIOUS DIVE

Decompression Mode

_____ minutes ☐ No-Decompression ☐ In-water Air/Oxygen Decompression

_____ SLED ☐ In-water Air Decompression ☐ Surface Decompression Using Oxygen

_____ Repetitive Group Letter Designator

2. SURFACE INTERVAL

_____ hours ______ minutes on surface

_____ repetitive group from item 1 above

_____ new repetitive group letter designator from Residual Nitrogen Timetable

3. RESIDUAL NITROGEN TIME FOR REPETITIVE DIVE

Altitude from Table 9-4 _________ feet

Actual Depth of Dive (corrected per section 9-13.3) _________ fsw

Sea Level Equivalent Depth of repetitive dive from Table 9-4 _________ SLED

_____ new repetitive group letter designator from item 2 above

______ minutes, residual nitrogen time from Residual Nitrogen Timetable

4. EQUIVALENT SINGLE DIVE TIME

_____ minutes, residual nitrogen time from item 3 above

\+ _____ minutes, actual bottom time of repetitive dive

= _____ minutes, equivalent single dive time

5. DECOMPRESSION FOR REPETITIVE DIVE

_____ SLED of repetitive dive

_____ minutes, equivalent single dive time from item 4 above

Decompression Mode (check one)

☐ No-Decompression ☐ In-water Air/Oxygen Decompression

☐ In-water Air Decompression ☐ Surface Decompression Using Oxygen

___________ schedule used (depth/time)

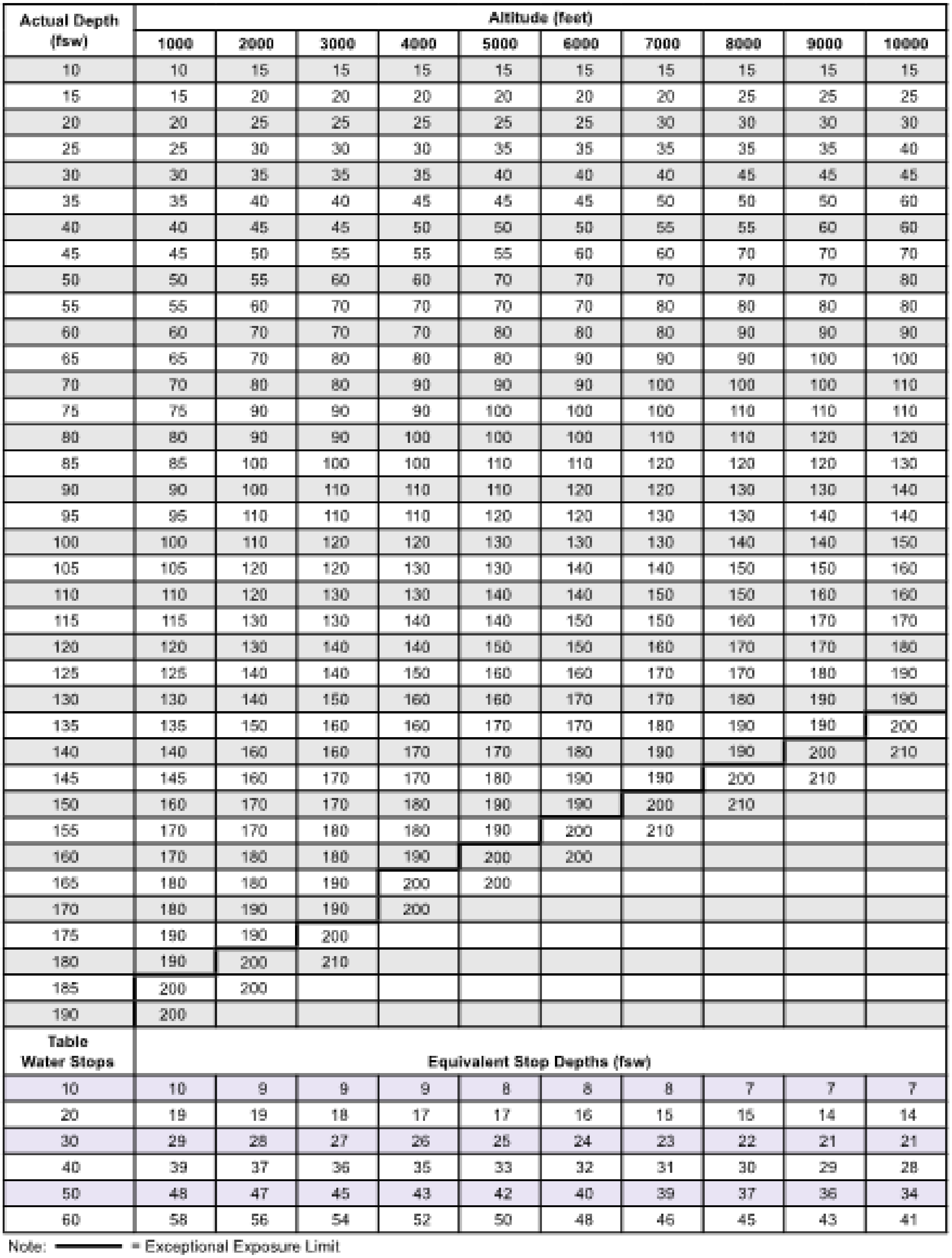
Sea Level Stop Depth	Altitude Stop Depth	Water Stop Time	Chamber Stop Time
60 fsw	_________ fsw	_________ min	
50 fsw	_________ fsw	_________ min	_________ min*
40 fsw	_________ fsw	_________ min	_________ min*
30 fsw	_________ fsw	_________ min	_________ min*
20 fsw	_________ fsw	_________ min	

13. Repetitive Group Letter Designator ______

* Chamber stops on SurDO$_2$ will be at 50, 40, and 30 fsw

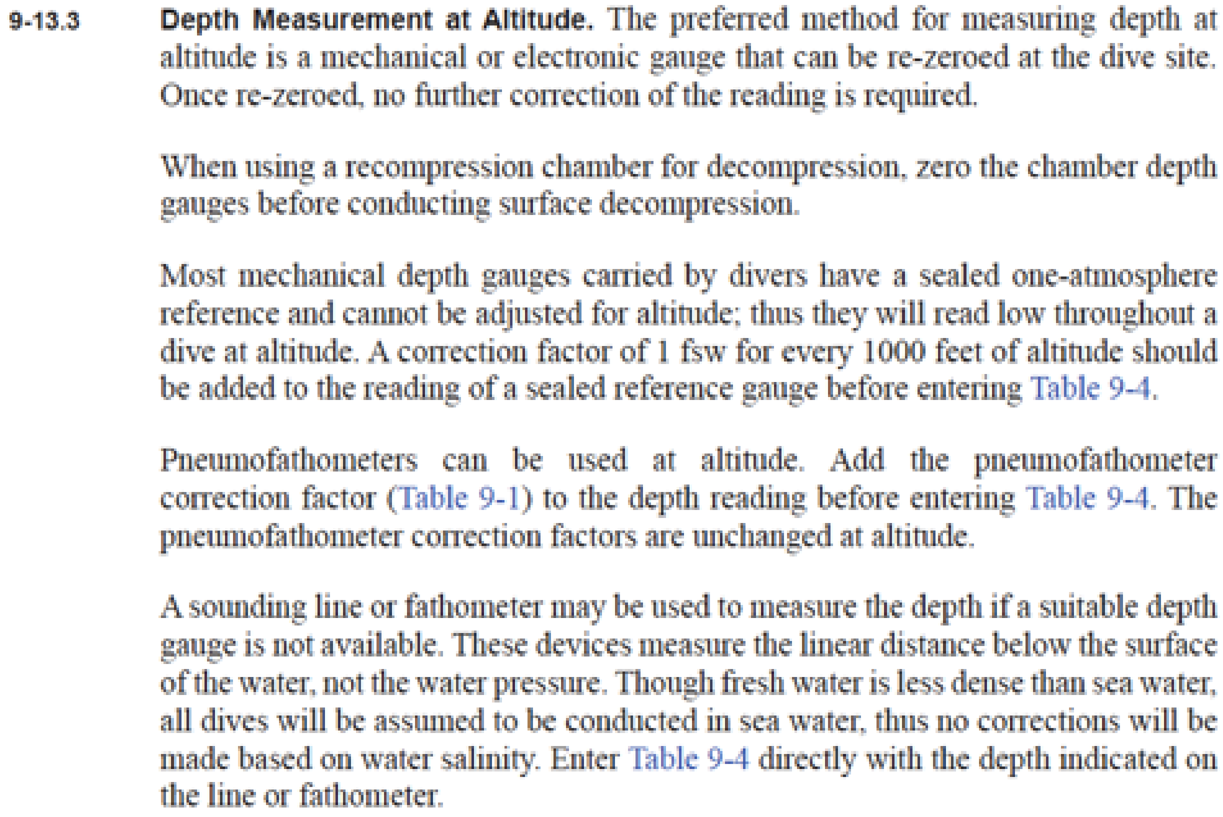
Figure 9-18. Repetitive Dive at Altitude Worksheet.

Table 9-4. *Sea Level Equivalent Depth (fsw).*



Actual Depth (fsw)	Altitude (feet)									
	1000	**2000**	**3000**	**4000**	**5000**	**6000**	**7000**	**8000**	**9000**	**10000**
10	10	15	15	15	15	15	15	15	15	15
15	15	20	20	20	20	20	20	25	25	25
20	20	25	25	25	25	25	30	30	30	30
25	25	30	30	30	35	35	35	35	35	40
30	30	35	35	35	40	40	40	45	45	45
35	35	40	40	45	45	45	50	50	50	60
40	40	45	45	50	50	50	55	55	60	60
45	45	50	55	55	55	60	60	70	70	70
50	50	55	60	60	70	70	70	70	70	80
55	55	60	70	70	70	70	80	80	80	80
60	60	70	70	70	80	80	80	90	90	90
65	65	70	80	80	80	90	90	90	100	100
70	70	80	80	90	90	90	100	100	100	110
75	75	90	90	90	100	100	100	110	110	110
80	80	90	90	100	100	100	110	110	120	120
85	85	100	100	100	110	110	120	120	120	130
90	90	100	110	110	110	120	120	130	130	140
95	95	110	110	110	120	120	130	130	140	140
100	100	110	120	120	130	130	130	140	140	150
105	105	120	120	130	130	140	140	150	150	160
110	110	120	130	130	140	140	150	150	160	160
115	115	130	130	140	140	150	150	160	170	170
120	120	130	140	140	150	150	160	170	170	180
125	125	140	140	150	160	160	170	170	180	190
130	130	140	150	160	160	170	170	180	190	190
135	135	150	160	160	170	170	180	190	190	200
140	140	160	160	170	170	180	190	190	200	210
145	145	160	170	170	180	190	190	200	210	
150	160	170	170	180	190	190	200	210		
155	170	170	180	180	190	200	210			
160	170	180	180	190	200	200				
165	180	180	190	200	200					
170	180	190	190	200						
175	190	190	200							
180	190	200	210							
185	200	200								
190	200									
Table Water Stops	**Equivalent Stop Depths (fsw)**									
10	10	9	9	9	8	8	8	7	7	7
20	19	19	18	17	17	16	15	15	14	14
30	29	28	27	26	25	24	23	22	21	21
40	39	37	36	35	33	32	31	30	29	28
50	48	47	45	43	42	40	39	37	36	34
60	58	56	54	52	50	48	46	45	43	41

Note: ——— = Exceptional Exposure Limit



9-13.3 **Depth Measurement at Altitude.** The preferred method for measuring depth at altitude is a mechanical or electronic gauge that can be re-zeroed at the dive site. Once re-zeroed, no further correction of the reading is required.

When using a recompression chamber for decompression, zero the chamber depth gauges before conducting surface decompression.

Most mechanical depth gauges carried by divers have a sealed one-atmosphere reference and cannot be adjusted for altitude; thus they will read low throughout a dive at altitude. A correction factor of 1 fsw for every 1000 feet of altitude should be added to the reading of a sealed reference gauge before entering Table 9-4.

Pneumofathometers can be used at altitude. Add the pneumofathometer correction factor (Table 9-1) to the depth reading before entering Table 9-4. The pneumofathometer correction factors are unchanged at altitude.

A sounding line or fathometer may be used to measure the depth if a suitable depth gauge is not available. These devices measure the linear distance below the surface of the water, not the water pressure. Though fresh water is less dense than sea water, all dives will be assumed to be conducted in sea water, thus no corrections will be made based on water salinity. Enter Table 9-4 directly with the depth indicated on the line or fathometer.

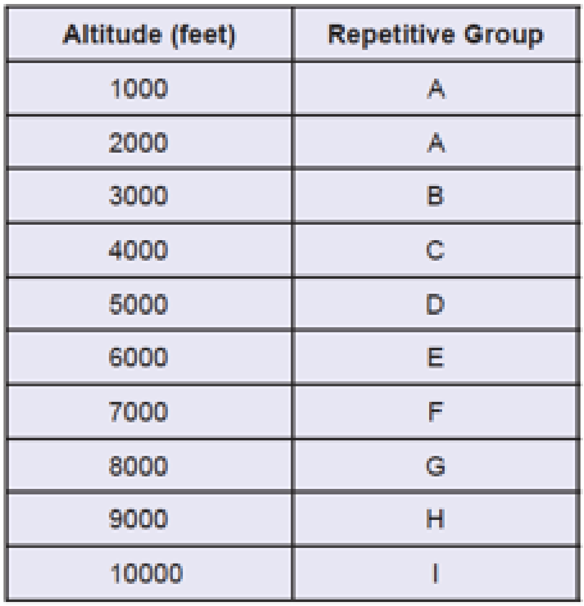
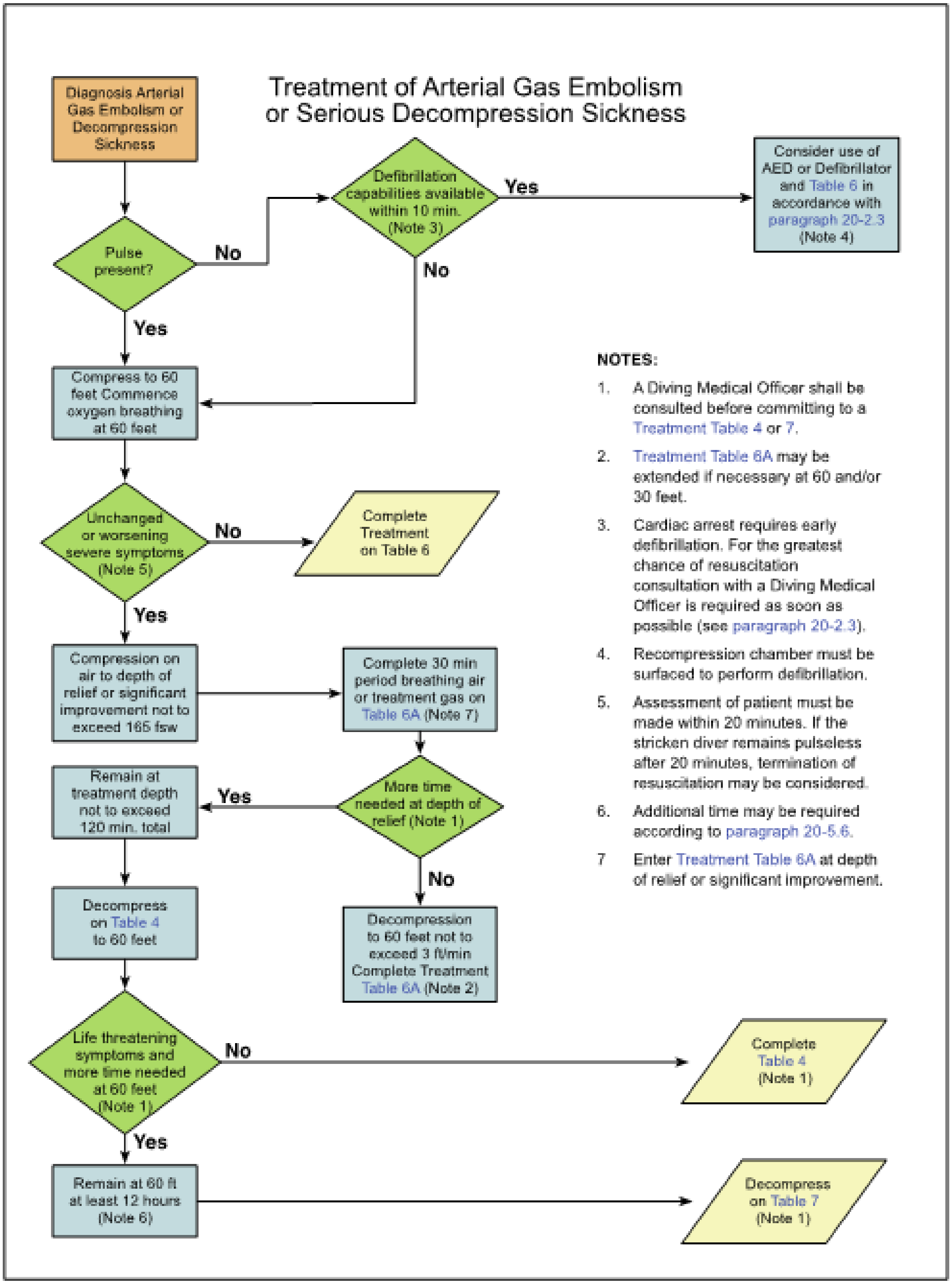


Table 9-5. *Repetitive Groups Associated with Initial Ascent to Altitude.*

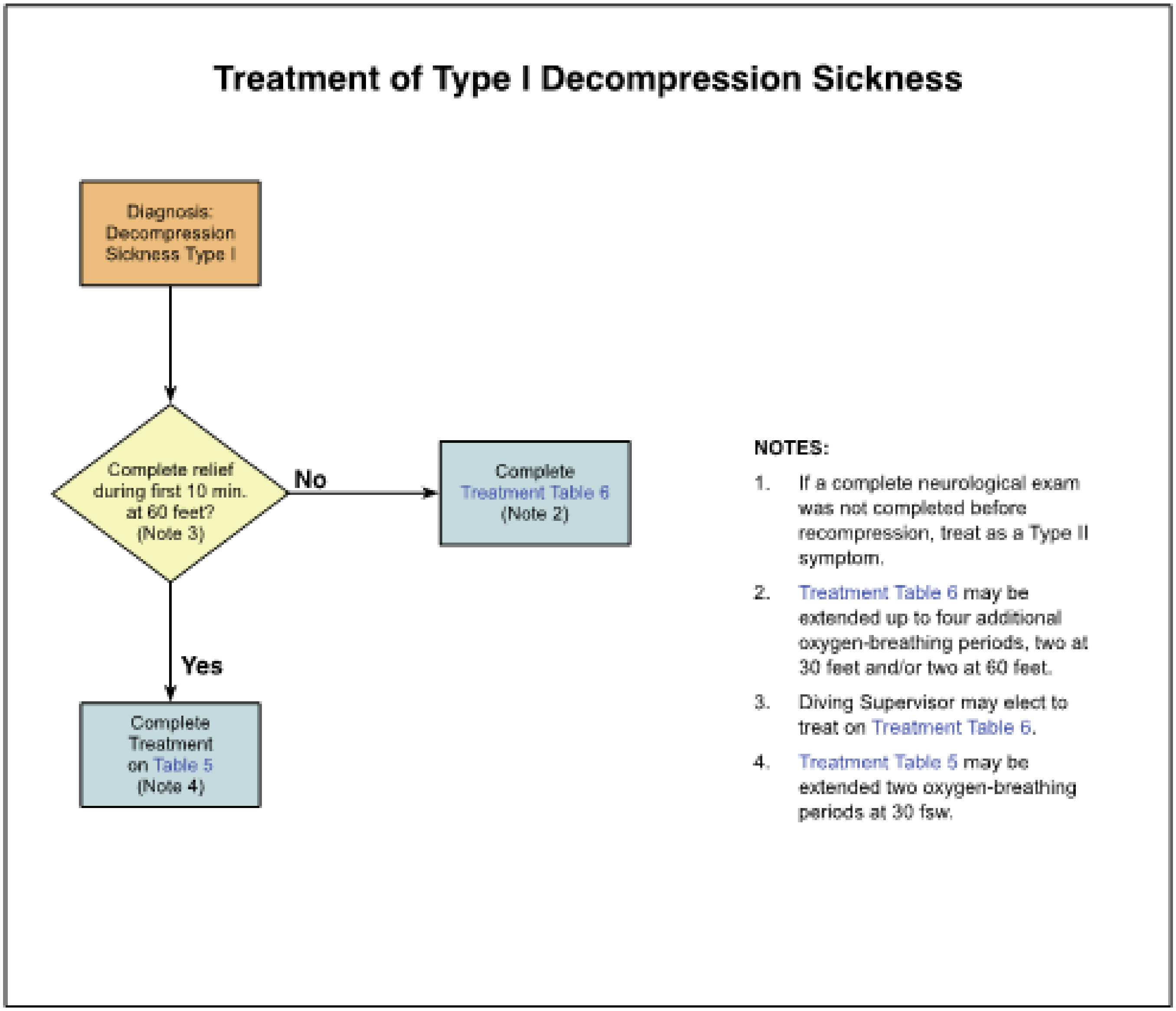
Altitude (feet)	Repetitive Group
1000	A
2000	A
3000	B
4000	C
5000	D
6000	E
7000	F
8000	G
9000	H
10000	I



NOTES:

1. A Diving Medical Officer shall be consulted before committing to a Treatment Table 4 or 7.
2. Treatment Table 6A may be extended if necessary at 60 and/or 30 feet.
3. Cardiac arrest requires early defibrillation. For the greatest chance of resuscitation consultation with a Diving Medical Officer is required as soon as possible (see paragraph 20-2.3).
4. Recompression chamber must be surfaced to perform defibrillation.
5. Assessment of patient must be made within 20 minutes. If the stricken diver remains pulseless after 20 minutes, termination of resuscitation may be considered.
6. Additional time may be required according to paragraph 20-5.6.
7. Enter Treatment Table 6A at depth of relief or significant improvement.

Figure 20-1. Treatment of Arterial Gas Embolism or Serious Decompression Sickness.

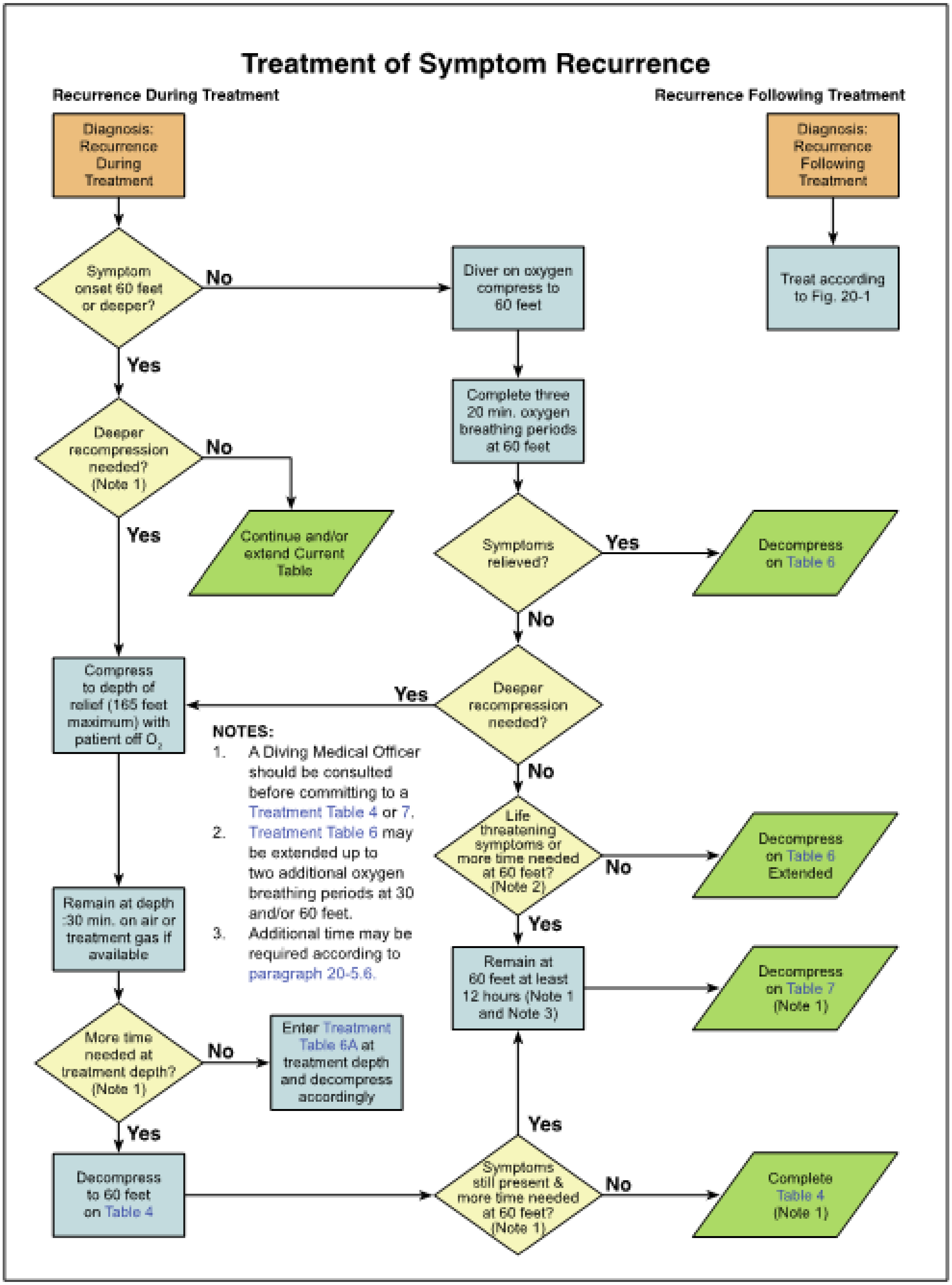


NOTES:

1. If a complete neurological exam was not completed before recompression, treat as a Type II symptom.
2. Treatment Table 6 may be extended up to four additional oxygen-breathing periods, two at 30 feet and/or two at 60 feet.
3. Diving Supervisor may elect to treat on Treatment Table 6.
4. Treatment Table 5 may be extended two oxygen-breathing periods at 30 fsw.

Figure 20-2. Treatment of Type I Decompression Sickness.

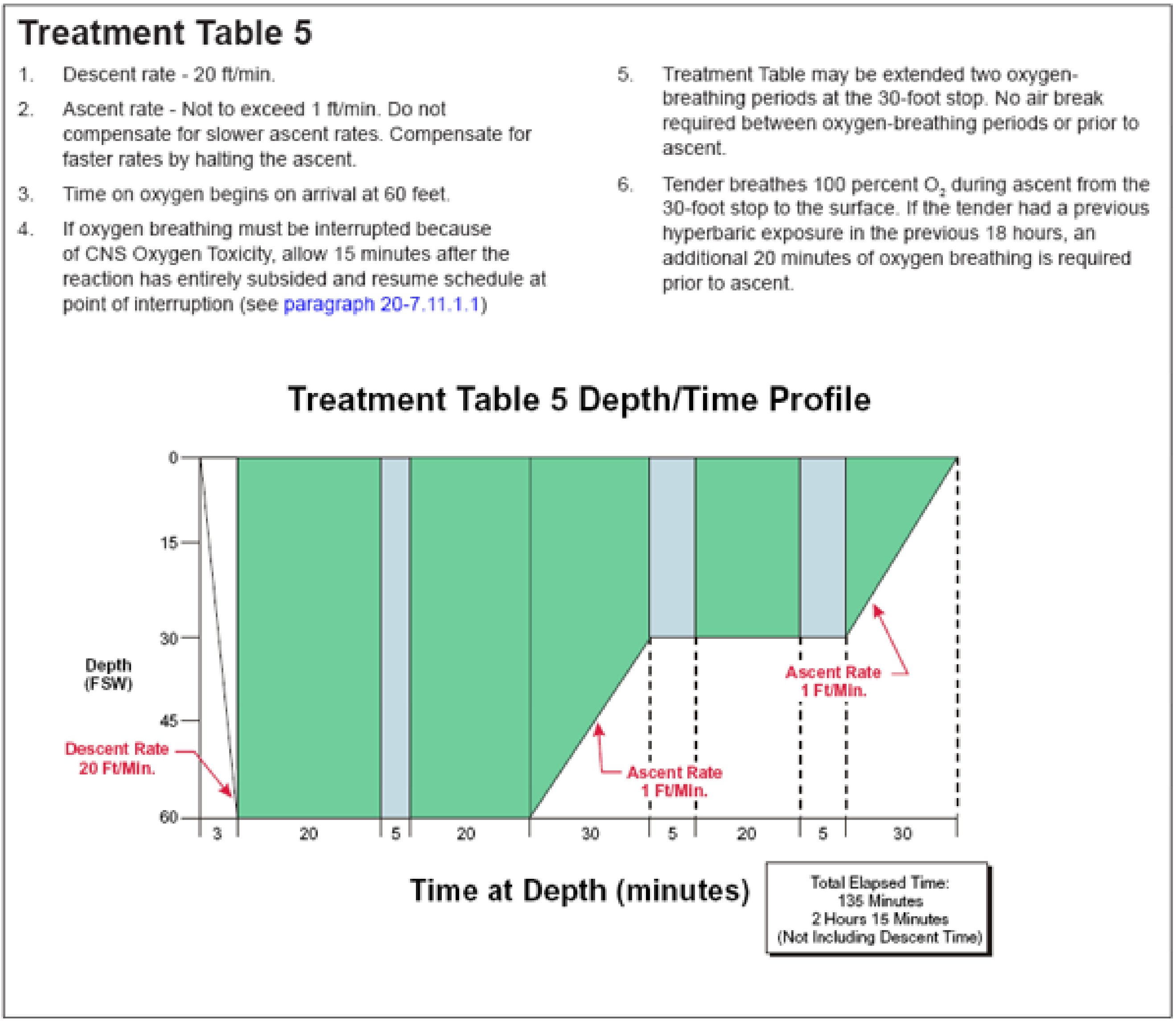
20-12.4.1 **Modification of Emergency Kits.** Because the available facilities may differ on board ship, at land-based diving installations, and at diver training or experimental units, the responsible Diving Medical Officer or Diving Medical Technician are authorized to augment the emergency kits to suit the local needs.



NOTES:

1. A Diving Medical Officer should be consulted before committing to a Treatment Table 4 or 7.
2. Treatment Table 6 may be extended up to two additional oxygen breathing periods at 30 and/or 60 feet.
3. Additional time may be required according to paragraph 20-5.6.

Figure 20-3. Treatment of Symptom Recurrence.



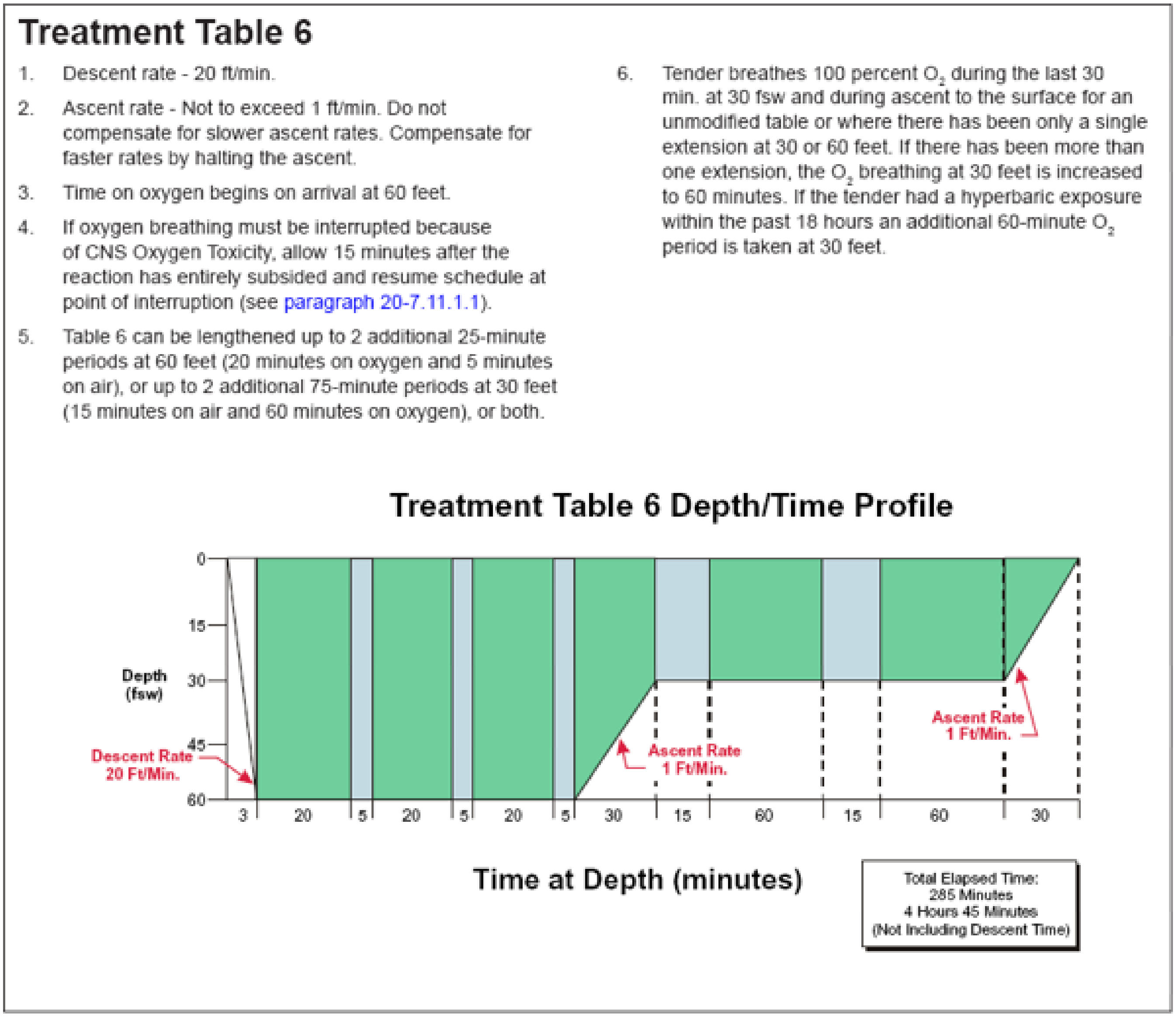
Treatment Table 5

1. Descent rate - 20 ft/min.
2. Ascent rate - Not to exceed 1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
3. Time on oxygen begins on arrival at 60 feet.
4. If oxygen breathing must be interrupted because of CNS Oxygen Toxicity, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption (see paragraph 20-7.11.1.1)
5. Treatment Table may be extended two oxygen-breathing periods at the 30-foot stop. No air break required between oxygen-breathing periods or prior to ascent.
6. Tender breathes 100 percent O_2 during ascent from the 30-foot stop to the surface. If the tender had a previous hyperbaric exposure in the previous 18 hours, an additional 20 minutes of oxygen breathing is required prior to ascent.

Treatment Table 5 Depth/Time Profile

Total Elapsed Time:
135 Minutes
2 Hours 15 Minutes
(Not Including Descent Time)

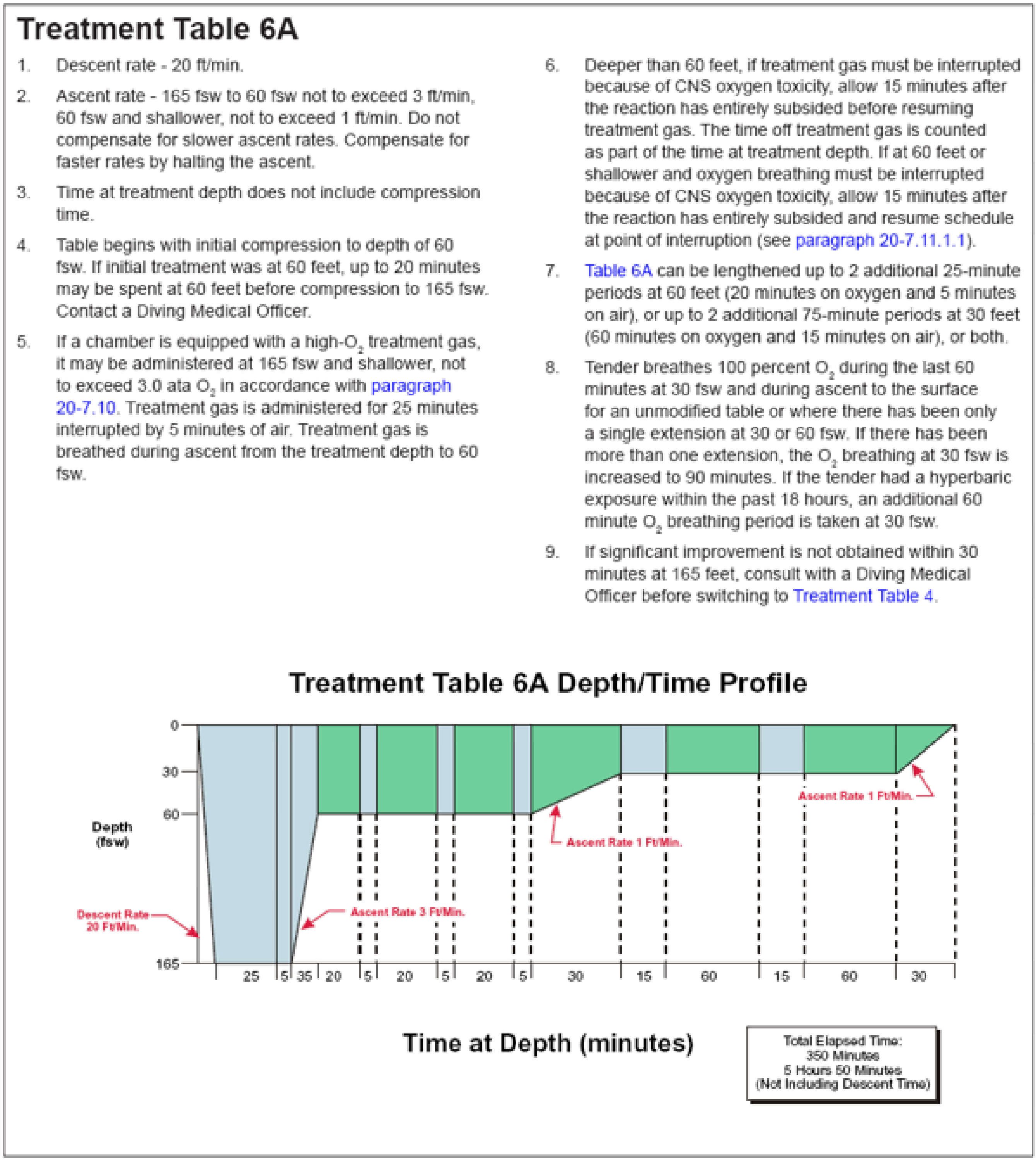
Figure 20-4. Treatment Table 5.



Treatment Table 6

1. Descent rate - 20 ft/min.
2. Ascent rate - Not to exceed 1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
3. Time on oxygen begins on arrival at 60 feet.
4. If oxygen breathing must be interrupted because of CNS Oxygen Toxicity, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption (see paragraph 20-7.11.1.1).
5. Table 6 can be lengthened up to 2 additional 25-minute periods at 60 feet (20 minutes on oxygen and 5 minutes on air), or up to 2 additional 75-minute periods at 30 feet (15 minutes on air and 60 minutes on oxygen), or both.
6. Tender breathes 100 percent O$_2$ during the last 30 min. at 30 fsw and during ascent to the surface for an unmodified table or where there has been only a single extension at 30 or 60 feet. If there has been more than one extension, the O$_2$ breathing at 30 feet is increased to 60 minutes. If the tender had a hyperbaric exposure within the past 18 hours an additional 60-minute O$_2$ period is taken at 30 feet.

Figure 20-5. Treatment Table 6.



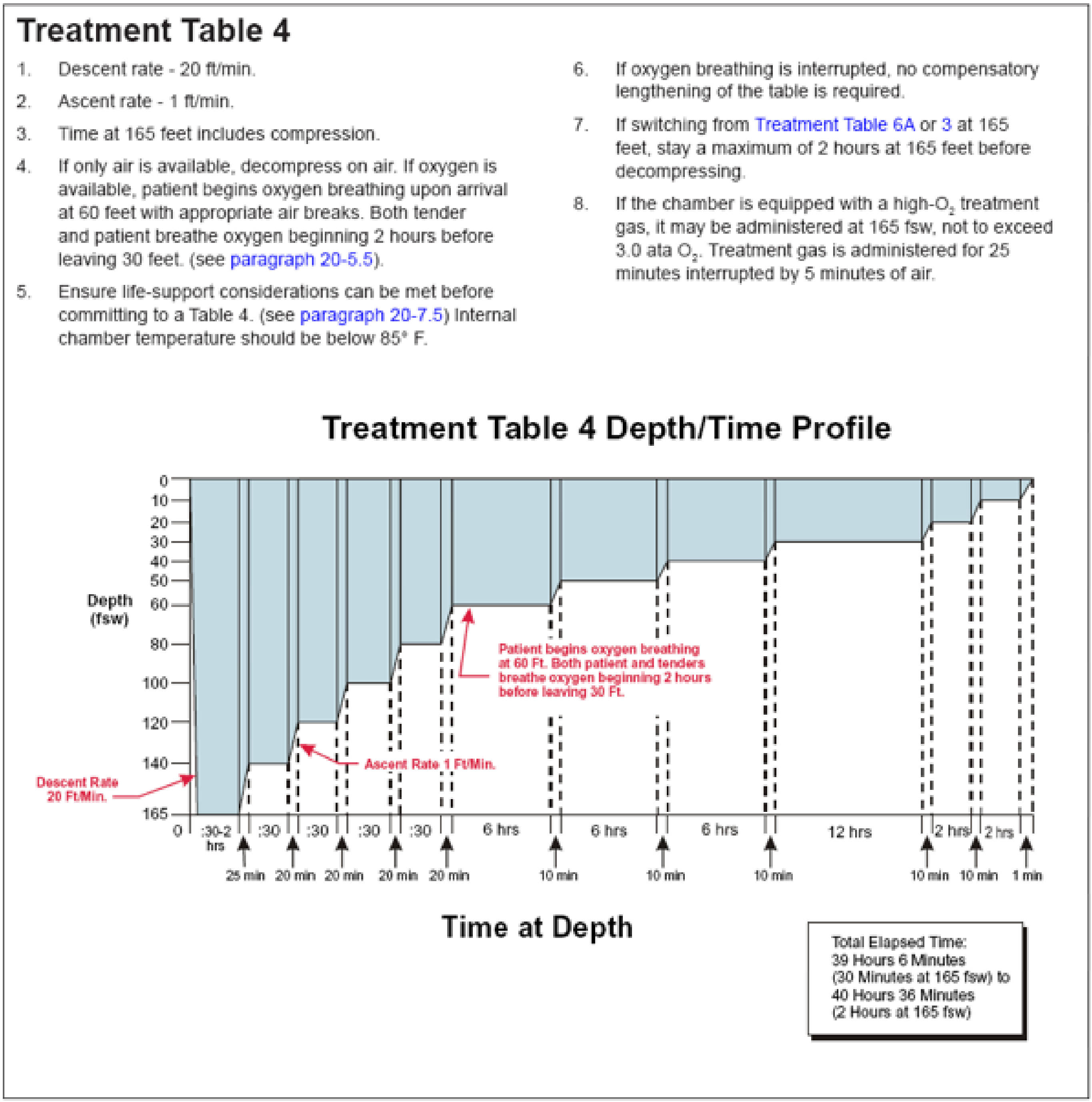
Treatment Table 6A

1. Descent rate - 20 ft/min.
2. Ascent rate - 165 fsw to 60 fsw not to exceed 3 ft/min, 60 fsw and shallower, not to exceed 1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
3. Time at treatment depth does not include compression time.
4. Table begins with initial compression to depth of 60 fsw. If initial treatment was at 60 feet, up to 20 minutes may be spent at 60 feet before compression to 165 fsw. Contact a Diving Medical Officer.
5. If a chamber is equipped with a high-O_2 treatment gas, it may be administered at 165 fsw and shallower, not to exceed 3.0 ata O_2 in accordance with paragraph 20-7.10. Treatment gas is administered for 25 minutes interrupted by 5 minutes of air. Treatment gas is breathed during ascent from the treatment depth to 60 fsw.
6. Deeper than 60 feet, if treatment gas must be interrupted because of CNS oxygen toxicity, allow 15 minutes after the reaction has entirely subsided before resuming treatment gas. The time off treatment gas is counted as part of the time at treatment depth. If at 60 feet or shallower and oxygen breathing must be interrupted because of CNS oxygen toxicity, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption (see paragraph 20-7.11.1.1).
7. Table 6A can be lengthened up to 2 additional 25-minute periods at 60 feet (20 minutes on oxygen and 5 minutes on air), or up to 2 additional 75-minute periods at 30 feet (60 minutes on oxygen and 15 minutes on air), or both.
8. Tender breathes 100 percent O_2 during the last 60 minutes at 30 fsw and during ascent to the surface for an unmodified table or where there has been only a single extension at 30 or 60 fsw. If there has been more than one extension, the O_2 breathing at 30 fsw is increased to 90 minutes. If the tender had a hyperbaric exposure within the past 18 hours, an additional 60 minute O_2 breathing period is taken at 30 fsw.
9. If significant improvement is not obtained within 30 minutes at 165 feet, consult with a Diving Medical Officer before switching to Treatment Table 4.

Treatment Table 6A Depth/Time Profile

Total Elapsed Time:
350 Minutes
5 Hours 50 Minutes
(Not Including Descent Time)

Figure 20-6. Treatment Table 6A.



Treatment Table 4

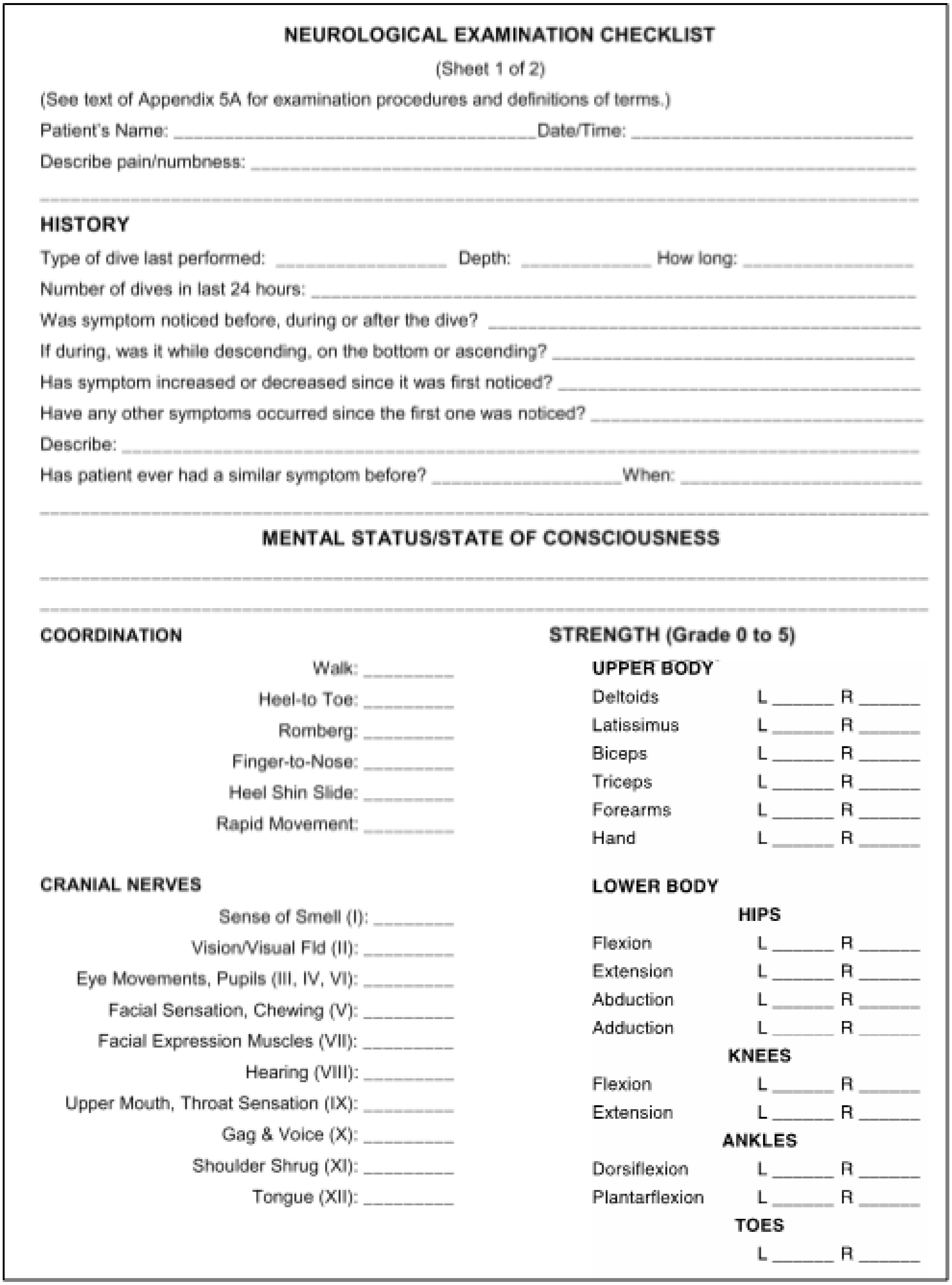
1. Descent rate - 20 ft/min.
2. Ascent rate - 1 ft/min.
3. Time at 165 feet includes compression.
4. If only air is available, decompress on air. If oxygen is available, patient begins oxygen breathing upon arrival at 60 feet with appropriate air breaks. Both tender and patient breathe oxygen beginning 2 hours before leaving 30 feet. (see paragraph 20-5.5).
5. Ensure life-support considerations can be met before committing to a Table 4. (see paragraph 20-7.5) Internal chamber temperature should be below 85° F.
6. If oxygen breathing is interrupted, no compensatory lengthening of the table is required.
7. If switching from Treatment Table 6A or 3 at 165 feet, stay a maximum of 2 hours at 165 feet before decompressing.
8. If the chamber is equipped with a high-O_2 treatment gas, it may be administered at 165 fsw, not to exceed 3.0 ata O_2. Treatment gas is administered for 25 minutes interrupted by 5 minutes of air.

Treatment Table 4 Depth/Time Profile

Total Elapsed Time:
39 Hours 6 Minutes
(30 Minutes at 165 fsw) to
40 Hours 36 Minutes
(2 Hours at 165 fsw)

Figure 20-7. Treatment Table 4.

Neurological Examination Checklist



NEUROLOGICAL EXAMINATION CHECKLIST

(Sheet 1 of 2)

(See text of Appendix 5A for examination procedures and definitions of terms.)

Patient's Name: ______________________ Date/Time: ______________________

Describe pain/numbness: ____

____

HISTORY

Type of dive last performed: ____________ Depth: __________ How long: ____________

Number of dives in last 24 hours: ____________________________________

Was symptom noticed before, during or after the dive? ______________________

If during, was it while descending, on the bottom or ascending? ______________________

Has symptom increased or decreased since it was first noticed? ______________________

Have any other symptoms occurred since the first one was noticed? ______________________

Describe: ____

Has patient ever had a similar symptom before? ____________ When: ______________

____

MENTAL STATUS/STATE OF CONSCIOUSNESS

____

____

COORDINATION

Walk: _________

Heel-to Toe: _________

Romberg: _________

Finger-to-Nose: _________

Heel Shin Slide: _________

Rapid Movement: _________

CRANIAL NERVES

Sense of Smell (I): _________

Vision/Visual Fld (II): _________

Eye Movements, Pupils (III, IV, VI): _________

Facial Sensation, Chewing (V): _________

Facial Expression Muscles (VII): _________

Hearing (VIII): _________

Upper Mouth, Throat Sensation (IX): _________

Gag & Voice (X): _________

Shoulder Shrug (XI): _________

Tongue (XII): _________

STRENGTH (Grade 0 to 5)

UPPER BODY

Deltoids L ______ R ______

Latissimus L ______ R ______

Biceps L ______ R ______

Triceps L ______ R ______

Forearms L ______ R ______

Hand L ______ R ______

LOWER BODY

HIPS

Flexion L ______ R ______

Extension L ______ R ______

Abduction L ______ R ______

Adduction L ______ R ______

KNEES

Flexion L ______ R ______

Extension L ______ R ______

ANKLES

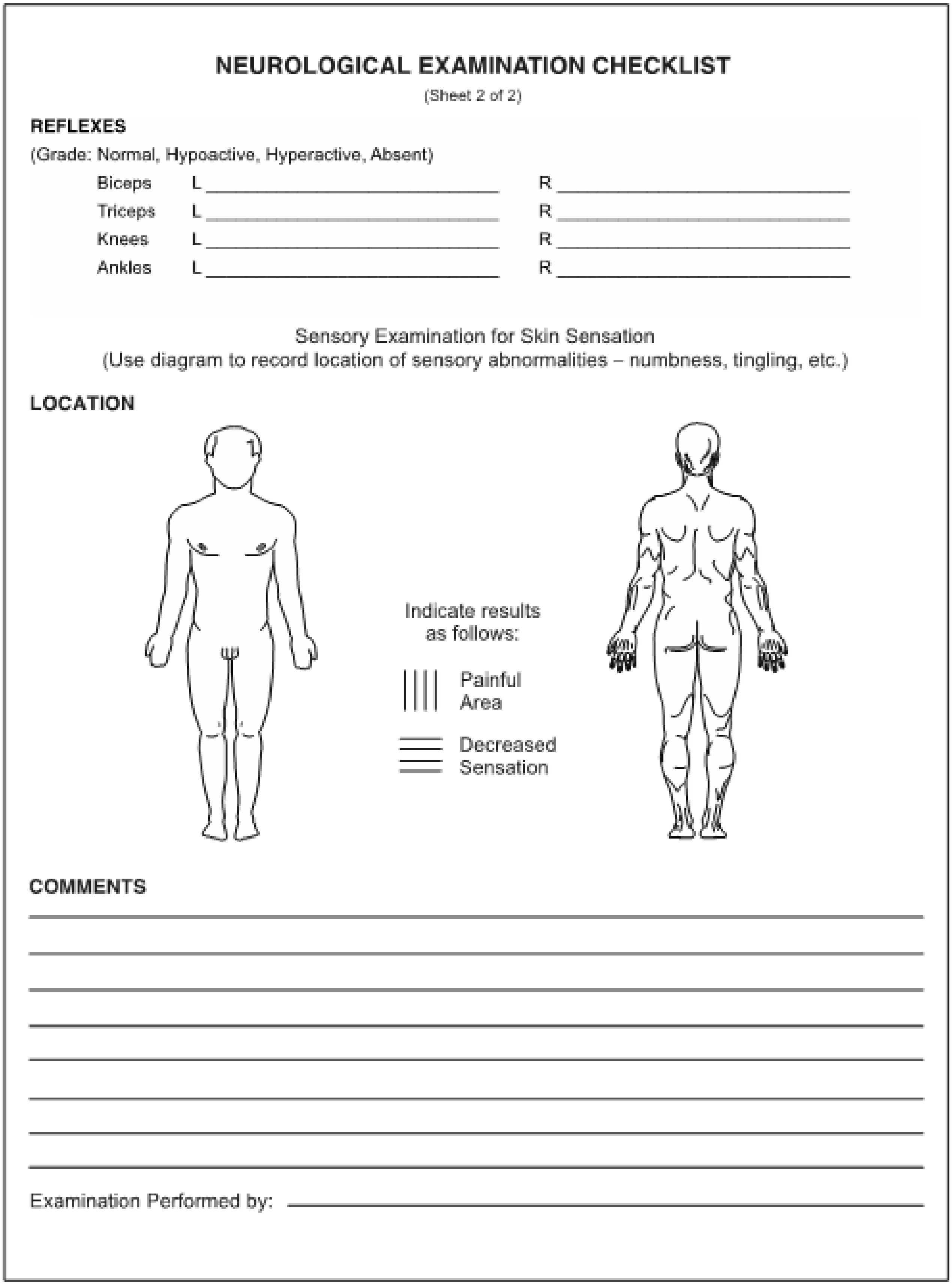
Dorsiflexion L ______ R ______

Plantarflexion L ______ R ______

TOES

L ______ R ______

Figure 5A-1a. Neurological Examination Checklist (sheet 1 of 2).



NEUROLOGICAL EXAMINATION CHECKLIST

(Sheet 2 of 2)

REFLEXES

(Grade: Normal, Hypoactive, Hyperactive, Absent)

Biceps L ______________________ R ______________________
Triceps L ______________________ R ______________________
Knees L ______________________ R ______________________
Ankles L ______________________ R ______________________

Sensory Examination for Skin Sensation
(Use diagram to record location of sensory abnormalities – numbness, tingling, etc.)

LOCATION

Indicate results as follows:

|||| Painful Area

≡ Decreased Sensation

COMMENTS

____
____
____
____
____
____
____
____

Examination Performed by: ______________________________________

Figure 5A-1b. Neurological Examination Checklist (sheet 2 of 2).

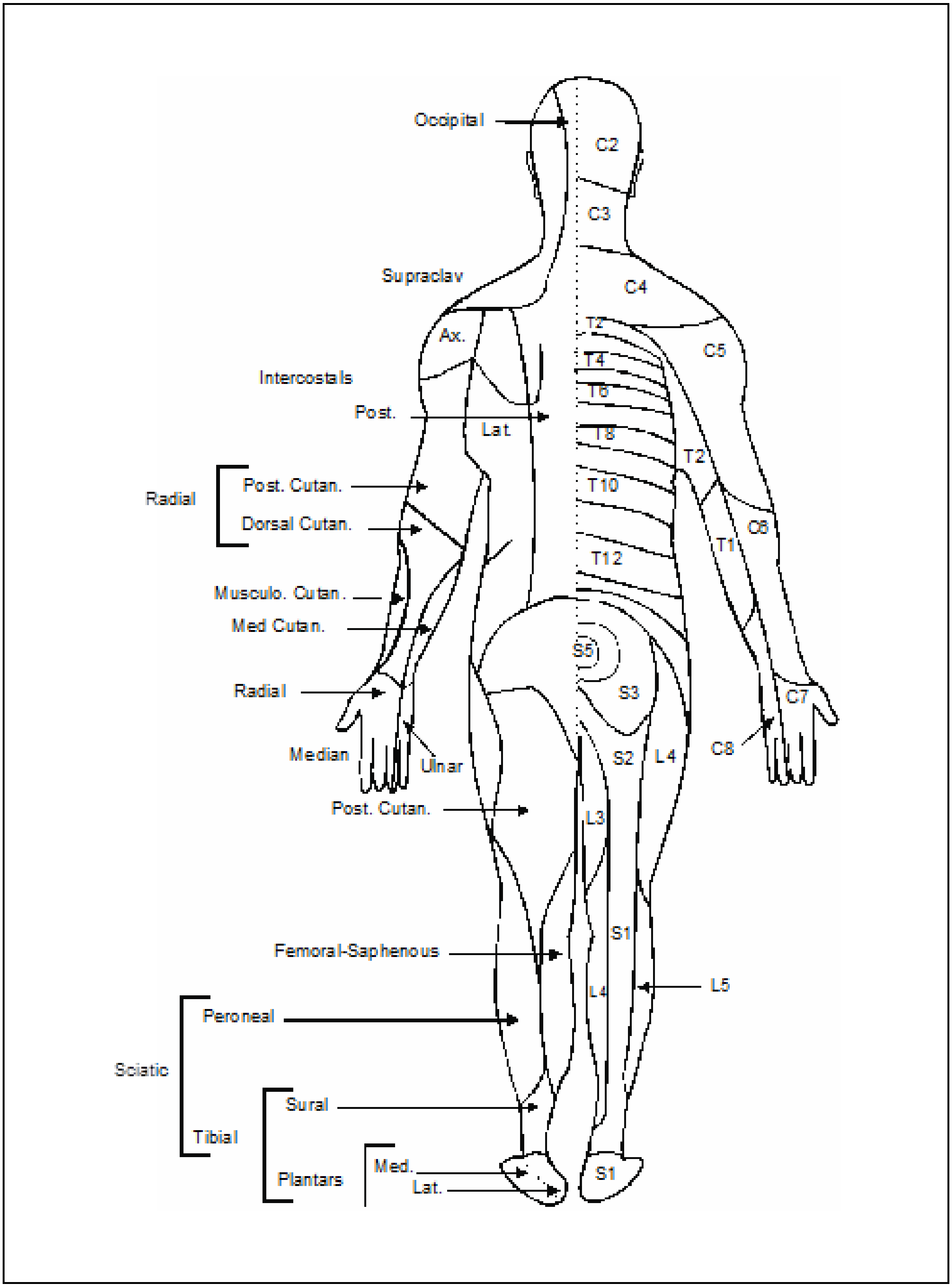


Figure 5A-2a. Dermatomal Areas Correlated to Spinal Cord Segment (sheet 1 of 2).

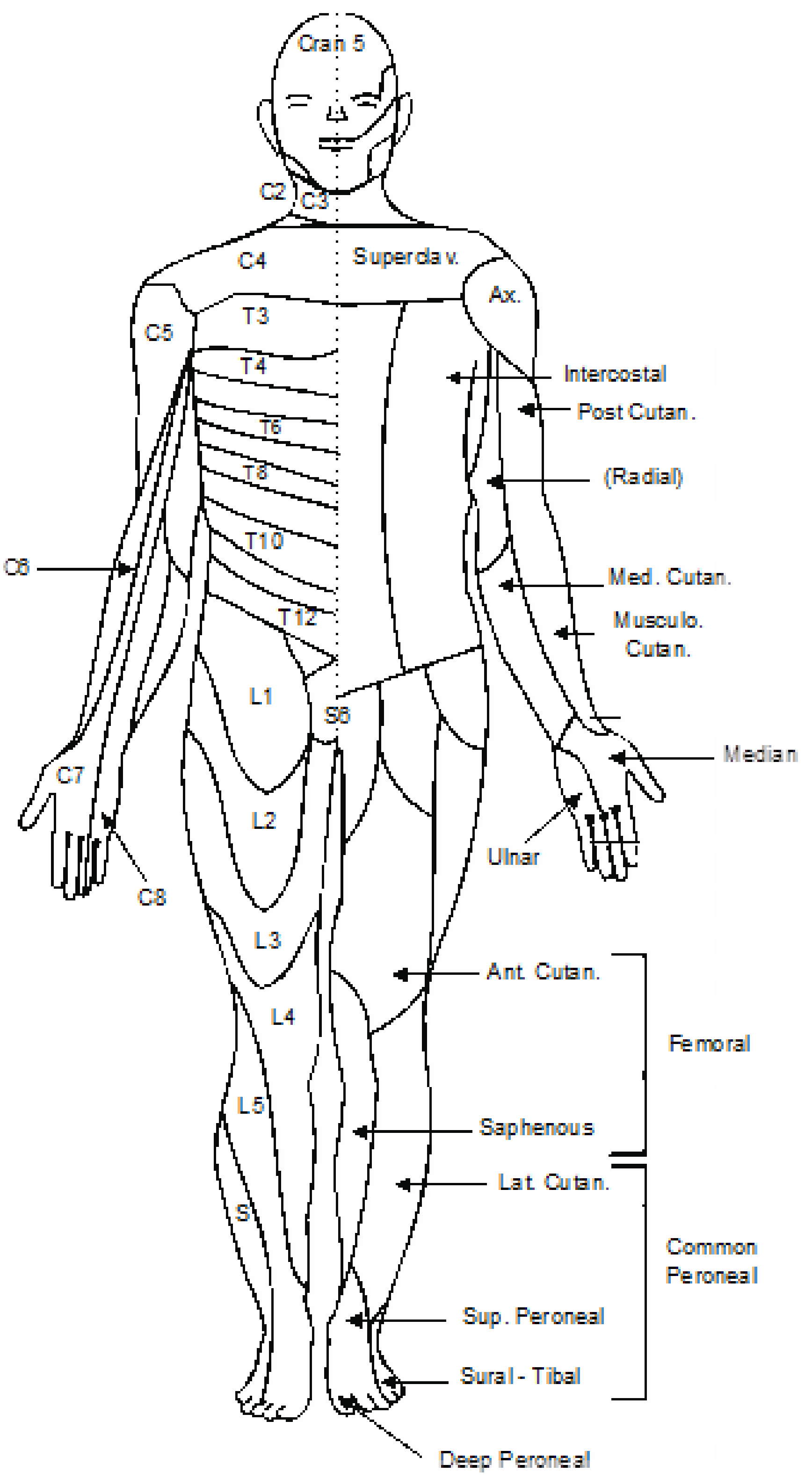


Figure 5A-2b. Dermatomal Areas Correlated to Spinal Cord Segment (sheet 2 of 2).

2016

Appendix G: AOR GUIDELINES for MEDICAL EXAMINATION of DIVERS

AOR employees require periodic medical exams are required to mitigate acute risks of DCS and POIS and monitor for chronic health risks due to exposure to hazardous substances. Additionally, employees may require immunizations / foreign travel clearance incident to foreign travel.

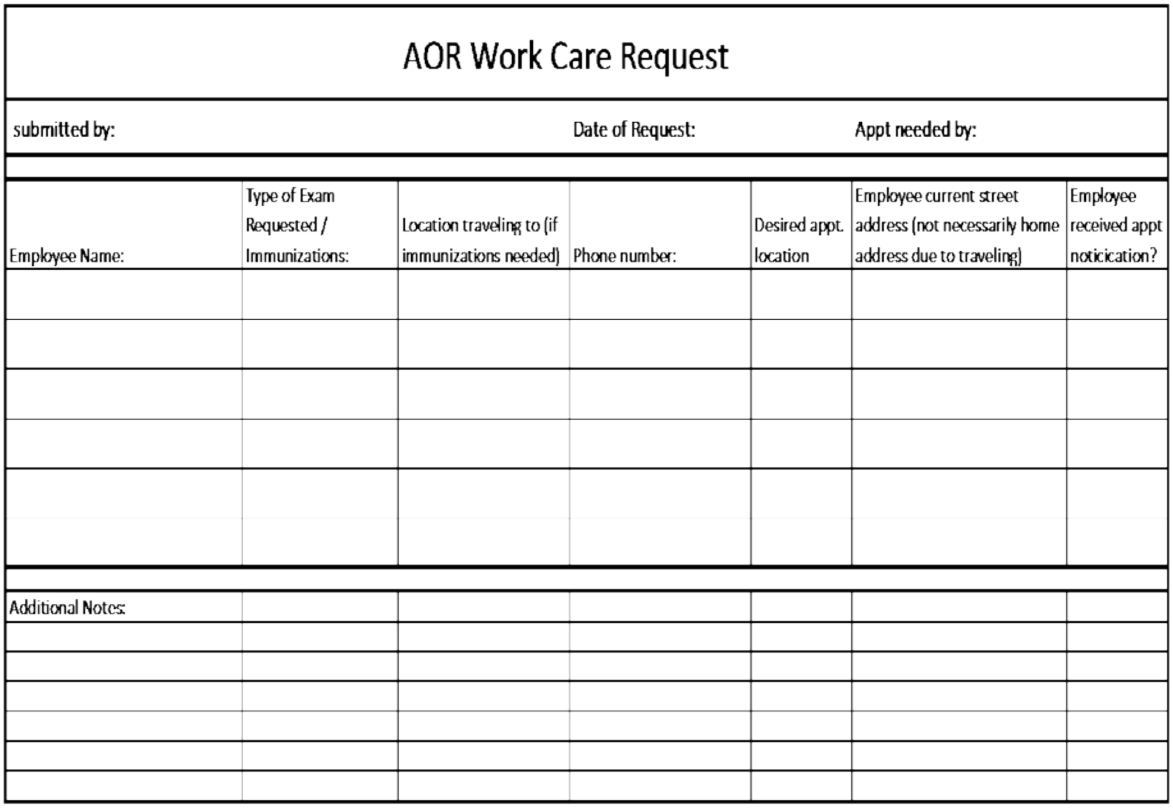
AOR utilizes WorkCare, Inc. exclusively for all company employee occupational health needs. Personal health concerns should be attended to via individual employee health plan options.

Some instances that may prompt a request for a WorkCare appointment:

- Pre-employment Exams
- Drug Testing
- Travel Medicine (Travel Care)
- Hearing Conservation
- Respiratory Compliance
- Human Performance Evaluations
- Dive medical clearance
- HAZWOPER clearance

AOR employees requiring medical clearance shall submit a WorkCare request to AOR HR via their supervisor utilizing the Work Care request form. Employees are responsible for making all scheduled appointments and for NOT submitting ANY personal health (HIPPA) related information to AOR supervisors, managers and staff via any means.

Request for Physical Examination Form:



AOR Work Care Request

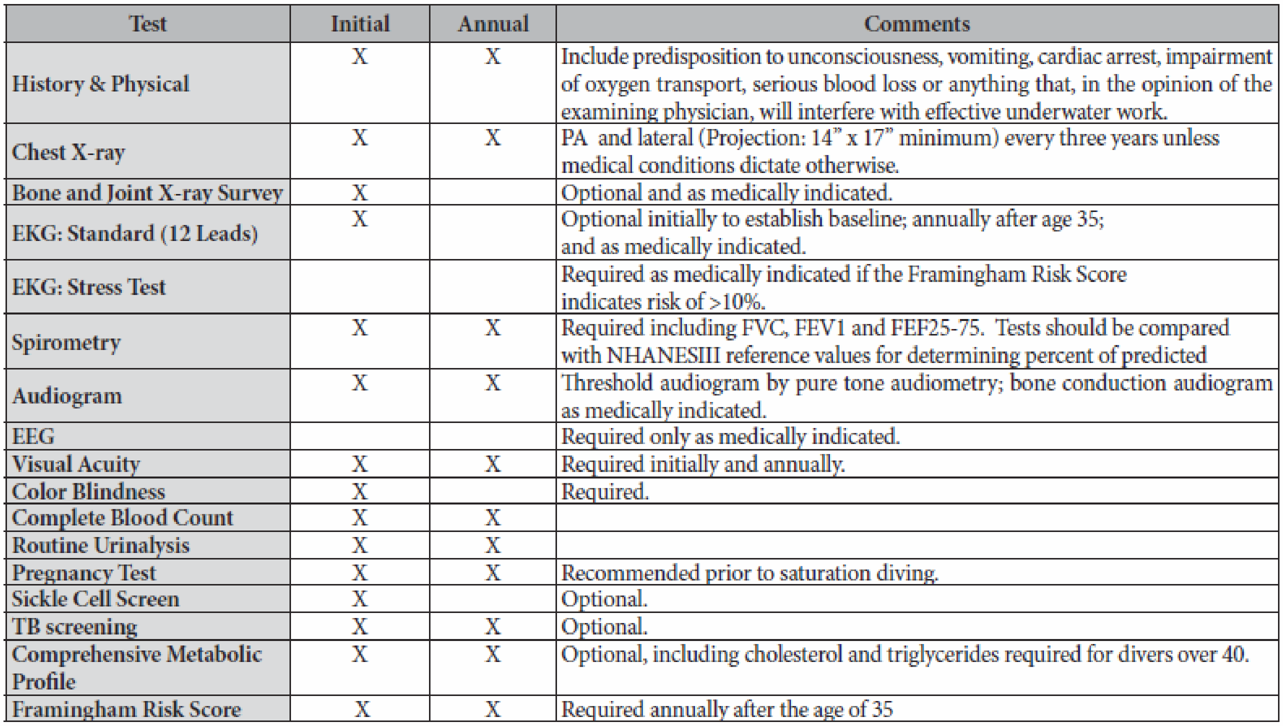
submitted by: Date of Request: Appt needed by:

Employee Name:	Type of Exam Requested / Immunizations:	Location traveling to (if immunizations needed)	Phone number:	Desired appt. location	Employee current street address (not necessarily home address due to traveling)	Employee received appt noticication?

Additional Notes:

Employees performing hazardous work shall be entered into AOR’s medical surveillance program with initial and periodic exams. Employees performing diving shall receive base line and annual exams as follows with the basic requirements below:

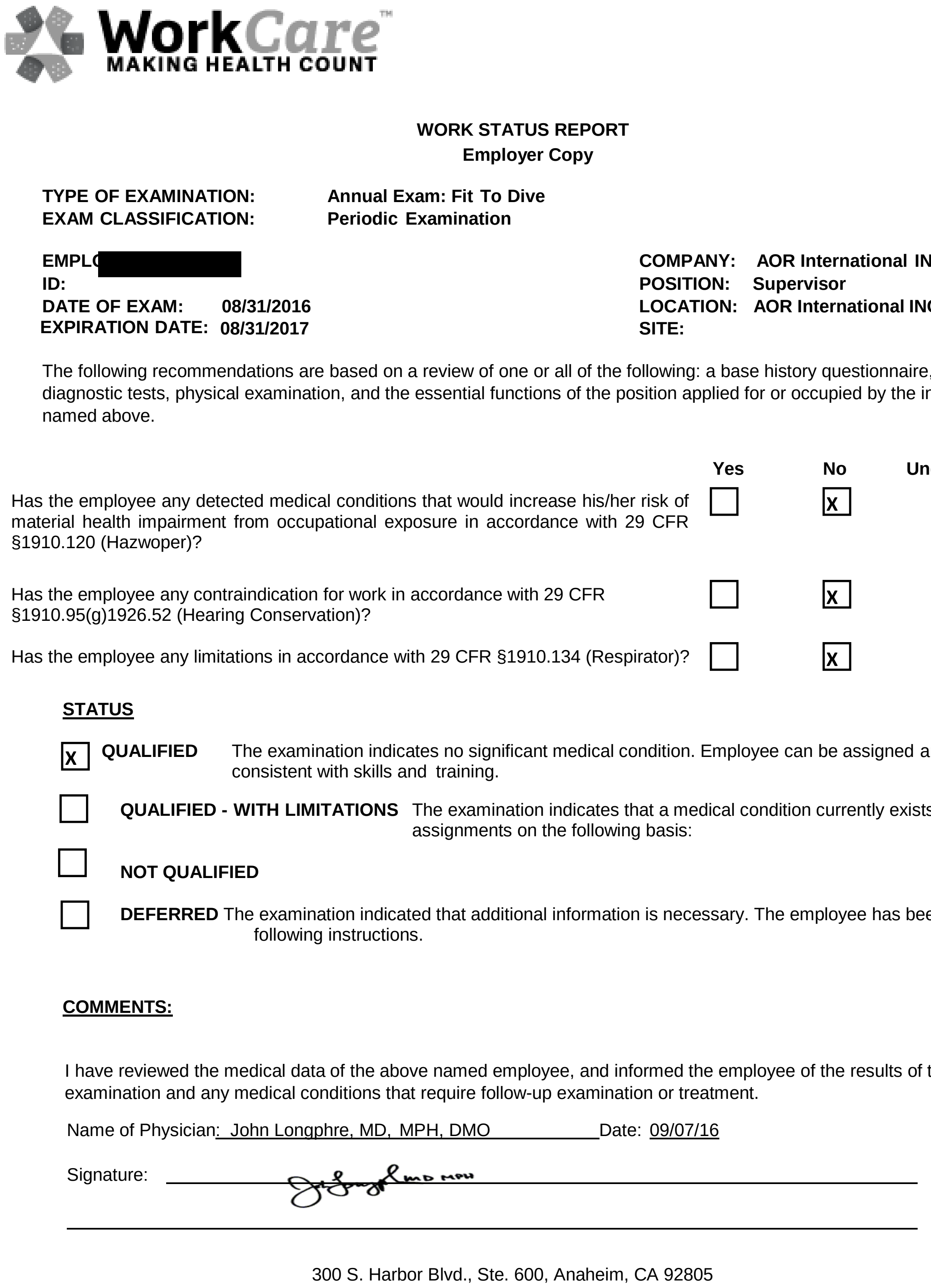
Medical Tests for Diving:



Test	Initial	Annual	Comments
History & Physical	X	X	Include predisposition to unconsciousness, vomiting, cardiac arrest, impairment of oxygen transport, serious blood loss or anything that, in the opinion of the examining physician, will interfere with effective underwater work.
Chest X-ray	X	X	PA and lateral (Projection: 14” x 17” minimum) every three years unless medical conditions dictate otherwise.
Bone and Joint X-ray Survey	X		Optional and as medically indicated.
EKG: Standard (12 Leads)	X		Optional initially to establish baseline; annually after age 35; and as medically indicated.
EKG: Stress Test			Required as medically indicated if the Framingham Risk Score indicates risk of >10%.
Spirometry	X	X	Required including FVC, FEV1 and FEF25-75. Tests should be compared with NHANESIII reference values for determining percent of predicted
Audiogram	X	X	Threshold audiogram by pure tone audiometry; bone conduction audiogram as medically indicated.
EEG			Required only as medically indicated.
Visual Acuity	X	X	Required initially and annually.
Color Blindness	X		Required.
Complete Blood Count	X	X	
Routine Urinalysis	X	X	
Pregnancy Test	X	X	Recommended prior to saturation diving.
Sickle Cell Screen	X		Optional.
TB screening	X	X	Optional.
Comprehensive Metabolic Profile	X	X	Optional, including cholesterol and triglycerides required for divers over 40.
Framingham Risk Score	X	X	Required annually after the age of 35

WorkCare will issue a medical clearance letter similar to the sample letter below within five business days of the scheduled health exam. The employee will receive exam findings within ten days of the scheduled exam. Ensure the reviewing physician is a knowledgeable in the physiology of diving.

WorkCare issues letter of Clarence:



WorkCare™
MAKING HEALTH COUNT

WORK STATUS REPORT
Employer Copy

TYPE OF EXAMINATION: **Annual Exam: Fit To Dive**
EXAM CLASSIFICATION: **Periodic Examination**

EMPL[redacted]
ID:
DATE OF EXAM: **08/31/2016**
EXPIRATION DATE: **08/31/2017**

COMPANY: **AOR International INC**
POSITION: **Supervisor**
LOCATION: **AOR International INC**
SITE:

The following recommendations are based on a review of one or all of the following: a base history questionnaire, supporting diagnostic tests, physical examination, and the essential functions of the position applied for or occupied by the individual named above.

	Yes	**No**	**Undecided**
Has the employee any detected medical conditions that would increase his/her risk of material health impairment from occupational exposure in accordance with 29 CFR §1910.120 (Hazwoper)?	☐	☒	☐
Has the employee any contraindication for work in accordance with 29 CFR §1910.95(g)1926.52 (Hearing Conservation)?	☐	☒	☐
Has the employee any limitations in accordance with 29 CFR §1910.134 (Respirator)?	☐	☒	☐

STATUS

☒ **QUALIFIED** The examination indicates no significant medical condition. Employee can be assigned any work consistent with skills and training.

☐ **QUALIFIED - WITH LIMITATIONS** The examination indicates that a medical condition currently exists that limits work assignments on the following basis:

☐ **NOT QUALIFIED**

☐ **DEFERRED** The examination indicated that additional information is necessary. The employee has been given the following instructions.

COMMENTS:

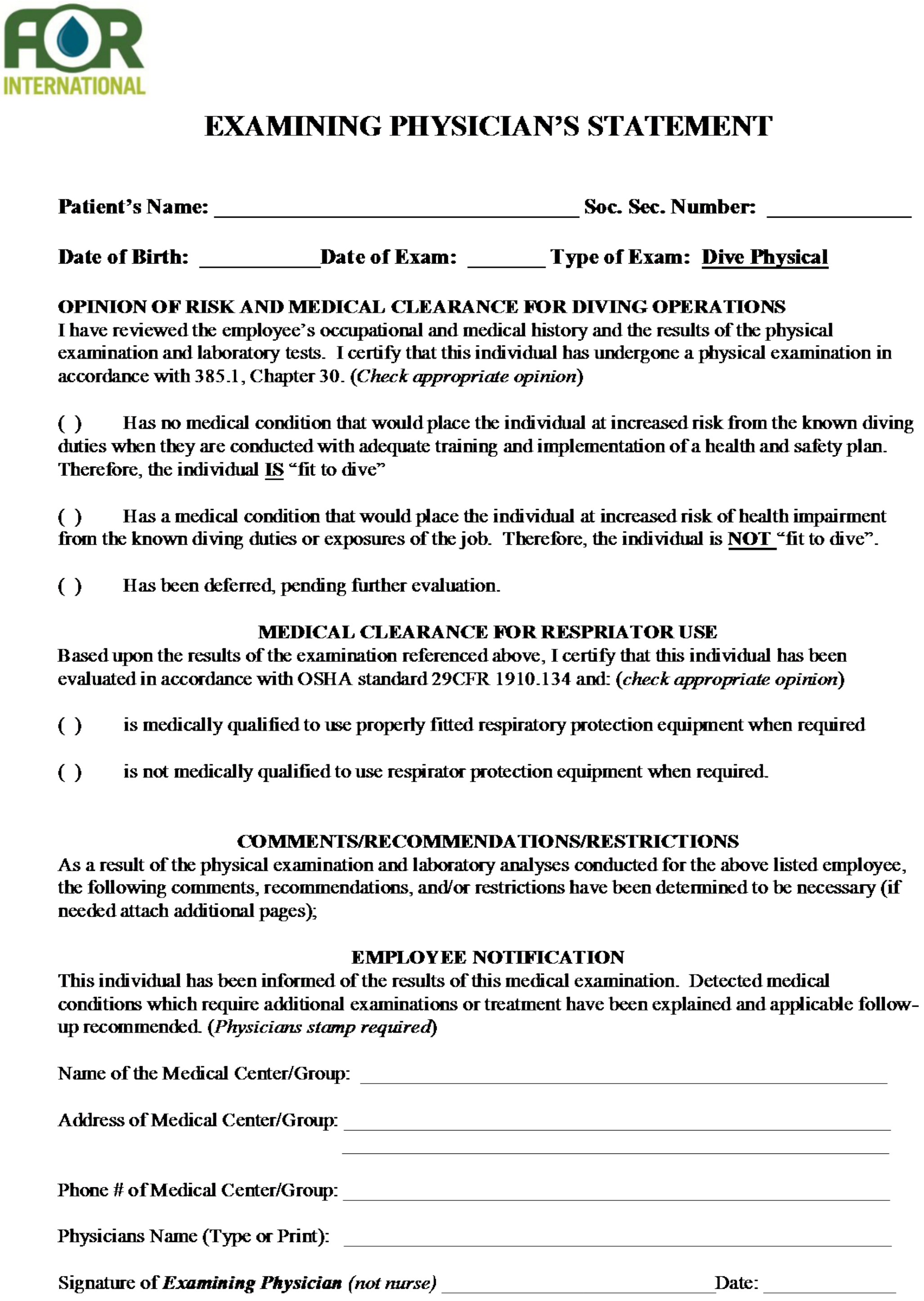
I have reviewed the medical data of the above named employee, and informed the employee of the results of the medical examination and any medical conditions that require follow-up examination or treatment.

Name of Physician: John Longphre, MD, MPH, DMO Date: 09/07/16

Signature:

300 S. Harbor Blvd., Ste. 600, Anaheim, CA 92805

In the absence of an available WorkCare provider, diving clearance may be accepted from other providers. In these cases, the diving clearance shall be documented on the AOR sample form at the end of this appendix.



AOR INTERNATIONAL

EXAMINING PHYSICIAN'S STATEMENT

Patient's Name: ________________________________ **Soc. Sec. Number:** ____________

Date of Birth: __________**Date of Exam:** _______ **Type of Exam:** **Dive Physical**

OPINION OF RISK AND MEDICAL CLEARANCE FOR DIVING OPERATIONS
I have reviewed the employee's occupational and medical history and the results of the physical examination and laboratory tests. I certify that this individual has undergone a physical examination in accordance with 385.1, Chapter 30. (*Check appropriate opinion*)

( ) Has no medical condition that would place the individual at increased risk from the known diving duties when they are conducted with adequate training and implementation of a health and safety plan. Therefore, the individual **IS** "fit to dive"

( ) Has a medical condition that would place the individual at increased risk of health impairment from the known diving duties or exposures of the job. Therefore, the individual is **NOT** "fit to dive".

( ) Has been deferred, pending further evaluation.

MEDICAL CLEARANCE FOR RESPRIATOR USE
Based upon the results of the examination referenced above, I certify that this individual has been evaluated in accordance with OSHA standard 29CFR 1910.134 and: (*check appropriate opinion*)

( ) is medically qualified to use properly fitted respiratory protection equipment when required

( ) is not medically qualified to use respirator protection equipment when required.

COMMENTS/RECOMMENDATIONS/RESTRICTIONS
As a result of the physical examination and laboratory analyses conducted for the above listed employee, the following comments, recommendations, and/or restrictions have been determined to be necessary (if needed attach additional pages);

EMPLOYEE NOTIFICATION
This individual has been informed of the results of this medical examination. Detected medical conditions which require additional examinations or treatment have been explained and applicable follow-up recommended. (*Physicians stamp required*)

Name of the Medical Center/Group: ____

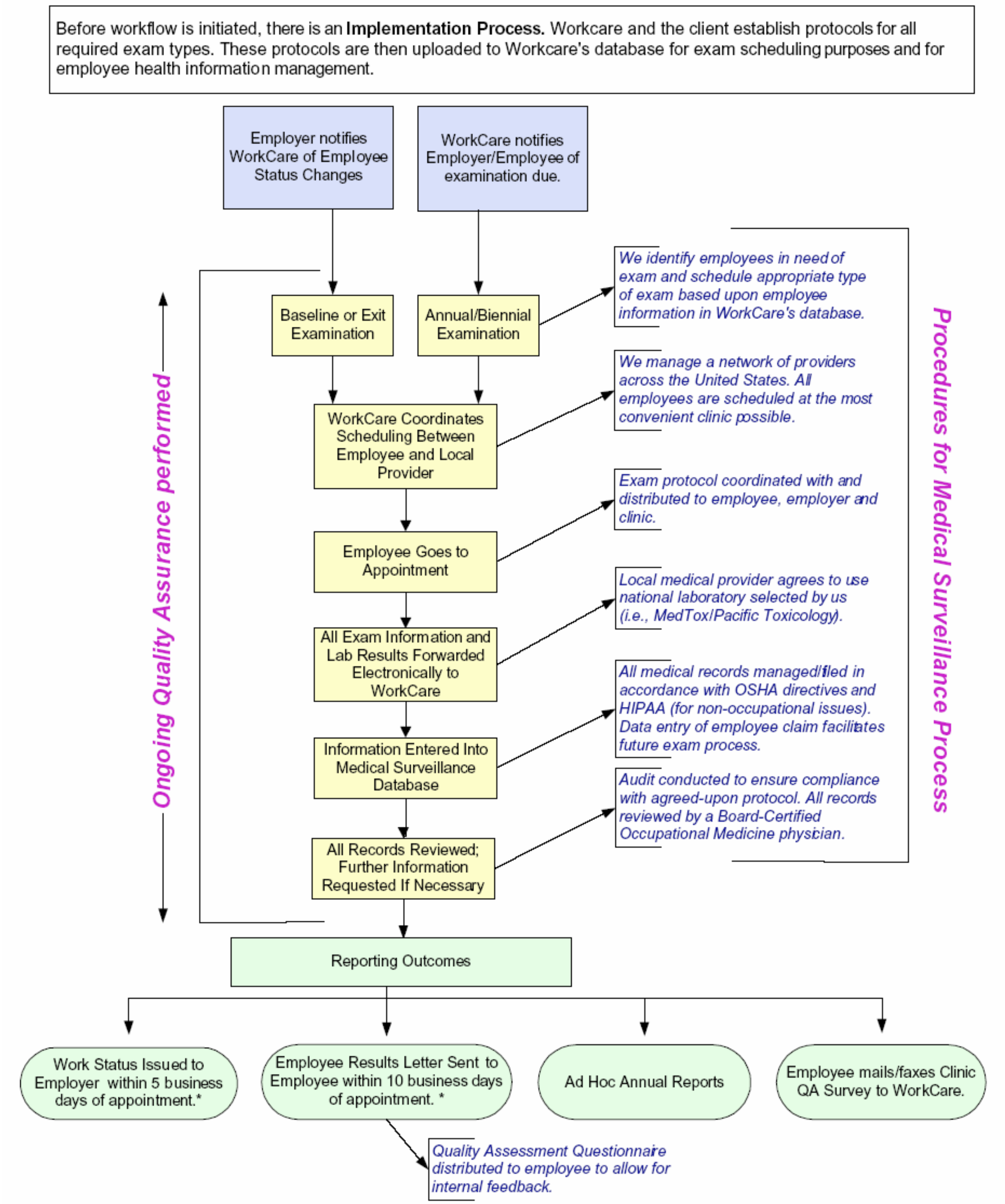
Address of Medical Center/Group: ____
____

Phone # of Medical Center/Group: ____

Physicians Name (Type or Print): ____

Signature of ***Examining Physician*** *(not nurse)* ______________________Date: __________

WorkCare outline of Medical Surveillance Procedures:



Before workflow is initiated, there is an **Implementation Process.** Workcare and the client establish protocols for all required exam types. These protocols are then uploaded to Workcare's database for exam scheduling purposes and for employee health information management.

We identify employees in need of exam and schedule appropriate type of exam based upon employee information in WorkCare's database.

We manage a network of providers across the United States. All employees are scheduled at the most convenient clinic possible.

Exam protocol coordinated with and distributed to employee, employer and clinic.

Local medical provider agrees to use national laboratory selected by us (i.e., MedTox/Pacific Toxicology).

All medical records managed/filed in accordance with OSHA directives and HIPAA (for non-occupational issues). Data entry of employee claim facilitates future exam process.

Audit conducted to ensure compliance with agreed-upon protocol. All records reviewed by a Board-Certified Occupational Medicine physician.

Quality Assessment Questionnaire distributed to employee to allow for internal feedback.

* Reporting turnaround times may differ if client does not use WorkCare's scheduling services.

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Appendix H: CONTAMINATED WATER DIVING OPERATIONS

Diving in contaminated water poses a serious health risk to divers and topside personnel. All equipment and manning levels should be considered the recommended minimum approach to diving in contaminated environments and any applicable decompression required. Increased manning levels and additional equipment may be required for any diving in chemical, micro-biological, or radiological environments, including any water posing any thermal or toxic threat to the diver.

All diving procedures should follow guidance listed in the U.S. Navy publication Guidance for Diving in Contaminated Waters, Revision 1 (15 March 2008).

When planning diving in contaminated water AOR dive plans shall address:

- Expected types of contaminants;
- Identification methods and sources of contaminants
- Diver and topside contaminated water training;
- Levels of protection for divers and topside personnel (Equipment selection);
- Decontamination Procedures, including procedures incident to a diver casualty;
- Medical evaluation support and post dive monitoring;
- Hazardous waste minimization and disposal (If Applicable).

HAZARD EVALUATION AND IDENTIFICATION

Resources and methods for mitigating contaminated water conditions are available in the ADCI Consensus Standards, 6.2 Edition (2016.) Technical advice and testing procedures should be sought from a qualified industrial hygienist.

When considering potential contaminated water sites particular care should be taken when divers are expected to be in mud/sediment as that is where heavy metal contaminants accumulate. Additionally, rainfall and points of storm water or other discharges contribute to surface and vertical water contamination. Knowledge of industrial or agriculture activity in the surrounding local and upstream watershed is vital to making an informed hazard assessment.

Local, state and federal water management or environmental agencies and universities may be able to assist with identifying and addressing concerns with specific contaminants.

PERSONNEL TRAINING

- All personnel participating in contaminated water diving shall complete Hazardous Waste Operations and Emergency Response (HAZWOPER) training IAW 29 CFR 1910.120 and have adequate and specific training for the specific equipment, procedures and methods used.
- Dry suits
- PPE for topside and diving personnel
- Decon procedures

EQUIPMENT

PPE that protects the topside crew shall be selected commensurate with the toxins present.

See ADCI consensus standard section five for EPA selection guidelines. In no case shall topside personnel be dressed in less than outer protection (rain suit / water repellant coveralls) and face shield or goggles.

- Diving equipment protects the diver from skin, eye, and mucus membrane contact with the contaminated water and inspiration of contaminates.

An often overlooked hazard when diving in contaminated water is inspiration of contaminated water through the second stage regulator as water that leaks into the regulator body is atomized and mixed with the incoming air. It is for this reason that SCUBA shall not be used in any diving environment where contamination may be reasonably suspected.

- Surface supplied diving equipment with single exhaust valves have the same liability in contaminated water as SCUBA. Therefore, SSA equipment with double exhaust valves or a return line should be used commensurate with the risk.

Equipment used for contaminated water diving shall be maintained in exceptional condition with special care to the exhaust valves as deterioration may occur even during short dives that may require changing valves between dives. Operate, repair, and store diving equipment in accordance with the manufactures' recommendations.

- Dry suits shall be thoroughly inspected prior to use with special care given to zippers and seals. Do not use dry suits with dry rot, or apparent deterioration. Keep dry suits out of sunlight as it contributes to deterioration. Operate, repair, and store dry suits in accordance with the manufactures' recommendations.

GENERAL DECONTAMINATION PROCEDURES

AOR shall use a "zoned" approach to decontamination as described in ADCI consensus standard section five. Three zones shall be established that move the diver and crew from "dirty" to clean" in a progressive manner.

The diver will remain helmeted until fully decontaminated. Divers must be disciplined and directed in this manner as this is counter to all surface supplied training and practice where the helmet comes off first.

Personnel shall treat all dirty equipment with care and be attentive to avoid cross contamination. Attention to detail and use of a disciplined and methodical approach will ensure the protection of the dive crew.

DIVER CASUALTY

In the event of a diver casualty while diving in a contaminated water environment only general guidance can be given. Onsite supervisory personnel must make an informed decision that takes immediate life support into consideration over protection from potential long term health effects. All efforts to expedite a full or abbreviated decontamination shall be taken while responding to a diving casualty in a contaminated water environment.

MEDICAL MONITORING

Medical personnel shall be consulted when planning for diving in contaminated water to ensure proper precautions are taken and post-dive monitoring of divers is conducted. All employees performing work in contaminated environments shall be medically monitored – See Appendix G for AOR's medical surveillance program.

HAZARDOUS WASTE MINIMIZATION

Federal, state, or local regulations may require that residue collected in the decontamination process be collected and disposed of as hazardous waste. This will require prior coordination with local officials to ensure compliance. Every effort should be made to minimize the amount of waste generated consistent with personnel safety.

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Appendix I - GLOSSARY

Appendix I - GLOSSARY

ACFM (actual cubic feet per minute): Refers to the actual volume of gas supplied to a diver, bell, etc., at ambient pressure.

Activity Hazard Analysis (AHA): A method used to determine the steps of a specific job; outlines potential risks and hazards associated with the job and actions or procedures that will eliminate or minimize the risks.

Ambient Pressure: The surrounding pressure, at depth (actual, or simulated in a hyperbaric chamber) to which the diver, bell, etc., is subjected.

Ascent Times: The time interval between leaving the bottom when the dive is terminated and reaching the surface (1 ATA).

ATA (atmosphere absolute): Total pressure, including atmospheric, to which a diver, bell, etc., is subjected.

ATM (atmosphere): A unit of pressure equivalent to 14.7 psi or 760 mm of mercury.

Bail-out: An emergency situation in which a diver leaves bottom and comes directly to the surface, exceeding normal controlled ascent rates and missing scheduled decompression water stops.

Bail-out Bottle: See *Diver-Carried Reserve Breathing Gas*.

Bends: Alternative term for *Decompression Illness*.

BIBS: See *Built-in Breathing System*.

Bottom Time: The total elapsed time, measured in minutes, from the time the diver leaves the surface in descent to the time he begins ascent.

Breathing System: Device or apparatus for delivering respirable breathing mixture.

Built-in Breathing System: A device or apparatus for delivering respirable breathing mixture that is installed in a permanent fashion to the habitat.

Cleaned for Oxygen Service: Cleaning of equipment or system to ensure elimination of all hydrocarbons and other potentially dangerous contaminants when system is to be used in oxygen service. See also *Oxygen Cleaning*.

CNS: Central nervous system.

Compressor: A machine that raises air, or other gases, to a pressure above 1 ATM.

CPR (Cardiopulmonary Resuscitation): A combination or artificial respiration and artificial circulation.

Cylinder: A pressure ship for the storage of gases.

Decompression: Releasing from pressure or compression; following a specific decompression table or procedure during ascent; ascending in the water or experiencing pressure in the chamber.

Decompression Chamber (DDC): A deck chamber capable of controlled pressurization and depressurization; used for decompression, recompression, and treatment of diving injuries, submarine medicine or as a surface habitat for saturation divers.

Decompression Schedule: A time/depth profile with a specific bottom time and depth whose application is calculated to reduce the pressure on a diver to within safe limits.

Decompression Sickness (DCS): A condition that produces bubbles of gas in the blood or tissues of the diver during or after the ascent or other pressure reduction.

Decompression Table: A set of decompression schedules computed from a common protocol.

Dive Location: The ship or other structure from which dives are conducted and supported.

Dive Team: Divers and diver support personnel involved in a diving operation, including the diving supervisor.

Diver-Worn Equipment: Equipment required for the safety and wellbeing of the diver; worn by or attached to the diver while he is underwater.

Diving Operations: Any operation in which some type of diving or underwater work involves planned human exposure to increased pressure.

Dry Suit: A diving suit designed to exclude water from the surface of the body.

Exhaust Valve: A valve controlling the venting of gas from a DDC, divers helmet, suit, or buoyancy- changing equipment.

Embolism: See *Gas Embolism*.

FFW: Feet of Freshwater

FSW: Feet of Seawater

Harness: The approved combination of straps and fasteners used to attach equipment and umbilical to the diver.

Helium De-scrambler: An electronic device designed to render intelligible the words spoken in a helium hyperbaric environment.

Hyperbaric Conditions: Pressure conditions in excess of surface pressure.

Liveboating: The practice of supporting a diver from a Vessel that is underway.

Maximum Working Pressure: The maximum pressure to which a pressure containment device can be exposed under operating conditions.

MAWP (Maximum Allowable Working Pressure): See *Maximum Working Pressure*.

Mixed-gas Diving: A diving technique in which a diver is supplied with a gas mixture other than air for respiration.

NAVSCOLEOD: U.S. Naval School EOD

No-Decompression Diving: Diving that involves depths and times so that ascent to the surface can be made without water stops and/or subsequent chamber decompression.

Non-Return Valve (check valve): A one-way check valve installed in a gas system to permit gas flow in one direction only; all diving helmets must have a non-return valve at the gas supply inlet to prevent depressurization of the helmet and the resultant squeeze, should the gas supply be lost.

Over-bottom Pressure: That pressure above ambient that a breathing-gas supply must attain to the helmet/mask so that the diver will have a sufficient supply of gas.

Oxygen Cleaning: Special cleaning process for equipment in oxygen systems that removes all flammables.

Partial Pressure: That portion of the total gas pressure exerted by a particular constituent of the breathing mixture.

Pneumofathometer: A depth measuring device consisting of an opened-end hose fixed to the diver, with the surface-end connected to a gas supply and a pressure gauge.

PSI (pounds per square inch): An expression of pressure; 1 ATM = 14.7 psi.

PVHO (Pressure Vessel for Human Occupancy): See *Decompression Chamber*.

Rack Operator: Position implemented as needed on mixed-gas diving operations.

Relief Valve: A pressure-relieving device that prevents pressure from rising above a pre-set level.

Risk Assessment: A formal process of assessing and quantifying risk and probability with the desired result of developing action to reduce the perceived risk and probability.

SCUBA: A mode of diving that employs a Self-Contained Underwater Breathing Apparatus.

Standby Diver: Designated qualified diver at the dive location available to immediately assist the diver in the water.

Surface-Supplied Diving: A diving mode in which a diver receives breathing gas from a supply on the surface.

Treatment Tables: A depth, time, and breathing media profile designed to treat a diver for gas embolism or decompression sickness.

Umbilical: A hose bundle between the dive location and the diver and/or bell that supplies a lifeline, breathing gas, communications, power, and heat appropriate for the diving mode or conditions.

Valve: A device that starts, stops, or regulates the flow of fluids or gasses.

Volume Tank: A pressure ship connected to the outlet of a gas supply and used as a gas reservoir.

Weight Belt: A belt worn by a diver to achieve desired buoyancy.

Working Pressure: The pressure that a containment device is exposed to under normal operating conditions.

Work Site: An underwater location where work is performed.

Penetration dive: A dive that requires a diver to access an area that is both a physically confining space and one in which there is no direct access to the surface for recovery of the diver from the water by the tender.

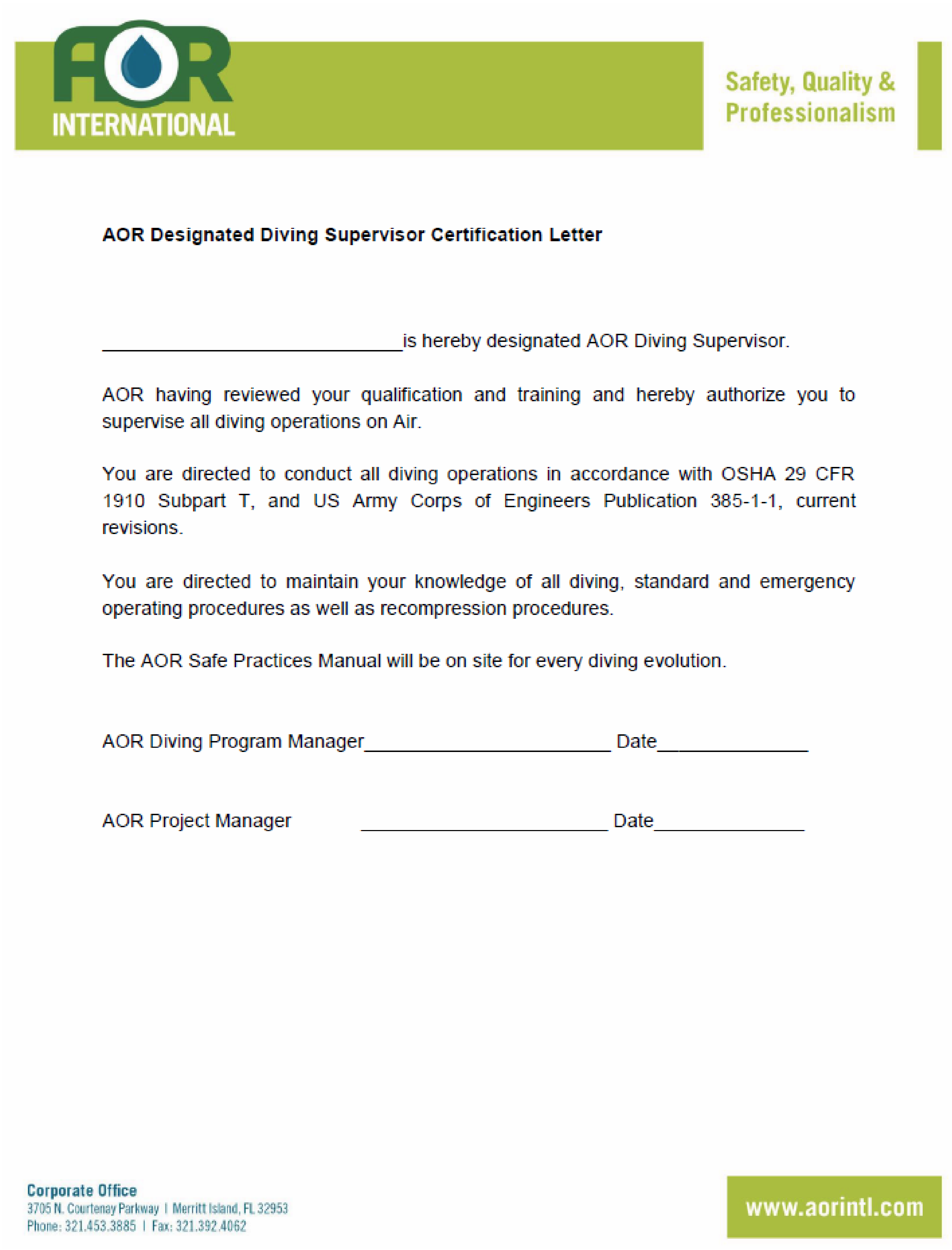
Physically confining and limited access space: Any underwater space that would restrict the diver's ability to rotate himself head to toe, 180 degrees in any plane.

Direct access to the surface: A dive location where the diver can be easily pulled to the surface by a surface tender. This does not necessarily mean that there is not an obstruction on the surface directly above the diver during the dive, but that there is nothing to restrict the diver from being pulled back to the point of entry at the water surface by a topside tender.

Diver working around corners: A situation where the umbilical may become fouled or where line pull signals may become dissipated due to the dive site configuration creating an impossibility of a straight-line pull between the surface tender and the diver. When performing penetration diving, if the entrance to the penetration is underwater and not readily accessible from the surface, then the diver shall be tended at the entrance of the penetration by an in-water tender at all times. The purpose of the in-water tender is to tend the penetrating diver's umbilical and to assist should the diver require assistance in the event of a fouled umbilical or entrapment. In these conditions, the dive team must include an additional tender/diver.

2016

Appendix J: DESIGNATED DIVE SUPERVISOR LETTER



AOR INTERNATIONAL
Safety, Quality &
Professionalism

AOR Designated Diving Supervisor Certification Letter

______________________________is hereby designated AOR Diving Supervisor.

AOR having reviewed your qualification and training and hereby authorize you to supervise all diving operations on Air.

You are directed to conduct all diving operations in accordance with OSHA 29 CFR 1910 Subpart T, and US Army Corps of Engineers Publication 385-1-1, current revisions.

You are directed to maintain your knowledge of all diving, standard and emergency operating procedures as well as recompression procedures.

The AOR Safe Practices Manual will be on site for every diving evolution.

AOR Diving Program Manager_________________________ Date_______________

AOR Project Manager _________________________ Date_______________

Corporate Office
3705 N. Courtenay Parkway | Merritt Island, FL 32953
Phone: 321.453.3885 | Fax: 321.392.4062
www.aorintl.com

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Appendix K: OSHA 29 CFR 1910, Subpart T

Commercial Diving Operations

Authority: Sections 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, and 657); Sec. 107, Contract Work Hours and Safety Standards Act (the Construction Safety Act) (40 U.S.C. 333); Sec. 41, Longshore and Harbor Workers' Compensation Act (33 U.S.C. 941); Secretary of Labor's Order No. 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 3–2000 (65 FR 50017), or 5–2002 (67 FR 65008) as applicable; 29 CFR part 1911.

Source: 42 FR 37668, July 22, 1977, unless otherwise noted.

General

§ 1910.401 Scope and application.

(a) *Scope.*

(1) This subpart (standard) applies to every place of employment within the waters of the United States, or within any State, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, the Trust Territory of the Pacific Islands, Wake Island, Johnston Island, the Canal Zone, or within the Outer Continental Shelf lands as defined in the Outer Continental Shelf Lands Act (67 Stat. 462, 43 U.S.C. 1331), where diving and related support operations are performed.

(2) This standard applies to diving and related support operations conducted in connection with all types of work and employments, including general industry, construction, ship repairing, shipbuilding, shipbreaking and longshoring. However, this standard does not apply to any diving operation:

(i) Performed solely for instructional purposes, using open-circuit, compressed-air SCUBA and conducted within the no-decompression limits;

(ii) Performed solely for search, rescue, or related public safety purposes by or under the control of a governmental agency; or

(iii) Governed by 45 CFR part 46 (Protection of Human Subjects, U.S. Department of Health and Human Services) or equivalent rules or regulations established by another federal agency, which regulate research, development, or related purposes involving human subjects.

(iv) Defined as scientific diving and which is under the direction and control of a diving program containing at least the following elements:

(A) Diving safety manual which includes at a minimum: Procedures covering all diving operations specific to the program; procedures for emergency care, including recompression and evacuation; and criteria for diver training and certification.

(B) Diving control (safety) board, with the majority of its members being active divers, which shall at a minimum have the authority to: Approve and monitor diving projects; review and revise the diving safety manual; assure compliance with the manual; certify the depths to which a diver has been trained; take disciplinary action for unsafe practices; and, assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for SCUBA diving.

(3) *Alternative requirements for recreational diving instructors and diving guides.* Employers of recreational diving instructors and diving guides are not required to comply with the decompression-chamber requirements specified by paragraphs (b)(2) and (c)(3)(iii) of §1910.423 and paragraph (b)(1) of §1910.426 when they meet all of the following conditions:

(i) The instructor or guide is engaging solely in recreational diving instruction or dive-guiding operations;

(ii) The instructor or guide is diving within the no-decompression limits in these operations;

(iii) The instructor or guide is using a nitrox breathing-gas mixture consisting of a high percentage of oxygen (more than 22% by volume) mixed with nitrogen;

(iv) The instructor or guide is using an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus (SCUBA); and

(v) The employer of the instructor or guide is complying with all requirements of Appendix C of this subpart.

(b) *Application in emergencies.* An employer may deviate from the requirements of this standard to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage, provided that the employer:

(1) Notifies the Area Director, Occupational Safety and Health Administration within 48 hours of the onset of the emergency situation indicating the nature of the emergency and extent of the deviation from the prescribed regulations; and

(2) Upon request from the Area Director, submits such information in writing.

(c) *Employer obligation.* The employer shall be responsible for compliance with:

(1) All provisions of this standard of general applicability; and

(2) All requirements pertaining to specific diving modes to the extent diving operations in such modes are

conducted.
[42 FR 37668, July 22, 1977, as amended at 47 FR 53365, Nov. 26, 1982; 58 FR 35310, June 30, 1993; 69 FR 7363, Feb. 17, 2004]

§ 1910.402 Definitions.

As used in this standard, the listed terms are defined as follows:
Acfm: Actual cubic feet per minute.
ASME Code or equivalent:
ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section VIII, or an equivalent code which the employer can demonstrate to be equally effective.
ATA: Atmosphere absolute.
Bell: An enclosed compartment, pressurized (closed bell) or unpressurized (open bell), which allows the diver to be transported to and from the underwater work area and which may be used as a temporary refuge during diving operations.
Bottom time: The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver begins ascent.
Bursting pressure: The pressure at which a pressure containment device would fail structurally
Cylinder: A pressure vessel for the storage of gases.
Decompression chamber: A pressure vessel for human occupancy such as a surface decompression chamber, closed bell, or deep diving system used to decompress divers and to treat decompression sickness.
Decompression sickness: A condition with a variety of symptoms which may result from gas or bubbles in the tissues of divers after pressure reduction.
Decompression table: A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures.
Dive-guiding operations means leading groups of sports divers, who use an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus, to local undersea diving locations for recreational purposes.
Dive location: A surface or vessel from which a diving operation is conducted.
Dive-location reserve breathing gas: A supply system of air or mixed-gas (as appropriate) at the dive location which is independent of the primary supply system and sufficient to support divers during the planned decompression.
Dive team: Divers and support employees involved in a diving operation, including the designated person-in-charge.
Diver: An employee working in water using underwater apparatus which supplies compressed breathing gas at the ambient pressure.
Diver-carried reserve breathing gas: A diver-carried supply of air or mixed gas (as appropriate) sufficient under standard operating conditions to allow the diver to reach the surface, or another source of breathing gas, or to be reached by a standby diver.
Diving mode: A type of diving requiring specific equipment, procedures and techniques (SCUBA, surface-supplied air, or mixed gas).
Fsw: Feet of seawater (or equivalent static pressure head).
Heavy gear: Diver-worn deep-sea dress including helmet, breastplate, dry suit, and weighted shoes.
Hyperbaric conditions: Pressure conditions in excess of surface pressure.
In water stage: A suspended underwater platform which supports a diver in the water.
Liveboating: The practice of supporting a surfaced-supplied air or mixed gas diver from a vessel which is underway.
Mixed-gas diving: A diving mode in which the diver is supplied in the water with a breathing gas other than air.
No-decompression limits: The depth-time limits of the “no-decompression limits and repetitive dive group designation table for no-decompression air dives”, U.S. Navy Diving Manual or equivalent limits which the employer can demonstrate to be equally effective.
Psi(g): Pounds per square inch (gauge).
Recreational diving instruction means training diving students in the use of recreational diving procedures and the safe operation of diving equipment, including an open-circuit, semi-closed-circuit, or closed-circuit self-contained underwater breathing apparatus, during dives.
Scientific diving means diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks. Scientific diving does not include performing any tasks usually associated with commercial diving such as: Placing or

removing heavy objects underwater; inspection of pipelines and similar objects; construction; demolition; cutting or welding; or the use of explosives.
SCUBA diving: A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.
Standby diver: A diver at the dive location available to assist a diver in the water.
Surface-supplied air diving: A diving mode in which the diver in the water is supplied from the dive location with compressed air for breathing.
Treatment table: A depth-time and breathing gas profile designed to treat decompression sickness.
Umbilical: The composite hose bundle between a dive location and a diver or bell, or between a diver and a bell, which supplies the diver or bell with breathing gas, communications, power, or heat as appropriate to the diving mode or conditions, and includes a safety line between the diver and the dive location.
Volume tank: A pressure vessel connected to the outlet of a compressor and used as an air reservoir.
Working pressure: The maximum pressure to which a pressure containment device may be exposed under standard operating conditions
[42 FR 37668, July 22, 1977, as amended at 47 FR 53365, Nov. 26, 1982; 69 FR 7363, Feb. 17, 2004]

Personnel Requirements

§ 1910.410 Qualifications of dive team.

(a) *General.*
(1) Each dive team member shall have the experience or training necessary to perform assigned tasks in a safe and healthful manner.
(2) Each dive team member shall have experience or training in the following:
(i) The use of tools, equipment and systems relevant to assigned tasks;
(ii) Techniques of the assigned diving mode: and
(iii) Diving operations and emergency procedures.
(3) All dive team members shall be trained in cardiopulmonary resuscitation and first aid (American Red Cross standard course or equivalent).
(4) Dive team members who are exposed to or control the exposure of others to hyperbaric conditions shall be trained in diving-related physics and physiology.
(b) *Assignments.* (1) Each dive team member shall be assigned tasks in accordance with the employee's experience or training, except that limited additional tasks may be assigned to an employee undergoing training provided that these tasks are performed under the direct supervision of an experienced dive team member.
(2) The employer shall not require a dive team member to be exposed to hyperbaric conditions against the employee's will, except when necessary to complete decompression or treatment procedures.
(3) The employer shall not permit a dive team member to dive or be otherwise exposed to hyperbaric conditions for the duration of any temporary physical impairment or condition which is known to the employer and is likely to affect adversely the safety or health of a dive team member.
(c) *Designated person-in-charge.* (1) The employer or an employee designated by the employer shall be at the dive location in charge of all aspects of the diving operation affecting the safety and health of dive team members.
(2) The designated person-in-charge shall have experience and training in the conduct of the assigned diving operation.
General Operations Procedures
§ 1910.420 Safe practices manual.
(a) *General.* The employer shall develop and maintain a safe practices manual which shall be made available at the dive location to each dive team member.
(b) *Contents.*
(1) The safe practices manual shall contain a copy of this standard and the employer's policies for implementing the requirements of this standard.
(2) For each diving mode engaged in, the safe practices manual shall include:
(i) Safety procedures and checklists for diving operations;
(ii) Assignments and responsibilities of the dive team members;
(iii) Equipment procedures and checklists; and
(iv) Emergency procedures for fire, equipment failure, adverse environmental conditions, and medical illness and injury.
[42 FR 37668, July 22, 1977, as amended at 49 FR 18295, Apr. 30, 1984]

§ 1910.421 Pre-dive procedures.

(a) *General.* The employer shall comply with the following requirements prior to each diving operation, unless otherwise specified.
(b) *Emergency aid.* A list shall be kept at the dive location of the telephone or call numbers of the following:
(1) An operational decompression chamber (if not at the dive location);
(2) Accessible hospitals;
(3) Available physicians;
(4) Available means of transportation; and
(5) The nearest U.S. Coast Guard Rescue Coordination Center.
(c) *First aid supplies.*
(1) A first aid kit appropriate for the diving operation and approved by a physician shall be available at the dive location.
(2) When used in a decompression chamber or bell, the first aid kit shall be suitable for use under hyperbaric conditions.
(3) In addition to any other first aid supplies, an American Red Cross standard first aid handbook or equivalent, and a bag-type manual resuscitator with transparent mask and tubing shall be available at the dive location.
(d) *Planning and assessment.* Planning of a diving operation shall include an assessment of the safety and health aspects of the following:
(1) Diving mode;
(2) Surface and underwater conditions and hazards;
(3) Breathing gas supply (including reserves);
(4) Thermal protection;
(5) Diving equipment and systems;
(6) Dive team assignments and physical fitness of dive team members (including any impairment known to the employer);
(7) Repetitive dive designation or residual inert gas status of dive team members;
(8) Decompression and treatment procedures (including altitude corrections); and
(9) Emergency procedures.
(e) *Hazardous activities.* To minimize hazards to the dive team, diving operations shall be coordinated with other activities in the vicinity which are likely to interfere with the diving operation.
(f) *Employee briefing.*
(1) Dive team members shall be briefed on:
(i) The tasks to be undertaken;
(ii) Safety procedures for the diving mode;
(iii) Any unusual hazards or environmental conditions likely to affect the safety of the diving operation; and
(iv) Any modifications to operating procedures necessitated by the specific diving operation.
(2) Prior to making individual dive team member assignments, the employer shall inquire into the dive team member's current state of physical fitness, and indicate to the dive team member the procedure for reporting physical problems or adverse physiological effects during and after the dive.
(g) *Equipment inspection.* The breathing gas supply system including reserve breathing gas supplies, masks, helmets, thermal protection, and bell handling mechanism (when appropriate) shall be inspected prior to each dive.
(h) *Warning signal.* When diving from surfaces other than vessels in areas capable of supporting marine traffic, a rigid replica of the international code flag “A” at least one meter in height shall be displayed at the dive location in a manner which allows all-round visibility, and shall be illuminated during night diving operations.
[42 FR 37668, July 22, 1977, as amended at 47 FR 14706, Apr. 6, 1982; 54 FR 24334, June 7, 1989]

§ 1910.422 Procedures during dive.

(a) *General.* The employer shall comply with the following requirements which are applicable to each diving operation unless otherwise specified.
(b) *Water entry and exit.*
(1) A means capable of supporting the diver shall be provided for entering and exiting the water.
(2) The means provided for exiting the water shall extend below the water surface.
(3) A means shall be provided to assist an injured diver from the water or into a bell.
(c) *Communications.*
(1) An operational two-way voice communication system shall be used between:
(i) Each surface-supplied air or mixed-gas diver and a dive team member at the dive location or bell (when provided or required); and

(ii) The bell and the dive location.

(2) An operational, two-way communication system shall be available at the dive location to obtain emergency assistance.

(d) *Decompression tables.* Decompression, repetitive, and no-decompression tables (as appropriate) shall be at the dive location.

(e) *Dive profiles.* A depth-time profile, including when appropriate any breathing gas changes, shall be maintained for each diver during the dive including decompression.

(f) *Hand-held power tools and equipment.*

(1) Hand-held electrical tools and equipment shall be de-energized before being placed into or retrieved from the water.

(2) Hand-held power tools shall not be supplied with power from the dive location until requested by the diver.

(g) *Welding and burning.*

(1) A current supply switch to interrupt the current flow to the welding or burning electrode shall be:

(i) Tended by a dive team member in voice communication with the diver performing the welding or burning; and

(ii) Kept in the open position except when the diver is welding or burning.

(2) The welding machine frame shall be grounded.

(3) Welding and burning cables, electrode holders, and connections shall be capable of carrying the maximum current required by the work, and shall be properly insulated.

(4) Insulated gloves shall be provided to divers performing welding and burning operations.

(5) Prior to welding or burning on closed compartments, structures or pipes, which contain a flammable vapor or in which a flammable vapor may be generated by the work, they shall be vented, flooded, or purged with a mixture of gases which will not support combustion.

(h) *Explosives.*

(1) Employers shall transport, store, and use explosives in accordance with this section and the applicable provisions of §1910.109 and §1926.912 of Title 29 of the Code of Federal Regulations.

(2) Electrical continuity of explosive circuits shall not be tested until the diver is out of the water.

(3) Explosives shall not be detonated while the diver is in the water.

(i) *Termination of dive.* The working interval of a dive shall be terminated when:

(1) A diver requests termination;

(2) A diver fails to respond correctly to communications or signals from a dive team member;

(3) Communications are lost and can not be quickly re-established between the diver and a dive team member at the dive location, and between the designated person-in-charge and the person controlling the vessel in live boating operations; or

(4) A diver begins to use diver-carried reserve breathing gas or the dive-location reserve breathing gas.

§ 1910.423 Post-dive procedures.

(a) *General.* The employer shall comply with the following requirements which are applicable after each diving operation, unless otherwise specified.

(b) *Precautions.*

(1) After the completion of any dive, the employer shall:

(i) Check the physical condition of the diver;

(ii) Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness;

(iii) Advise the diver of the location of a decompression chamber which is ready for use; and

(iv) Alert the diver to the potential hazards of flying after diving.

(2) For any dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas as a breathing mixture, the employer shall instruct the diver to remain awake and in the vicinity of the decompression chamber which is at the dive location for at least one hour after the dive (including decompression or treatment as appropriate).

(c) *Recompression capability.*

(1) A decompression chamber capable of recompressing the diver at the surface to a minimum of 165 fsw (6 ATA) shall be available at the dive location for:

(i) Surface-supplied air diving to depths deeper than 100 fsw and shallower than 220 fsw;

(ii) Mixed gas diving shallower than 300 fsw; or

(iii) Diving outside the no-decompression limits shallower than 300 fsw.

(2) A decompression chamber capable of recompressing the diver at the surface to the maximum depth of the dive shall be available at the dive location for dives deeper

than 300 fsw.
(3) The decompression chamber shall be:
(i) Dual-lock;
(ii) Multiplace; and
(iii) Located within 5 minutes of the dive location.
(4) The decompression chamber shall be equipped with:
(i) A pressure gauge for each pressurized compartment designed for human occupancy;
(ii) A built-in-breathing-system with a minimum of one mask per occupant;
(iii) A two-way voice communication system between occupants and a dive team member at the dive location;
(iv) A viewport; and
(v) Illumination capability to light the interior.
(5) Treatment tables, treatment gas appropriate to the diving mode, and sufficient gas to conduct treatment shall be available at the dive location.
(6) A dive team member shall be available at the dive location during and for at least one hour after the dive to operate the decompression chamber (when required or provided).
(d) *Record of dive.*
(1) The following information shall be recorded and maintained for each diving operation:
(i) Names of dive team members including designated person-in-charge;
(ii) Date, time, and location;
(iii) Diving modes used;
(iv) General nature of work performed;
(v) Approximate underwater and surface conditions (visibility, water temperature and current); and
(vi) Maximum depth and bottom time for each diver.
(2) For each dive outside the no-decompression limits, deeper than 100 fsw or using mixed gas, the following additional information shall be recorded and maintained:
(i) Depth-time and breathing gas profiles;
(ii) Decompression table designation (including modification); and
(iii) Elapsed time since last pressure exposure if less than 24 hours or repetitive dive designation for each diver.
(3) For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information shall be recorded and maintained:
(i) Description of decompression sickness symptoms (including depth and time of onset); and
(ii) Description and results of treatment.
(e) *Decompression procedure assessment.* The employer shall:
(1) Investigate and evaluate each incident of decompression sickness based on the recorded information, consideration of the past performance of decompression table used, and individual susceptibility;
(2) Take appropriate corrective action to reduce the probability of recurrence of decompression sickness; and
(3) Prepare a written evaluation of the decompression procedure assessment, including any corrective action taken, within 45 days of the incident of decompression sickness.
[42 FR 37668, July 22, 1977, as amended at 49 FR 18295, Apr. 30, 1984]

Specific Operations Procedures

§ 1910.424 SCUBA diving

(a) *General.* Employers engaged in SCUBA diving shall comply with the following requirements, unless otherwise specified.
(b) *Limits.* SCUBA diving shall not be conducted:
(1) At depths deeper than 130 fsw;
(2) At depths deeper than 100 fsw or outside the no-decompression limits unless a decompression chamber is ready for use;
(3) Against currents exceeding one (1) knot unless line-tended; or
(4) In enclosed or physically confining spaces unless line-tended.
(c) *Procedures.*
(1) A standby diver shall be available while a diver is in the water.
(2) A diver shall be line-tended from the surface, or accompanied by another diver in the water in continuous visual contact during the diving operations.
(3) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.

(4) A diver-carried reserve breathing gas supply shall be provided for each diver consisting of:
(i) A manual reserve (J valve); or
(ii) An independent reserve cylinder with a separate regulator or connected to the underwater breathing apparatus.
(5) The valve of the reserve breathing gas supply shall be in the closed position prior to the dive.

§ 1910.425 Surface-supplied air diving.

(a) *General.* Employers engaged in surface-supplied air diving shall comply with the following requirements, unless otherwise specified.
(b) *Limits.*
(1) Surface-supplied air diving shall not be conducted at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw.
(2) A decompression chamber shall be ready for use at the dive location for any dive outside the no-decompression limits or deeper than 100 fsw.
(3) A bell shall be used for dives with an in water decompression time greater than 120 minutes, except when heavy gear is worn or diving is conducted in physically confining spaces.
(c) *Procedures.*
(1) Each diver shall be continuously tended while in the water.
(2) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
(3) Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.
(4) For dives deeper than 100 fsw or outside the no-decompression limits:
(i) A separate dive team member shall tend each diver in the water;
(ii) A standby diver shall be available while a diver is in the water;
(iii) A diver-carried reserve breathing gas supply shall be provided for each diver except when heavy gear is worn; and
(iv) A dive-location reserve breathing gas supply shall be provided.
(5) For heavy-gear diving deeper than 100 fsw or outside the no-decompression limits:
(i) An extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver.
(ii) An in water stage shall be provided to divers in the water.
(6) Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply shall be provided whenever the diver is prevented by the configuration of the dive area from ascending directly to the surface.

§ 1910.426 Mixed-gas diving.

(a) *General.* Employers engaged in mixed-gas diving shall comply with the following requirements, unless otherwise specified.
(b) *Limits.* Mixed-gas diving shall be conducted only when:
(1) A decompression chamber is ready for use at the dive location; and
(i) A bell is used at depths greater than 220 fsw or when the dive involves in water decompression time of greater than 120 minutes, except when heavy gear is worn or when diving in physically confining spaces; or
(ii) A closed bell is used at depths greater than 300 fsw, except when diving is conducted in physically confining spaces.
(c) *Procedures.*
(1) A separate dive team member shall tend each diver in the water.
(2) A standby diver shall be available while a diver is in the water.
(3) A diver shall be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.
(4) Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression.
(5) Each diving operation shall have a dive-location reserve breathing gas supply.
(6) When heavy gear is worn:
(i) An extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver; and
(ii) An in water stage shall be provided to divers in the water.
(7) An in water stage shall be provided for divers without access to a bell for dives deeper than 100 fsw or outside the no-decompression limits.

(8) When a closed bell is used, one dive team member in the bell shall be available and tend the diver in the water.
(9) Except when heavy gear is worn or where physical space does not permit, a diver-carried reserve breathing gas supply shall be provided for each diver:
(i) Diving deeper than 100 fsw or outside the no-decompression limits; or
(ii) Prevented by the configuration of the dive area from directly ascending to the surface.

§ 1910.427   Live boating.

(a) *General.* Employers engaged in diving operations involving live boating shall comply with the following requirements.
(b) *Limits.* Diving operations involving live boating shall not be conducted:
(1) With an in water decompression time of greater than 120 minutes;
(2) Using surface-supplied air at depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;
(3) Using mixed gas at depths greater than 220 fsw;
(4) In rough seas which significantly impede diver mobility or work function; or
(5) In other than daylight hours.
(c) *Procedures.* (1) The propeller of the vessel shall be stopped before the diver enters or exits the water.
(2) A device shall be used which minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.
(3) Two-way voice communication between the designated person-in-charge and the person controlling the vessel shall be available while the diver is in the water.
(4) A standby diver shall be available while a diver is in the water.
(5) A diver-carried reserve breathing gas supply shall be carried by each diver engaged in live boating operations.
Equipment Procedures and Requirements

§ 1910.430   Equipment.

(a) *General.*
(1) All employers shall comply with the following requirements, unless otherwise specified.
(2) Each equipment modification, repair, test, calibration or maintenance service shall be recorded by means of a tagging or logging system, and include the date and nature of work performed, and the name or initials of the person performing the work.
(b) *Air compressor system.*
(1) Compressors used to supply air to the diver shall be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.
(2) Air compressor intakes shall be located away from areas containing exhaust or other contaminants.
(3) Respirable air supplied to a diver shall not contain:
(i) A level of carbon monoxide (CO) greater than 20 p/m;
(ii) A level of carbon dioxide (CO_2) greater than 1,000 p/m;
(iii) A level of oil mist greater than 5 milligrams per cubic meter; or
(iv) A noxious or pronounced odor.
(4) The output of air compressor systems shall be tested for air purity every 6 months by means of samples taken at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist.
(c) *Breathing gas supply hoses.* (1) Breathing gas supply hoses shall:
(i) Have a working pressure at least equal to the working pressure of the total breathing gas system;
(ii) Have a rated bursting pressure at least equal to 4 times the working pressure;
(iii) Be tested at least annually to 1.5 times their working pressure; and
(iv) Have their open ends taped, capped or plugged when not in use.
(2) Breathing gas supply hose connectors shall:
(i) Be made of corrosion-resistant materials;
(ii) Have a working pressure at least equal to the working pressure of the hose to which they are attached; and
(iii) Be resistant to accidental disengagement.
(3) Umbilicals shall:
(i) Be marked in 10-ft. increments to 100 feet beginning at the diver's end, and in 50 ft. increments thereafter;
(ii) Be made of kink-resistant materials; and
(iii) Have a working pressure greater than the pressure equivalent to the maximum depth of the dive (relative

to the supply source) plus 100 psi.
(d) *Buoyancy control.*
(1) Helmets or masks connected directly to the dry suit or other buoyancy-changing equipment shall be equipped with an exhaust valve.
(2) A dry suit or other buoyancy-changing equipment not directly connected to the helmet or mask shall be equipped with an exhaust valve.
(3) When used for SCUBA diving, a buoyancy compensator shall have an inflation source separate from the breathing gas supply.
(4) An inflatable flotation device capable of maintaining the diver at the surface in a face-up position, having a manually activated inflation source independent of the breathing supply, an oral inflation device, and an exhaust valve shall be used for SCUBA diving.
(e) *Compressed gas cylinders.* Compressed gas cylinders shall:
(1) Be designed, constructed and maintained in accordance with the applicable provisions of 29 CFR 1910.101 and 1910.169 through 1910.171.
(2) Be stored in a ventilated area and protected from excessive heat;
(3) Be secured from falling; and
(4) Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded, or when used for SCUBA diving.
(f) *Decompression chambers.* (
1) Each decompression chamber manufactured after the effective date of this standard, shall be built and maintained in accordance with the ASME Code or equivalent.
(2) Each decompression chamber manufactured prior to the effective date of this standard shall be maintained in conformity with the code requirements to which it was built, or equivalent.
(3) Each decompression chamber shall be equipped with:
(i) Means to maintain the atmosphere below a level of 25
percent oxygen by volume;
(ii) Mufflers on intake and exhaust lines, which shall be regularly inspected and maintained;
(iii) Suction guards on exhaust line openings; and
(iv) A means for extinguishing fire, and shall be maintained to minimize sources of ignition and combustible material.
(g) *Gauges and timekeeping devices.* (
1) Gauges indicating diver depth which can be read at the dive location shall be used for all dives except SCUBA.
(2) Each depth gauge shall be deadweight tested or calibrated against a master reference gauge every 6 months, and when there is a discrepancy greater than two percent (2 percent) of full scale between any two equivalent gauges.
(3) A cylinder pressure gauge capable of being monitored by the diver during the dive shall be worn by each SCUBA diver.
(4) A timekeeping device shall be available at each dive location.
(h) *Masks and helmets.*
(1) Surface-supplied air and mixed-gas masks and helmets shall have:
(i) A non-return valve at the attachment point between helmet or mask and hose which shall close readily and positively; and
(ii) An exhaust valve.
(2) Surface-supplied air masks and helmets shall have a minimum ventilation rate capability of 4.5 Acfm at any depth at which they are operated or the capability of maintaining the diver's inspired carbon dioxide partial pressure below 0.02 ATA when the diver is producing carbon dioxide at the rate of 1.6 standard liters per minute.
(i) *Oxygen safety.*
(1) Equipment used with oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be designed for oxygen service.
(2) Components (except umbilicals) exposed to oxygen or mixtures containing over forty percent (40%) by volume oxygen shall be cleaned of flammable materials before use.
(3) Oxygen systems over 125 psig and compressed air systems over 500 psig shall have slow-opening shut-off valves.
(j) *Weights and harnesses.*
(1) Except when heavy gear is worn, divers shall be equipped with a weight belt or assembly capable of quick release.
(2) Except when heavy gear is worn or in SCUBA diving, each diver shall wear a safety harness with:

(i) A positive buckling device;
(ii) An attachment point for the umbilical to prevent strain on the mask or helmet; and
(iii) A lifting point to distribute the pull force of the line over the diver's body.
[39 FR 23502, June 27, 1974, as amended at 49 FR 18295, Apr. 30, 1984; 51 FR 33033, Sept. 18, 1986]

Recordkeeping

§ 1910.440 Recordkeeping requirements.

(a)(1) [Reserved]
(2) The employer shall record the occurrence of any diving-related injury or illness which requires any dive team member to be hospitalized for 24 hours or more, specifying the circumstances of the incident and the extent of any injuries or illnesses.
(b) *Availability of records.*
(1) Upon the request of the Assistant Secretary of Labor for Occupational Safety and Health, or the Director, National Institute for Occupational Safety and Health, Department of Health and Human Services of their designees, the employer shall make available for inspection and copying any record or document required by this standard.
(2) Records and documents required by this standard shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.1020 (a)–(e) and (g)–(i). Safe practices manuals (§1910.420), depth-time profiles (§1910.422), recordings of dives (§1910.423), decompression procedure assessment evaluations (§1910.423), and records of hospitalizations (§1910.440) shall be provided in the same manner as employee exposure records or analyses using exposure or medical records. Equipment inspections and testing records which pertain to employees (§1910.430) shall also be provided upon request to employees and their designated representatives.
(3) Records and documents required by this standard shall be retained by the employer for the following period:
(i) Dive team member medical records (physician's reports) (§1910.411)—5 years;
(ii) Safe practices manual (§1910.420)—current document only;
(iii) Depth-time profile (§1910.422)—until completion of the recording of dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness;
(iv) Recording of dive (§1910.423)—1 year, except 5 years where there has been an incident of decompression sickness;
(v) Decompression procedure assessment evaluations (§1910.423)—5 years;
(vi) Equipment inspections and testing records (§1910.430)—current entry or tag, or until equipment is withdrawn from service;
(vii) Records of hospitalizations (§1910.440)—5 years.
(4) After the expiration of the retention period of any record required to be kept for five (5) years, the employer shall forward such records to the National Institute for Occupational Safety and Health, Department of Health and Human Services. The employer shall also comply with any additional requirements set forth at 29 CFR 1910.20(h).
(5) In the event the employer ceases to do business:
(i) The successor employer shall receive and retain all dive and employee medical records required by this standard; or
(ii) If there is no successor employer, dive and employee medical records shall be forwarded to the National Institute for Occupational Safety and Health, Department of Health and Human Services.
[42 FR 37668, July 22, 1977, as amended at 45 FR 35281, May 23, 1980; 47 FR 14706, Apr. 6, 1982; 51 FR 34562, Sept. 29, 1986; 61 FR 9242, Mar. 7, 1996; 71 FR 16672, Apr. 3, 2006]

Appendix A to Subpart T to Part 1910—Examples of Conditions Which May Restrict or Limit Exposure to Hyperbaric Conditions

The following disorders may restrict or limit occupational exposure to hyperbaric conditions depending on severity, presence of residual effects, response to therapy, number of occurrences, diving mode, or degree and duration of isolation.

History of seizure disorder other than early febrile convulsions

Malignancies (active) unless treated and without recurrence for 5 yrs. Chronic inability to equalize sinus and/or middle ear pressure. Cystic or cavitary disease of the lungs. Impaired organ function caused by alcohol or drug use. Conditions requiring continuous medication for control (e.g., antihistamines, steroids, barbiturates, mood altering drugs, or insulin).

Meniere's disease

Hemoglobinopathies

Obstructive or restrictive lung disease

Vestibular end organ destruction

Pneumothorax

Cardiac abnormalities (e.g., pathological heart block, valvular disease, intraventricular conduction defects other than isolated right bundle branch block, angina pectoris, arrhythmia, coronary artery disease).

Juxta-articular osteonecrosis

Appendix B to Subpart T to Part 1910—Guidelines for Scientific Diving

This appendix contains guidelines that will be used in conjunction with §1910.401(a)(2)(iv) to determine those scientific diving programs which are exempt from the requirements for commercial diving. The guidelines are as follows:

1. The Diving Control Board consists of a majority of active scientific divers and has autonomous and absolute authority over the scientific diving program's operations.
2. The purpose of the project using scientific diving is the advancement of science; therefore, information and data resulting from the project are non-proprietary.
3. The tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks traditionally associated with commercial diving are not included within scientific diving.
4. Scientific divers, based on the nature of their activities, must use scientific expertise in studying the underwater environment and, therefore, are scientists or scientists in training.

[50 FR 1050, Jan. 9, 1985]

Appendix C to Subpart T to Part 1910—Alternative Conditions Under §1910.401(a)(3) for Recreational Diving Instructors and Diving Guides (Mandatory)

Paragraph (a)(3) of §1910.401 specifies that an employer of recreational diving instructors and diving guides (hereafter, “divers” or “employees”) who complies with all of the conditions of this appendix need not provide a decompression chamber for these divers as required under §§1910.423(b)(2) or (c)(3) or 1910.426(b)(1).

1. Equipment Requirements for Rebreathers

(a) The employer must ensure that each employee operates the rebreather (i.e*.,* semi-closed-circuit and closed-circuit self-contained underwater breathing apparatuses (hereafter, “SCUBAs”)) according to the rebreather manufacturer's instructions.

(b) The employer must ensure that each rebreather has a counter lung that supplies a sufficient volume of breathing gas to their divers to sustain the divers' respiration rates, and contains a baffle system and/or other moisture separating system that keeps moisture from entering the scrubber.

(c) The employer must place a moisture trap in the breathing loop of the rebreather, and ensure that:

(i) The rebreather manufacturer approves both the moisture trap and its location in the breathing loop; and

(ii) Each employee uses the moisture trap according to the rebreather manufacturer's instructions.

(d) The employer must ensure that each rebreather has a continuously functioning moisture sensor, and that:

(i) The moisture sensor connects to a visual (*e.g.,* digital, graphic, analog) or auditory (*e.g.,* voice, pure tone) alarm that is readily detectable by the diver under the diving conditions in which the diver operates, and warns the diver of moisture in the breathing loop in sufficient time to terminate the dive and return safely to the surface; and

(ii) Each diver uses the moisture sensor according to the rebreather manufacturer's instructions.

(e) The employer must ensure that each rebreather contains a continuously functioning CO_2sensor in the breathing loop, and that:

(i) The rebreather manufacturer approves the location of the CO_2sensor in the breathing loop;

(ii) The CO_2sensor is integrated with an alarm that operates in a visual (e.g*.,* digital, graphic, analog) or auditory (e.g*.,* voice, pure tone) mode that is readily detectable by each diver under the diving conditions in

which the diver operates; and
(iii) The CO_2 alarm remains continuously activated when the inhaled CO_2 level reaches and exceeds 0.005 atmospheres absolute (ATA).
(f) Before each day's diving operations, and more often when necessary, the employer must calibrate the CO_2 sensor according to the sensor manufacturer's instructions, and ensure that:
(i) The equipment and procedures used to perform this calibration are accurate to within 10% of a CO_2 concentration of 0.005 ATA or less;
(ii) The equipment and procedures maintain this accuracy as required by the sensor manufacturer's instructions; and
(iii) The calibration of the CO_2 sensor is accurate to within 10% of a CO_2 concentration of 0.005 ATA or less.
(g) The employer must replace the CO_2 sensor when it fails to meet the accuracy requirements specified in paragraph 1
(f)(iii) of this appendix, and ensure that the replacement CO_2 sensor meets the accuracy requirements specified in paragraph 1(f)(iii) of this appendix before placing the rebreather in operation.
(h) As an alternative to using a continuously functioning CO_2 sensor, the employer may use a schedule for replacing CO_2-sorbent material provided by the rebreather manufacturer. The employer may use such a schedule only when the rebreather manufacturer has developed it according to the canister-testing protocol specified below in Condition 11, and must use the canister within the temperature range for which the manufacturer conducted its scrubber canister tests following that protocol. Variations above or below the range are acceptable only after the manufacturer adds that lower or higher temperature to the protocol.
(i) When using CO_2-sorbent replacement schedules, the employer must ensure that each rebreather uses a manufactured (*i.e.,* commercially pre-packed), disposable scrubber cartridge containing a CO_2-sorbent material that:
(i) Is approved by the rebreather manufacturer;
(ii) Removes CO_2 from the diver's exhaled gas; and
(iii) Maintains the CO_2 level in the breathable gas (*i.e.,* the gas that a diver inhales directly from the regulator) below a partial pressure of 0.01 ATA.
(j) As an alternative to manufactured, disposable scrubber cartridges, the employer may fill CO_2 scrubber cartridges manually with CO_2-sorbent material when:
(i) The rebreather manufacturer permits manual filling of scrubber cartridges;
(ii) The employer fills the scrubber cartridges according to the rebreather manufacturer's instructions;
(iii) The employer replaces the CO_2-sorbent material using a replacement schedule developed under paragraph 1(h) of this appendix; and
(iv) The employer demonstrates that manual filling meets the requirements specified in paragraph 1(i) of this appendix.
(k) The employer must ensure that each rebreather has an information module that provides:
(i) A visual (e.g*.,* digital, graphic, analog) or auditory (e.g*.,* voice, pure tone) display that effectively warns the diver of solenoid failure (when the rebreather uses solenoids) and other electrical weaknesses or failures (e.g*.,* low battery voltage);
(ii) For a semi-closed circuit rebreather, a visual display for the partial pressure of CO_2, or deviations above and below a preset CO_2 partial pressure of 0.005 ATA; and
(iii) For a closed-circuit rebreather, a visual display for: partial pressures of O_2 and CO_2, or deviations above and below a preset CO_2 partial pressure of 0.005 ATA and a preset O_2 partial pressure of 1.40 ATA or lower; gas temperature in the breathing loop; and water temperature.
(l) Before each day's diving operations, and more often when necessary, the employer must ensure that the electrical power supply and electrical and electronic circuits in each rebreather are operating as required by the rebreather manufacturer's instructions.
2. Special Requirements for Closed-Circuit Rebreathers
(a) The employer must ensure that each closed-circuit rebreather uses supply-pressure sensors for the O_2 and diluent (i.e*.,* air or nitrogen) gases and continuously functioning sensors for detecting temperature in the inhalation side of the gas-loop and the ambient water.
(b) The employer must ensure that:
(i) At least two O_2 sensors are located in the inhalation side of the breathing loop; and
(ii) The O_2 sensors are: functioning continuously; temperature compensated; and approved by the rebreather manufacturer.
(c) Before each day's diving operations, and more often when necessary, the employer must calibrate O_2 sensors as required by the sensor manufacturer's instructions. In doing so, the employer must:
(i) Ensure that the equipment and procedures used to perform the calibration are accurate to within 1% of the O_2 fraction by volume;

(ii) Maintain this accuracy as required by the manufacturer of the calibration equipment;
(iii) Ensure that the sensors are accurate to within 1% of the O_2 fraction by volume;
(iv) Replace O_2 sensors when they fail to meet the accuracy requirements specified in paragraph 2(c)(iii) of this appendix; and
(v) Ensure that the replacement O_2 sensors meet the accuracy requirements specified in paragraph 2(c)(iii) of this appendix before placing a rebreather in operation.
(d) The employer must ensure that each closed-circuit rebreather has:
(i) A gas-controller package with electrically operated solenoid O_2-supply valves;
(ii) A pressure-activated regulator with a second-stage diluent-gas addition valve;
(iii) A manually operated gas-supply bypass valve to add O_2 or diluent gas to the breathing loop; and
(iv) Separate O_2 and diluent-gas cylinders to supply the breathing-gas mixture.
3. O_2 Concentration in the Breathing Gas
The employer must ensure that the fraction of O_2 in the nitrox breathing-gas mixture:
(a) Is greater than the fraction of O_2 in compressed air (*i.e.,* exceeds 22% by volume);
(b) For open-circuit SCUBA, never exceeds a maximum fraction of breathable O_2 of 40% by volume or a maximum O_2 partial pressure of 1.40 ATA, whichever exposes divers to less O_2; and
(c) For a rebreather, never exceeds a maximum O_2 partial pressure of 1.40 ATA.
4. Regulating O_2 Exposures and Diving Depth
(a) Regarding O_2 exposure, the employer must:
(i) Ensure that the exposure of each diver to partial
pressures of O_2 between 0.60 and 1.40 ATA does not exceed the 24-hour single-exposure time limits specified either by the 2001 National Oceanic and Atmospheric Administration Diving Manual (the “2001 NOAA Diving Manual”), or by the report entitled “Enriched Air Operations and Resource Guide” published in 1995 by the Professional Association of Diving Instructors (known commonly as the “1995 DSAT Oxygen Exposure Table”); and
(ii) Determine a diver's O_2-exposure duration using the diver's maximum O_2 exposure (partial pressure of O_2) during the dive and the total dive time (i.e*.,* from the time the diver leaves the surface until the diver returns to the surface).
(b) Regardless of the diving equipment used, the employer must ensure that no diver exceeds a depth of 130 feet of sea water (“fsw”) or a maximum O_2 partial pressure of 1.40 ATA, whichever exposes the diver to less O_2.
5. Use of No-Decompression Limits
(a) For diving conducted while using nitrox breathing-gas mixtures, the employer must ensure that each diver remains within the no-decompression limits specified for single and repetitive air diving and published in the 2001 NOAA Diving Manual or the report entitled “Development and Validation of No-Stop Decompression Procedures for Recreational Diving: The DSAT Recreational Dive Planner,” published in 1994 by Hamilton Research Ltd. (known commonly as the “1994 DSAT No-Decompression Tables”).
(b) An employer may permit a diver to use a dive-decompression computer designed to regulate decompression when the dive-decompression computer uses the no-decompression limits specified in paragraph 5(a) of this appendix, and provides output that reliably represents those limits.
6. Mixing and Analyzing the Breathing Gas
(a) The employer must ensure that:
(i) Properly trained personnel mix nitrox-breathing gases, and that nitrogen is the only inert gas used in the breathing-gas mixture; and
(ii) When mixing nitrox-breathing gases, they mix the appropriate breathing gas before delivering the mixture to the breathing-gas cylinders, using the continuous-flow or partial-pressure mixing techniques specified in the 2001 NOAA Diving Manual, or using a filter-membrane system.
(b) Before the start of each day's diving operations, the employer must determine the O_2 fraction of the breathing-gas mixture using an O_2 analyzer. In doing so, the employer must:
(i) Ensure that the O_2 analyzer is accurate to within 1% of the O_2 fraction by volume.
(ii) Maintain this accuracy as required by the manufacturer of the analyzer.
(c) When the breathing gas is a commercially supplied nitrox breathing-gas mixture, the employer must ensure that the O_2 meets the medical USP specifications (Type I, Quality Verification Level A) or aviator's breathing-oxygen specifications (Type I, Quality Verification Level E) of CGA G–4.3–2000 (“Commodity Specification for Oxygen”). In addition, the commercial supplier must:
(i) Determine the O_2 fraction in the breathing-gas mixture using an analytic method that is accurate to within 1% of the O_2 fraction by volume;
(ii) Make this determination when the mixture is in the charged tank and after disconnecting the charged tank from the charging apparatus;

(iii) Include documentation of the O_2-analysis procedures and the O_2 fraction when delivering the charged tanks to the employer.
(d) Before producing nitrox breathing-gas mixtures using a compressor in which the gas pressure in any system component exceeds 125 pounds per square inch (psi), the:
(i) Compressor manufacturer must provide the employer with documentation that the compressor is suitable for mixing high-pressure air with the highest O_2 fraction used in the nitrox breathing-gas mixture when operated according to the manufacturer's operating and maintenance specifications;
(ii) Employer must comply with paragraph 6(e) of this appendix, unless the compressor is rated for O_2 service and is oil-less or oil-free; and
(iii) Employer must ensure that the compressor meets the requirements specified in paragraphs (i)(1) and (i)(2) of §1910.430 whenever the highest O_2 fraction used in the mixing process exceeds 40%.
(e) Before producing nitrox breathing-gas mixtures using an oil-lubricated compressor to mix high-pressure air with O_2, and regardless of the gas pressure in any system component, the:
(i) Employer must use only uncontaminated air (i.e*.,* air containing no hydrocarbon particulates) for the nitrox breathing-gas mixture;
(ii) Compressor manufacturer must provide the employer with documentation that the compressor is suitable for mixing the high-pressure air with the highest O_2 fraction used in the nitrox breathing-gas mixture when operated according to the manufacturer's operating and maintenance specifications;
(iii) Employer must filter the high-pressure air to produce O_2-compatible air;
(iv) The filter-system manufacturer must provide the employer with documentation that the filter system used for this purpose is suitable for producing O_2-compatible air when operated according to the manufacturer's operating and maintenance specifications; and
(v) Employer must continuously monitor the air downstream from the filter for hydrocarbon contamination.
(f) The employer must ensure that diving equipment using nitrox breathing-gas mixtures or pure O_2 under high pressure (*i.e.,* exceeding 125 psi) conforms to the O_2-service requirements specified in paragraphs (i)(1) and (i)(2) of §1910.430.
7. Emergency Egress
(a) Regardless of the type of diving equipment used by a diver (i.e*.,* open-circuit SCUBA or rebreathers), the employer must ensure that the equipment contains (or incorporates) an open-circuit emergency-egress system (a “bail-out” system) in which the second stage of the regulator connects to a separate supply of emergency breathing gas, and the emergency breathing gas consists of air or the same nitrox breathing-gas mixture used during the dive.
(b) As an alternative to the “bail-out” system specified in paragraph 7(a) of this appendix, the employer may use:
(i) For open-circuit SCUBA, an emergency-egress system as specified in §1910.424(c)(4); or
(ii) For a semi-closed-circuit and closed-circuit rebreather, a system configured so that the second stage of the regulator connects to a reserve supply of emergency breathing gas.
(c) The employer must obtain from the rebreather manufacturer sufficient information to ensure that the bail-out system performs reliably and has sufficient capacity to enable the diver to terminate the dive and return safely to the surface.
8. Treating Diving-Related Medical Emergencies
(a) Before each day's diving operations, the employer must:
(i) Verify that a hospital, qualified health-care professionals, and the nearest Coast Guard Coordination Center (or an equivalent rescue service operated by a state, county, or municipal agency) are available to treat diving-related medical emergencies;
(ii) Ensure that each dive site has a means to alert these treatment resources in a timely manner when a diving-related medical emergency occurs; and
(iii) Ensure that transportation to a suitable decompression chamber is readily available when no decompression chamber is at the dive site, and that this transportation can deliver the injured diver to the decompression chamber within four (4) hours travel time from the dive site.
(b) The employer must ensure that portable O_2 equipment is available at the dive site to treat injured divers. In doing so, the employer must ensure that:
(i) The equipment delivers medical-grade O_2 that meets the requirements for medical USP oxygen (Type I, Quality Verification Level A) of CGA G–4.3–2000 (“Commodity Specification for Oxygen”);
(ii) The equipment delivers this O_2 to a transparent mask that covers the injured diver's nose and mouth; and
(iii) Sufficient O_2 is available for administration to the injured diver from the time the employer recognizes the symptoms of a diving-related medical emergency until the injured diver reaches a decompression chamber for treatment.
(c) Before each day's diving operations, the employer must:

(i) Ensure that at least two attendants, either employees or non-employees, qualified in first-aid and administering O_2 treatment, are available at the dive site to treat diving-related medical emergencies; and

(ii) Verify their qualifications for this task.

9. Diving Logs and No-Decompression Tables

(a) Before starting each day's diving operations, the employer must:

(i) Designate an employee or a non-employee to make entries in a diving log; and

(ii) Verify that this designee understands the diving and medical terminology, and proper procedures, for making correct entries in the diving log.

(b) The employer must:

(i) Ensure that the diving log conforms to the requirements specified by paragraph (d) ("Record of dive") of §1910.423; and

(ii) Maintain a record of the dive according to §1910.440 ("Recordkeeping requirements").

(c) The employer must ensure that a hard-copy of the no-decompression tables used for the dives (as specified in paragraph 6(a) of this appendix) is readily available at the dive site, whether or not the divers use dive-decompression computers.

10. Diver Training

The employer must ensure that each diver receives training that enables the diver to perform work safely and effectively while using open-circuit SCUBAs or rebreathers supplied with nitrox breathing-gas mixtures. Accordingly, each diver must be able to demonstrate the ability to perform critical tasks safely and effectively, including, but not limited to: recognizing the effects of breathing excessive CO_2 and O_2; taking appropriate action after detecting excessive levels of CO_2 and O_2; and properly evaluating, operating, and maintaining their diving equipment under the diving conditions they encounter.

11. Testing Protocol for Determining the CO_2 Limits of Rebreather Canisters

(a) The employer must ensure that the rebreather manufacturer has used the following procedures for determining that the CO_2-sorbent material meets the specifications of the sorbent material's manufacturer:

(i) The North Atlantic Treating Organization CO_2 absorbent-activity test;

(ii) The RoTap shaker and nested-sieves test;

(iii) The Navy Experimental Diving Unit ("NEDU")-derived Schlegel test; and

(iv) The NEDU MeshFit software.

(b) The employer must ensure that the rebreather manufacturer has applied the following canister-testing materials, methods, procedures, and statistical analyses:

(i) Use of a nitrox breathing-gas mixture that has an O_2 fraction maintained at 0.28 (equivalent to 1.4 ATA of O_2 at 130 fsw, the maximum O_2 concentration permitted at this depth);

(ii) While operating the rebreather at a maximum depth of 130 fsw, use of a breathing machine to continuously ventilate the rebreather with breathing gas that is at 100% humidity and warmed to a temperature of 98.6 degrees F (37 degrees C) in the heating-humidification chamber;

(iii) Measurement of the O_2 concentration of the inhalation breathing gas delivered to the mouthpiece;

(iv) Testing of the canisters using the three ventilation rates listed in Table I below (with the required breathing-machine tidal volumes and frequencies, and CO_2-injection rates, provided for each ventilation rate):

Table I—Canister Testing Parameters

Ventilation rates (Lpm, ATPS[1])	**Breathing machine tidal volumes (L)**	**Breathing machine frequencies (breaths per min.)**	**CO_2 injection rates (Lpm, STPD[2])**
22.5	1.5	15	0.90
40.0	2.0	20	1.35
62.5	2.5	25	2.25

[1] ATPS means ambient temperature and pressure, saturated with water.

[2] STPD means standard temperature and pressure, dry; the standard temperature is 32 degrees F (0 degrees C).

(v) When using a work rate (*i.e.,* breathing-machine tidal volume and frequency) other than the work rates listed in the table above, addition of the appropriate combinations of ventilation rates and CO_2-injection rates;

(vi) Performance of the CO_2 injection at a constant (steady) and continuous rate during each testing trial;

(vii) Determination of canister duration using a minimum of four (4) water temperatures, including 40, 50, 70, and 90 degrees F (4.4, 10.0, 21.1, and 32.2 degrees C, respectively);

(viii) Monitoring of the breathing-gas temperature at the rebreather mouthpiece (at the “chrome T” connector), and ensuring that this temperature conforms to the temperature of a diver's exhaled breath at the water temperature and ventilation rate used during the testing trial;[1]

[1] NEDU can provide the manufacturer with information on the temperature of a diver's exhaled breath at various water temperatures and ventilation rates, as well as techniques and procedures used to maintain these temperatures during the testing trials.

(ix) Implementation of at least eight (8) testing trials for each combination of temperature and ventilation-CO_2-injection rates (for example, eight testing trials at 40 degrees F using a ventilation rate of 22.5 Lpm at a CO_2-injection rate of 0.90 Lpm);

(x) Allowing the water temperature to vary no more than ± 2.0 degrees F (± 1.0 degree C) *between* each of the eight testing trials, and no more than ± 1.0 degree F (± 0.5 degree C) *within* each testing trial;

(xi) Use of the average temperature for each set of eight testing trials in the statistical analysis of the testing-trial results, with the testing-trial results being the time taken for the inhaled breathing gas to reach 0.005 ATA of CO_2(*i.e.,* the canister-duration results);

(xii) Analysis of the canister-duration results using the repeated-measures statistics described in NEDU Report 2–99;

(xiii) Specification of the replacement schedule for the CO_2-sorbent materials in terms of the lower prediction line (or limit) of the 95% confidence interval; and

(xiv) Derivation of replacement schedules only by interpolating among, but not by extrapolating beyond, the depth, water temperatures, and exercise levels used during canister testing.

[69 FR 7363, Feb. 17, 2004]

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Appendix L: EM 385-1-1 CH. 30

SECTION 30

Diving Operations

30.A General. All USACE diving operations, both government and contractor shall be performed in accordance with this manual. Failure to meet these requirements will be cause for rejection or cessation of operations.

30.A.01 *Unless otherwise delegated in this section*, requests for waivers or variance to the requirements of this section must be made in accordance with Appendix D of this manual through the local Designated Dive Coordinator (DDC) or the Alternate Dive Coordinator (ADC) acting on their behalf.

30.A.02 *Diving shall not be used* as a work method if the work objective can be more safely and efficiently accomplished by another means, including but not limited to, using Remotely Operated Vehicles (ROV's), and/or camera systems, or by dewatering the work area so work may be accomplished in the dry.

30.A.03 *Surface-Supplied Air (SSA)* shall be used whenever possible in accordance with the practical constraints of the diving operations.

30.A.04 Live boating will not be used without prior specific acceptance by the DDC.

30.A.05 *Training documentation shall be in compliance* with the OSHA Diving Standards 29 CFR 1910.410 and shall show that dive team members, including dive tenders, have successfully completed training to the appropriate level (e.g., SSA diver's certificate, surface supplied mixed-gas diver certificate). Copies of all dive-related training certificates are required. Such training shall be provided by:

a. A commercial diving school, military school, Federal school (e.g., USACE), or an Association of Commercial Diving Educators (ACDE) accredited school;

b. An in-house training program that meets the requirements contained in ANSI/ACDE01, or in the Association of Diving Contractors International (ADCI) Consensus Standards;

c. Training for Scientific Divers using compressed air (SCUBA or SSA), shall be in compliance with 29 CFR 1910.410 and shall meet the above requirements or the training guidelines in the Standards for Scientific Diving published by the American Academy of Underwater Scientists (AAUS).

30.A.06 Proof of certification (a diploma and/or official transcript) as a commercial working diver from an accredited commercial dive school and other dive-related training certificates (e.g. chamber operator, saturation diver, etc.) are required as proof of a dive team member's certification and/or experience. An ADCI card or similar certification from an internationally recognized commercial diving organization may be substituted as proof of training for divers demonstrating more than five (5) years of diving experience within the six (6) years preceding beginning of dive operations.

30.A.07 Contractors shall provide dive-log evidence that each dive team member has training and experience consistent with the performance requirements of the scope of work.

a. As a minimum, each diver, back-up diver, and dive team supervisor shall have at least 1 year of commercial experience in the applicable position.

b. Divers shall have completed at least 4 working dives with similar decompression techniques as in the dive plan, using the particular diving techniques and equipment. Divers shall demonstrate that at least 1 of the 4 qualification dives was performed in the last 9 months prior to the start of dive operations.

c. Dive tenders must have previous experience and training as a dive tender.

30.A.08 Each dive team member shall have current certification in first aid and CPR from the American Red Cross (ARC), the American Heart Association (AHA), or from an organization whose training adheres to the standards of the International Liaison Committee on Resuscitation, or from a Licensed Physician (LP).

a. Additionally, each dive team member shall have current certification in the use of emergency oxygen systems, and, if provided on the dive site, the use of Automated External Defibrillators (AEDs).

b. All classes shall contain a hands-on component and cannot be taken online. Evidence of this will be a photocopy of the certificates. The certificate(s) shall state the date of issue and length of validity.

Note: Training in the use of emergency oxygen systems shall be specific to underwater diving and shall meet the requirements of a nationally recognized training organization such as Divers Alert Network (DAN), Professional Association of Diving Instructors (PADI), National Association of Underwater Instructor s (NAUI), the YMCA or other recognized sources.

30.A.09 Divers shall receive an annual diving physical according to ADCI or similar standards preferably by a hyperbaric physician (MD or DO) or other licensed physician knowledgeable in the physiology of diving.

a. A "Fit to Dive" statement that each diver has been medically examined within the previous 12 months and has been determined fit and approved to dive shall be signed and signature stamped by the examining physician.

b. The DDC will maintain a file of physician "Fit to Dive" statement for all USACE qualified divers.

c. Contractors shall submit physician's "Fit to Dive" statement to the DDC in accordance with Section 30.A.13.

d. After any serious diving-related injury or illness such as an over-pressurization injury and/or decompression illness, divers shall be re-examined by a hyperbaric physician and be re-certified as "Fit to Dive".

30.A.10 Divers will wait at least 12 hours before flying after any dive. This interval should be extended to 24 hours following multiple days of repetitive dives.

30.A.11 When diving at altitudes of 1000 ft. (304.8 m) or more of elevation above sea level, dive supervisors shall use appropriate high-altitude decompression tables that compensate for the increased elevation.

30.A.12 Contract diving operations will be monitored and/or inspected by personnel qualified as USACE Dive Inspectors. Individual USACE Dive teams shall be inspected during operations at least once annually by the DDC, ADC and/or Dive Safety Representative (DSR).

a. Qualified Dive Inspectors shall hold current USACE training certification as Dive Inspector, Diver/ Dive Supervisor, Dive Safety Administrator, or Dive Coordinator. All USACE personnel used as dive inspectors must be approved by the DDC prior to performing inspector duties.

Note: Use of trained monitors/inspectors with other credentials will be considered on a case-by-case basis and may be approved in writing by the DDC and HQUSACE Program Manager (PM) for Diving Safety.

b. Inspectors shall conduct on-site monitoring/inspections of contractor dive sites during pre-dive conference, equipment inspection, and initial dives. Monitoring should be continuous for the duration of the contract dive activity but may be intermittent, as determined by the DDC based on an evaluation of the job complexity and degree of hazards.

30.A.13 The following documents are required for all Contractor diving operations. All documents will be reviewed and found acceptable by two of the following: DDC/ADC/DSR, prior to start of diving operations. Contractors shall submit the documents to the DDC through the Contracting Officer (KO). Additional documentation may be required depending on the scope of the diving operation:

a. Safe Practices Manual; > See Section 30.A.15.
b. Dive Operations Plan(s); > See Section 30.A.16.
c. AHA to cover all aspects of the job; > See Section 30.A.17.
d. Emergency Management Plan; > See Section 30.A.18.
e. Dive Personnel Qualifications. > See Sections 30.A.05 – 30.A.09.

Note: The above review requirement is that two USACE Qualified Personnel independently evaluate the documents prior to acceptance. The ADC may substitute for either the DDC or DSR in the review and/or acceptance process if these personnel are not available at the time of review.

30.A.14 A Dive Operations Plan, AHA, emergency management plan, and personnel list with qualifications will be developed for each separate diving operation.

a. These documents will be submitted to the DDC through the KO for review, and found acceptable, prior to commencement of diving operations and will be at the diving location at all times. Each of these documents will become a part of the project file.

b. Potential high-hazard conditions, such as penetration diving, contaminated environment diving, dives outside the no decompression limits, and in areas where differential pressure entrapment hazards exist, will be specifically addressed in the Dive Operations Plan and AHA when they are anticipated as part of the diving operation.

c. Diving in contaminated water is prohibited for all USACE projects unless supporting documentation is provided that demonstrates that divers and topside personnel are not exposed to, or will be protected from, known or potential contamination hazards that would pose a chronic or acute health risk.

(1) All divers and topside personnel shall be trained, equipped and resourced to dive in contaminated water.

(2) The dive plan shall be accepted by the GDA within 10 business days prior to dive operations and shall specifically address the areas below in accordance with the U.S. Navy Guidance for Diving In Contaminated Waters, SS521-AJ-PRO-010 located at the U.S. Navy SEA 00C3 website:

(i) Types of contaminants and Category (CAT 1, 2, 3, 4). Additional hazard scenarios and control measures shall be considered for surface, mud-line/sediment, rainfall, points of discharge, and vertical and bottom water contamination (i.e., a diver walking/crawling/working including swim fin action that stirs up bottom sediments);

(ii) Levels of protection and protective equipment;

(iii) Contaminated water diver and topside personnel training and qualifications;

(iv) Sources of information used to determine water quality;

(v) Dive Station Decontamination Procedures for Divers and Topside Personnel;

(vi) Medical evaluation support and post dive monitoring;

(vii) Hazardous waste minimization and disposal.

30.A.15 Safe Practices Manual. Contractors and USACE Districts/Labs with in-house dive teams shall develop and maintain a safe practices manual that encompasses their entire diving program. The safe practices manual shall be available at all times to the Government representative and all dive team members at each diving location. The safe practices manual shall include, as a minimum, the following:

a. Dive safety procedures and checklists;

b. Assignments and responsibilities of dive team members;

c. Equipment certifications, procedures, and inspection checklists;

d. Emergency procedures for fire, equipment failure, adverse weather conditions, and medical illness or injury and specific procedures for:

(1) Entrapped or fouled diver including fouled umbilical (suction and entanglement/debris);

(2) Actions upon loss of vital support equipment;

(3) Actions upon loss of gas supply;

(4) Action upon loss of communication;

(5) Lost diver plan (SCUBA Operations only);

(6) Injured diver plan;

(7) Actions upon discovery of fire;

(8) Diver blow up/over rapid ascent to surface;

(9) Diver loss of consciousness; and

(10) Injury/illness of member of surface crew with diver in the water.

e. Procedures for internal safety inspections (frequency, checklists, etc.);

f. A complete copy of OSHA, 29 CFR 1910, Subpart T, and a statement of the employer's policy for ensuring compliance with the standard;

g. The appropriate U.S. Navy Table(s), including as a minimum:

(1) U.S. Navy Table of No-Decompression Limits and Repetitive Group Designation for No-Decompression Air Dives;

(2) U.S. Navy Residual Nitrogen Timetables for Repetitive Air Dives;

(3) U.S. Navy Standard Air Decompression Table.

h. A sample of the diving log sheets to be used;

i. A sample of the repetitive dive worksheets or equivalent (dive profile method) to be used;

j. An outline of the fitness for duty (including medical) requirements for dive team members, and

k. An outline of administrative and record-keeping procedures.

30.A.16 Dive Operations Plan. This plan is a general overview of all tasks to be performed, dive modes and equipment, site access, etc. Complex projects involving more than one work task, location, and/or dive team require task-specific dive plans as part of the overall Dive Operations Plan. As a minimum, the Dive Operations Plan will contain the following:

a. Date of dive plan submission;

b. Name and contact information for diving supervisor preparing the dive plan;

c. Names and duties of on-site dive team members, including diving supervisor;

d. List of diving equipment to be used;

e. Type of diving platform to be used;

f. Detailed description of the mission; Identify how/if work will be divided into separate tasks or phases of work;

g. Date(s), time(s), duration, and location of operation;

h. Diving mode used (SCUBA, SSA, and snorkeling) including a description of the backup air supply, as required;

i. Nature of work to be performed by the divers, including tools used and materials to be handled or installed;

j. Anticipated surface and underwater conditions, to include visibility, temperature, currents, etc. Thermal protection will be considered as appropriate;

k. Maximum single dive bottom time for the planned depth of dive for each diver. Altitude adjustments to dive tables will be calculated for dives made at altitudes of 1000 ft
(304.8 m) or more above sea level;

l. Identification of topside assistance/support to the dive team (i.e., crane operator, lock operator, etc.);
m. Means of direct communication between the dive site and the DDC, project office, the lockmaster or USACE project manager, and the contracting officer (if applicable);

n. Plans submitted for Contractor operations shall also include the name of Contractor (and diving subcontractor if applicable), Contract number, and names and contact information for key personnel.

Note: The dive plan will include the following statement: "If for any reason the dive plan is altered in mission, depth, personnel, or equipment, the DDC will be contacted in order to review and accept the alteration prior to actual operation."

30.A.17 Activity Hazard Analysis (AHA). An AHA represents the dive team's best effort to anticipate and mitigate or prevent the adverse effects of equipment failure, extreme weather and environmental conditions, or other hazardous/unexpected situations.

a. AHA's shall address risk to personnel, property and to impacts to the overall USACE mission. When required, a new AHA shall be conducted to reflect changes in site conditions, operational changes, etc.

b. Each AHA will be job specific and address each phase of work, to include the hazards associated with flying after diving.

c. For USACE dive teams, a Risk Assessment Code (RAC) shall be applied to all underwater diving activities, with residual risk being approved by the appropriate level of command.

b. Hazardous Energy Control (HEC) procedures in accordance with Section 12 of this manual and procedures for dealing with differential pressures will be included if appropriate.

(1) If HEC procedures are required for the diving operation, the diving supervisor will visually check all lockout/tagout and other control procedures/devices to assure they are in place and redundant where possible prior to the commencement of the diving operation.

(2) A copy of any clearances/permits to be issued to deal with identified hazards will be attached to the AHA.

e. Some dives may be sufficiently complex to warrant several separate analyses.

f. The AHA will be covered in detail at the pre-dive conference.

30.A.18 Emergency management plan. An emergency management plan will be prepared for each dive operation. The minimum content of the plan will be as follows:

a. Location and phone number of nearest operational recompression chamber if not located at the dive site and the Divers Alert Network (DAN) phone number (919-684-9111);

b. Location, directions to and phone number(s) of nearest hospital(s) or available physicians capable of treating dive injuries;

c. Location and phone number of nearest USCG Rescue Coordination Center, where appropriate;

d. Description of an emergency victim transport plan including phone numbers of appropriate emergency transport services;

e. Procedures and phone numbers or other means of communications to activate emergency services at the facility where the work is being performed;

f. Diver rescue procedures conducted by the dive team, including responsibilities of team members, best location(s) where injured divers may be removed from the water, and best location(s) for performing first aid/stabilization prior to emergency medical assistance arrival.

30.A.19 Prior to the initial work on each dive operation, a Pre-Dive Conference shall be held with key personnel designated by the DDC to discuss the Dive Operations plan, AHA, and Emergency Management Plan and any modifications needed. For contractor operations, the pre-dive conference will also be attended by the USACE dive inspector or DDC and a representative of the Contractor with sufficient authority to implement any changes required by the USACE diving inspector or coordinator.

30.A.20 Prior to each dive, the entire dive team will be briefed in detail on the following (as a minimum):

a. Description of mission and location, including drawings and/or photographs pertinent to the mission and equipment and materials that are to be installed as part of the mission;

b. Description of diving apparatus/equipment and craft to be used;

c. Maximum working depth with estimated bottom times and water temperatures;

d. Names and duties of personnel on the team (when possible, incorporate at least one person on the dive that has previously performed the same or similar mission);

e. Discussion of AHA; and

f. Emergency procedures.

30.A.21 Upon completion of each diving operation or at the conclusion of each day, a dive team debriefing shall be conducted by the dive supervisor. At the debriefing divers are advised of the location of the nearest recompression chamber (if not located on site), the phone number for DAN or local dive medical facility, and cautioned on the limitations of their post dive activities including repetitive dives, traveling to higher altitude, and flying.

30.A.22 If for any reason the dive mission is altered:

a. Minor to moderate revisions to the accepted dive plan will be reviewed and accepted by the DDC or ADC prior to continuing the operation. These revisions may include differences in time, date, dive team members, work methods/tools used, and other changes that do not affect overall risk. This review may be conducted electronically or verbally and confirmed in writing after completion of the dive operation.

b. Major changes or those which modify high-risk activities, such as modifying pressure differential and hazardous energy controls, adding penetration diving, changing dive equipment modes (i.e. from SCUBA to SSA), discovery of unexpected contaminated diving conditions, etc. require a two-person review as outlined in Section 30.A.13.

c. For contract operations, the project superintendent or the dive supervisor shall submit/request the revised plan through the GDA for DDC acceptance.

30.A.23 All diving activities shall be conducted with full knowledge and close coordination with the GDA and on-site authorities such as the dive inspector, lockmaster/project manager, etc.

30.A.24 For each diver and dive, the following dive log information, as a minimum, shall be recorded and maintained at the dive location:

a. Full name;

b. Date, time and location of dive;

c. Maximum depth and bottom time;

d. Surface interval between dives;

e. Breathing medium and type of equipment used;

f. Group classification at the beginning and end of each interval and repetitive dive worksheet;

g. Underwater and surface conditions;

h. Depth(s) and duration(s) of any decompression stops;

i. Date and time of last previous dive if it occurred in the last 24 hours;

j. Name of Dive Supervisor(s) during dive;

k. General description of work performed; and

l. For dives outside the no-decompression limits, deeper than 100 ft salt water (fsw) (30.5m), or using mixed-gas, include depth-time and breathing-gas profiles and decompression tables (including any modifications).

30.A.25 For each dive in which decompression sickness and/or pulmonary barotraumas is suspected or symptoms are evident, the following information shall be recorded and maintained:

a. Descriptions of signs and symptoms (including depth and time of onset);

b. Description and results of treatment; and

c. Name, address, and phone number of attending physician.

30.A.26 Prior to the dive, the Dive Supervisor shall assure, as a minimum, the following pre-dive checks are performed:

a. Breathing air tanks contain sufficient air supply to perform the required work (i.e., standby air tanks are on site and full to the necessary capacity);

b. All diving equipment shall be checked for proper function prior to diver entry;

c. All necessary safety equipment specified herein is on site and functioning properly;

d. Lockout/tagout procedures are followed;

e. When applicable, crane signals are reviewed and radio communication with the crane operator is functioning properly;

f. When applicable, welding or cutting procedures are clearly reviewed, the proper welder polarity is set, and precautions have been taken to ensure that electrocution will not occur;

g. When applicable, blasting procedures are clearly reviewed and precautions have been taken to ensure unplanned/unscheduled blasts will not occur;

h. A pre-dive briefing shall be given that includes, but is not limited to, the accident management plan, AHA, equipment checklist, diving logs, diving conditions, and diving procedures;

i. When applicable, manbaskets used for diver access shall be inspected and load tested prior to use, and a Critical Lift Plan shall be submitted per Section 16.H and Section 30.B.06).

30.A.27 Copies of the dive logs shall be submitted to the DDC after completion of the dive operation. For USACE dive teams, these records shall be maintained on file for two years.

30.B Diving Operations.

30.B.01 Staging areas, where the fully suited and equipped diver enters the water, shall be selected and configured based on a hazard analysis that includes an examination of:

a. Ease of diver access to the water;

b. Hazards to diver (currents, equipment, etc.) in route from surface to work area;

c. Ability of standby diver to access the water immediately and to reach the diver quickly;

d. If used as the topside dive team station, the ability to protect topside members and the standby diver from weather, operational, and other hazards;

e. Whether topside equipment can be stowed safely and function properly;

f. If diver entry to water is remote from the staging area, the standby diver shall be placed at the water entry or immediately accessible to it.

30.B.02 All Dive teams shall be manned in accordance with the criteria established in Appendix G.

30.B.03A standby diver will be provided whenever a diver(s) is in the water to serve as immediate emergency assistance to the primary diver(s).

a. Untethered SCUBA divers, working in “buddy” pairs, shall have one tethered standby diver at the surface for each pair.

b. A standby diver will deploy only after the dive supervisor assesses the situation and instructs him/her to do so.

c. The standby diver shall be fully equipped to dive and immediately available the entire time the diver is in the water.

    (1) The standby shall don all specific gear (suits, harnesses, and equipment) they will wear/use and test all for proper operation before the primary diver leaves the surface.

    (2) With the exception of Appendix G, Table G-3, the stand-by diver shall not assume other work responsibilities, other than communications, as required, with the diver.

    (3) All gear shall be maintained operational and ready for immediate use for the duration of the dive. If any of the tested gear is exchanged or replaced during the dive, it shall be donned and tested by the standby.

d. The standby diver shall be dressed appropriately for the water and air temperature and remain fully suited up with helmet/mask ready for immediate donning from the time the primary diver leaves the surface until reaching the work area/working depth. The standby may remove the portions of his or her gear needed to prevent heat/cold stress and prevent fatigue. If the AHA identifies a need for the standby diver to remain fully dressed to deploy, it will address measures that will be taken to control these hazards (i.e., standby in water at surface). Any gear that has been removed must be maintained ready for immediate donning and use, accessible to the standby at the entry to the water.

e. If configuration of the surface staging area prevents safe, immediate entry of the standby into the water, the standby diver will be placed in the water fully dressed prior to the primary diver leaving the surface, and remain at the surface ready for deployment if needed.

30.B.04 Dive operations that require surface decompression as an integral part of the dive operation shall have a trained competent person (CP)/operator, whose sole purpose is to attend to the chamber operation.

a. In dive operations where the chamber is required for emergency, first aid, or used for other unexpected recompression events, a team member with other team duties (tender, console operations, etc.) not diving during the current dive may serve as the chamber operator so long as he is specifically trained and competent in hyperbaric chamber operations. If used for the latter purpose, all diving shall be suspended during the chamber operations.

b. Whenever a chamber is on site, the chamber CP/operator shall be capable of communicating with a diving physician.

c. Divers completing a recompression dive will remain within 60 minutes drive time from a fully operable and staffed recompression chamber for a minimum of 2 hours after completing the recompression dive.

30.B.05 Dive operations will be conducted in full coordination with external operations and processes that may impact the safety of the dive.

a. When the operation of machinery or release of hazardous energy will affect the diver or dive team safety, the dive supervisor will develop a HECP. > See Section 12. When diving at a facility with an existing HECP, the dive supervisor will review the facility’s plan and establish positive control procedures with the facility leader.

b. When water traffic, land-based traffic, industrial operations, heavy equipment operation, or other operations exist that present a hazard to the diver or dive team, the dive supervisor shall coordinate with the controlling authorities to minimize the hazards. This shall include coordination with the USCG, as required, for establishing a safety zone.

30.B.06 Crane operations conducted to support diving operations shall follow the requirements of Section 16 of this manual.

a. All working dives requiring communications between the divers and topside to direct crane load movements, etc., shall be performed in SSA mode.

b. The crane operator will take direction from the tender or supervisor directly in communication with the diver.

c. Crane operations where the load is placed or removed while a diver is underwater shall be considered Critical Lifts and the diver/load director will participate in the Critical Lift Plan development as outlined in Section 16.H.

d. If divers are required to perform rigging duties, they must be a qualified rigger and meet the personnel qualifications listed in Section 15.B.

30.B.07 When dives will take place in an area or facility where potential or actual pressure differentials exist (i.e., locks, dams, spillways, powerhouses, etc.), the dive supervisor will develop specific plans and procedures, in coordination with the facility operator, to prevent diver exposure to pressure differentials. The plans and procedures shall be site-specific and include the following:

a. Identification of all potential exposure points (gate sills, valve openings, holes, etc.);

b. Means for identifying whether control structures/mechanisms are fully in place (measurements of stop gates and openings, valve indicators, etc.);

c. Methods for checking pressure differential openings (observing current/water flow, remote testing of opening area with objects (rope, sandbags, cinders, etc.);

d. Route diver will take from staging area to work area with specific designs to prevent diver and umbilical from uncontrolled pressure differential openings;

e. Procedures for immediate emergency pressure equalization or reduction, if possible, and

f. Procedures for emergency diver extraction or rescue due to pressure differential exposure, including standby diver deployment precautions.

30.B.08 Underwater Welding and Burning Operations.

a. Underwater welding and burning shall be limited to SSA mode only.

b. Equipment configuration and procedures shall be in accordance with the U.S. Navy Underwater Cutting & Welding Manual, S0300-BB-MAN-010.

c. Divers performing underwater welding and burning operations shall be equipped with the following as a minimum:

  (1) A rubber or neoprene dive suit in good condition that provides electrical insulation to the diver;

  (2) Insulating gloves with a cuff that, as a minimum, reaches and fully covers the wrist;

  (3) A welding/burning eye shield attached to the dive helmet with appropriate shade for the conditions at the working area.

30.C SCUBA Operations.

30.C.01 SCUBA diving operations shall not be conducted:

a. At depths greater than 100 ft (30.5 m);

b. On dives outside the no-decompression limits unless a dual lock, multi-place, recompression chamber (capable of recompressing diver at the surface to a depth equivalent to 165 ft (50.3 m) of sea water) is available at the dive location and is immediately available for use, a trained competent operator is on site, and the chamber is of sufficient size to accommodate the diver as well as an inside tender;

c. Against currents exceeding one knot;

d. In enclosed or physically confining spaces;

e. Using closed circuit or semi-closed circuit SCUBA;

b. In visibility less than 3 ft (0.9 m) unless line tended with diver/surface two-way voice communications;

c. In areas where pressure differentials exist and it cannot be positively verified that all potential leaks have been eliminated;

d. When the diver does not have direct access to the surface.

30. C.02 Specific operational requirements for SCUBA operations are as follows:

a. The minimum sized SCUBA tank allowed as primary air is a standard 80 ft3 aluminum tank pressurized to at least 2,700 PSI at the beginning of dive operations.
  (1) Divers shall terminate their dive so that they reach the surface with a minimum tank pressure of 500 PSI.
  (2) Each diver shall be equipped with a minimum 30 ft3 bailout bottle for emergency use pressurized to at least 90 percent of its working PSI rating and equipped with a separate 1st and 2nd stage regulator. An “octopus” is not considered to be an alternate air source.

b. Each diver shall be equipped with a buoyancy compensation device (BCD) having a manually activated inflation source, an oral inflation device, and an exhaust valve.

c. Each SCUBA diver shall be equipped with a submersible cylinder pressure gauge capable of being monitored by the diver during the dive.

d. Each SCUBA diver shall be equipped with a weight belt or assembly capable of quick release.

e. Each SCUBA diver shall be equipped with a depth gauge and knife.

f. SCUBA air cylinders shall comply with the following requirements:

(1) Air cylinders of seamless steel or aluminum that meet DOT 3AA and DOT 3AL specifications are approved for used on USACE projects;

(2) Each cylinder used on USACE projects must have identification symbols stamped into the shoulder of the tank; and

(3) SCUBA tanks used on USACE projects must be visually inspected internally at least annually and hydrostatically tested at least once every 5 years in accordance with DOT and the CGA regulations; hydrostatic test dates will be stamped into the shoulder of each tank.

g. A timekeeping device shall be used for recording diving times for all SCUBA diving operations. When two-way voice communications are not used, each dive supervisor and diver shall have a timekeeping device. When two-way voice communications are used, the dive supervisor, at a minimum shall have a timekeeping device.

h. Each tethered SCUBA diver shall wear a safety harness with a positive buckling device, attachment point for the safety line, and a lifting point to distribute the pull force of the line over the diver’s body while maintaining the body in a heads-up vertical position when unconscious or inert.

30.D Surface Supplied Air (SSA) Operations.

30.D.01 SSA operations shall not be conducted at depths greater than 190 ft (57.9 m) except that dives with bottom times of 30 minutes or less may be conducted to depth of 220 ft (67 m). Exceptional exposure dives, as defined by the US Navy Diving Manual, shall not be conducted except in emergency lifesaving situations. USACE in-house SSA operations shall not exceed a depth of 110 ft (33.5 m) unless a waiver is requested by the DDC and approved by the HQUSACE Dive Safety Program Manager.

30.D.02 SSA equipment components shall be a type specifically designed to be used in diving support systems.

30.D.03 A recompression chamber shall be available for all SSA operations when diving outside the decompression limits, utilizing mixed gas, and/or when diving at or deeper than 100 ft (30.5 m) is planned.

a. Under these conditions, a dual lock, multi-place, recompression chamber (capable of recompressing a diver at the surface to a depth equivalent to 165 ft (50.3 m) of sea water) must be available at the dive location and immediately available for use.

b. The chamber must be of sufficient size to accommodate the diver as well as an inside tender, and a trained chamber operator must be immediately available.

c. Sufficient oxygen shall be available to complete chamber operations.

30.D.04 A bell shall be used for dives with an in-water decompression time greater than 120 minutes, unless heavy gear is worn or diving is conducted in physically confining spaces.

30.D.05 Minimum specific operational requirements for SSA diving operations are as follows:

a. Each diver shall be continuously tendered while in the water, with one diver per tender, regardless of depth. The tender shall not perform any other duties outside of tending the diver except as allowed by Appendix G;

b. An underwater tender/diver shall be stationed at the immediate underwater point of entry when any overhead obstruction limiting direct access to the surface is present and/or penetration diving is conducted or in enclosed or physically confining spaces;

c. Each diving operation shall have a primary breathing air supply sufficient to support divers for the duration of the planned dive, including decompression;

d. Each diver must have a reserve breathing supply available that can be turned on immediately by the diver in the event of loss of air. The reserve breathing air supply shall be of sufficient capacity to recover the diver and complete emergency recompression (if required) in the event of loss of primary air but no less than 30 ft3 (0.85 m3). Heavy-gear diving is exempted from these provisions because the gear carries its own reserve;

e. Each dive location shall have a reserve breathing air supply integral or in-line with the primary air source sufficient to safely terminate the dive and recover the diver(s) in the event of loss of the primary air supply;

f. For dives deeper than 100 ft (30.5 m) or outside the no decompression limits and using heavy gear, a spare air supply hose, to replace the diver's air hose should it become damaged, shall be available to the standby diver. An in-water support stage shall be provided to divers in water when using heavy gear, regardless of depth;

g. Electronic communication systems with an external speaker shall be incorporated so the entire dive team can monitor communications.

(1) Communications devices shall be tested prior to each dive, maintained in an operable condition, and protected from damage during use and storage IAW the manufacturer's recommendations.

(2) All dive operations will be terminated in a safe, orderly fashion using line-pull signals if voice communications are lost.

(3) Defective electronic communication equipment shall not prevent a standby diver from deploying in an emergency if the dive supervisor determines it is safe for the diver to deploy and line-pull signals are used.

30.E Mixed-Gas Diving Operations.

30.E.01 A dual lock, multi-place, recompression chamber with a trained, competent operator shall be available and ready for use at the dive location for any mixed-gas dive. Sufficient oxygen shall be available to complete chamber operations. At extreme depth, mixed gas diving can only be done if:

a. A bell is used at depths greater than 220 ft (67 m) or when the dive involves in-water decompression time of greater than 120 minutes (except when heavy gear is worn or when diving in physically confining spaces), or

b. A closed bell is used at depths greater than 300 ft (91.4 m), except when diving is conducted in physically confining spaces.

30.E.02 Each diving operation shall have a primary breathing gas supply sufficient to support divers for the duration of the planned dive, including decompression.

30. E.03 Each diving operation shall have a reserve breathing gas supply integral or in-line with the primary air source sufficient to safely recover the diver(s) in the event of failure of the primary breathing gas supply.

30. E.04 When heavy gear is worn:

a. An extra breathing gas hose capable of supplying breathing gas to the diver in the water shall be available to the standby diver, and

b. An in-water stage shall be provided to divers in the water.

30.E.05 An in-water stage shall be provided for divers without access to a bell for dives deeper than 100 ft (30.4 m) or outside the no-decompression limits.

30.E.06 When a closed bell is used, one dive team member in the bell shall be available and tend the diver in the water.

30.E.07 Oxygen Enriched Air.

a. The use of “Oxygen Enriched Air” (OEA) such as Nitrox (EANx) breathing mixtures by USACE in-house dive teams requires the specific initial approval of the HQUSACE Dive Safety Program Manager prior to the first use of such equipment. Requests for approval will be accompanied by a written program that identifies training, certification, and procedures for OEA use. Use of OEA by Contractors requires approval by the local DDC.

b. Navy or NOAA Nitrox Dive Tables or other decompression tables designed specifically for the OEA mixture being used shall be followed without exception.

c. The use of OEA/Nitrox is considered mixed gas diving and requires a decompression chamber on site and ready for use.

30.E.08 Contractors must provide evidence of training and experience with OEA breathing mixtures prior to actual diving operations.

30.E.09 OEA breathing mixture shall be analyzed/tested by the diver to assure proper mix prior to each use. No more than 40% OEA is allowed for normal diving operations. Higher OEA concentrations are allowable for in-water decompression at shallow safety stops.

30.E.10 Use of Surface Decompression with Oxygen (SUR-D-O2) and/or 100% oxygen in-water decompression by trained and certified dive teams, shall only be authorized as a decompression methodology upon submittal of an oxygen-specific decompression plan and schedule, and only with the expressed written approval of the District Dive Coordinator or alternate.

30. F Equipment Requirements.

30.F.01 Equipment modifications, repairs, tests, calibrations, or maintenance shall be recorded by means of a tagging or logging system, and include the date and nature of work performed and the name of the individual performing the work.

30.F.02 Air compressor systems used on-site as a direct source to supply air to SSA divers (Direct Source Compressors) shall be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve, and a drain valve.

30.F.03 Direct Source compressors shall be of sufficient capacity to overcome any line loss or other losses and deliver a minimum 4.5 ft3 (2.1 l/s), actual, or a delivery amount (cfm) as set by the helmet manufacturer, to each diver at the maximum diving depth.

30.F.04 All air compressor intakes shall be located away from/upwind of areas containing exhaust or other contaminants.

a. All shall be equipped with appropriate in-line air purifying absorbent beds and/or filters inserted into the supply line to assure breathing air quality.

b. Oil-lubricated compressors containing a petroleum or potential CO-producing lubricant for the air pressurization pistons will not be used.

c. All monitor/alarm systems shall be so designed with a visual and/or audio alarm and placed so that the dive supervisor will be made aware of the hazardous conditions.

d. Direct Source compressors shall be equipped specifically for their intended use and shall have a suitable approved means to regulate the pressure and a low air pressure alarm in the system. In addition, they will have a Carbon Monoxide (CO) monitor with alarm in the following situations:

(1) The compressor is powered by an internal combustion engine,

(2) Compressors used in close proximity to internal combustion engines that may/will be running during dive operations (boat motors, generators, cranes, etc.). Air intake pipes shall be placed away from/upwind of the exhaust source;

(3) Fueling a compressor during operation shall not be allowed.

30.F.05 Air compressor systems will be tested by means of sampling at the connection to the distribution system.

a. All air compressors with a working pressure greater than 500 psi will be tested every six months by an accredited testing laboratory.

b. Compressors with a working pressure less than 500 psi may be tested in-house with documentation every six months and must be tested by an accredited testing laboratory every two years. Lab accreditation shall be from NIST/NVLAP, American Association of Laboratory Accreditation (A2LA – for environmental or calibration) or similar recognized accreditation.

c. Purchased air must be certified by the supplier that it has been tested and meets the standards below.

d. A copy of the certificate of analysis showing the breathing air meets the minimum acceptable criteria shall be provided to the GDA.

e. Air purity standards are as follows:

(1) Air shall not contain a level of carbon monoxide greater than 10 ppm;
(2) Air shall not contain a level of carbon dioxide greater than 1,000 ppm;
(3) Air shall not contain a level of oil mist greater than 5 mg/m3;
(4) Air shall not contain a level of hydrocarbons other than methane greater than 25 ppm; and
(5) Air shall not contain a noxious or pronounced odor.

30.F.06 Breathing supply hoses.

a. Breathing air supply hoses shall be suitable for breathing gas service or shall be specifically manufactured for SSA use. Hoses shall have a maximum allowable working pressure equal to or greater than supply pressure plus 150 psi.

b. Breathing air supply hoses shall have connectors made of corrosion resistant materials and have a working pressure at least equal to the working pressure of the hose to which they are attached: connectors must not be able to become accidentally disengaged.

c. Umbilicals shall be marked, beginning at the divers end, in 10 ft (3 m) increments to 100 ft (30.5 m) and in 50 ft (15.2 m) increments thereafter. > See Table 30-1. USACE inhouse dive teams shall use the following umbilical marking system found in the ADCI Consensus Standard 006 in order to assure consistency and interoperability:

d. Umbilicals shall have a nominal breaking strength of 1000 lb (453.6 kg) and shall be made of kink resistant materials.

e. Hoses must be tested prior to being placed into initial service and after any repair, modification, or alteration, and at least every 12 months to 1.5 times the working pressure. Umbilical assemblies shall be tensile tested at the same time intervals by subjecting each hose-to-fitting connection to a 200 lb axial load.

f. When breathing gas hoses are not in use, their open ends must be closed by capping.

g. The umbilical assembly used for the standby diver must be of sufficient length to reach the primary diver at the furthest distance he can proceed from the dive station or beyond.

h. Umbilicals shall be carefully tended to maintain them and the diver clear of hazards such as propellers (including those of ROV's) or intakes present in the diving zone, so that the diver or umbilical cannot be drawn into them.

30.F.07 SSA and mixed-gas helmets and masks shall have a non-return valve at the attachment between the helmet or mask and hose which will close readily and also have an exhaust valve.

a. Helmets and masks shall have a minimum ventilation rate capacity of 4.5 ft3 (2.1 L/s) (actual) at the depth at which they are operated.

b. The use of Jack Brown masks is prohibited on SSA operations unless it incorporates electronic communication and a means of incorporating a diver carried bailout system.

TABLE 30-1 Umbilical Markings

Distance (from diver's end)	Marking
10 ft [3 m]	one white band
20 ft [6.1 m]	two white bands
30 ft [9.2 m]	three white bands
40 ft [12.2 m]	four white bands
50 ft [15.2 m]	one yellow band
60 ft [18.3 m]	1 yellow/1 white
70 ft [21.3 m]	1 yellow/2 white
80 ft [24.4 m]	1 yellow/3 white
90 ft [27.4 m]	1 yellow/4 white
100 ft [30.5 m]	1 red band
150 ft [45.7 m]	1 red/1 yellow
200 ft [61 m]	2 red bands
250 ft [76.2 m]	2 red/1 yellow
300 ft [91.5 m]	3 red bands

Note: For each 50 ft (15.2 m) thereafter the sequence continues by increasing the number of red bands at each even increment of 100 ft (30.5 m). In cases where the umbilical color matches an above band color, a reasonable substitute may be used (contrasting outline on same-color tape, contrasting diagonal pattern, replacement with color not used above).

30.F.08 SSA and mixed-gas helmets and masks must be capable of supporting a reserve breathing supply which can be immediately turned on by the diver in event of loss of air.

30.F.09 SSA and mixed-gas helmets and masks must be capable of supporting a two-way or four-way diver-surface communication system.

30.F.10 Weights and harnesses. Unless heavy gear is worn, each tethered diver shall wear a divers safety harness with a positive buckling device, attachment point for the safety line, and a lifting point to distribute the pull force of the line over the diver's body while maintaining the body in a heads-up vertical position when unconscious or inert.

30.F.11 The following emergency and first aid equipment shall be located at all dive sites:

a. A first aid kit meeting the requirements of Section 3;

b. An oxygen resuscitation system shall contain a pocket mask with O2 inlet, nonrebreather mask, demand inhalator and/or demand resuscitator capable of delivering oxygen for a minimum of 30 minutes at 15 lpm or until emergency medical assistance can be administered; and

c. A stokes litter or backboard, equipped with at least four body straps and snap buckles, a head block and have flotation capability.

30.F.12 When diving from vessels, International alpha code and recreational dive flags with a minimum dimension of 23 in (58.4 cm) will be displayed a minimum of 3 ft (0.9 m) above the working surface at the dive location during diving operations. When diving from surfaces other than vessels in areas capable of supporting marine traffic, a rigid replica of the international code flag "A" at least 3 ft (1 m) in height shall be displayed at the dive location in a manner which allows all-round visibility, and shall be illuminated during night diving operations.

30.F.13 Hand-held power tools shall be tested and certified to be safe for underwater use. These tools shall be de-energized at the surface before being placed into or retrieved from the water and shall not be supplied with power until requested by the diver.

30.F.14 The use of one-atmosphere suits (e.g., Newt Suits) requires the specific approval of the MSC DDC and FOA DDC prior to the use of such equipment.

30.G Scientific Snorkeling.

30.G.01 Scientific snorkeling will be conducted only with prior acceptance of the DDC.

30.G.02 Scientific snorkeling will be allowed only for environmental assessments such as fish surveys, stream surveys, and the like. It will not be used for structural inspections or other work.

30.G.03 An on-site snorkeling team shall be made up of no less than two persons: snorkeler, and observer/assistant. Additional site personnel may be required by the DDC or Safety Office DSR based on site hazards and conditions. Snorkeling team plans and procedures shall be developed and enacted by a team supervisor who is qualified and experienced in scientific snorkeling.

30.G.04 Quality assurance for contractor snorkeling operations will be provided by USACE certified Diving Inspectors or qualified USACE scientific snorkelers.

30.G.05 Scientific snorkeling will only be done on the surface of the water. No diving of any kind is permitted.

a. Untethered scientific snorkeling will NOT be allowed in waters deeper than 5 ft (1.5 m), in bodies of water that a snorkeler cannot wade across, or anywhere a pressure differential may exist.

b. Scientific snorkeling in open waters greater than 5 feet deep may be allowed by the local DDC based on an acceptable AHA and compliance with all of the following:

(1) The snorkeler shall be tethered with a harness and a maximum of 40 ft (12.2 m) of floating line;

(2) The tether must be constantly tended from the shore or boat;

(3) The snorkeler must wear a device providing a minimum of 15.5 lbs (7 kg) of positive buoyancy (Type III PFD, fully inflated snorkeling vest, etc.), and

(4) There are no potential tether entanglement hazards in the snorkeling area (overhanging branches, surface stumps, rocks, etc.).

30.G.06 All snorkelers and observers/assistants will be certified as skin divers (snorkelers) or open water divers by a nationally-recognized organization (e.g., Professional Association of Diving Instructors (PADI), National Association of Underwater Instructors (NAUI), etc.) or the U.S. Forest Service Snorkel Safety Program.

30.G.07 An observer/assistant will accompany each untethered snorkeler either along the shore or in a boat and be within 50 ft (15.2 m) of the snorkeler at all times.

a. Two untethered snorkelers in the same body of water may act as observer/ assistant for each other if they remain within 50 ft (15.2 m) of each other.

b. Non-snorkeling observer/assistants shall wear a PFD and be equipped with a throw bag and/or ring buoy with at least 70 ft (21.3) of line, and must be capable of performing a rescue on the specific snorkeler(s) in an emergency.

30.G.08 Areas of extreme water velocity and turbulence will be avoided especially those immediately upstream from debris jams or bedrock outcrops.

30.G.09 Snorkelers will be provided with appropriate thermal protection.

30.G.10 Employees will be determined medically fit by a licensed physician (DO or MD) prior to snorkeling. This certification shall be signed by a physician familiar with sports medicine, and state that each snorkeler is physically and medically fit to perform snorkeling activities according to commonly accepted sports medicine guidelines. The Contractor shall submit such certification to the GDA for acceptance.

30.G.11 All snorkeling team members shall be certified in first aid and CPR. Certification shall be in accordance with most recent Emergency Cardiovascular Care (ECC) guidelines, and/or American Heart Association or ARC standards.

30.G.12 A first aid kit meeting the requirements of Section 3 will be available at each location where snorkeling is being performed. A means of securely transporting an unconscious person, such as a litter or stretcher, shall be provided when snorkeling is conducted in areas inaccessible to vehicles or boats.

30.G.13 A means of communication capable of contacting emergency services must be available at locations where snorkeling is performed.

30.G.14 Each snorkeler will be equipped with a Dive Equipment Manufacturer's Association (DEMA) rated professional grade mask, fins, snorkel and snorkeling vest.

30.G.15 A snorkeling protocol will be developed and included in the project file. It will contain as a minimum, the following:

a. An AHA for each specific snorkeling mission. Particular detail will be given to currents and other environmental considerations;

b. Records for snorkeling activities will be maintained and will include as a minimum:

(1) Snorkeler's annual physician certifications;

(2) AHAs, and

(3) A snorkeling plan that is based on the requirements of Section 30.A.15.a-e. Contractors shall submit these to the GDA for acceptance by the DDC/SOH Dive Safety Officer a minimum of 10 days prior to start of work.

30.G.16 Snorkelers will wear apparel which provides appropriate protection from environmental conditions. The apparel must include fins or other appropriate foot protection.

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Appendix M: EM 385-1-1 Appendix G Manning Requirements

Manning Levels for Dive Teams

1. General. Manning level tables shown are a minimum. Actual manning levels may increase, as determined by the DDC, after considering the diving support systems, the task at hand, weather conditions, dive platform and location, and other factors. Team members may rotate through the dive team positions as long as the minimum manning levels are maintained and team members are qualified and accepted for the position.

2. SCUBA: Untethered, 0 to 100 ft (0 to 30.5 m).

   a. Untethered SCUBA divers shall always be accompanied by another diver in continuous visual contact.

   b. When depth of dive is 0-100 ft (0-30.5 m), the minimum dive team will be composed as shown in Table G-1:

TABLE G-1 Dive Team Composition SCUBA -Untethered, 0 to 100 ft (0 to 30.5 m)

Personnel	Number
Diving Supervisor	1
Divers (in visual contact)	2
Standby Diver*	1
TOTAL TEAM	4

3. SCUBA: Tethered with communications, 0 to 100 ft (0 to 30.5 m). When depth of the dive is 0-100 ft (0-30.5 m), the minimum dive team will be composed as shown in Table G 2:

Table G-2 Dive Team Composition SCUBA-Tethered with communications, 0 to 100 ft (0 to 30.5 m)

Personnel	Number
Diving Supervisor ***	1
Diver in Water	1
Standby Diver* (tethered with communications)	1
Tender	1
TOTAL TEAM	4

4. Surface Supplied Air: 0 to 100 ft (0 to 30.5 m).

a. When surface supplied air is being used as the diving mode, the minimum dive team will be composed as shown in Table G-3:

Table G-3 Dive Team Composition Surface Supplied Air, 0 to 100 ft (0 to 30.5 m) Within No Decompression Limits

Personnel	Number	Penetration Dive
Diving Supervisor ***	1	1
Diver in Water	1	2
Standby Diver*	1	1
Tender	1	2
TOTAL TEAM	4	6

b. Deploying the Standby Diver as a Working Diver. The Standby diver may be deployed as a working diver provided all of the following conditions are met:

   (1) Surface-supplied no-decompression dive of 60 fsw or less;
   (2) Divers are in close proximity, (based on site specific requirements), with unimpeded access to each other;
   (3) Divers have communications with each other at all times;

(4) No entanglement hazard exist;
(5) Prior to deploying the standby diver, the work area shall be determined to be free of hazards (ie., suctions, discharges) by the diver on the job site;
(6) The dive is NOT a penetration or confined space dive;
(7) Each diver has a full-time tender (which brings the minimum number of the teasm members to 5).

5. Surface Supplied Air: 101 to 190 ft (30.8 to 57.9 m).

When surface supplied air is being used as the diving mode, the minimum dive team will be composed as shown in Table G-4:

Table G-4 Dive Team Composition Surface Supplied Air, 0 to 100 ft Requiring Decompression and All Surface Supplied Air, 101 to 190 ft (30.8 to 57.9 m)

Personnel	Dives within no decompression limits	Dives requiring decompression	Penetration Dive
Diving Supervisor ***	1	1	1
Chamber Operator**	**/1	****/1	1
Diver in Water	1	1	2
Standby Diver*	1	1	1
Tender	1	1	2
Standby Diver Tender	1	1	1
TOTAL TEAM	5/6	5/6	8

6. Surface Supplied Mixed Gas Diving. For surface supplied mixed gas diving, to include OEA (Nitrox, ect), the minimum dive team will be composed as shown in Table G-5:

Table G-5 Dive Team Composition Surface Supplied Mixed Gas Diving

Personnel	Dives within no decompression limits	Dives requiring decompression	Penetration Dive
Diving Supervisor ***	1	1	1
Chamber Operator**	**/1	****/1	1
Diver in Water	1	1	2
Standby Diver*	1	1	1
Tender	1	1	2
Standby Diver Tender	1	1	1
TOTAL TEAM	5/6	5/6	8

Notes:
*** The standby diver will be rested and capable of performing emergency rescue assistance. When working is limited to no decompression limits, the standby diver shall be sufficiently free of residual nitrogen to allow for 25 minutes of bottom time at the working depth without exceeding “NO Decompression Limits.”**
**** The Competent Person/chamber operator may be any non-diving member of the dive team when the chamber is only for emergency use when diving within the no-decompression limits. Saturation diving requires that a life support technician will serve as the chamber operator.**
***** The supervisor may be the standby tender for dives under 100 ft (30,5 m).**
****** The Competent Person/chamber operator may be and non-diving member of the dive team if all diving ceases during chamber operation.**

Appendix B

Environmental Protection Plan

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Appendix B
Revision 0
Environmental Protection Plan for the Remedial Investigation

Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Prepared by
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November 2019

Appendix B

Environmental Protection Plan for the Remedial Investigation

Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Contract No. W912DR-15-D-0014 Delivery Order (DO) W912DR18F0587

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November 2019
Revision: 0
EA Project No. 63029587

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LIST OF ACRONYMS AND ABBREVIATIONS

AOCs	Area(s) of Concern
ASTs	Above ground storage tanks
CMP	Coastal Management Program
CZMA	Coastal Zone Management Act
DGM	Digital Geophysical Mapping
EA	EA Engineering, Science, and Technology, Inc., PBC
EPP	Environmental Protection Plan
FUDS	Formerly Used Defense Site
HTRW	Hazardous, Toxic, and Radioactive Waste
MC	Munitions constituents
MD	Munitions debris
MDAS	Material documented as safe
MEC	Munitions and explosives of concern
MRS	Munitions response site
NERR	National Estuarine Research Reserve
NY	New York
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
PIPC	Palisades Interstate Park Commission
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
SI	Site Inspection
UFP	Uniform Federal Policy
USDA	United States Department of Agriculture
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

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1. INTRODUCTION

This Environmental Protection Plan (EPP) has been developed to describe the approach, methods, and procedures that will be employed to minimize pollution, protect and conserve natural resources, restore damage, and control noise and dust during the Remedial Investigation (RI) at the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS) in Stony Point, Rockland County, New York (NY). Potential site resources and possible mitigation measures that can be used to avoid or lessen the impacts from RI activities are identified below.

The existing resources on the Iona Island Naval Ammunition Depot FUDS, as detailed in this EPP, were determined from the following documents:

- Final Archive Search Report for Iona Island, prepared by USACE – St. Louis District, dated March 1998.

- *Final Site-Specific Report for the Site Inspection of Iona Island* prepared by Alion Science and Technology (Alion), dated September 2006.

- *Final Historical Photographic of Iona Island - U.S. Army Geospatial Center, September 2018.*

- *Final Community Relations Plan for Iona Island Formerly Used Defense Site* prepared by EA Engineering, Science, and Technology, Inc., PBC (EA), dated March 2019.

Additional information pertaining to natural and cultural resources was obtained during a site visit (11 October 2018) and a Technical Project Planning (TPP) meeting (7 November 2018) among New York State Department of Conservation (NYSDEC), Palisades Interstate Park Commission (PIPC), U.S. Army Corps of Engineers (USACE), and EA that occurred at Bear Mountain State Park.

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2. POTENTIAL SITE RESOURCES

Iona Island is in Stony Point, NY south of West Point and north of Manhattan, is part of Bear Mountain State Park, and is maintained by PIPC. RI activities pertaining to the 1903 Explosion Area Munitions Response Site (MRS-01) and 19 Hazardous (HTRW) Areas of Concern (AOCs) will be conducted at the Iona Island Naval Ammunition Depot FUDS (refer to Figures 2 and 11-3 of the Uniform Federal Policy [UFP] Quality Assurance Project Plan [QAPP]). MRS-01 is centered between former Buildings 209 and 210 (refer to Figures 11-1 and 17-2 of the UFP-QAPP).The AOCs include the locations/footprints of 16 former buildings, 4 former above-ground storage tanks (ASTs), a former dumping area, 2 former coal storage areas, and 3 former transformers where contaminants related to the facilities or from historic processes during the site's commission as an ammunition depot may be present.

The potential site resources listed below are discussed in the context of the Iona Island Naval Ammunition Depot FUDS based on available data.

2.1 THREATENED AND ENDANGERED SPECIES

To identify threatened and endangered (T&E) species, EA submitted a request to the NY Natural Heritage Program for a formal review of the project area on 11 December 2018. EA received an email on 4 April 2018 from the Natural Heritage Program stating that they would be providing a response to the request soon. As of 9 April 2018, no response had been received. However, a previous request was conducted by Alion in 2007 for the Site Inspection (SI) Report. Information from that response is provided in Table 2-1 below and includes both State and Federal status for the species identified that may potentially inhabit the Iona Island Naval Ammunition Depot FUDS. The letter also notes that the area includes several protected communities: Freshwater Tidal Marsh, Brackish Intertidal Mudflats, Brackish Tidal Marsh, Oak-tulip Tree Forest, Anadromous Fish Conservation Area, and Waterfowl Winter Concentration Area. In addition, EA searched the USFWS Environmental Conservation Online System for federally-listed T&E species in Rockland County, NY. The search revealed four species, which are also included in Table 2-1 below.

Table 2-1 Federal and State (New York) Listed Threatened and Endangered Species Potentially Present on Iona Island

Common Name	***Scientific Name***	**Federal Status**	**State Rank**	**State Status**
Plant Species of Special Concern				
Saltmarsh bulrush	*Bolboschoenus novae-angliae*	NL	S1	E
Terrestrial starwort	*Callitriche terrestris*	NL	S2S3	T
Long’s bittercress	*Cardamine longyi*	NL	S2	T
Water pigmyweed	*Crassula aquatica*	NL	S1	E
Yellow Flatsedge	*Cyperus flavescens*	NL	S1	E
Saltmarsh spikerush	*Eleocharis uniglumis var. halophila*	NL	S2	T
Small-flowered crowfoot	*Ranunculus micranthus*	NL	S3	T
Spongy arrowhead	*Sagittaria montevidensis var. spongiosa*	NL	S2	T
Saltmarsh aster	*Symphyotrichum subulatum*	NL	S2	T
Small whorled pogonia	*Isotria medeoloides*	T	-	NL
Wildlife Species of Special Concern				
Indiana bat	*Myotis sodalist*	E	-	NL
Northern long-eared bat	*Myotis septentrionalis*	T	-	NL
Bald eagle	*Haliaeetus leucocephalus*	T	S2S3B,S2N	T
Bog turtle	*Clemmys muhlenbergii*	T	S2	E
Timber rattlesnake	*Crotalus horridus*	NL	S3	T
Shortnose sturgeon	*Acipenser brevirostrum*	E	S1	E
Atlantic sturgeon	*Acipenser oxyrinchus*	C	S1	P
Least bittern	*Ixobrychus exilis*	NL	S3B,S1N	T
Kentucky warbler	*Oporornis formosus*	NL	S2	P
Fence lizard	*Sceloporus undulatus*	NL	S1	T

Plant Species Ranks

S1 – Extremely rare; usually 5 or fewer populations or occurrences in the state; or may be a few remaining individuals; often especially vulnerable to extirpation

S2 – Very rare; usually between 6 to 20 populations or occurrences; or with many individuals in fewer occurrences; often susceptible to becoming extirpated

S3 - Rare to uncommon; usually between 21 to 100 populations or occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances

Wildlife Species Ranks

S1 – Highly state rare, critically imperiled in New York
S2 – State rare; imperiled in New York because of rarity
S3 – Rare to uncommon
B – Animal is migratory, and rank refers only to the breeding status
N – Animal is migratory, and rank refers only to non-breeding status.

Key to Codes

T – threatened
NL – not listed
SC – special concern
E – endangered
P – protected
C - candidate

Sources: NYSDEC. NY Natural Heritage Program. Letter to Corinne Shia dated 11 October 2007.

2.2 RESEARCH AREAS AND PROJECTS

During the 11 October 2018 Site Visit, the Science Director at PIPC noted that research projects are conducted on Iona Island. He stated that long-term research sites are potentially located within the Iona Island Naval Ammunition Depot FUDS boundary. Research teams include personnel from Hudson River National Estuarine Research Reserve (NERR), U.S. Department of Agriculture (USDA), and Cornell University. Studies include an eastern box turtle telemetry survey and a rare plant species monitoring program. There is also an active invasive species removal program to reduce the amount of *Phragmites* spp. on the island. Various walking tours, naturalist groups, and park education groups regularly visit the island; access is by permit only.

2.3 WATER RESOURCES

Iona Island is bordered on the east by the Hudson River; on the northwest by the mouth of Doodletown Bight, an expanse of shallows and mudflats; on the west and southwest by Iona Island Marsh, a tidal marsh that occupies one mile between Iona Island and the mainland (refer to Figures 2 and 11-3 of the UFP QAPP). Iona Island is separated from the mainland by Snake Hole Creek on the south and Doodletown Brook on the west and north. There are no surface water bodies or drainages on the land-portion of the island within the FUDS boundary, however many areas of the island and adjoining marshes are influenced by the Hudson River.

The Hudson River originates in the Adirondack Mountains of Upstate New York, and flows southward 315 miles to the Atlantic Ocean at New York Harbor, between New York City and Jersey City. Maximum river depths are found in the Hudson Highlands between West Point and Peekskill, New York, with the deepest point of 196 ft at West Point (Yozzo et al, 2005). The lower half of the Hudson River from Troy to New York Harbor, a distance of 125.5 miles, is an estuary (drowned river valley) affected by semidiurnal tides, with two highs and two lows occurring within a 25-hour period (Yozzo et al. 2005). The tidal range averages approximately 2.9 feet (Yozzo et al. 2005).

Salinity zones in the Hudson are determined by a combination of hydrographic factors, primarily the tidal surge of saline water upriver from the Atlantic Ocean and the magnitude of freshwater flow into the upper estuary. Freshwater flow in the Hudson estuary follows a typical seasonal pattern, with highest flow during the spring and lowest flow during late summer and early fall under an average runoff regime the salt front (0.5 parts per trillion) reaches Newburgh by late summer/early fall. During conditions of high freshwater runoff, usually during spring, the salt front may be pushed downriver as far as the Bronx (Yozzo et al. 2005).

Iona Island is located 41.2 miles upstream from New York Harbor and approximately 30 miles upstream of Bronx, NY. The section of the Hudson River at Iona Island is narrow and deep, with strong currents and a rocky bottom substrate. The width of the Hudson River at Iona Island is approximately 0.3 mile east of Iona Island, and the river in this area has a depth of approximately 165 ft. Tidal influence at Iona Island is approximately 3.5 ft, and shorelines may not be accessible during high tide conditions (Alion 2008).

Doodletown Brook, located west of Iona Island, is the principal tributary to Iona Island Marsh and drains an area of approximately 2.9 square miles (Yozzo et al. 2005). Doodletown Brook flows eastward into Doodletown Bight and then to the Hudson River, near the northern end of Iona Island. Snake Hole Creek originates in the low marshes southwest of Iona Island and flows southwesterly, then southeast, and finally east to the Hudson River. The Creek divides Iona Island Marsh into Salisbury Meadow on the west and Ring Meadow, on the east side.

Groundwater at and in the vicinity of Iona Island is found in both overburden and underlying bedrock. Groundwater in overburden at Iona Island was encountered at a depth of 2 ft near the former dumping area between Iona Island and Round Island during the October 1996 soil sampling event; likely because bedrock is close to the surface and infiltration, where possible, is very slow (Greeley-Polhemus 1997). Shallow groundwater is likely influenced by the Hudson River.

Crystalline bedrock of the Hudson Highlands acts as a relatively poor aquifer. Groundwater in the gneiss and granitic rocks only occurs in fractures and joints (Heisig 2010). Bedrock groundwater at Iona Island is likely encountered at depths greater than 6 ft as based on the rock outcrop soil description reported in the Rockland County Soil Survey (Bonnell 1990).

Groundwater recharge is primarily from infiltration of local precipitation, with downward seepage of water through overburden into underlying bedrock and/or direct infiltration of precipitation on exposed bedrock surfaces. Upward seepage of water from bedrock also recharges surficial deposits in low-lying areas. Shallow groundwater flow in surficial deposits and weathered bedrock likely follows topography, with discharge to surface water bodies (i.e., Hudson River). Due to the crystalline nature of the bedrock, groundwater flow is restricted to joint and fracture systems that generally trend northeast-southwest (Olcott 1995).

Groundwater usage in the Hudson Highlands is largely limited to domestic wells along the periphery of the parklands. Maximum yields of wells completed in the crystalline rocks rarely exceed 70 gallons per minute, and limited aquifer storage in crystalline rock makes such wells susceptible to decreased yields during dry periods unless they are in hydraulic connection with surface water (Heisig 2010).

2.4 CULTURAL AND ARCHEOLOGICAL RESOURCES

The New York State Historic Preservation Office was contacted about planned remedial investigation activities at Iona Island via letter in January 2019 in accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966. On 28 March 2019, the State Historic Preservation Office provided notification of concurrence with the determination that the project activities will have no adverse effect upon cultural resources in or eligible for inclusion in the National Registers of Historic Places.

2.4.1 Archaeological Resources

A complete archeological survey of Iona Island has not been performed to date. However, it is unlikely that any undisturbed archeological site will be present at Iona Island due to the historical demolition of buildings and reworking of soil on the island.

2.4.2 Historic Buildings and Structures

No historic sites have been identified as eligible for listing on the National Register of Historic Places. No suspected or known cultural resources have been identified at Iona Island. In the instance that the location of a known cultural, archaeological, and/or historically significant area is identified, field crews will be informed of the location prior to the start of work. Any work conducted near known areas of significance will be coordinated with the Installation's archaeologist. Should any historic or archeological resources be uncovered during the course of the RI, work will cease in the area where resources were uncovered, and the State Historic Preservation Office will be contacted. Work will resume in the area after approval from PIPC and USACE.

2.5 COASTAL ZONE

Iona Island is situated within the New York Coastal Zone. Activities proposed for this RI will occur within the New York Coastal Zone and will include land-based, water-based, and potentially, aerial geophysical surveys. Shallow excavations for single anomalies will be conducted, and deep excavations (15-20 feet below ground surface or below sediment surface) will be conducted if burial pits are identified. Disturbance to coastal areas will be kept to a minimum and activities will be conducted in compliance with New York Coastal Zone regulations.

New York's State's Coastal Management Program (CMP) is administered by the New York State Department of State (NYSDOS) and carried out in partnership with local governments and State and Federal agencies. The CMP is based on a set of 44 coastal policies that guide coastal management actions at all levels of government in the State to ensure the appropriate use and protection of coasts and waterways.

The Federal regulations that implement the consistency provisions of the Coastal Zone Management Act (CZMA) are presented in 15 CFR Part 930. These regulations establish the procedures to be followed to ensure that Federal agency activities are consistent with the enforceable policies of the CMP. These regulations apply to actions taken by, or conducted on behalf of, Federal agencies. The types of activities covered by the CZMA include activities requiring authorizations or other forms of approval from Federal agencies, activities involving financial assistance from Federal agencies, and outer continental shelf activities. Any Federal agency considering undertaking an activity is required to submit a consistency determination with other necessary information and data to the NYSDOS. The Department of State reviews a Federal agency's proposed activity and consistency determination and renders its own decision regarding the consistency of the activity with the CMP.

USACE submitted a coastal policy analysis to the New York State Coastal Management Program on 4 November 2019 regarding the plan to perform work in the Hudson River along Iona Island. On 22 November 2019, the Department of State provided a letter of concurrence with the USACE's consistency determination regarding the consistency of the proposed activities to perform both land-based and subsurface investigations at Iona Island.

2.6 VEGETATION

Native vegetation within the marsh is dominated by narrow leaf cattail (*Typha angustifolia*) with common reed (*Phragmites* spp.) and swamp rose mallow (*Hibiscus moscheutos*). Crack willow (*Salix fragilis*) is present at the mouth of Doodletown Brook within the tidal swamp. Compaction of soil, salt water intrusion, and site disturbance have resulted in a significant presence of invasive species (estimated at 60 percent of the vegetation on the island). Recent wetland restoration has been conducted on site, with approximately 50 percent of the marsh restored from invasive species (including *Phragmites* spp.) to native vegetation such as cattails (Bluestone 2018).

The upland terrestrial areas of the island consist of deciduous, rocky woodland communities including oaks (*Quercus* spp.), ashes (*Fraxinus* spp.), birches (*Betula* spp.), willows (*Salix* spp.), red maple (*Acer rubrum*), and elms (*Ulmus* spp.). The woodlands are maintained for their value as cover, perch sites, and buffer zones.

2.7 WASTE DISPOSAL SITES

Based on the findings from the 2008 SI, there are no confirmed munitions debris (MD) burial areas on Iona Island (Alion 2008). One former dumping area (AOC #16 – Area D) was identified between Iona and Round Island.

This RI is being conducted, in part to determine if additional munitions and explosives of concern (MEC)/MD waste disposal/burial areas are present within the RI areas. Geophysical investigations will be conducted along the shoreline and within the AOCs to search for munitions related disposal/burial areas and targets areas.

3. MITIGATION PROCEDURES

3.1 COORDINATION WITH THE PIPC

Action will be taken during the RI field activities to minimize or mitigate any adverse impact to the environment. EA will work closely with the Science Director at PIPC to minimize impacts to the environment. The Science Director has provided information on the existing natural and cultural resources present at Iona Island for inclusion within this EPP. During the field kickoff meeting, EA will work with PIPC's Science Director to properly train the field team in identifying and avoiding these natural and cultural resources.

3.2 BURNING ACTIVITIES

No burning activities will be completed during the RI.

3.3 DUST AND EMISSIONS CONTROL

RI activities will generate little to no dust or emissions; therefore, a dust control plan will not be required.

3.4 SPILL CONTROL AND PREVENTION

Minimal amounts of chemicals will be brought onsite during the field activities. These will be limited to fuel (i.e., gasoline, diesel, etc.) for field equipment and decontamination fluids. Vehicle refueling will be completed at commercial offsite facilities. All attempts will be made to refuel field equipment on paved locations at or near MRS-01 and AOCs. A spill kit will be available during refueling operations for field equipment. Field procedures will focus on minimizing or preventing spills during field activities; however, if a spill of hazardous chemicals occurs, field personnel will contain the spill and contact the PIPC point-of-contact, the Science Director. Spill management and resolution will be conducted according to PIPC guidelines.

3.5 ACCESS ROUTES

EA will use established roadways (dirt or paved) to the extent possible to gain access to the RI areas. Within the RI areas, field personnel will strive to confine motorized traffic to established access routes to reduce potential impacts to surface topography and vegetation.

3.6 VEGETATION PROTECTION AND RESTORATION

In order to minimize potential impacts to federal and state listed plants and animals, EA will consult with the PIPC and provide site-specific training to the field team before beginning any vegetation removal activities at MRS-01 and the AOCs. Field personnel will be trained to identify sensitive species and their habitat.

Based on observed site conditions, some vegetation may need to be removed from the AOCs. Vegetation will generally be hand-cut, using man-portable brush cutters.

If necessary, extensive vegetation clearing or use of mechanical equipment such as a skid-steer track loader with brush mower attachment will be discussed with the PIPC in advance for approval. No vegetation restoration is anticipated due to the thickness of the existing vegetation and the minimal vegetation clearance that is anticipated to occur.

3.7 THREATENED AND ENDANGERED SPECIES

The Atlantic sturgeon and shortnose sturgeon live primarily in the ocean but migrate to coastal rivers for spawning in April to June (NYSDEC 2019). In New York, spawning and nursery grounds for juveniles are located in the Lower Hudson River (refer to Table 1-1).

Bald eagles primarily use Iona Island during the coldest winter months (mid-November to mid-March), and typically stay on the east side of the island, along the shoreline with the Hudson River. The least bittern is a marsh bird with an active breeding window from April through July.

Currently, both off- and on-land activities (external geophysical, HTRW sampling, and advanced digital geophysical mapping [DGM], and diving) are planned for fall/winter.

The temporal boundary for the investigation will be phased and include multiple mobilizations to account for seasonal considerations such as vegetation (HTRW sampling and DGM and AGC will be performed during spring prior to marsh and island growth), avoidance of avoid the key time periods and sensitive locations for wintering bald eagles (mid-December thru early March, depending on winter severity) and marsh bird breeding (the nesting/fledging of the least bittern in the marsh grasses to the west of Iona Island during mid-April – mid-July), and Hudson River tides (e.g., diving will be performed during slack tide when possible for safety considerations). Field activities will be conducted on a schedule that avoids the key time periods and sensitive locations indicated for these species to the extent practicable. If work needs to be conducted during key time periods, additional coordination will be conducted with Bear Mountain State Park POC to allow access at the tail ends of these periods. PIPC’s Science Director will provide a guide to direct the field team and avoid unnecessary disturbance.

EA will also provide site-specific training to the field team before beginning any activities that may be in a potential bald eagle wintering area or least bittern nesting site. Field personnel will be trained to identify and avoid sensitive species (e.g., least bittern, bald eagles) and their habitats to ensure T&E species are not impacted during the RI. If sensitive species are identified in a work area, the field team will temporarily stop work and consult with PIPC’s Science Director.

3.8 WATER RUN-ON AND RUN-OFF CONTROL

If the potential exists for encountering surface water within land-based areas where soils have been exposed (e.g., following vegetation removal, intrusive investigation of anomalies, or post-detonation), appropriate precautions will be used to control water run-on and run-off during completion of field activities. This may include the use of silt fencing or other best management practices, as appropriate.

3.9 EQUIPMENT DECONTAMINATION

Non-disposable, reusable equipment that may directly or indirectly contact samples will be decontaminated between sampling locations in accordance with EA's SOP 005. This equipment includes, but is not limited to, incremental sampling tools used to collect incremental soil samples; drilling augers used during soil boring advancement; ponar dredges used during sediment sampling; stainless steel scoops or bowls used to composite discrete soil or sediment samples; and water level meters used to measure water depths in temporary wells.

Reusable personal protective equipment (PPE) or clothing that becomes contaminated during site work will be appropriately cleaned before reuse or will be disposed of and replaced.

3.10 WASTE MANAGEMENT PLAN

Expendable waste used in completing the sampling (including used PPE and general trash, dedicated acetate sleeves, temporary well casing and tubing, plastic spoons/scoops, etc.) will be bagged and properly disposed of as general debris/trash.

Decontamination wash water (deionized water and non-phosphate soap) will be limited and will be contained in 5-gallon buckets. Whether or not the disposal of wash water offsite is required will be determined among project stakeholders, and if necessary, the wash water will be characterized prior to disposal.

Soil cuttings generated during soil boring advancement will be returned to borings following removal of temporary wells. Purge water generated during groundwater sampling and decontamination fluids used during equipment decontamination tasks will be discarded to ground surface.

3.11 POST-ACTIVITY CLEAN-UP

Solid waste generated during the RI will be removed from the site on an as needed basis and will be disposed of as general refuse (as discussed in Section 2.2). MDAS will be removed after RI activities have been completed and prior to leaving the site. Any material potentially presenting an explosive hazard or MEC that are found during the RI will also be disposed of by EA. MEC disposal operations will include the demolition of suspected MEC and the subsequent removal of MD and backfilling of holes resulting from the detonation. No post-detonation sampling for residual munitions constituents (MC) will occur as it is assumed that all energetics will be consumed upon detonation.

3.12 AIR MONITORING PLAN

Exposure to volatiles or particulates in air via inhalation is not significant because the site is vegetated. Based on the site history, site conductions, and the nature of the proposed RI activities (e.g., digging target anomalies and soil sampling), an Air Monitoring Plan is not necessary.

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Appendix C

Technical Project Planning Meeting #1

Iona Island Formerly Used Defense Site
Military Munitions Response Program and Installation Restoration Program
Remedial Investigation through Decision Document
Technical Project Planning Meeting TPP #1
Meeting Memorandum
7 November 2018 0800 EDT

Meeting Attendees

Name of Attendee	Organization	Title
Todd Beckwith	CENAB	Technical Support
David King	CENAB	Geophysicist
Erin Kirby	CENAE	Project Manager
Cheryl Montgomery	CENAE	Risk Assessor
Rosemary Schmidt	CENAE	Geologist
Steven Scharf	NYSDEC	Project Manager
Edwin McGowan	PIPC/Parks	Science Director
Mike Tambroni	EA	Deputy Project Manager
Bob Casey	EA	Senior Scientist
Mike McGuire	EA*	Geophysics Program Lead
Dan Hinckley	EA*	Chemist
Melissa Beauchemin	EA	Risk Assessor
Nicole Wagner	EA	Scientist
Amanda Kohn	EA	Geologist
John Breznick	ANJV*	Geophysicist

Notes: * Indicates participation by teleconference.
ANJV = Acorn SI/NAEVA Joint Venture
CENAB = United States Army Corps of Engineers – Baltimore District
CENAE = United States Army Corps of Engineers – New England District
EA = EA Engineering, P.C. and Its Affiliate EA Science and Technology
NYSDEC = New York State Department of Environmental Conservation
PIPC = Palisades Interstate Park Commission

Meeting Minutes

Agenda Items	Meeting Minutes
• Introductions, CENAB, CENAE, PIPC/Parks, NYSDEC, and EA	- Following introductions by participants, Mike Tambroni (EA Deputy Project Manager) facilitated the Technical Project Planning (TPP) Meeting #1. General notes / minutes are below.
• TPP Purpose, presented by Mike Tambroni	- Purpose of the meeting is to present the technical approach from a high-level view and get feedback from stakeholders. - TPP is a four-phase process developed by the United States Army Corps of Engineers (USACE). The meeting will cover Phase 1 (Identify the project), Phase II (Determine data needs), and Phase 3 (Develop data collection options). The final data collection program will be presented in the Work Plans, which will be in Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) format. - EA will provide NYSDEC with a crosswalk of the UFP-QAPP.
• CERCLA Process, presented by Mike Tambroni	- The project follows the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The contract scope includes Remedial Investigation (RI) through Decision Document (DD). We are currently in the RI Phase. - Planning and investigative work during the RI phase will consider alternatives that may be included in the Feasibility Study (FS).
• Scope and Objectives, presented by Mike Tambroni (EA)	- The purpose of the project is to achieve DDs at the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS) for one Munitions Response Site (MRS), MRS-01 1903 Explosion and 16 Hazardous, Toxic, and Radioactive Waste (HTRW) Areas of Concern (AOCs).

Meeting Minutes

Agenda Items	Meeting Minutes
• **Scope and Objectives (continued)**, presented by Mike Tambroni (EA)	- Aboveground storage tanks (ASTs) and underground storage tanks (USTs) have been closed out under the Containerized HTRW (CON-HTRW) Program and will not be included as part of this investigation. - Separate UFP-QAPPs and two RIs will be completed for the project for the Military Munitions Response Program (MMRP) and the HTRW AOCs. - Mr. Scharf (NYSDEC) asked about radioactive waste. Mr. Tambroni (EA) noted there is no record of radioactive waste use at the site.
• **Site Location and Background, Site History**, presented by Mike Tambroni (EA)	- Iona Island is located in Stony Point, New York (NY) (south of West Point and north of Manhattan) and is maintained by Bear Mountain State Park. - Formerly used by the Navy between 1900 and 1947 as a Naval Ammunition Depot. - Aerial photograph on slide 7 looking north over island shows ammunition depot buildings, main dock. Majority of buildings were demolished. Mr. McGowan (PIPC) provided information about the current site conditions - some building slabs remain at Iona Island, and a bulkhead is still present on the shoreline. - The Navy used the site for preparing, assembling, maintaining, inspecting, and testing of ammunition; and storage of bulk explosives, ammunition, and ordnance material.
• **Physical Environment, Site Use and Potential Receptors**, presented by Mike Tambroni (EA)	- Land, wetland, and river environments. - Shallow soil, potential perched groundwater over bedrock. - Hudson River is tidally influenced, approximately 3.5 feet (ft). - Aerial photograph on slide 9 from early 2000s shows view looking west over Iona Island prior to marsh restoration. - Mr. McGowan (PIPC) provided information on use of the Iona Island regarding potential human receptors. • Use is limited to educational outings, history tours (6-8 times per year with approximately 50 people). The Island was used by the Boy Scouts for camping in the past. No longer used by the Scouts as the Island is not regularly patrolled by the Park Service, and there are physical hazards (not related to munitions or contaminants of potential concern [COPCs]). Park staff use the Island for storage. • Canoeing is by permit only. • There is no intent to put in a trail system. • Construction worker receptors are limited. There are no anticipated construction plans beyond potentially converting existing buildings for other use or constructing new storehouse. • There have been plans in the past to develop part of the island as a retreat/nature center, and a sewer system was even installed, but never used. • A developer has recently proposed plans for constructing an environmental center/nature center, however these plans have not been approved and are very preliminary. • Future use not anticipated to change from current use. • There are no deed restrictions currently on the property.

Meeting Minutes

Agenda Items	Meeting Minutes
• Physical Environment, Site Use and Potential Receptors (continued), presented by Mike Tambroni (EA)	- Majority of Island is open space. Seasonal closure in December through March for bald eagle use. Eagles primarily use the Island during the coldest winter months, and typically stay on the east side of the island. - Iona Marsh is part of National Estuarine Research Reserve - A busy freight rail line is located immediately east of the Island along the point of access. - Assume potential for continued recreational use in the future –while there were plans for development at one time, there are no anticipated plans for development on the horizon. It is unlikely that Iona Island would be treated like other parks due to accessibility and conditions of the site. - It is possible that buildings in disrepair could be demolished or existing footprints of buildings could be repurposed. There is no plan for utility work. - The existing storehouse has a defunct water supply/waterline that was put in to connect to a reservoir in Doodletown, but this was never hooked up. - The existing storehouse may have a working well that could be sampled as part of RI. There is a small staff in the storage house. Water is not potable – it is connected to an outdoor tap/faucet. - .
• MMRP sites discussion/overview, presented by Mike Tambroni (EA)	- Various munitions-related items were found in the past at the MRS as result of historic use of the site for military munitions. Ammunition was not manufactured at Iona Island. Activities included loading, filling/assembling, and storing munitions, including 13-inch shells. Chemical composition for the ordnance items of interest will be reviewed and a MC list will be developed and included in the MEC QAPP. Analytical suite will be selected based on munitions and explosives of concern (MEC) identified. - Three areas of interest have been identified for MEC investigation including: 1903 area, former loading docks and downstream shoreline, and dump area between Iona Island and Round Island. - Available information on the types and conditions of MEC is limited. A grenade was found in mid-1980s near buildings 311 and 314, however there is no information on whether the grenade was a practice or contained high explosives. A portion of 3.75-inch rocket warhead (tip of rocket) has also been recovered. - There is no indication of discarded military munitions (DMM) on land. In past during low water, ordnance items were reported along the eastern shoreline. Ordnance was not observed during the site walk. - Mr. McGowan (PIPC) stated that there are empty, large ordnance shells in storage – shells were X-rayed and confirmed to be practice (empty/inert). - It is unlikely that munitions would have been buried on land. Overburden at Iona Island is shallow. Main concern for DMM is the dump area and Hudson River. Historical records indicate that common practice by the Navy was to dispose of excess munitions out at sea.

Meeting Minutes

Agenda Items	Meeting Minutes
• **1903 Explosion Area RI approach**, presented by Mike Tambroni (EA)	- Munitions constituents (MC) sampling will be conducted if a breached munition item is found. MC analysis will include a tailored list of MC metals and explosives specific to the ordnance item identified. - 1903 Explosion Area will be investigated using random Digital Geophysical Mapping (DGM) grid and Cued Advanced Geophysical Classification (AGC). The approximately 124.2-acre explosion area radius was provided by USACE. DGM will be conducted in 100x100ft grids. Vegetation would have to be cut to a maximum of 4 inches in each grid. There will be no cutting of existing trees. - Mr. McGowan (PIPC) stated that there are plant stands in the marsh and asked about moving grids if needed to avoid the stands. Restoration work has been conducted since 2008. EA can move locations as needed. There are surface elevation measuring points used to measure sedimentation rates; Mr. McGowan will provide the locations, however he believes they are just outside the explosion area. The entire marsh has been cut/mowed/mulched in the past, with multiple tracks/directions. Paths are currently mowed for access. - Mr. McGowan (PIPC) stated that protected migratory birds arrive and nest in April and fledge in July on Iona Island. Mike Tambroni (EA) stated that EA is targeting fall/winter for the investigative work when vegetation is down and water is lower. - Former building foundations/slabs may be visible with DGM, as such grids will not be located near these features. - Mr. McGowan (PIPC) stated that there is a memorial grove of small trees and, he will pull together a map showing the location. - Access to the marsh on the southwestern portion of the site near the railroad will be through a gate and along the railroad shoulder. EA will need to gain access from CSX (railroad), who will likely require a CSX employee to be onsite during investigation activities in this area. - If marsh conditions do not allow for the DGM, the alternative method will include mag and dig in this area. EA would work around tides.
• **Dump Area RI approach**, presented by Mike Tambroni (EA)	- DGM will be conducted in tightly spaced transects in the Dump Area. - Three areas were presented and included the Dump Area, non-DoD fill area, and 1940s shoreline fill area for fire line right-of-way and sewer discharge pipe. - Discussion ensued regarding investigation of the non-DoD, post-1960s fill area in the southern marsh adjacent to the southeastern side of Iona Island. Mr. Scharf (NYSDEC) suggested conducting test pitting in this area. His rationale is that there may be rubble from former Iona Island buildings overlying kickout MEC from the 1903 explosion. The explosion area radius expands over this area. The area is within the confines of the site, however construction debris was not moved/put there by DoD. USACE will check on the responsible party and funding for investigation. The area is likely not eligible for funding under the FUDS Program. Also, the investigation using grid squares distributed across the radius of the explosion area will provide a statistically-valid and meaningful evaluation of the blast area even if there is not a grid located specifically within the footprint of the post-DoD fill area. There is no record of filling in this area

Meeting Minutes

Agenda Items	Meeting Minutes
	prior to 1965. The area is a former wetland filled with loose material, and contains voids within/below debris. - 1940s fill area may be a potential HTRW site.
• **Former docks and shoreline RI approach**, presented by Mike Tambroni (EA)	- Docks will be investigated using underwater mag and dig. Shoreline will be investigated digital geophysical mapping (DGM). - While the primary flow direction of the Hudson River is south, tides could result in northward flow. USACE suggested expanding the shoreline investigation area north of the docks. In addition, USACE suggested expanding DGM downstream around Round Island.
• **Visual Sampling Plan**, presented by Mike McGuire (EA)	- Overview of the use of a Visual Sampling Plan (VSP) to determine the number and size of grids that will be used to investigate the 1903 Explosion. VSP is a module to statistically evaluate areas for the amount of potential munitions/MEC. Iona Island is not a high public land use area because the site does not include beaches, schools, or residential areas. Program inputs included MEC density input of 0.5 MEC per acre, 95% confidence level, and overall size of 1903 explosion area (124.2 acres). Output of VSP: investigate 6 acres, dig targets, and estimate potential MEC density. 100x100-ft grid is approximately 0.5 acres. Distributed grids throughout the 1903 explosion area to statistically evaluate the site. Grids are random but biased (avoiding tops of buildings, bedrock outcrops). Data will be collected (i.e., intrusively investigate selected targets) and a post-investigation analysis will be conducted to evaluate munitions density.
• **HTRW background**, presented by Bob Casey (EA)	- USACE obtained a right of entry permit from PIPC for conducting work on Iona Island. - USACE will need to contact CSX to pursue access from the railroad. - 16 HTRW AOCs with operational use and activities conducted by Navy are being investigated under this RI. Underground storage tanks (USTs) and above ground storage tanks (ASTs) are covered under containerized HTRW (con-HTRW). USTs were not truly underground – tanks put in place and bermed/buried. Former gasoline/diesel USTs/ASTs have been removed, geophysics investigations have been conducted at potential former UST locations. No additional USTs identified. NYSDEC will check database for closure documents. - Previous environmental investigations at Iona Island detected metals and semi-volatile organic compounds (SVOCs) in soil. EA is still developing the complete list of COPCs. Mr. Scharf (NYSDEC) asked about solvent use. There are no records or documentation of use. Based on overall conceptual site model (CSM), chlorinated volatile organic compounds (VOCs) would not be present. Last use would have been over 70 years ago. Physical environment is not conducive to long-term persistence – shallow soil over bedrock, tidal influence. Furthermore, AST and UST programs have been closed under con-HTRW so petroleum VOCs will not be pursued.

Meeting Minutes

Agenda Items	Meeting Minutes
• **CERCLA discussion**, presented by Bob Casey (EA)	- The HTRW RI is being conducted in accordance with CERCLA. The Army is the lead agency under the Defense Environmental Restoration Program (DERP), and DERP follows CERCLA per executive order. During the RI analytical results will be compared to screening criteria, and a human health risk assessment (HHRA) and screening level ecological risk assessment (SLERA) will be conducted. Under the FS, additional applicable or relevant and appropriate requirements (ARARs) such as state standards will be included to assess remedial action alternatives/goals. - Mr. Scharf (NYSDEC) asked about NYSDEC screening criteria. NYSDEC part 375 criteria is risk based. The RIs follow CERCLA and use a risk-based calculation, not a pass/fail of criteria. Mr. Scharf will run the approach past the health department. • USACE stated that this decision is programmatic. HHRA unacceptable risk is defined as an incremental cancer risk of greater than 10^{-4} and/or a hazard quotient greater than 1. Risk is managed between 10^{-4} and 10^{-6}. RIs will include site-specific risk assessments, which include a calculation of risk. Remediation will not be based on screening criteria, but rather the site-specific risk assessment which looks at exposure based on use.
• **Previous investigations and potential data gaps,** presented by Bob Casey (EA)	- Overview of previous investigations. Analytical data were compared to NYSDEC criteria. USACE suggested comparing previous data to EPA screening criteria to determine COPCs. EA will incorporate both EPA and NYSDEC screening values. The lowest value will be used to set Project Action Limits and to initially screen the data for the risk assessments. - Need to define background concentrations. Look at areas close to the site but not under influence of the site or other industrial activities. Locations need to be relevant to the study area for comparison. USACE stated that background locations in previous studies were too close to the site. Mr. Scharf (NYSDEC) suggested background locations in Bear Mountain State Park.
• **HTRW Data Quality Objectives discussion**, presented by Bob Casey (EA)	- Overview of HTRW contaminations and RI goals. 16 AOCs were grouped into three larger AOC groupings to determine area for investigation. Dr. Montgomery (CENAE) asked how AOC groupings were developed. Mr. Casey (EA) stated groupings were based on geographic location and historical Site Investigation (SI) data, including surface soil lead concentrations. A discussion of the previous proposed approach with discrete sampling ensued. Original intent was to bound high concentration soil areas. Elevated lead concentrations were reported in soil during the SI. Some of the higher lead detections were near the solder reclamation facility and incinerator. Lead was also likely related to lead-based paint. Soil has been considerably re-worked and re-distributed across the site during building demolition, which contributed to wide-spread, sporadic detections of lead in soil. Initial screening of analytical data was based on NYSDEC soil cleanup objective of 450 milligrams per kilogram (mg/kg). Areas with high concentrations above 450 mg/kg were targeted for further investigation. Detections of COPCs

Meeting Minutes

Agenda Items	Meeting Minutes
	outside the three AOC groupings were low. EA will re-screen previous results to develop a COPC list based on previous activities, site features (such as the incinerator and landfill) and focus on FUDs-related activities and related contaminants, and add this information to the rationale for the drawing of the AOC groupings.
• Proposed HTRW RI discussion, presented by Bob Casey (EA)	- RI will be conducted in two phases. Phase I will include surface and subsurface soil sampling using incremental sampling methodology (ISM). Results will be presented in a data summary report. Phase II will include additional sampling as needed. - Dr. Montgomery (CENAE) asked why sediment sampling was not being conducted. Mr. Casey (EA) stated that they would only investigate sediment if warranted per the Center of Expertise (CX) request. The Hudson River is a contaminated waterway with a history of impacts and potential to impact Iona Island and the shoreline. A discussion of sediment sampling and pros/cons ensued. Dr. Montgomery requested sediment sampling in key areas as it is uncommon not to sample sediment, especially at an island site. It was stated that it would be difficult to evaluate whether impacts are from DoD activities or an upstream source. Dr. Montgomery requested adding additional information in the UFP-QAPP detailing whether or not sediment sampling would be conducted and the rationale behind the decision. If the Hudson River depth/bathymetry and flow rates would not support a sustainable benthic habitat, then sediment sampling along the River could be eliminated. Alternatively, if the CSM indicates a need for sediment sampling based on data collected during Phase I and/or if MC/MEC is identified along the shoreline, sediment sampling in the River could be conducted during Phase II. - A discussion of groundwater sampling was conducted. Perched overburden groundwater sampling is proposed in Phase I, with perched defined as sustained flow. Bedrock sampling would be conducted in Phase II. The existing storage house well could also be included in the groundwater investigation. - Mr. Scharf (NYSDEC) said he would like to see where groundwater discharges to surface water. Ms. Schmidt (USACE) agreed that the site will need to be put in geologic context. Although there may be radial groundwater flow locally on the island, this may be overwhelmed by groundwater flow from the adjacent hillside (large recharge area) discharging to the river. - Site-specific geology/hydrogeology information will be further detailed in the UFP-QAPP.
• ISM approach, presented by Dan Hinckley (EA)	- Prior discussions occurred among USACE and EA that related to sampling design and whether discrete or incremental soil methodology (ISM) was most appropriate. USACE CX recommended using ISM for surface soil based on the munitions-related constituents and wide-spread detections. ISM is a statistical-based approach that is the most efficient and cost-effective way to obtain the largest quantity of surficial soil data across a large site.

Meeting Minutes

Agenda Items	Meeting Minutes
	- The ISM concept is to take an area/decision unit, grab aliquots, and composite aliquots for sampling. 200x200-ft decision units (DUs) (approximately 1 acre) were selected for Iona Island. - Surface soil sampling plan is to collect 50 aliquots across each DU at 0-6" depth, producing a sample approximately 1 to 2 kilograms in size for each DU. The samples would be sent to the lab for processing, which involves drying, sieving, and grinding. The concept is to homogenize soil associated with each DU, with analytical results providing concentration of chemicals for each DU. Decisions could be made for each DU depending on receptors – exposure could be calculated using results from individual DUs or a combined number of DUs – calculate mean exposure across an area. - Subsurface soil sampling plan is to advance 5 borings per DU, take 10 aliquots from cores up to 4 feet or until groundwater or bedrock is reached. A total of 50 subsurface aliquots would be collected for each DU. - DUs are approximately 1 acre in size based on the primary receptors (park employees, occasional recreational users, possible construction workers). - Surface soil would be collected using hand augers or similar tool. - Subsurface soil would be collected using a Geoprobe, with borings advanced to bedrock. It was noted that track or truck-mounted Geoprobes are available. The investigation area does not extend into the marsh.
• **Phase I data evaluation**, discussion presented by Bob Casey (EA)	- Interim data report will include screening and risk assessment. TPP meeting will be conducted to discuss data. Phase II investigation will be further defined following Phase I Report/TPP.
• **Path forward discussion**, presented by Bob Casey (EA)	- TPP Memorandum will be prepared following this TPP meeting to review and summarize action items. - UFP-QAPPs will be submitted to stakeholders (NYSDEC, PCIP) in Draft Final form in 2019, anticipating March 2019. - E-QAPP discussion – data will be managed in FUDs Online Chemical Database (FUDSCHEM), which is a storage system for USACE. It is important that E-QAPP be 100% correct. NYSDEC requested electronic data (EQUIS/Earth soft).
• Additional discussion	- Mr. McGowan (PIPC) mentioned the Hudson River Research Project – DOT is conducting wetland mitigation. Parks department supplied 3 sites on Iona Island to use as potential banking area. Potentially using a parking lot area on the north end of the Island. - Mr. Beckwith (USACE) mentioned a potential MMRP issue with bulk explosives at former buildings. Explosives could have washed into building foundation cracks, sumps, utility pipes through floor drains, drywells, sumps, cracks, etc. Requests evaluation of accumulation of bulk explosives, which could be an explosive safety issue. Could also be an MC issue. Could locate former slabs and infrastructure on maps or with geophysics. This effort is not a part of the current funded investigation.

Action Items

Responsibility	Action Item
EA	• Send historical documents to stakeholders. • Conduct National Heritage consult with the New York Park Service. • Re-evaluate previous data and historical site use/activities to define COPC list and support AOC groupings.
CENAE/CENAB	• Check on appropriate funding stream for non-DoD Fill Area for potential future investigation. • Follow up on potential MMRP issue with bulk explosives at former buildings which could be an explosive safety issue and/or MC issue. This was not in the original scope. • Coordinate with CSX to obtain access agreement
NYSDEC	• Check database for UST/AST closure documents.
PIPC	• Confirm no future development plans with the Executive Director. • Provide a map of the location of the memorial grove of trees. • Provide map with locations of potential wetland reclamation areas.

FORMER IONA ISLAND NAVAL AMMUNITION DEPOT STONY BROOK, NEW YORK

Technical Project Planning (TPP) Meeting #1

TPP Meeting Objectives

- Purpose of this TPP meeting is to:
    - Gain a common understanding of the site history
    - Facilitate discussion and understanding of stakeholder concerns
    - Achieve concurrence on project objectives
    - Understand project constraints/dependencies
    - Present Conceptual Site Model (CSM) and proposed approach
    - Outline the next steps of the project

- Results of this meeting will be used to shape Project Plans.
    - Early planning and communication will facilitate progress towards site close-out

Technical Project Planning

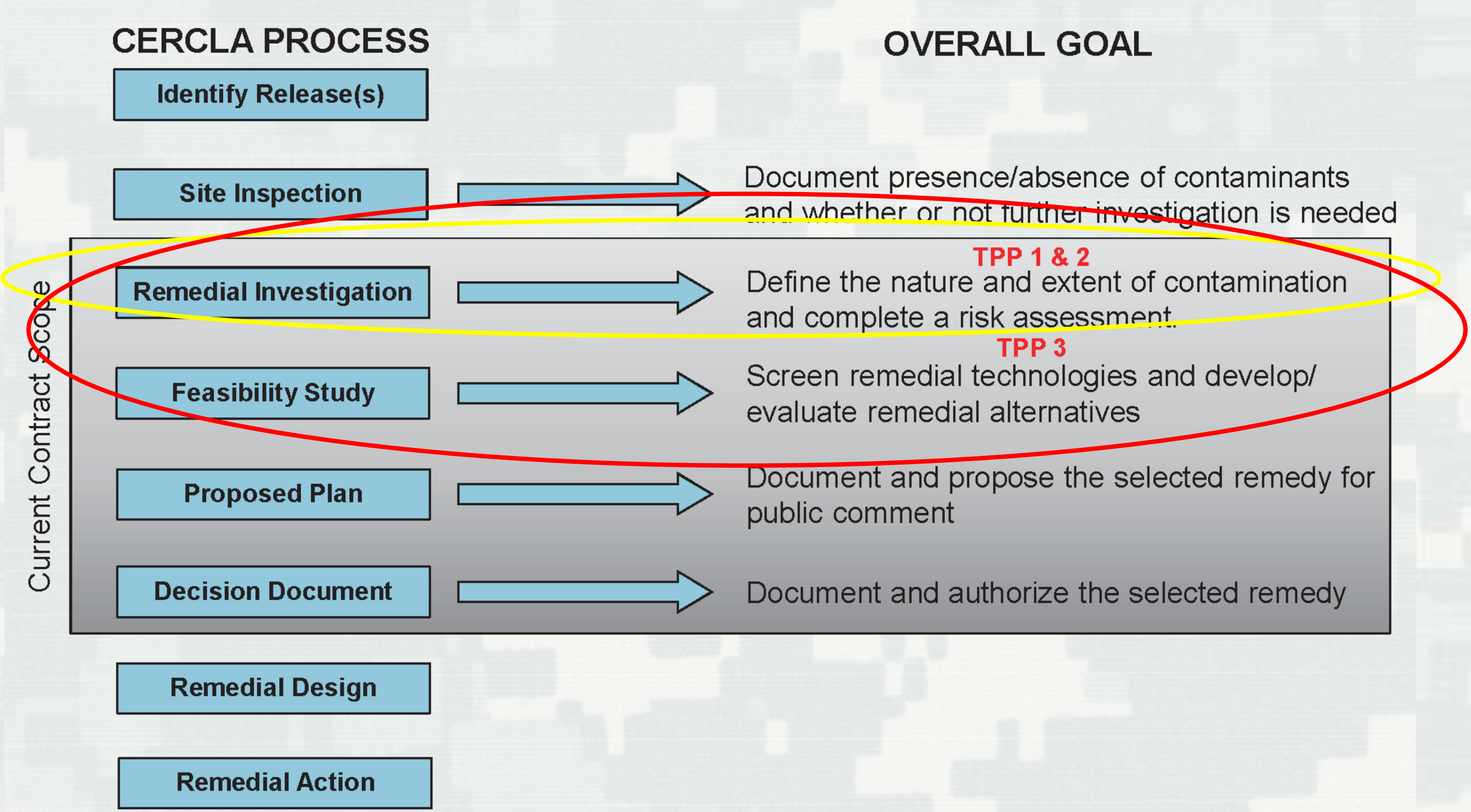
TPP is a four-phase process:

- ☐ **Phase I – Identify the project**
  - Stakeholders?
  - Project definition/CSM?
  - Customer goals?

- ☐ **Phase 2 – Determine data needs**
  - What *do* we know?
  - What *don't* we know?

- ☐ **Phase 3 – Develop data collection options**
- ☐ **Phase 4 – Finalize data collection program**
  - How best to get the information we need?

CERCLA Process



CERCLA PROCESS	OVERALL GOAL
Identify Release(s)	
Site Inspection	Document presence/absence of contaminants and whether or not further investigation is needed
Remedial Investigation	TPP 1 & 2 Define the nature and extent of contamination and complete a risk assessment
Feasibility Study	TPP 3 Screen remedial technologies and develop/ evaluate remedial alternatives
Proposed Plan	Document and propose the selected remedy for public comment
Decision Document	Document and authorize the selected remedy
Remedial Design	
Remedial Action	

Note: *CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act*

Scope and Objectives

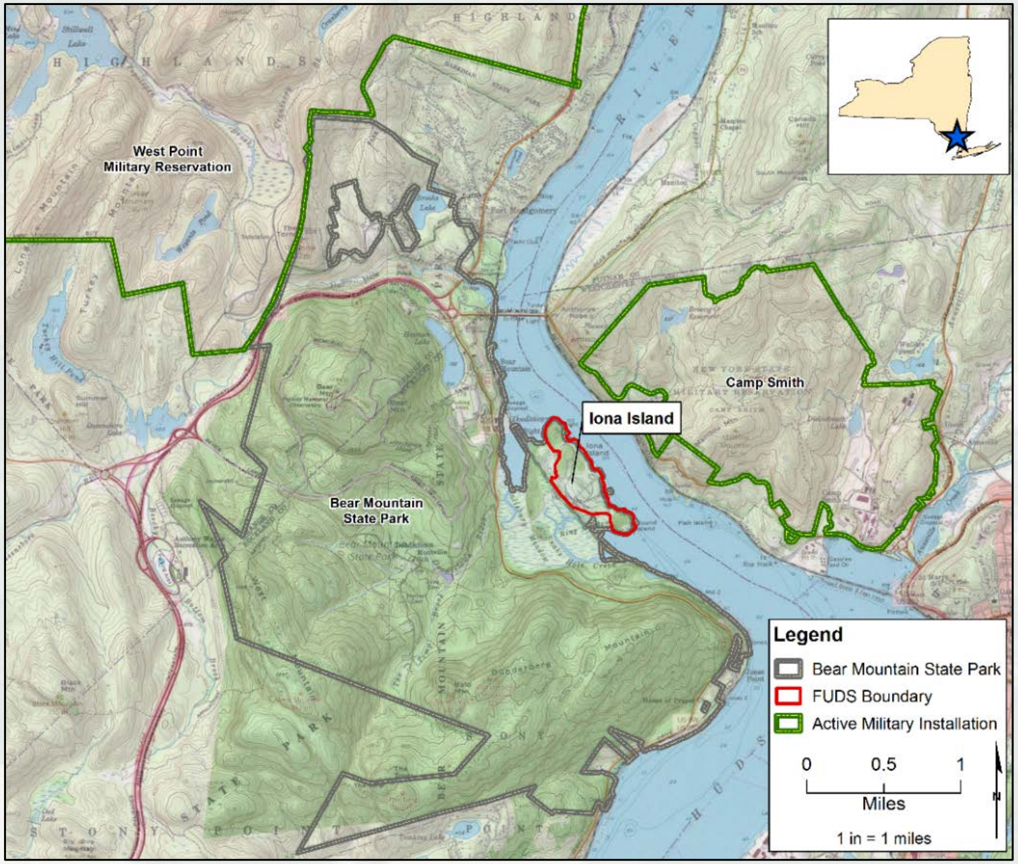
- Project Scope
  - ➢ Achieve Decision Documents at the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS) for;
    - ✓ Munitions Response Site (MRS), MRS-01 1903 Explosion
    - ✓ 19 Hazardous, Toxic, and Radioactive Waste (HTRW) Areas of Concerns (AOCs)

- Project Objective:
  - ➢ Complete RIs for MRS-01 1903 Explosion and the 19 HTRW AOCs

➢ Note: *Installation Restoration Program (IRP) AOCs are referred to as HTRW AOCs for the remainder of the presentation.*

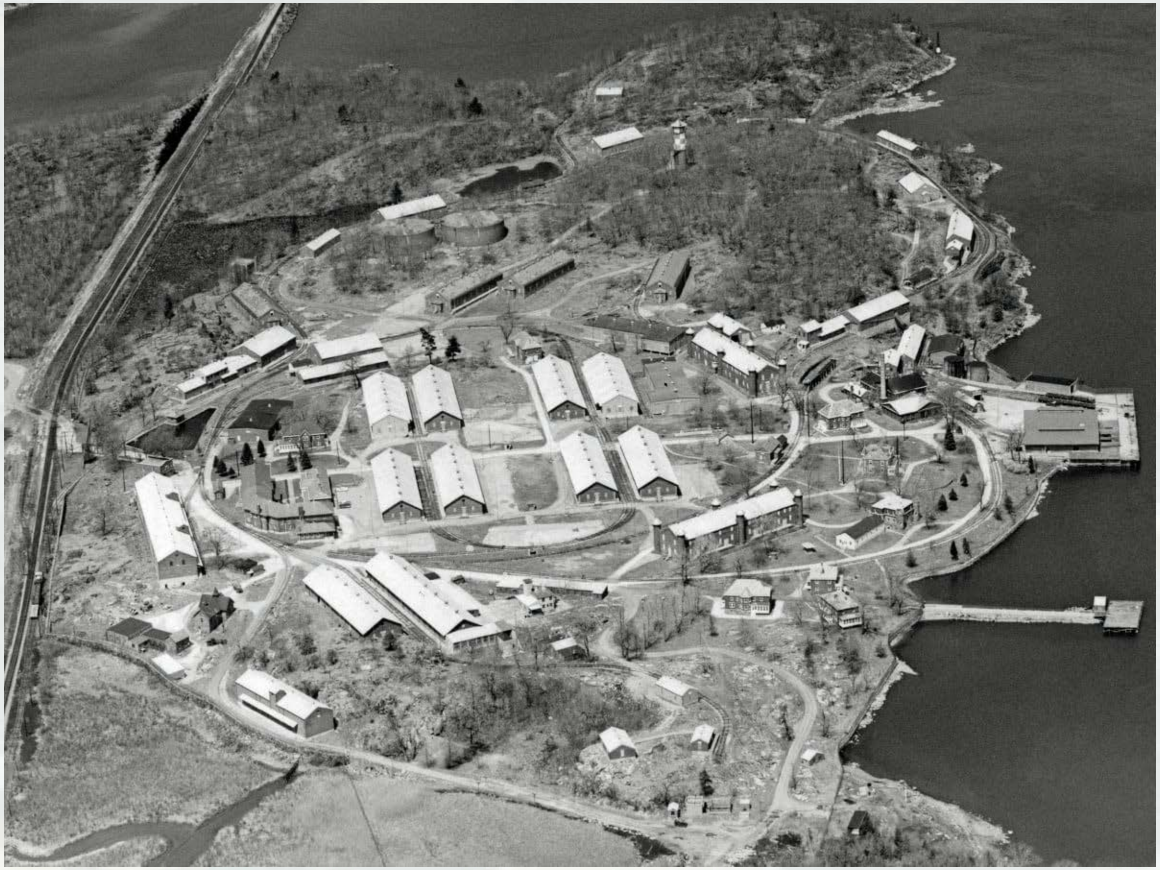
Site Location and Background

- Iona Island and Round Island along the Hudson River in the town of Stony Brook, Rockland County, NY
- 124.2 acres of land and inland water
- Currently owned by the Palisades Interstate Park Commission (PIPC); maintained by Bear Mountain State Park



Site History

- Used by Navy between 1900 and 1947: Naval Ammunition Depot
- 146 buildings on the island in 1951 when the installation was deactivated
- Majority of buildings and structures have been demolished



Site History

- Preparing, assembling, maintaining, inspecting and testing ammunition
- Storage of bulk explosives, ammunition and ordnance material
  - World War I (WWI) and WWII munitions
  - Loaded ~4,600 ships during WWII

Physical Environment

- Land, tidal wetlands, and river environments are all present
- Shallow soil overlying bedrock
- Majority of native soil has been disturbed
- Perched groundwater
- Surface water flow to Doodletown Brook, Snake Hole Creek, Hudson River
- Hudson River is tidally influenced (~3.5 feet), maximum depth of 143 feet close to Iona Island

Site Use and Potential Receptors

- Status of areas/land use is limited to Park offices/storage, conservation, research and recreation
- Access to the island is restricted/limited; future use is not anticipated to deviate from current use
- Human receptors: recreational users/trespassers, construction workers, park employees and researchers
- Ecological receptors: sensitive environments (tidal wetlands/marsh), threatened and endangered species

MMRP Previous Investigations

- Historically, various munitions-related items found
  - During low water, ordnance items have been reported along the eastern shoreline near “dump area”
  - Munitions Debris (MD)
    - grenade found near Bldg. 311 and 314
    - small arms cartridge casings
    - 6-pound projectile cartridge case
    - signal flare
    - portion of a 3.75-inch rocket warhead
- 2007 Site Inspection: no Munitions and Explosives of Concern (MEC) or MD identified during field reconnaissance; no explosives detected (only metals).

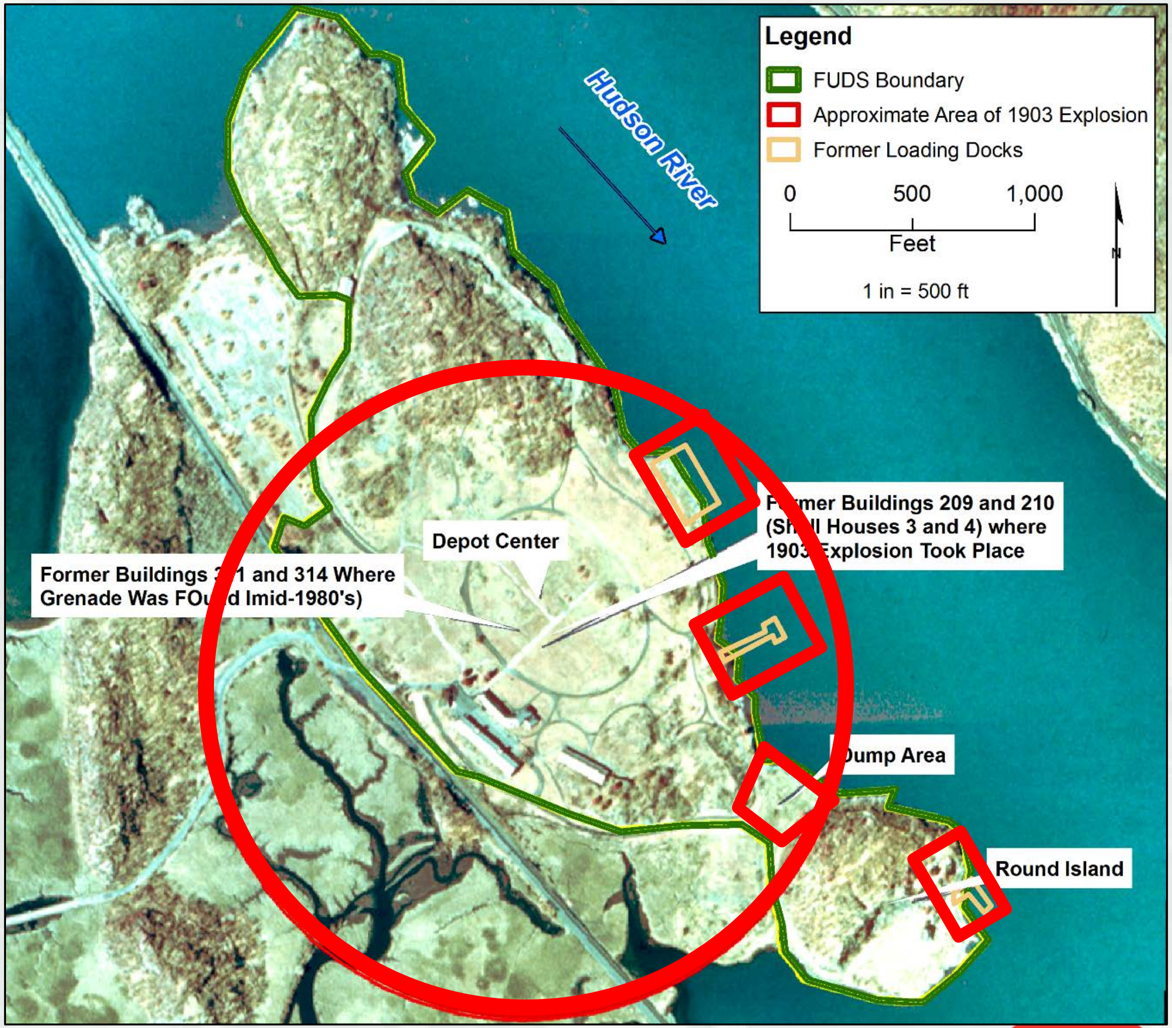
MMRP Investigation Overview

- ***3 Areas***

➢ MRS-01 1903 Explosion area (approximately 124.2 acres)

➢ Former loading docks and downstream shoreline

➢ Dump area between Iona Island and Round Island



MMRP Data Gaps

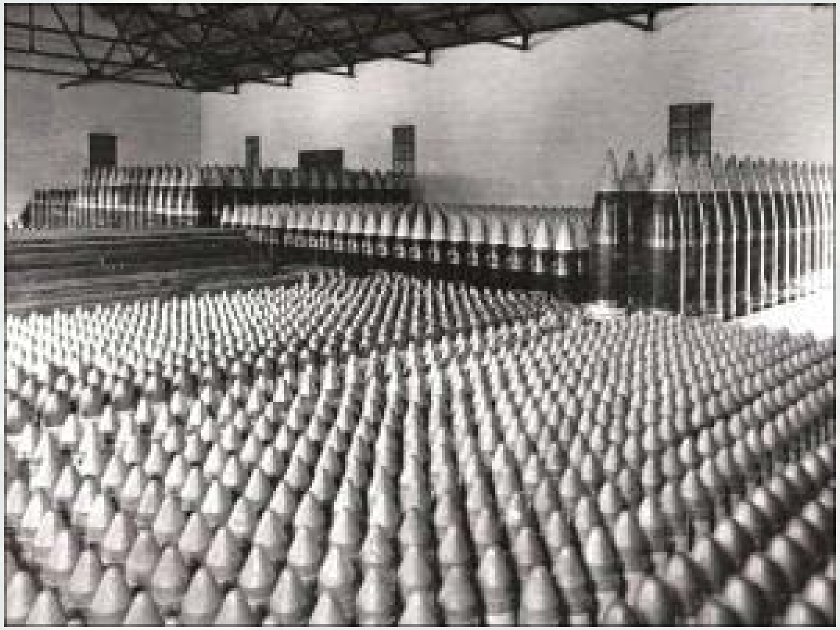
- MRS-01 1903 Explosion area has not been fully delineated/investigated in regards to horizontal and vertical extent of MEC

- Loading dock areas have not been characterized

- Dump area has not been characterized

- Potential MEC present at Iona Island based on historical information/previous investigations and includes:

    - 13-inch shells, 1-pounders, 6-pounders, and 6-inch ammunition distributed throughout the land, water, or wetland areas from the MRS-01 1903 Explosion area



MMRP Data Quality Objectives (DQOs)

1) State the Problem

- MEC may be present as a result of historical activities at the MRS/FUDS.
- MC (explosives and metals) may be present where breached MC is found.

2) Goal

- Determine the horizontal and vertical extent of MEC/MC.

3) Inputs

- MEC
  - ✓ Previous investigations.
  - ✓ Digital Geophysical Mapping (DGM) transects and grids.
  - ✓ Cued Advanced Geophysical Classification (AGC) survey.
  - ✓ Intrusive investigation on land of targets interest.
  - ✓ Intrusive investigation in water at former loading docks.
- MC
  - ✓ Analytical data (explosives) if breached MEC is discovered.

MMRP DQOs (Cont'd)

4) Boundaries

- RI areas for investigation are based on calculations of maximum kick-out area (MRS-01 1903 Explosion), historical photographs (debris / dump area), and maps (former docks and shoreline).

5) Analysis Approach

- Delineate and characterize MEC in MRS-01 1903 Explosion area Identify and characterize disposal areas
- Identify and characterize MEC in water around loading docks
- Identify and characterize MEC along shoreline downstream of loading docks
- Characterize MC (if source is identified)

MMRP DQOs (Cont'd)

6) Performance/Acceptance Criteria

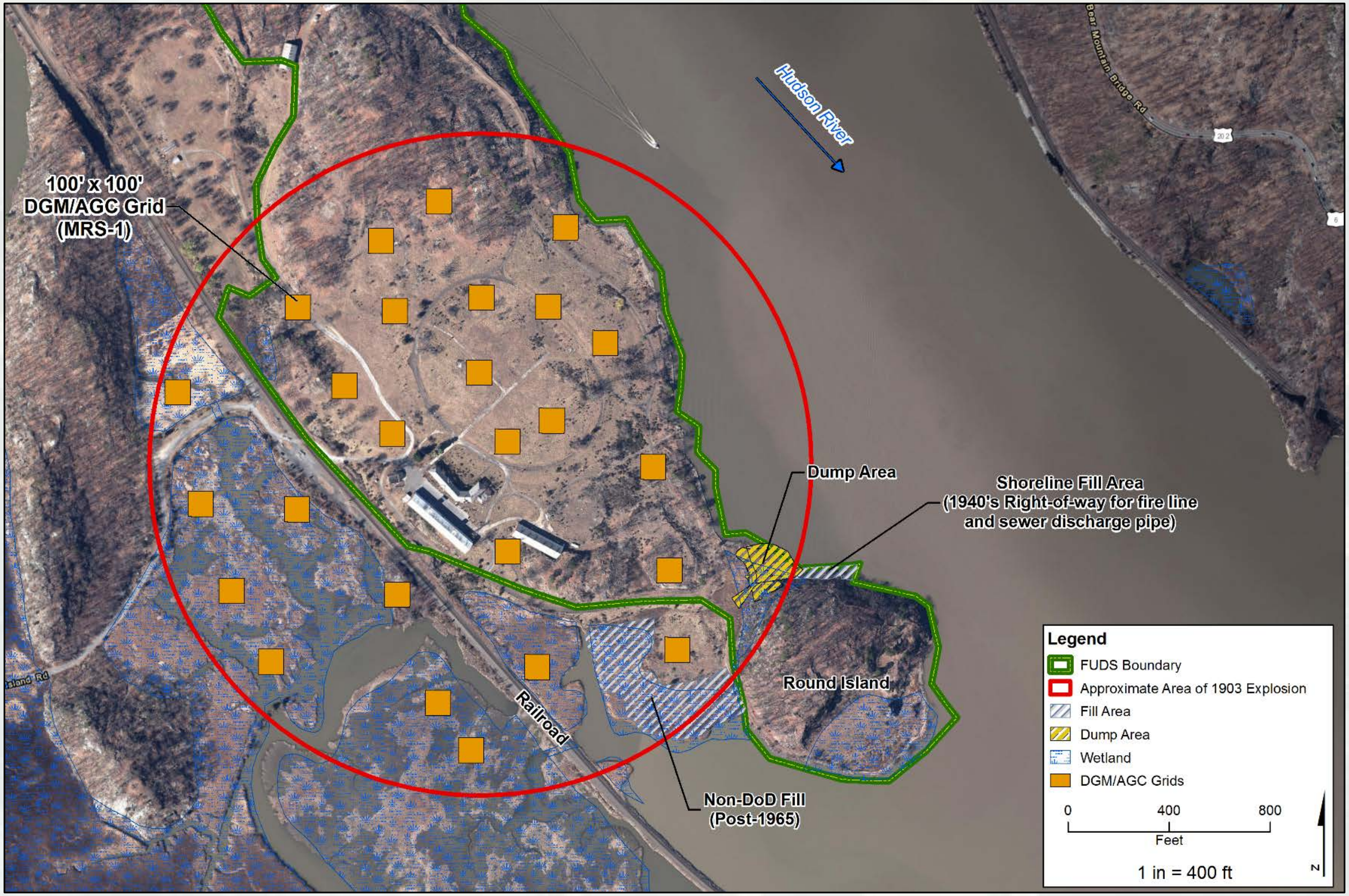
- MEC
  - Engineering Manual (EM) 200-1-15 and AGC QAPP templates to develop measurement and performance criteria (MPCs) used for the investigation
- MC
  - Laboratory Method Detection Limits/Reporting Limits for explosives and metals

7) Develop Plan for Obtaining Data

- Uniform Federal Policy – Quality Assurance Project Plan (UFP-QAPP)

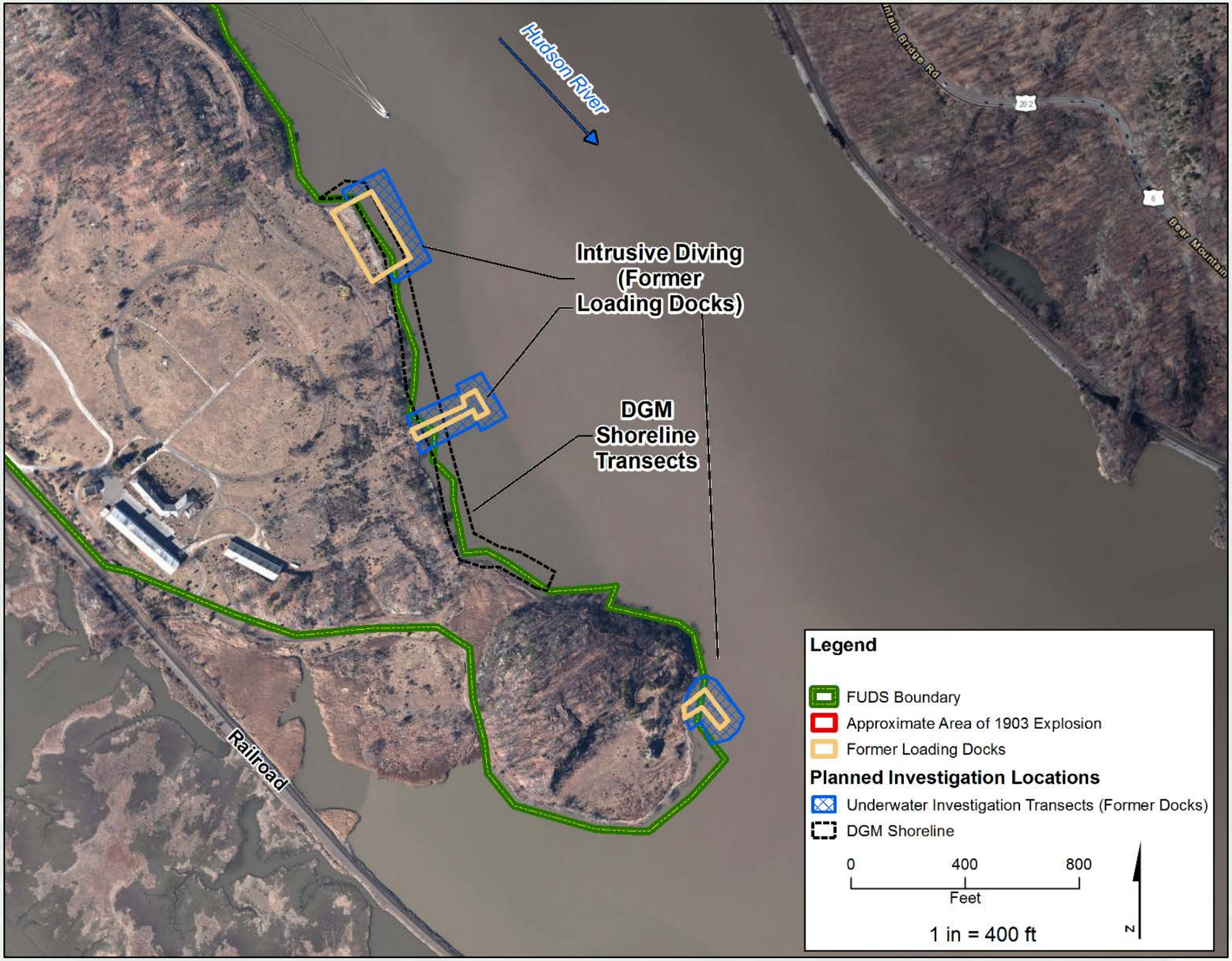
- Definable Features of Work (DFWs)

Proposed MMRP RI Approach



Proposed MMRP RI Approach

Proposed MMRP RI Approach



Proposed MMRP RI Approach

Phase 1

- Land DGM Survey over accessible portions of MRS-1, Hudson River shoreline, and likely “dump site”

Evaluation

- DGM Data Analysis, Target Anomaly Identification, Potential Disposal Feature Identification
- Select Target Anomalies for AGC
- Review Results with PDT (TPP #2)

Phase 2

- Data Collection of Selected Target Anomalies utilizing Advanced Geophysical Classification

Evaluation

- Advanced Geophysical Classification Data Analysis
- Generate “dig list” targets for Intrusive Investigation
- Review Results with PDT (TPP #3)

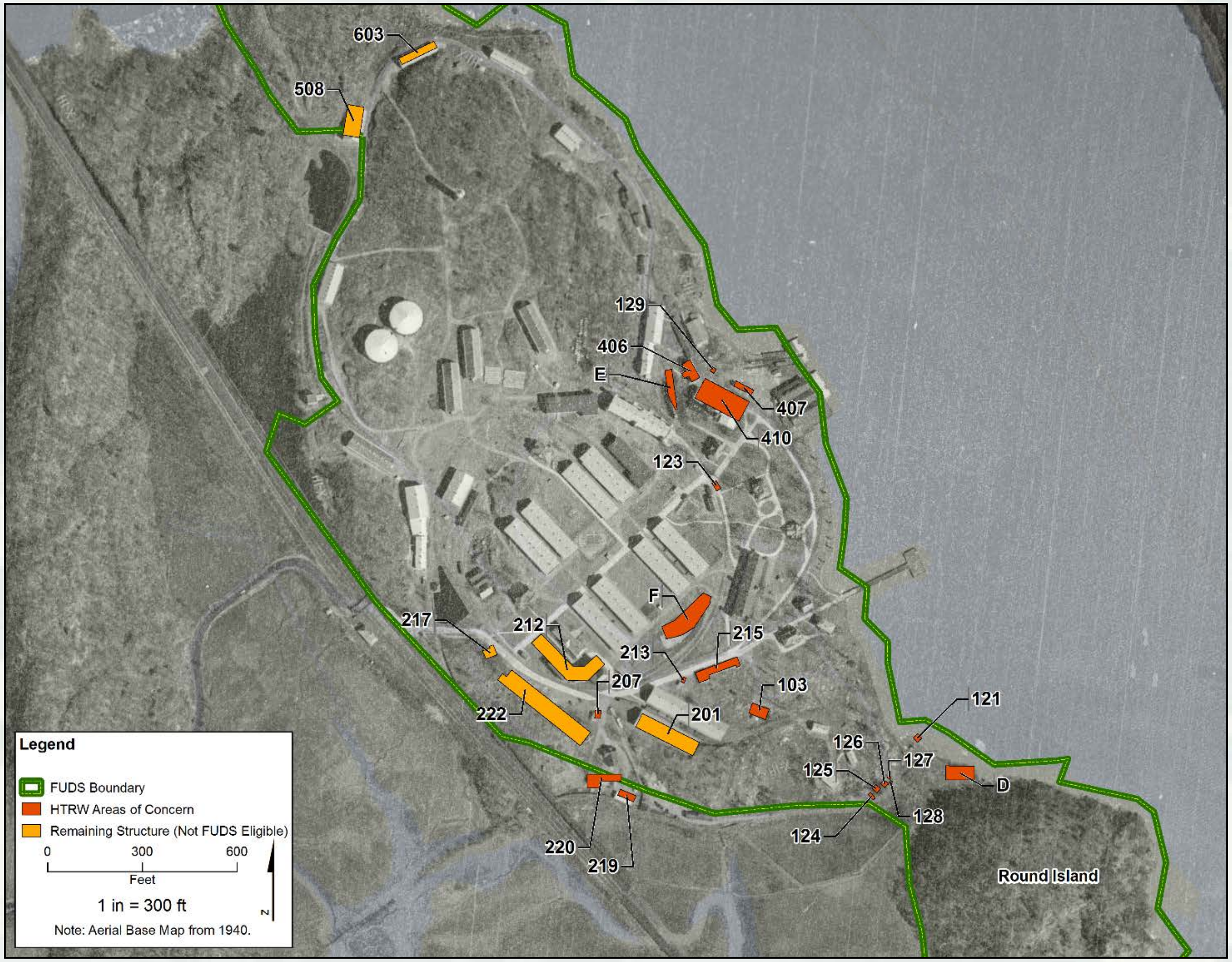
Phase 3

- Reacquire and Intrusively Investigate “dig list” targets
- Intrusively Investigate Potential Disposal Feature
- “Mag & Dig” portions of MRS-1 not suitable for DGM/AGC
- Dive on Hudson River Docks

Evaluation

- Review Results with PDT (TPP #4)

HTRW Overview

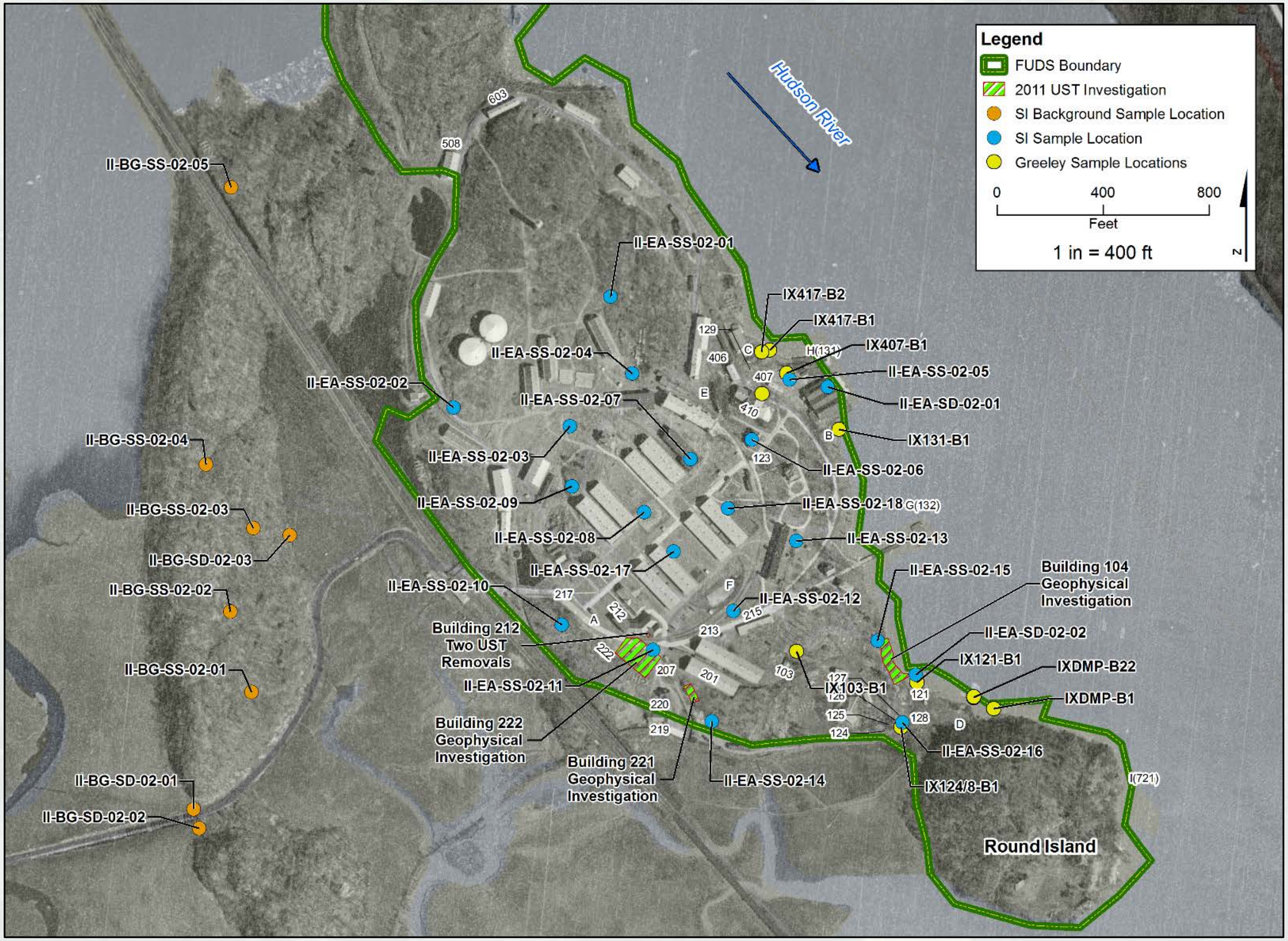


- Historical information and previous investigations document 16 AOCs
  - ➢ Historical activities and dumping may have resulted in the release of contaminants to surface soil.

HTRW Previous Investigations

- Many areas of Iona Island are influenced by the Hudson River, including shoreline and adjoining wetlands
- Previous investigations focused on former structures (buildings, USTs/ASTs, and storage areas) and suspected dumping area
- Existing soil data for metals and SVOCs (PAHs)
- Full COPC list will be developed and included in QAPP

HTRW Previous Investigations - Soil Sampling



HTRW Potential Data Gaps

- Extent of COPCs has not been delineated
- No previous subsurface soil or groundwater sampling
- No previous biota sampling or toxicity testing
- Verify federal and state threatened/endangered species status
- Request for Section 106 Consultation
- Conduct human health and ecological risk assessments

HTRW DQOs

1) **State the Problem**
   - Contamination may have been released as a result of historical DoD activities
   - Concentrations may pose a risk to human health and ecological receptors

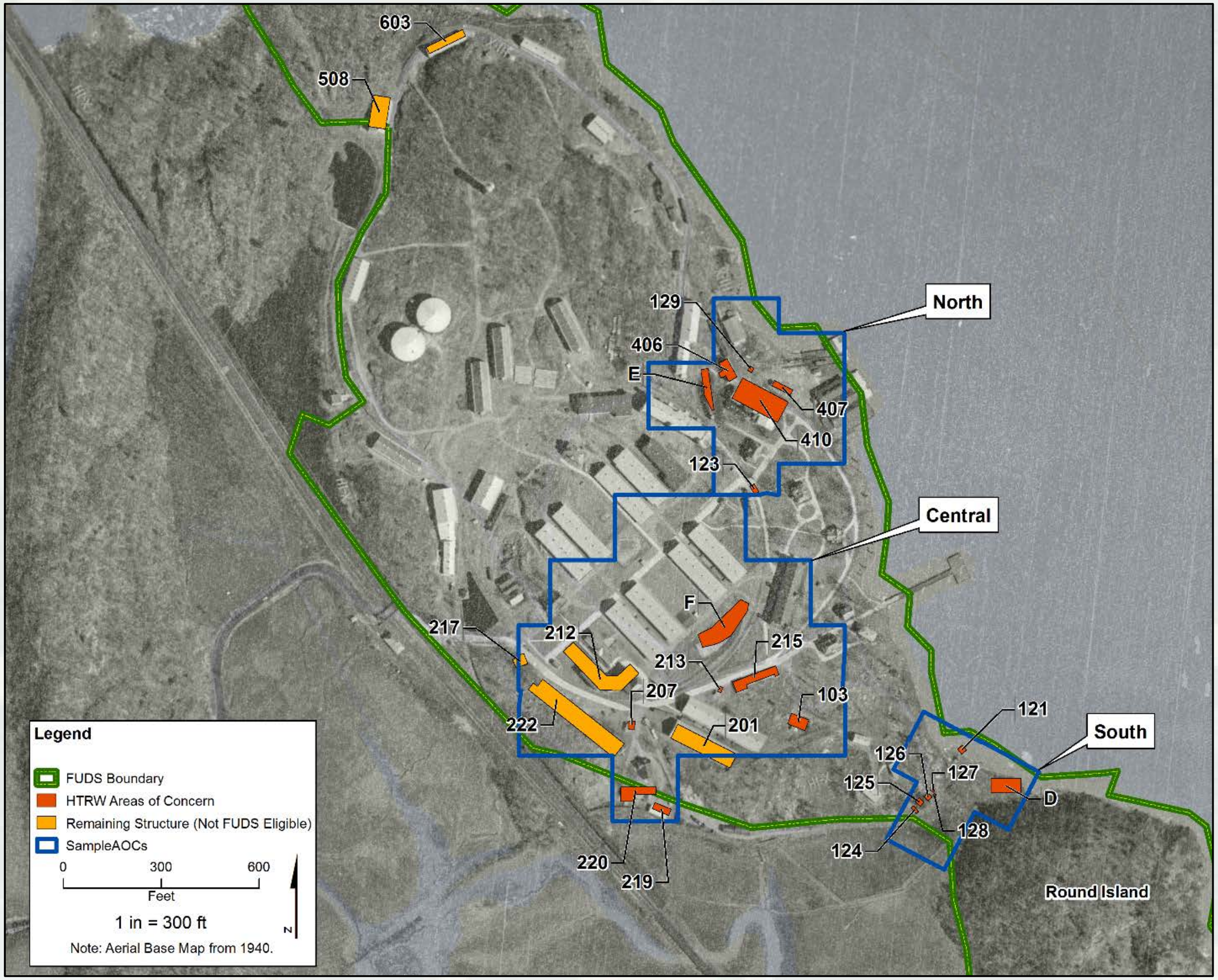
2) **Goal**
   - Determine if COPCs are present above available human health and ecological screening risk levels
   - Perform a Human Health Risk Assessment (HHRA)
   - Perform a Screening-Level Ecological Risk Assessment (SLERA)

1) **Inputs**
   - Historical use/operations and investigations at Iona Island
   - United States Environmental Protection Agency (EPA) regional screening levels (RSLs)
   - Ecological screening levels

HTRW DQOs (Cont'd)

4) Boundaries

- 16 AOC locations grouped into 3, larger AOC groupings (North, Central and South) based on geographic location and historical usage



HTRW DQOs (Cont'd)

5) Analytic Approach

- Delineate metals and PAH concentrations in surface and subsurface soil using incremental sampling methodology (ISM)
- Background concentrations for metals and PAHs from background study area
- Collect additional data to conduct human health and ecological risk assessments as needed

6) Performance/Acceptance Criteria

- RI follows CERCLA
- Screening analytical results to latest EPA RSLs

7) Develop Plan for Obtaining Data

- Approval of UFP-QAPP

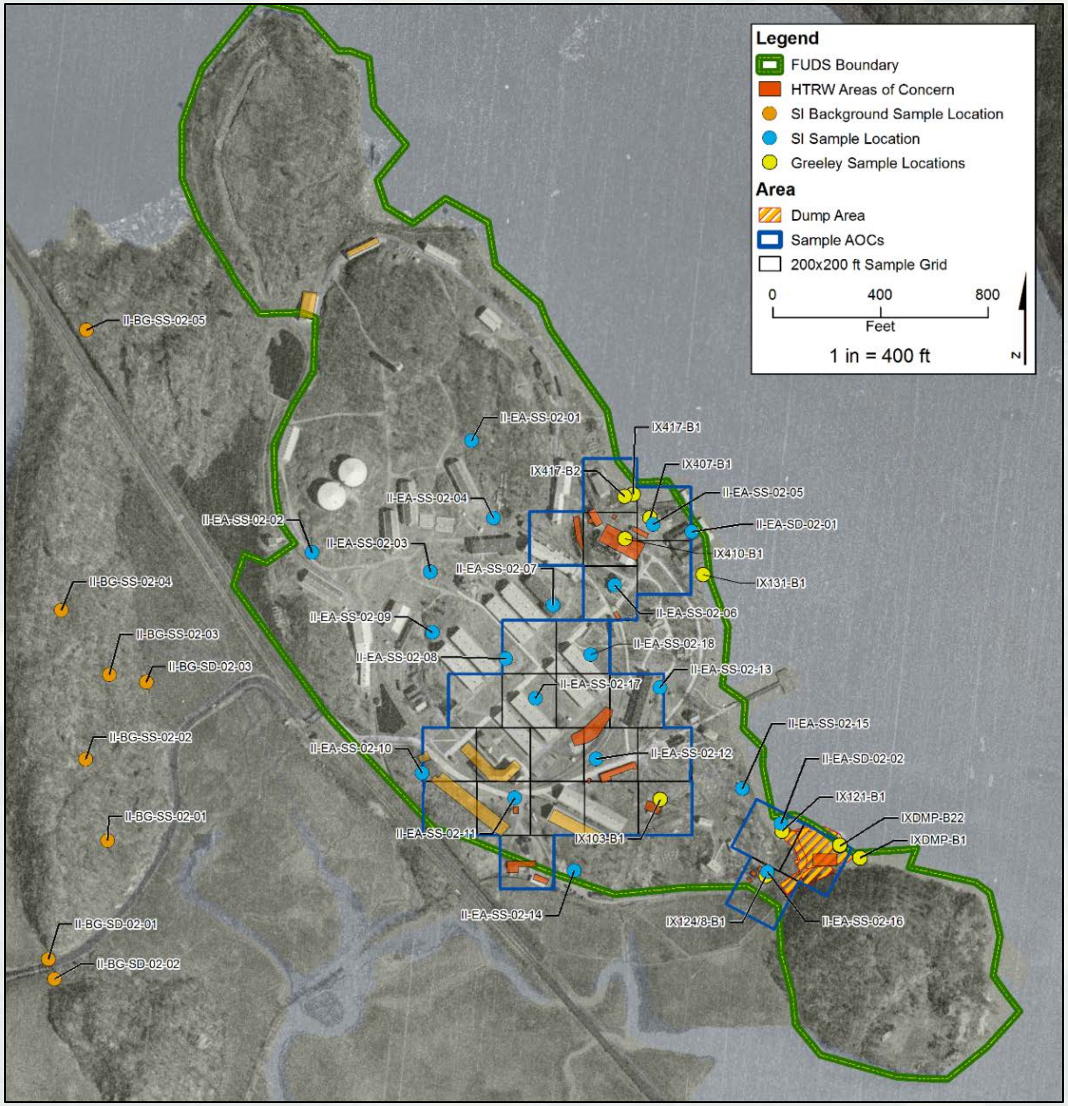
Proposed HTRW RI Approach

- General (Phased) approach for execution of data collection:
  - ***Phase I:***
    - ISM for sampling surface and subsurface soil sampling,
    - Perched groundwater sampling
  - ***Phase II***:
    - Additional environmental media will be targeted and sampled as needed to clearly define COPC migration routes and determine the full extent of impacts.

Proposed HTRW RI Phase I

- ISM for surface and subsurface soil using 200x200-ft sample units (approximately 1 acre area) across 3 AOC investigation areas, additional background area
- 50 aliquots per sample unit
  - Surface soil 0-12”
  - Subsurface below 12”
- Grab sampling of perched groundwater in each AOC – 2 in northern AOC, 4 in Central AOC, and 2 in southern AOC

Proposed HTRW RI Phase I Approach (Cont'd)



Proposed HTRW RI Phase I Data Evaluation

- If COPCs exceed background concentrations for soil and EPA RSLs for soil or groundwater, a Baseline HHRA and SLERA will be conducted according to USEPA and USACE guidance for those COPCs
- Prepare Phase I Data Summary Report to present results
- Determine if additional data collection is needed (Phase II)
- Areas may be identified for "off-ramping"
- Only those contaminants identified as COCs will be carried forward to the FS

Potential HTRW RI Phase II Approach

- Phase II sampling to further refine nature and extent and exposure routes of COPCs:
  - Groundwater background sampling
  - Bedrock groundwater collection and analysis
  - Sediment sampling, sediment toxicity studies, ecotoxicity
  - Porewater collection and analysis
  - Benthic community analysis
  - Tissue collection and analysis

Path Forward

- Upcoming documents for review and comment:
  - TPP Memorandum
    - ✓ Summarize today's meeting
    - ✓ Identify action items and assign to team
  - UFP-QAPP
    - ✓ Summarize the RI Approaches
    - ✓ UFP-QAPPs will be submitted (March 2019) to stakeholders as Draft Final for review and comment

Appendix D

Human Health Risk Assessment Work Plan

APPENDIX D
Human Health Risk Assessment Work Plan

Remedial Investigation
UFP-QAPP
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Prepared for

United States Army Corps of Engineers
Baltimore District

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
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Syracuse, New York 13211

January 2020
Version: FINAL
EA Project No.: 63029587

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ACRONYMS AND ABBREVIATIONS

95% UCLM	95 percent upper confidence limit of the mean
µg	micrograms
ABS	fraction of constituent absorbed, unitless
ADAF	age-dependent adjustment factor
AOC	area of concern
AST	above ground storage tank
AT	averaging time
ATSDR	Agency for Toxic Substance and Disease Registry
BTV	background threshold value
BW	body weight
CalEPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
CFR	Code of Federal Regulation
cm^2/day	square centimeters per day
cm/hr	centimeters per hour
COPC	contaminant of potential concern
CR	contact rate
CSM	conceptual site model
DA_{event}	dermal absorbed dose per event
DAD	dermal absorbed dose
DAF	dosimetric adjustment factor
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DU	Decision Unit
EC	exposure concentration
ED	exposure duration
EF	exposure frequency
EFH	Exposure Factors Handbook
ELCR	excess lifetime cancer risk
USEPA	United States Environmental Protection Agency
EPC	exposure point concentration
ET	exposure time
EV	event frequency
FA	chemical specific fraction absorbed
FUDS	formerly used defense sites

ACRONYMS AND ABBREVIATIONS

GSA	General Service Administration
GIABS	gastrointestinal absorption factor, unitless
HEC	human equivalent concentration
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
IRS	soil ingestion rate
IRW	groundwater ingestion rate
ITRC	Interstate Technology & Regulatory Council
IUR	inhalation unit risk
kg	kilogram
kg/day	kilogram(s) per day
L/day	liters per day
LADI	lifetime cancer average daily intake
LEC_{10}	lower limit on effective concentration, 10% response level
LOAEL	lowest-observed-adverse-effect level
LOD	limit of detection
m^3	cubic meter
mg/cm^2	milligrams per cubic meter
mg/kg	milligrams per kilograms
mg/kg-day	milligrams per kilogram body weight per day
mg/L	milligram per liter
NCP	National Oil and Hazardous Substance Contingency Plan
NOAEL	no-observed-adverse-effect level
NYSDEC	New York State Department of Environmental Conservation
OSWER	Office of Solid Waste and Emergency Response
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PEF	particulate emission factor
PIPC	Palisades Interstate Park Commission
POD	point of departure
PPRTV	provisional peer-reviewed toxicity value
QC	quality control

ACRONYMS AND ABBREVIATIONS

QAPP	quality assurance project plan
RAGS	Risk Assessment Guidance for Superfund
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
RSL	regional screening level
SA	skin surface area
SF	cancer slope factor
SI	site investigation
the Site	the Former Iona Island Naval Ammunition Depot
SVOC	semi-volatile organic compound
TAL	target analyte list
UCL	upper confidence limit
UF	uncertainty factor
UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
VOC	volatile organic compound
WOE	weight-of-evidence

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1. INTRODUCTION

The purpose of this human health risk assessment (HHRA) work plan is to describe activities and methods that will be used to assess risk to human health and the environment at formally used defense site (FUDS) C02NY074403, Iona Island Naval Ammunition Depot located in Stony Point, Rockland County, New York. The HHRA characterizes the current and potential threats to human health that may be posed by contaminants as a result of past site use as a Naval Ammunition Depot. The HHRA evaluates the potential risk to receptors based upon the current and reasonable future conditions on Iona Island as a result of any releases from the Naval Ammunition Depot constructed on the island. The findings of the risk assessments will be used in risk management decisions to determine if potential remedial actions are necessary or the current circumstances are protective of human health. This document sets for the risk assessment approach as a mean of obtaining a consensus on risk assessment methodologies prior to the risk assessment effort.

1.1 PROJECT BACKGROUND

The Former Iona Island Naval Ammunition Depot is located on the west bank of the Hudson River about 45 miles upstream from the mouth of the river where it drains into the Atlantic Ocean. The island is part of the Hudson River National Estuarine Research Reserve, a Significant Coastal Fish and Wildlife Habitat Area and National Natural Landmark. It is located 41.2 miles upstream from New York Harbor and 2.5 miles northwest of Peekskill, New York. Iona Island is bordered on the east by the Hudson River; on the northwest by the mouth of Doodletown Bight, an expanse of shallows and mudflats; on the west and southwest by Iona Island Marsh, a tidal marsh that occupies one mile between Iona Island and the mainland including Salisbury Meadow, Snake Hole Creek, and Ring Meadow. The tidal marsh connects the island to Bear Mountain State Park in Rockland County. To the island’s south lays the former Round Island which was connected to Iona Island by the Navy with fill material around 1965. The island, although partially fenced, can be accessed by Iona Island Road, a narrow two-lane road crossing railroad tracks and the connecting wetlands.

The Iona Island Naval Ammunition Depot FUDS consists of approximately 124 acres of land and inland water. Just less than a mile long and less than one half mile wide, the island has gentle sloping rocky hills that rise up 80 feet above mean sea level. Within the FUDS boundary there are freshwater emergent wetlands, estuarine and marine deepwater, and freshwater forested/shrub wetlands, although most of the site is paved or lightly forested. The tidal wetlands connecting the island are one of the largest tidal wetlands associated with the Hudson River. Most of the surface consists of pavement or thin layers of artificial fill overlying bedrock. Surface water runoff from the island runs directly to the Hudson River. There are no surface water bodies on the land-portion of the island within the FUDS boundary, however many areas of the island and adjoining marshes are influenced by the Hudson River. Shallow groundwater exists in the fractures and joints of the gneiss and granitic bedrock in a potentially perched aquifer, but groundwater is not used for drinking water anywhere in the vicinity of the FUDS.

The Navy used the site as an Ammunition Depot from 1900 to 1947. Activities included preparing, assembling, maintaining, inspecting, testing, and issuing ammunition; however, there was no manufacturing conducted on site. Iona Island Naval Ammunition Depot was deactivated in 1947.

The former depot was excessed by the Navy in 1957 and transferred to the General Services Administration (GSA). GSA conveyed the FUDS property to Palisades Interstate Park Commission (PIPC) in 1965. PIPC currently utilizes a portion of Iona Island as a storage facility; however, the property is closed to the public and use is restricted to park purposes only.

Historical Department of Defense (DoD) activities at the Iona Island Naval Ammunition Depot FUDS may have resulted in the release of contaminants to environmental media (surface soil, subsurface soil, sediment, surface water, and groundwater) at concentrations that may pose a risk to human health and ecological receptors. The United States Army Corps of Engineers (USACE) is conducting work at the site under the Defense Environmental Restoration Program (DERP) for FUDS (DERP-FUDS) and in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendment and Reauthorization Act, and the National Oil and Hazardous Substances Contingency Plan (National Contingency Plan [NCP]). The FUDS program cleans up only DoD-generated eligible contamination, which occurred before the transfer of the property to private owners or federal, state, or local governments.

Previous investigations have identified 19 areas of concern (AOCs) that will be investigated. These AOCs are in the footprints of former site facilities where various contaminant of potential concern (COPCs) resulting from historical site activities have been detected or may be present (Figure 1):

AOC #1. Former Building 103 – Paint and Oil Storage
AOC #2. Former Building 121 – Incinerator
AOC #3. Former Building 123 – Garage Building
AOC #4. Former Buildings 124 to 128 – Sewage Disposal Plant (and Suspected Outfall)
AOC #5. Former Building 207 – Marine Garage Building
AOC #6. Former Building 213 – Paint Locker for Building 202
AOC #7. Former Building 215 – Garage Building
AOC #8. Former Building 219 – Garage Building
AOC #9. Former Building 220 – Garage Building
AOC #10. Former Building 406 – Tin, Electrical, and Annealing Shop Building
AOC #11. Former Building 407 – Paint Shop and Pipe Shop
AOC #12. Former Building 410 – Power House
AOC #13. Area A – One Former Fuel Oil above ground storage tank (AST) (2,500 gallons); located near Former Building 233
AOC #14. Area B – One Former Fuel Oil AST (size unknown); located near Dock 131
AOC #15. Area C – Two Former Fuel Oil ASTs (size unknown); located near Former Building 417
AOC #16. Area D – Dumping Area

AOC #17. Area E – Former Coal Trestle and Storage Area; located near Former Building 410
AOC #18. Area F – Former Coal Storage Area; located near Former Building 215
AOC #19. Three Former Transformers – (T1 northwest of Building 406, T2 near Area D, and T3 northeast of Building 220).

1.2 HHRA OBJECTIVES

The overall objective of the HHRA is to determine if there are potential human health risk concerns under current and potential conditions on Iona Island. The specific objectives of this Work Plan include:

- outline regulatory basis and guidance for conducting the HHRA;
- identify initial COPCs based upon site investigation (SI) history;
- identify data that will be evaluated in the HHRA;
- outline the methods for determining COPCs for data collected in the RI;
- develop a conceptual site model that characterizes relevant contaminant pathways and receptors of concern;
- identify receptors of concern exposure parameters;
- provide intake evaluation methods;
- identify proposed toxicity data and/or applicable sources; and
- illustrate the methods for calculating total carcinogenic risk and non-carcinogenic hazards for receptors of concern.

1.3 GENERAL APPROACH

The human health risk assessment (HHRA) will follow the procedures and methodologies set forth by USEPA and USACE. Specific guidance documents used to evaluate potential risks to human health include the following:

- Risk Assessment Guidance for Superfund (RAGS), *Volume 1: Human Health Evaluation Manual (Part A) (Interim Final)*, USEPA/540/1-89/002). December 1989.
- RAGS, *Volume 1: Human Health Evaluation Manual Supplemental Guidance – “Standard Default Exposure Factors” (Interim Final)*, Publication 9285.6-03. 25 March 1991a.
- RAGS, *Volume I – Human Health Evaluation Manual (Part B – Development of Risk-based Preliminary Remediation Goals)*. USEPA/540/R-92/003. December 1991b.
- *Guidelines for Data Usability in Risk Assessment (Part A)*. Office of Solid Waste and Emergency Response (OSWER), Publication OSWER 9285.7-09A. December 1991c.
- RAGS, *Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments)*. Office of Emergency and Remedial Response.
- *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER 9285.7-53. Office of Emergency and Remedial Response. December 2002b.

- RAGS, *Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment)* Final, USEPA/540/R/99/005, OSWER 9285.7-02EP, Office of Superfund Remediation and Technology Innovation. July 2004b.
- *Guidelines for Carcinogen Risk Assessment*. Risk Assessment Forum. USEPA/630/P-03/001F. March 2005.
- *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*. Risk Assessment Forum, USEPA/630/R-03/003F. March 2005.
- *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part F: Supplemental Guidance for Inhalation Risk Assessment) Final*. Office of Superfund Remediation and Technology Innovation, USEPA-540-R-070-002. January 2009.
- *Exposure Factors Handbook, 2011 Edition*. USEPA/600/R-090/052F. September 2011.
- *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Exposure Factors*, OSWER Directive 9200.1-120-Update. 6 February 2014.
- *Risk Assessment Handbook Volume I: Human Health Evaluation*. USACE Engineering Manual 200-1-4. 31 January 1999.
- *Standard Scopes of Work for Environmental Risk Assessments*. USACE Engineer Pamphlet 200-1-15. 30 June 2016.
- *Environmental Quality – Formerly Used Defense Sites (FUDS) Program Policy*. USACE Engineer Regulation 200-3-1. 10 May 2004.
- *Tri-Service Position Paper on Background Levels in Risk Assessment*. USACE, Environmental and Munitions Center of Expertise, Omaha, NE. October.

2. HHRA METHODOLOGY

The purpose of the HHRA is to evaluate potential human health concerns from exposure to environmental media within the site that have been affected by past DoD activities. To determine human health concerns, the HHRA evaluates potential exposure to sources of contamination and routes of migration based on current and potential future site uses. The HHRA results are based upon potential exposure pathways that can occur or are reasonably likely to occur in the future. Risks determined in the HHRA are considered baseline risks associated with exposure to media affected by former site activities. The baseline risk assumes no remedial actions or other means of exposure reduction (i.e., land use controls, digging restrictions, etc.). The HHRA evaluates the reasonable maximum exposure that has the potential to occur at the site. Therefore, the results of the HHRA are considered potential and should be used as a guideline in making risk management decisions.

Following USEPA guidance (USEPA 1989) and USACE guidance (1999), the HHRA methodology involves a four-step process: data evaluation and hazard assessment, exposure assessment, toxicity assessment, and risk characterization. The following sections detail each step.

2.1 DATA EVALUATION

The purpose of the data evaluation is to determine if data is of sufficient quantity and quality for use in the HHRA. In addition, COPCs are identified so the HHRA focuses on chemicals that may contribute to overall risk concerns at the site. COPCs are identified for each potential exposure medium through comparison to human health risk screening levels and background levels. Data evaluation for the HHRA, as defined in USEPA RAGS Part A (1989), will be performed based upon the following steps:

1. Data collected from the RI will be sorted by DU. Due to reworking of surface and subsurface soil during building demolition, and similarity of COPCs for various AOCs (as presented in Table 10-5 of the HTRW RI UFP-QAPP), it may not be possible determine the exact AOC origin for COPCs detected during the RI. However, the sorting of data by DU will allow the risk assessment to evaluate areas around an AOC that may have been affected by past activities. .
2. Analytical methods will be evaluated.
3. Data quality will be evaluated with respect to sample quantitation limits for development of Project Action Limits (PALs). Any PALs for analytes below the quantitation limits will be evaluated for potentially more sensitive analytical methods or will be discussed under uncertainty.
4. Data will be validated and verified in accordance with information in the HTRW UFP-QAPP Worksheets #14, #36, and #27.
5. A set of data for use in the risk assessment will be scoped, collected, validated and evaluated for use in accordance with information presented in Worksheets #36 and #37.

6. COPCs for each exposure medium will be identified through the use of human health risk screening levels and background levels.

2.1.1 Proposed Sample Investigation

Problem Definition: *Environmental media may have been impacted as a result of historical use by the Navy. Further investigation is needed to evaluate the nature and extent of environmental impact and determine if concentrations of contaminants pose an unacceptable risk to human health and/or ecological receptors. There are insufficient data appropriate for conducting human health and ecological risk assessments and much of the existing data were generated from biased sampling designs, and there is an insufficient quantity of data. Therefore, a sample investigation is proposed to address this insufficiency.*

Proposed sampling, including both site and background sampling can be found in Worksheet #17 of the HTRW Uniform Federal Policy (UFP) – Quality Assurance Project Plan (QAPP) of which this risk work plan is appended. The primary COPCs at the site are metals (antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc) and SVOCs (PAHs and dinitrotoluenes). Additional AOC-specific COPCs include BTEX at AOC 13 - Area A (one former fuel oil AST located near former Building 233), AOC #14 - Area B (one former fuel oil AST located near Dock 131), and AOC #15 - Area C (two former fuel oil ASTs located near former Building 417); PCBs at AOC #19 (three former transformers); and explosives at AOC 16 - Area D (Dumping Area).

A multi-phased sample approach will be conducted as presented in the HTRW RI UFP-QAPP Worksheet #11. Phase I will include a comprehensive evaluation of COPCs in surface soil, subsurface soil, and shallow groundwater across the investigation area. Figure 1 presents a layout of the DUs that will be investigated in Phase I. An incremental sampling methodology approach has been selected for surface and subsurface soil to reduce data variability and increase sample representativeness. The Phase I incremental sampling methodology design, including establishment of decision units across the Phase I investigation area, is presented in Worksheet #11. In summary, 27 DUs sized at approximately 1-acre (200 ft x 200 ft) each have been established to address contamination originating from the 15 of the 19 HTRW AOCs (i.e. AOCs #1 through 12 [former HTRW buildings], AOC #17 – Area E (Former Coal Trestle and Storage Area near Former Building 410), and AOC #18 – Area F (Former Coal Storage Area near Former Building 215), and AOC #16 – Area D (Dumping Area). For significantly smaller structures identified as HTRW AOCs (i.e. AOCs #13, 14, and 15 [which address four former fuel oil ASTs] and AOC #19 [which addresses three former transformer locations]), smaller sized 60 ft x 60 ft DUs were established to reduce potential for averaging out or diluting COPC concentrations around these structures. Seven additional DUs of approximately 1-acre (e.g., 200 x 200 ft or 100 x 400 ft) have been established to address potential explosives contaminants at the seven former buildings identified as having significant potential for explosive hazard. A total of 8 upland soil background DUs sized at approximately 1-acre (200 ft x 200 ft) have been established in Bear Mountain State Park. Surface soil and subsurface soil samples will be sampled from each DU using the sampling methodology presented in Worksheet #14 of the

QAPP. In addition, discrete shallow groundwater samples will be collected from up to 18 locations within the investigation area.

The Phase I sampling design and rationale is presented in the HTRW RI UFP-QAPP Worksheet #17. Table 17-1 of the QAPP presents the analytes by media. Table 17-2 presents the decision units established across the Phase I investigation area, as well as the media and analytes to be sampled at each DU. In summary, the Phase I investigation will include the following:

- A comprehensive evaluation of target analyte list (TAL) metals/mercury and target compound list (TCL) SVOCs in surface soil, subsurface soil (each onsite 200 x 200 ft DU [DU-1 through DU-27]) and groundwater (up to 18 sampling locations)
- A background investigation of TAL metals and TCL SVOCs in surface and subsurface soil. Background sampling will be conducted to establish regional background metal and PAH concentration ranges in surface and subsurface soil and distinguish from impacts related to the former DoD activities;
- A targeted investigation of BTEX (soil), VOCs (groundwater), and PAHs (soil and groundwater) at AOC #13 - Area A (one former fuel oil AST located near former Building 233), AOC 14 - Area B (one former fuel oil AST located near Dock 131), and AOC #15 - Area C (two former fuel oil ASTs located near former Building 417);
- A targeted investigation of PCBs in soil and groundwater at AOC #19 (three former transformers); and
- A targeted investigation of PCBs and explosives in soil and groundwater at AOC #16 – Area D (Dumping Area).

2.1.2 Data Quality Evaluation

Data validation for newly collected samples will be conducted in accordance with the UFP – QAPP. Data validation will be performed based upon the procedures presented in Worksheet #36 of the UFP-QAPP. An assessment of data usability will be performed in the RI as described in Worksheet #37 of the UFP-QAPP, using precision, accuracy, representativeness, completeness, comparability, and sensitivity parameters. Any limitations will be compared to the project quality objectives and evaluation criteria. Results of the data usability will be evaluated before any data is included in the HHRA.

The HHRA will evaluate the inclusion or exclusion of data on the basis of analytical qualifiers. This evaluation will be performed in accordance with USEPA guidance (USEPA 1989 and 1992). It is anticipated that analytical qualifiers will be identified through the data validation process. The following procedures will be followed for sample results identified with data qualifiers:

- Analytical results bearing the U qualifier (indicating that the analyte is not detected at the given limit of detection [LOD]) will be retained in the data set and considered non-detects. Each non-detected COPC is assigned a numerical value equal to its LOD, if that

COPC was detected at least once in samples collected. For "U" qualified data resulting from higher dilution levels, the result from the undiluted or initial run will be included.
- Analytical results bearing the J qualifier (indicating that the reported value is estimated because the analyte is detected at a concentration below the LOQ or for other reasons), will be retained at the reported concentration.
- Analytical results bearing the R qualifier (indicating that the data was rejected) will not be evaluated in the HHRA.

Because soil samples for this project are ISM samples the 95% upper confidence limit of the mean of triplicate samples calculated as discussed in the QAPP Worksheet No. 14 will be used as the exposure concentration.

For groundwater discrete grab samples will be taken, and duplicates will be handled as follows:

- If both samples/analyses show that the analyte is present, the maximum value of the two detected concentrations will be retained for analysis
- If both samples/analyses are not detected, the lowest of the two non-detect LODs will be retained for analysis (if the analyte was detected in other samples collected on site)
- If only one sample/analysis indicated that the analyte is present, the detected result will be retained for analysis and the non-detect value will be discarded.

The qualification and validation of analytical data includes a comparison of site data to the corresponding blank (laboratory, equipment rinse, field and trip) data. If the detected concentration in the sample is less than 10 times the concentration of common laboratory contaminants or 5 times the concentration of other chemicals reported in the blank, it is given a "B" qualifier and is not considered valid for use in the risk assessment. Laboratory quality control (QC) samples, spikes, and blanks are not included in the HHRA.

2.1.3 Selection of COPCs

The human health risk screening levels that will be used in the HHRA are presented in the UFP-QAPP Worksheet #15. Media of concern are surface soil, sediment, and groundwater. It is important to note that, as described in Section 2.1.1, the assessment of Iona Island is to be performed in phases. Phase 1 will include soil and groundwater. If necessary, sediment will be sampled during Phase 2. To assure a complete workplan exposure parameters for sediment have also been included in the human health workplan. The human health risk screening levels for these media are selected from the following:

1. For the soil and sediment samples, the screening levels will be the USEPA Residential Regional Screening Levels (RSLs) (May 2019 or most recent version) will be used. A restrictive clause is in place for the island that it shall only be used for park purposes only; therefore, residential development is unlikely to occur at the Site (USACE 1995). However, EPA Residential Soil RSLs are included to assess for potential children receptors at the Site, including site visitation for nature walks and potential camping.

These values will be modified for direct contact and inhalation to reflect noncancer hazard quotient of 0.1 and a cancer risk of 1 x 10^{-6}.

2. For groundwater samples, the screening levels will be based on the USEPA tap water RSL (May 2019 or most recent version) will be used. The values will be modified for direct contact and inhalation to reflect noncancer hazard quotient of 0.1 and cancer risk level of $1x10^{-6}$.

To identify COPCs, the 95% UCL of a DU for all analytes detected in each media will be compared to the human health risk screening levels. In addition, soil samples will also be compared to background threshold values (BTV) of metals and PAHs in soil.

The background comparison will be performed consistent with Decision Mechanism 4, Section 7.2.4 of ITRC guidance (2012). As discussed in this guidance, because of the special characteristics associated with incremental sampling (low variance, small sample sizes), background comparison requires careful consideration. A variety of background comparisons are discussed and will be applied to the Iona Island background comparison as detailed in Worksheet #14.

Analytes that exceed the risk screening levels and background concentrations will be considered COPCs. Analytes identified as COPCs will be evaluated further in the HHRA. Additionally, any detected analytes associated with DoD activity that have an LOD greater than or equal to the risk screening levels will be retained in the HHRA and discussed in the uncertainty section. These analytes will be evaluated in the uncertainty section of the HHRA. Any data that are qualified as rejected, with an “R” qualifier, will not be evaluated in the HHRA.

2.1.4 Data Summary

The selection of COPCs will be summarized in a table containing the following information: the maximum detected concentration, detection limit, frequency of detection, screening levels, background concentrations, and rationale for excluding or including COPCs. The results will be presented following the USEPA RAGS D format (USEPA 2002b).

2.2 EXPOSURE ASSESSMENT

The exposure assessment is conducted to identify the persons or receptors that are or may be exposed to the site, the pathways through which they are potentially exposed, and the magnitude of these potential exposures. To quantify the magnitude of exposure, required information must include the COPC concentrations in various exposure media to which receptors are exposed (exposure point concentrations [EPCs]) and receptor-specific exposure or intake factors that determine the amount of chemical that enters the body (either orally, absorbed through the skin, or inhaled).

The exposure assessment includes several steps:

- Evaluating the exposure setting, which includes a description of the land use and the potentially exposed human populations.
- Developing the conceptual site model (CSM), identifying the source of contamination, the contamination transport and release mechanisms, the exposure media, the exposure routes, and the potentially exposed populations.
- Calculating EPCs for each COPC for each of the complete exposure pathways identified in the CSM.
- Identifying the exposure models and parameters with which to calculate the exposure intakes.
- Calculating exposure intakes.

An exposure pathway describes a mechanism by which a population or individual may be exposed to chemicals present at a site. A complete exposure pathway requires the following four components:

- A source and mechanism of chemical release to the environment.
- An environmental transport medium for the released chemical.
- A point of potential human contact with the contaminated medium.
- A human exposure route at the point of exposure.

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual human exposure and are not included in the exposure assessment and resulting risk characterization. The HHRA exposure pathways are receptor-specific and address all potential receptors of concern.

2.2.1 Exposure Setting

The Former Iona Island Naval Ammunition Depot (the Site) is located on Iona Island, on the west side of the Hudson River, in Stony Point, Rockland County, New York. The Site is located approximately 45 miles upstream of the mouth of the Hudson River and seven miles south of West Point Military Academy. The 129-acre site is connected to the mainland by a narrow two-lane road. A busy freight rail line is located immediately east of the Island along the point of access.

Iona Island is part of the Hudson River National Estuarine Research Reserve and is under the administration of the Palisades Interstate Park Commission (PIPC) that operates the adjacent Bear Mountain State Park property. GSA conveyed the property to the Palisades Interstate Park Commission; it was under a "restrictive clause" (park purposes only) (USACE 1995). Iona Island is part of the much larger Hudson River National Estuarine Research Reserve and Significant Coastal Fish and Wildlife Habitat Area. The Hudson River National Estuarine Research Reserve is managed under New York’s Coastal Management Program. For the portions of Bear Mountain State Park that are open to the public, recreational opportunities include hiking, boating, and bird watching. There is a parking lot and scenic overlook located directly west of Iona Island, outside of the FUDS boundary.

The majority of the Island is open space. There is a parking lot and scenic overlook located directly west of Iona Island. It is closed seasonally from December through March for bald eagle use. Park staff use the Island for storage. Bear Mountain State Park employees access buildings used as storage areas at the property. Land and resource use information is presented in the HTRW RI UFP-QAPP Worksheet #10.

Groundwater and surface water at Iona Island are not used as a potable water source. In the 1990s, the water supply line that supplied Iona Island broke (near NYS Route 9W) on the causeway. Bear Mountain State Park did not repair the waterline break and a bedrock well was installed (March 1997) behind the existing storehouse (Building 222). Per Charlie Tonneson, Bear Mountain Park Engineering Department, this new well is not treated and is used for non-potable purposes only (bottled water is brought on Iona Island for drinking purposes).

Because of the Iona Island restrictive clause that it shall be used for park purposes only, residential development is not a possible future use (USACE 1995). The site recreational use is limited to educational outings, history tours (6-8 times per year with approximately 50 people). Additionally, the island has been historically used for camping. The Boy Scouts have used the Site within the past 5 years for activities. In addition, researchers are presently working in the marshes. Potential trespassers are a possibility because the shoreline is not fenced. Because the shoreline is not fenced, residents who live near the Island may access the site routinely during boating season.

Canoers can also access the Island, but canoeing is by permit only. There is no intent to put in a trail system associated with the state park. There have been plans in the 1970s to develop part of the island as a retreat/nature center, and a sewer system was even installed in the early 1970s, but was never used. There is no plan for utility work. Construction worker receptors are limited. There are no anticipated construction plans beyond potentially converting existing buildings for other use or constructing new storehouse. However, if parts of the site were developed for recreational use, construction workers could be potential future receptors. There are no deed restrictions currently on the property.

2.2.2 Conceptual Site Model

Within the exposure assessment, USEPA guidance (1989, 1991a,b) requires that plausible exposure under both current and future land-use be evaluated in the HHRA. Accordingly, potential receptors are identified for both current and future use scenarios for the Island. The HHRA evaluates the risk to a range of onsite human receptor populations that are either currently or are reasonably anticipated to be exposed to site-related constituents based upon current land use, overall Island land use, and reasonably anticipated future land use.

As a result of the exposure setting, the following receptors are anticipated: park personnel, researcher, construction worker, recreational user (adult, adolescent, and child), adolescent trespasser, and Boy Scouts/campers. It is noted that not all receptors are expected for all areas that will be evaluated within the Island. The risk assessment will identify specific areas each receptor is anticipated to use. Table 1 contains a listing of all exposure parameters assumed for each receptor. The following complete or potential exposure pathways are identified for each receptor and shown in Figure 2:

Park Personnel

The park personnel are assumed to be adults and work for the PIPC. Park personnel may perform maintenance activities such as grass mowing, site inspections, and general maintenance of the buildings. The park personnel are not expected to dig or perform other excavation activities. Therefore, contact is limited to surface soil. The following exposure pathways are considered potentially complete for the park personnel:

- Incidental ingestion of surface soil and sediment,
- Dermal contact with surface soil and sediment, and
- Inhalation of windblown particulates from surface soil.

Researcher

The researcher is also assumed to be an adult and work at the site on a limited or part-time basis. They are not full-time employees with the PIPC. The researchers are not expected to dig or perform other subsurface activities. Therefore, contact is limited to surface soil. The researcher is assumed to work or plant within the marshes so contact with sediment is expected. The following exposure pathways are considered potentially complete for the researcher:

- Incidental ingestion of surface soil and sediment,
- Dermal contact with surface soil and sediment,
- Inhalation of windblown particulates from surface soil.

The particulate pathway assumes COPCs are attached to soil particles and become airborne through wind action. Due to the moisture content of sediment, particulates are not expected to become airborne.

Construction Worker

The construction worker is also assumed to be an adult and work at the site during short-term construction projects (i.e., 1 year or less). They are expected to dig and perform other subsurface activities, including installation of utilities. Therefore, contact to both surface soil and subsurface soil is expected. Because the construction worker performs excavation activities, they may contact perched groundwater. These workers are not expected to contact sediment within the marsh area/wetlands. The following exposure pathways are considered potentially complete for the construction worker:

- Incidental ingestion of surface soil and perched groundwater,
- Dermal contact with surface soil and groundwater,
- Inhalation of windblown particulates from surface soil, and
- Inhalation of VOCs (if present) in the air of a trench.

Recreational User

The recreational user represents a multiple age-range family that may visit the site from canoeing or access from the State Park. The adult recreational user is assumed at over 18 years of age. The adolescent recreational user is assumed from 6 years to 16 years. The child recreational user is assumed from 2 years to 6 years. Recreational users younger than 2 years of age are not anticipated due to site access and site conditions that are not conducive to playgrounds or other play areas. The recreational user is representative of other low frequency receptors that may visit the site during tours or other group events. Risk results for the recreational user are protective of other low frequency visitors. The recreational user is not expected to dig. Therefore, their contact is limited with surface soil. Additionally, they may contact sediment within the marsh area/wetlands while also accessing the site. The following exposure pathways are considered potentially complete for the recreational user:

- Incidental ingestion of surface soil and sediment,
- Dermal contact with surface soil and sediment, and
- Inhalation of windblown particulates from surface soil.

Trespasser

The adolescent trespasser is assumed at an age range of 12 years to 18 years and represents a slightly older adolescent who may visit the site while boating along the eastern shoreline (Hudson River) or western shoreline (Iona Marsh) or hiking in the State Park. The trespasser is not anticipated to dig or contact the subsurface at the site. Therefore, contact is limited to surface soil at the site. The following exposure pathways are considered potentially complete for the trespasser:

- Incidental ingestion of surface soil and sediment,
- Dermal contact with surface soil and sediment, and
- Inhalation of windblown particulates from surface soil.

Boy Scout/Camper

The Boy Scouts are assumed at an age from 6 years to 16 years who would visit the site to camp and may perform other activities, such as planting or clean-up. The Boy Scout may contact surface soil, subsurface soil, and sediment within the marshes/wetlands. While the Boy Scout/camper may contact subsurface soil, they are not assumed to have significant contact with shallow groundwater. Any subsurface contact is expected to be from digging and is likely limited to soil. Any digging is not expected to produce large holes or trenches, that is likely expected with a construction worker, that would allow for groundwater to accumulate. The following exposure pathways are considered potentially complete for the Boy Scout/camper:

- Incidental ingestion of surface soil, subsurface soil, and sediment,
- Dermal contact with surface soil, subsurface soil, and sediment,
- Inhalation of windblown particulates from surface soil and subsurface soil.

The particulate pathway assumes COPCs are attached to soil particles and become airborne through wind action. Due to the moisture content of sediment, particulates are not expected to become airborne.

2.2.2.1 Soil Exposure Parameters

For all adult receptors (i.e., park personnel, researcher, adult recreational user, and construction worker), the body is assumed at 80 kg (USEPA 2014). For the child recreational user, the body weight is assumed 16 kg (USEPA 2011). This body weight is taken from the USEPA *Exposure Factors Handbook* (EFH) (USEPA 2011) Table 8-1 and is the average body weight for the age ranges of 2 to <3 years (13.8 kg) and 3 to <6 years (18.6 kg). For the adolescent recreational user, the Boy Scouts/camper, and the adolescent trespasser, the body weight is based upon the average of the age range evaluated taken from USEPA EFH Table 8-1.

The exposure duration (ED) for each receptor is based upon USEPA guidance (2011, 2014), professional judgement, and the age range evaluated. The park personnel is assumed to be a long-term, career park employee who has a duration of 25 years (USEPA 2011, 2014). The researcher is assumed to be a short-term, part-time park employee. Table 16-105 of USEPA EFH presents the occupational tenure of employed individuals by employment status. The median duration for a part-time employee is 3.1 years (USEPA 2011). Construction workers are assumed to be at the site for a 1-year duration (USEPA 2014, 2018). For all other receptors, the exposure duration is based upon the age-range evaluated.

For surface soil and subsurface soil, the exposure frequencies (EF), incidental ingestion rates, and skin surface areas available for contact are assumed to be the same. The soil skin adherence factor and dermal absorption factor are expected to differ.

The exposure frequencies for the park personnel and construction worker are taken from USEPA (2011, 2014) guidance. The park personnel are assumed to be similar to the default composite worker (both indoor and outdoor exposure) listed in USEPA guidance (1991a, 2014). Exposure frequencies for the researcher, trespasser, and Boy Scout/camper are based upon professional judgement. The exposure frequency for the recreational user is taken from New York State Department of Environmental Conservation (NYSDEC) (2006) guidance.

The construction worker and park personnel are assumed to contact soil for 250 days per year. A recreational user/trespasser is assumed to visit the site 31 days/year based on NYSDEC guidance (2006). This is assumed to occur over a 10-year exposure duration based upon the age range of 6 to 16 years for the adolescent recreational user/trespasser, 4-year duration for the child, and a 20-year duration for the adult. The camper exposure frequency was estimated based upon a typical number of days Boy Scouts spend camping. A requirement for camping within the Boy Scouts is for 20 nights/year. While this requirement is more likely for an older age range than the age range evaluated in this risk assessment, the estimate of 20 nights per year is reasonable. The exposure duration for the camper is based upon the age range evaluated. The exposure frequency for the trespasser assumes a visit 1 day per week, twice a month from April to November, which equals 16 days/year. The 1 day per week visit was typical for all users at New York State Parks (OPHRP 2016). The researcher is assumed to visit the site 2 days per week, 6 months per year (primarily in growing season to maintain marsh or other areas) for a total of 52 days per year.

The ingestion rate for the construction worker is taken from guidance for the calculation of the USEPA RSLs and Supplemental Guidance for Developing Soil Screening Levels (USEPA 2002, 2018). A construction worker soil ingestion rate of 330 mg/kg is assumed. For the park personnel and researcher, a soil ingestion rate of 100 mg/kg is assumed to account for primarily outdoor activities (USEPA 2011, 2014, 2018). For the adult, adolescent, and child recreational user, a soil ingestion rate of 100 mg/kg, 200 mg/kg, and 200 mg/kg similar to the adult and child resident, was assumed (USEPA 2011, 2014, 2018). For the Boy Scouts/campers, a soil ingestion rate equal to the resident child, 200 mg/kg, was assumed to account for expected high-contact rate (CR) with soil.

Dermal exposure to soil is assumed for exposed body surface areas only. The surface area (SA) available for contact generally assumes hands, forearms, head, lower legs, and feet for the resident. The construction worker and park personnel are only assumed to contact soil with hands, forearms, and head with a mean SA of 3,527 cm^2 (USEPA 2014). The adult recreational user SA available for contact was set to the SA for the adult resident of 6,032 cm^2 (USEPA 2014, 2018). For the adolescent recreational user, child recreational user, adolescent trespasser, and camper the mean SA was determined for the head, hands, forearms, and lower legs from Table 7-2 of the USEPA EFH (USEPA 2011). To account for the forearm and lower leg only, these body parts were assumed at 45% of the full arm and leg mean surface areas. For the child recreational user, the mean SA for the head, hands, forearms, and lower legs for the age groups of 2 to <3 years and 3 to <6 years was determined to be 2,107 cm^2 (USEPA 2011). For the adolescent recreational user and trespasser, the mean SA for the head, hands, forearms, and lower legs for the age groups of 11 to <16 years was determined to be 4,645 cm^2 (USEPA 2011). For the Boy Scout/camper, the mean SA for the head, hands, forearms, and lower legs for the age groups of 6 to <11 years and 11 to <16 years was determined to be 3,947 cm^2 (USEPA 2011).

Adherence factors for surface soil were taken from USEPA guidance for workers and residents (USEPA2011, 2015, 2018). The researcher and construction worker are expected to have higher contact with surface soil so the skin adherence factor is set to the USEPA default for a construction worker of 0.3 mg/cm^2. Additionally, the adherence factor for the recreational user, trespasser, and Boy Scout are set to the USEPA default of 0.2 mg/cm^2 for a recreator (USEPA 2018). The adherence factor for the park personnel is set to the USEPA default for a composite worker (0.12 mg/cm^2) to account for indoor and outdoor work (USEPA 2018).

Adherence factors for subsurface soil are based upon the expected activities for the construction worker and Boy Scout since they are the only receptors expected to contact the subsurface. Exhibit 3-3 of RAGS E (USEPA 2004) presents soil adherence factors based upon activities. Subsurface soil is assumed to be wetter than surface soil due to potential perched groundwater, so adherence factors are assumed to be higher than surface soil. For the construction worker, the 95th percentile adherence factor for a utility worker of 0.9 mg/cm^2 was selected (USEPA2004). For the Boy Scout, the adherence factor for children playing in wet soil (3.3 mg/cm^2) was selected (USEPA 2004).

The inhalation of soil particulates assumes a 24-hour exposure period for the Boy Scout/camper and an 8-hour workday for the researcher and park personnel. For the construction worker, the workday was determined from Table 16-20 of USEPA EFH (USEPA 2011), which presents the time spent in select outdoor locations and outdoor at construction sites. The 90% percentile time spent at a construction site for 18 to 64 years of age is 687 minutes/day. The 90% percentile time spent at a construction site for the Northeast Region is 695 minutes/day. Both of these times are similar and are approximately 11.5 hours per day. The recreational user and trespasser was assumed to only be present at the site for 4 hours/day. This is based upon a comparison of outdoor recreation times for doers only from Tables 16-25 and 16-26 of USEPA EFH (USEPA 2011). The 50% percentile and 90% percentile times for both the 11 to 16 age range (Table 16-25) and the 50% percentile and 90% percentile times for the Northeast Region ranged from 2 hours to 6 hours. Therefore, a value of 4 hours was selected. The particulate emission factor (PEF) was set to 1.21E+09 m^3/kg based upon NYSDEC guidance (2006).

2.2.2.2 Sediment Exposure Parameters

Exposure frequencies for contact with sediment were assumed equal to those for soil due to the low number of days per year the researcher, recreational user, trespasser and Boy Scout are at the Site. It is reasonable that they may contact sediment for these same number of days. However, for the Park Personnel, they are assumed to be at the site for 160 days per year. This receptor contact with sediment was assumed at half of the days they are estimated to be on-site. Incidental ingestion rates for sediment are not available, so soil incidental ingestion rates are usually used as a surrogate. However, the soil ingestion rates account for ingestion of dust (USEPA 2011). To determine the sediment ingestion rate for all receptors, only the soil ingestion rates only (i.e., no dust ingestion), 50 mg/day, were used from Table 5-1 of the USEPA 2011 EFH (USEPA 2011). For dermal contact, the skin surface area available for contact used for surface soil was assumed to be similar because this accounts for exposed skin surfaces of the receptor, so these areas will also be available for sediment contact. The adherence factor used for subsurface soil for similar aged receptors were assumed similar since they take into account a wetter soil with a higher adherence factor.

2.2.2.3 Groundwater Exposure Parameters

Due to the shallow depth of groundwater, the construction worker is assumed to be exposed to groundwater over the 1-year duration of construction. However, they are only assumed to contact groundwater at a frequency of 30 days per year due to the perched nature of groundwater and it not being consistent across the site. The construction worker is assumed to incidentally consume 0.08 L of water per exposed day based upon an ingestion rate of 0.01 L per hour for 8 hours (USEPA 2014). For dermal contact, the recommended surface area for construction worker exposure to groundwater is assumed as the head, hands, and forearms, which is 3,527 cm^2 (USEPA 2014).

2.2.3 Estimation of Exposure Point Concentrations

The concentration of COPCs in a given medium varies temporally and spatially. The anticipated level of contamination to which one is exposed (i.e., exposure point concentrations [EPC]) is likely an average level, and as such, EPCs are typically represented by average concentrations. For all media of concern, the EPC is represented by the 95 percent upper confident limit of the mean (95% UCL) (USEPA1989). The 95% UCL is used because assuming long-term contact with the maximum concentration is not reasonable (USEPA 1989).

As discussed in Worksheet #11 of the UFP-QAPP, incremental soil methodology (ISM) will be used to collect surface and subsurface soil samples from DUs across the site. The use of ISM results in a more precise estimate of concentrations within the DU as opposed to collecting multiple discrete samples in that same DU, and the data have much less variance, but fewer total samples. Resulting chemical analytical results provide an approximate estimate of the 95%UCL of the data for each DU. The 95%UCL will be calculated for detected contaminants in soil and subsurface soil in each DU using the Interstate Technology and Regulatory Council (ITRC) (2012) calculator and as discussed in Worksheets #11 and #14 of the UFP-QAPP.

Because an EPC represents the concentration of a COPC in site media to which a receptor may be exposed, it is possible that multiple DUs may be combined to represent an exposure area for a selected receptor. The evaluation of all individual DU 95%UCLs as the exposure area for site receptors would overestimate risks because it assumes that individual receptors spend 100 percent of their time within individual DUs at the Site. It is expected that receptors would move across the site and individual DUs resulting in exposure areas larger than a 200 by 200 foot DU (approximately 1 acre). The ITRC (2012) calculator includes area-weighting that will be used to develop EPCs for combining DUs. Additionally, the EPC can be represented by one DU 95%UCL to estimate a potential hot-spot exposure.

It is expected that Iona Island is not highly contaminated, and the variance in DU concentrations are expected to be similar. Most of the native soil on Iona Island has been filled, built on at one point in time, and/or paved (USACE 1998), and the demolition of former buildings/structures and reworking of soil may have mixed surface and subsurface soil throughout and across much of the former operational areas. Constituents associated with a given AOC may have been moved to locations far from their original source. Consequently, the collection of triplicate samples from each DU will not improve the precision. Incremental sampling replicates will include triplicate surface and subsurface soil samples (initial ISM samples plus two additional samples) collected as “batch” type replicates at a rate of 10% of each size DU (200 x 200 ft and 60 x 60 ft) per analyte group. Statistical techniques will be used to represent upper and lower estimates for DUs with only one ISM result. The methodology that will be followed to determine the upper and lower estimates for DUs with only one ISM result is presented in Worksheet #14.

If any discrete samples are collected (i.e., perched groundwater and sediment), ProUCL (USEPA 2015) will be used to calculate 95% UCLs. The results for EPC determination and exposure parameter selection will be presented following the USEPA RAGS D format (USEPA 2002b).

For calculation of the EPC, the following procedures will be followed for sample results identified with data qualifiers:

- Analytical results bearing the U qualifier (indicating that the analyte is not detected at the given LOQ) will be retained in the data set and considered non-detects. Each non-detected COPC is assigned a numerical value equal to its LOQ, if that COPC was detected at least once in samples collected. For “U” qualified data resulting from higher dilution levels, the result from the undiluted or initial run will be included.
- Analytical results bearing the J qualifier (indicating that the reported value is estimated) will be evaluated at the reported concentration.

Analytical results bearing the R qualifier (indicating that the data was rejected) will not be evaluated in the HHRA.

2.2.4 Calculation of Chemical Intake

The chemical intake is the exposure normalized over time and body weight and expressed in units of milligrams per kilogram body weight per day (mg/kg-day). The reasonable maximum exposure (RME) assumption represents the greatest liability that can be rationally expected to occur at the site. The dose of a chemical can be described using the following equation:

$$Dose = \frac{EPC\ x\ CR\ x\ EF\ x\ ED}{BW\ x\ AT}$$

Where:

Dose = chemical intake (mg/kg-day)
EPC = concentration of a COPC in given exposure medium (mg/kg or milligram per liter [mg/L])
CR = contact rate (kilograms per day [kg/day] or liters per day [L/day])
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)

AT = averaging time (days)

When evaluating longer-term (i.e., chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the AT) (USEPA 1989). This measure of intake is referred to as the average daily intake and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime (70 years) and are referred to as the lifetime average daily intake (USEPA 1989).

Table 1 presents the preliminary RME exposure parameters proposed for use in calculating chemical intakes for this HHRA. All intake calculation spreadsheets will be provided in USEPA RAGS D format (USEPA 2002). Calculations of intakes for complete exposure pathways identified in the CSM are described below.

2.2.4.1 Incidental Ingestion of Soil or Sediment

The following equation is used to estimate the intake associated with incidental ingestion of chemicals in soil or sediment by all receptors expected at the site (USEPA 1989):

$$Intake(mg/kg-day) = \frac{EPC_s \ x\ IRS\ x\ EF\ x\ ED}{BW\ x\ AT}$$

Where:

EPC_s = chemical concentration in soil or sediment (milligrams per kilogram [mg/kg])
IRS = soil or sediment ingestion rate (mg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
CF = conversion factor (10^{-6} kg/mg)
BW = body weight (kg)
AT = averaging time (days)
for non-carcinogens, AT = ED x 365 days/year
for carcinogens, AT = 70 years x 365 days/year

2.2.4.2 Dermal Contact with Soil or Sediment

The following equation is used to estimate the intake associated with direct dermal contact of chemicals in soil or sediment by all receptors expected at the site (USEPA 1989):

$$Intake(mg/kg-day) = \frac{EPC_s \ x\ SA x\ ABS\ x\ AF\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AT}$$

Where:

EPC_S = chemical concentration in soil or sediment (mg/kg)
SA = exposed skin surface area (square centimeter per day [cm^2/day])
ABS = fraction of chemical absorbed from soil or sediment to skin or dermal absorption factor (unitless)
AF = skin adherence factor (milligrams per cubic meter [mg/cm^2])
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)
for non-carcinogens, AT = ED x 365 days/year
for carcinogens, AT = 70 years x 365 days/year
CF = Conversion Factor (10^{-6} kg/mg)

For this equation, the exposed skin surface area (SA) is expressed in units of cm^2/day. This unit is used under the assumption that the amount of skin surface area exposed occurs per event and only one event takes place per day. The fraction of chemical absorbed from soil or sediment to skin, also called the dermal absorption factor (ABS) values, is presented in Table D-2.

2.2.4.3 Inhalation of Particulates and Volatiles from Soil

For inhalation, exposure concentrations (ECs) are calculated. ECs are time weighted average concentrations from contaminant concentrations in air, adjusted based on the characteristics of the exposure scenario being evaluated. The generic equation to calculate inhalation exposure concentration from soil or sediment for all receptors is given below (USEPA 2009):

$$EC = \frac{EPC_A \ x \ ET \ x \ EF \ x \ ED \ x \ CF_1}{AT \ x \ CF_2}$$

Where:

EC = exposure concentration ($\mu g/m^3$)
EPC_A = chemical concentration in air ($\mu g/m^3$)
ET = exposure time (hours/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
AT = averaging time (lifetime in years x 365 days/year)
CF_1 = conversion factor (1,000 µg/mg)
CF_2 = conversion Factor (24 hours/day)

The concentration of chemicals in air resulting from emissions from soil was developed following procedures presented in the USEPA Soil Screening guidance (USEPA 2002b). The chemical concentration in air is calculated from:

$$EPC_A = EPC_S x \left[\frac{1}{PEF} + \frac{1}{VF}\right]$$

Where:

EPC_A = chemical concentration in air (mg/m^3)
EPC_S = chemical concentration in soil (mg/kg)
PEF = particulate emission factor (cubic meters per kilogram [m^3/kg])
VF = volatilization factor (

The PEF relates the concentration of a chemical in soil or sediment with the concentration of dust particles in air. For all receptors, a PEF value of $1.21x10^9$ g/m^2-second per kg/m^3 is used based upon NYSDEC guidance (NYSDEC 2006):

The PEF for the construction worker will take into account particulate matter emissions from wind erosion, excavation soil dumping, dozing, grading, and tiling. The USEPA RSL calculator, available at: http://USEPA-prgs.ornl.gov/cgi-bin/chemicals/csl_search, will be used to determine the PEF for the construction worker. The PEF will be based upon potential construction that may occur at the site assuming excavation, grading, and tilling at the site which results in a PEF from other than vehicle traffic assuming 1 acre is disturbed during construction. Additionally, the VF will be determined using the USEPA RSL calculator. Outputs from the calculator will be provided in the HHRA.

2.2.4.4 Incidental Ingestion of Groundwater

The following equation is used to estimate the intake associated with ingestion of chemicals in groundwater at the site (USEPA 1989):

$$Intake(mg / kg - day) = \frac{EPC_W \ x \ IRW \ x \ EF \ x \ ED}{BW \ x \ AT}$$

Where:

EPC_W = chemical concentration in groundwater (mg/L)
IRW = groundwater incidental ingestion rate (L/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)

2.2.4.5 Dermal Contact with Groundwater

Dermal contact with groundwater is assumed to occur during construction activities. The following equation is used to estimate the intake associated with dermal contact with chemicals in groundwater (USEPA 2004):

$$DAD = \frac{DA_{event}\ x\ SA\ x\ EV\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AT}$$

Where:

DAD = dermal absorbed dose (mg/kg-day)
DA_{event} = dermal absorbed dose per event (mg/cm^2-event)
SA = skin-surface area available for contact (cm^2)
EV = event frequency (events/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days)
for non-carcinogens, AT = ED x 365 days/yr
for carcinogens, AT = 70 years x 365 days/yr

The absorbed dose per event (DA_{event}) is estimated using a non-steady state approach for organic compounds and a steady-state approach for inorganics. For organics, the following equations apply:

$$If\ t_{event} < t^*\ then: DA_{event} = (2)(K_p)(FA)(C_w)(CF)\left(\sqrt{\frac{6\tau\, t_{event}}{\pi}}\right)$$

$$If\ t_{event} > t^*\ then: DA_{event} = (K_p)(FA)(C_w)(CF)\left(\frac{t_{event}}{1+B} + 2\tau\left[\frac{1+3B+3B^2}{(1+B)^2}\right]\right)$$

Where:

t_{event} = event duration (hour/event)
t^* = time to reach steady-state conditions (hour)
K_p = permeability coefficient of water through skin (centimeters per hour [cm/hr])
FA = chemical-specific fraction absorbed (dimensionless)
C_w = chemical concentration in water (mg/L)
τ = lag time (hour)
π = Pi (dimensionless; equal to 3.14)
CF = conversion factor (0.011 L/cm^3)
B = dimensionless ratio of the permeability of the stratum corneum relative to permeability across the viable epidermis

A majority of the exposure assumptions for dermal contact with water are based on default assumptions presented in USEPA RAGS E guidance (USEPA 2004). For the contact during construction activities, the exposed surface area of the body available for contact is based on assumed activities.

2.3 TOXICITY ASSESSMENT

The toxicity assessment considers the types of potential adverse health effects associated with exposures to COPCs, the relationship between the magnitude of exposure and potential adverse effects, and the related uncertainties, such as the weight of evidence of a particular COPC's carcinogenicity in humans. USEPA (USEPA 1989) specifies that the assessment be accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether studies demonstrate that exposure to a COPC may cause the incidence of an adverse effect. USEPA specifies the dose-response assessment, which involves: (1) quantitative evaluation of the existing toxicity information, and (2) characterization of the relationship between the dose of the COPC administered or received, and the incidence of potentially adverse health effects in the exposed population. From this quantitative dose-response relationship, specific toxicity values are derived that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels (USEPA 1989).

Toxicity values will be selected according to USEPA (2003) and USACE (2016) guidance. The following hierarchy for human toxicity values will be used in the HHRA:

- Tier 1 values – USEPA's Integrated Risk Information System (IRIS) (USEPA 2019)
- Tier 2 values - USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs)
- Tier 3 values - Toxicity Values from other sources. Priority will be given to sources of information that use sound science and are the most current, peer-reviewed, transparent, and publicly available.

The primary source of toxicity information is IRIS (USEPA 2019). When toxicity information and factors are not available in IRIS, a secondary value is sought. Tier 2 values, USEPA's PPRTVs, are developed by the Office of Research and Development, the National Center for Environmental Assessment, and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program. Tier 3, other toxicity values, are considered when Tier 1 or Tier 2 toxicity values are not available. These toxicity values are taken from additional USEPA and non-USEPA sources and are chosen based on the most current and best peer-reviewed source available. The California USEPA (CalEPA) Office of Environmental Health Hazard Assessment Toxicity Criteria Database (CalEPA 2019), the California USEPA Cancer Potency Values (CalEPA 2009), the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (ATSDR 2019), and the Health Effects Assessment Summary Tables (USEPA 1997) are potential Tier 3 sources for this HHRA.

2.3.1 Toxicity Assessment for Non-Carcinogens

The methodology used by USEPA for deriving non-cancer reference values for non-carcinogens, and site-specific considerations for modifying or using these concentrations are discussed in detail in Barnes and Dourson (1988) and USEPA guidance (USEPA 2019). Non-carcinogens are typically judged to have a threshold daily dose below which deleterious or harmful effects are unlikely to occur. This concentration is called the no-observed-adverse-effect-level (NOAEL), and may be derived from either animal laboratory experiments or human epidemiology investigations (usually workplace studies). In developing a toxicity value or human NOAEL for non-carcinogens (i.e., a reference dose [RfD]), the regulatory approach is to (1) identify the critical toxic effect associated with chemical exposure (i.e., the most sensitive adverse effect); (2) identify the threshold dose in either an animal or human study; and (3) modify this dose to account for interspecies variability (where appropriate), differences in individual sensitivity (within-species variability), and other uncertainty and modifying factors. For the Reference Concentration (RfC), experimental exposures are extrapolated to a Human Equivalent Concentration (HEC). The HEC is determined through a two-step process that begins with a point of departure (POD) which is adjusted (multiplied) by a Dosimetric Adjustment Factor (DAF) (USEPA 2009). The POD can represent a NOAEL, lowest-observed-adverse-effect-level (LOAEL), benchmark concentration, lower confidence limit, and the lower limit on an effective concentration using a 10% response level (LEC_{10}). The DAF is for the specific site of the chemical's effects (e.g., respiratory tract, etc.). The DAF is dependent upon the nature of the contaminant and the target site of the toxic effect.

Uncertainty factors (UFs) are intended to account for specific types of uncertainty inherent in extrapolation from the available data. The UFs are generally 10-fold, default factors used in operationally deriving the RfD and RfC from experimental data. UFs less than 10 can be used. An UF of 3 can be used in place of one-half power ($10^{0.5}$), when appropriate. The UFs are intended to account for (1) variation in susceptibility among the members of the human population (i.e., inter-individual or intraspecies variability); (2) uncertainty in extrapolating animal data to humans (i.e., interspecies uncertainty); (3) uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (i.e., extrapolating from subchronic to chronic exposure); (4) uncertainty in extrapolating from a LOAEL rather than from a NOAEL; and (5) uncertainty associated with extrapolation when the database is incomplete. The maximum UF for the derivation of the RfCs used in this HHRA is 1,000. The maximum UF for the derivation of the RfDs used in this HHRA is 1,000. To calculate the RfD, the appropriate NOAEL is divided by the product of all the applicable UFs. This is expressed as:

$$\text{RfD} = \text{NOAEL} / (\text{UF}_1 \text{ x } \text{UF}_2 \text{ x } \text{UF}_3 \text{ x } \text{UF}_4)$$

The resulting RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-bw/day). To calculate the RfC, the HEC is divided by UFs and is expressed in units of mg/m^3.

2.3.2 Toxicity Assessment for Carcinogenicity

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold. There is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. USEPA uses a two-part evaluation for carcinogenic effects. This evaluation includes the assignment of a weight-of-evidence classification and the quantification of a cancer toxic potency concentration.

The USEPA has established five recommended standard hazard descriptors: "*Carcinogenic to Humans*," "*Likely to Be Carcinogenic to Humans*," "*Suggestive Evidence of Carcinogenic Potential*," "*Inadequate Information to Assess Carcinogenic Potential*," and "*Not Likely to Be Carcinogenic to Humans*" (USEPA 2005a). The weight-of-evidence (WOE) classification is based on a thorough scientific examination of the body of available data. Only compounds that have a WOE classification of B2 or above are considered to have carcinogenic potential in this risk assessment. Compounds with a WOE classification of C will be discussed in the uncertainty section.

Because the revised cancer guidelines (USEPA 2005a) are not yet incorporated into many of the IRIS chemical profiles, the WOE classifications defined by the USEPA (USEPA 1986, 1989) and shown in the toxicity profiles on the IRIS system will still be used when interpreting carcinogenic toxicity of COPCs. The WOE classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen (USEPA 1986). This WOE classification that will be used in the HHRA is defined as follows:

- Group A: Known human carcinogen
- Group B: Probable human carcinogen
- Group B1: Limited evidence of carcinogenicity in humans
- Group B2: Sufficient evidence in animals, but inadequate evidence in humans
- Group C: Possible human carcinogen (limited evidence of carcinogenicity in animals in the absence of human data)
- Group D: Human carcinogenicity not classifiable because of lack of data
- Group E: Evidence of non-carcinogenicity in humans (no evidence in at least two adequate animal tests in different species or in both epidemiological and animal studies)

Quantification is expressed as a slope factor (SF) for oral and dermal exposures and an Inhalation Unit Risk (IUR) for inhalation exposures, which reflects the dose-response data for the carcinogenic endpoint(s) (USEPA 1989 and 2009). The SF and the IUR are the upper 95th percentile confidence limit of the probability of response per unit daily intake of a chemical over a lifetime. The SF is expressed in units of proportion (of a population) affected per mg/kg-day. The IUR is expressed in $\mu g/m^3$. Typically, the SF and the IUR are used to estimate the upper-bound lifetime probability of a person developing cancer from exposure to a given concentration of a carcinogen. SFs and IURs are generally based on experimental animal data, unless suitable epidemiological studies are available. Because of the difficulty in detecting and measuring carcinogenic endpoints at low exposure concentrations, SFs and IURs are typically developed by using a model to fit the available high-dose, experimental animal data, and then extrapolating downward to the low-dose range to which humans are typically exposed. USEPA recommends the linear multistage model to derive a SF and IUR. The model is conservative and provides an upper bound estimate of excess lifetime cancer risk. These methods and approaches are discussed in greater detail within the USEPA *Cancer Guidelines* (USEPA 2005a).

Carcinogenic compounds will also be assessed for mutagenic modes of action. The mutagenic mode of action is assessed with a linear approach (USEPA 2005c). COPCs identified as mutagenic have sensitivity pertaining to cancer risks associated with early-life exposures. To account for the early-life exposure and the mutagenic mode of action, the cancer potency estimates will be adjusted by an age-dependent adjustment factor (ADAF). USEPA recommends, for mutagenic chemicals, when no chemical-specific data exist, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early life stage exposure (USEPA 2005b, 2005c). An ADAF modification for early life stage exposure to mutagenic COPCs is required because available studies indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood (USEPA 2005c). For this HHRA, the intakes for COPCs identified with a mutagenic mode of action will be modified by an ADAF for the following exposures (USEPA 2005c):

- For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth up until a child’s second birthday), a 10-fold adjustment.
- For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child’s second birthday up until their sixteenth birthday), a 3-fold adjustment.
- For exposures after turning 16 years of age, no adjustment.

For this HHRA, the adolescent recreational user, child recreational user, and adolescent trespasser are within the age range that requires adjustment for a mutagenic mode of action.

2.3.3 Toxicity Assessment Modification for Dermal Contact

Toxicity values specific to dermal exposures are not available and require adjustment of the oral toxicity values (oral RfDs or SFs). This adjustment accounts for the difference between the daily intake dose through dermal contact as opposed to ingestion. Most toxicity values are based on the actual administered dose and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to use in dermal contact risk assessment (USEPA 1989 and 2004). USEPA recommends utilizing oral absorption efficiency factors in converting oral toxicity values to dermal toxicity values (USEPA 2004). This adjustment accounts for the absorption efficiency in the “critical study,” which is utilized in determining the RfD and SF. Where oral absorption in the critical study is essentially complete (i.e., 100 percent), the absorbed dose is equivalent to the administered dose, and no adjustment of oral toxicity values is necessary when evaluating dermal exposures. When gastrointestinal absorption of a chemical in the critical study is poor (e.g., 1 percent), the absorbed dose is much smaller than the administered dose, and toxicity values for dermal exposure are adjusted to account for the difference in the absorbed dose relative to the administered dose. To account for the differences between the administered (oral) and the absorbed (dermal) dose, RfDs and SFs are modified by the gastrointestinal dermal absorption factor (GIABS).

Dermal SFs and dermal RfDs will be determined according to the following equation:

$$RfD_d = RfD_o \ x \ GIABS$$

$$SF_d = \frac{SF_o}{GIABS}$$

Where:

RfD_d	=	dermal reference dose (mg/kg-day)
RfD_o	=	oral reference dose (mg/kg-day)
GIABS	=	fraction of contaminant absorbed through the gastrointestinal tract
SF_d	=	dermal cancer slope factor
SF_o	=	oral cancer slope factor.

2.4 RISK CHARACTERIZATION

The characterization of human health risk involves the combining of information from the exposure assessment with that from the toxicity assessment. Chemical intakes for each receptor and each exposure pathway are combined with toxicity information to derive cumulative excess lifetime cancer risks (ELCRs) and cumulative non-cancer hazard indexes (HIs). The ELCRs and HIs will be presented in EPA RAGS D format (EPA 2002b). These tables will also present cumulative cancer risks or HIs for COPCs, pathways, and receptors.

Risk Characterization summary tables in the HHRA will reflect the following rounding convention. Results for individual COPCs will contain two significant figures. Only one significant figure will be used for cumulative results for all exposure pathways. The methodologies used to estimate carcinogenic risks and chronic and subchronic risks for non-carcinogens are described further in the sections below.

2.4.1 Hazard Index for Non-Carcinogenic Effects

The potential human health risks associated with exposures to non-carcinogenic COPCs are calculated by comparing the intake or the EC with the chemical-specific RfD or RfC, as per USEPA Guidance (USEPA 1989 and 2009). A hazard quotient (HQ) is derived for each COPC, as shown in the equation below:

$$HQ = \frac{Intake}{RfD} \quad \text{or} \qquad HQ = \frac{EC}{RfC \times (1{,}000 \ \mu g / mg)}$$

where:

HQ = Hazard Quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
$Intake$ = Calculated non-carcinogenic average daily intake (mg/kg-day)
EC = Exposure Concentration (µg/m^3)
RfD = Reference dose (mg/kg-day)
RfC = Reference concentration (mg/m^3)

If the average daily dose (intake) exceeds the RfD or RfC, the HQ will exceed a ratio of one (1.0) and there may be concern that potential adverse systemic health effects will be observed in the exposed populations. If the average daily dose (intake) does not exceed the RfD or the RfC, the HQ will not exceed 1.0 and there will be no concern that potential adverse systemic health effects will be observed in the exposed populations. HQ results for individual COPCs will contain two significant figures. In general, the greater the value of the HQ is above 1.0, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur. To evaluate the potential for exposure to multiple chemicals for each exposure pathway, a hazard index (HI) must be calculated. This approach assumes that the exposure to more than one chemical is additive and therefore, sums the HQs of all the COPCs:

$$HI = \Sigma HQ_n$$

In this aspect, synergistic and antagonistic interactions are not taken into account. Similar to the HQs, if the HI exceeds 1, the potential for non-carcinogenic adverse effects may exist. The overall receptor-specific HI is the sum of the HIs for all exposure pathways. Only one significant figure will be used for cumulative HI results for all exposure pathways. Not all chemicals affect the same systems in the human body. For each non-carcinogen, information regarding the target organ and other organ/systems that may be impacted will be collected. Where pathway-specific HIs exceed the target level of 1, non-cancer risks will be re-assessed for each target organ/system. Where organ/system-specific HIs exceed 1, the potential for adverse effect on human health is concluded.

2.4.2 Carcinogenic Risks

Carcinogenic risk is calculated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the lifetime cancer average daily intake (LADI) by the risk per unit dose (the SF) or multiplying the EC by the IUR.

This is shown in the following equation:

$$ELCR_n = LADI \times SF$$
$$ELCR_n = EC \times IUR$$

Where:

$ELCR_n$ = chemical-specific excess lifetime cancer risk for chemical “n”

$LADI$ = Lifetime average daily intake (mg/kg-day)
EC = Exposure Concentration (μg/m^3)
SF = Cancer slope factor (mg/kg-day)$^{-1}$
IUR = Inhalation Unit Risk (μg/m^3)$^{-1}$

Risk results for individual COPCs will contain two significant figures. Because the SF and the IUR are the statistical 95th percent upper-bound confidence limit on the dose-response slope, this method provides a conservative, upper-bound estimate of risk. It should be noted that the interpretation of the significance of the cancer risk estimate is based on the appropriate public policy. USEPA in the NCP (40 CFR Part 300) (USEPA 1990) states that:

"...For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} *and* 10^{-6}*."*

To evaluate the potential for exposure to multiple chemicals for each exposure pathway, risks resulting from exposure to multiple carcinogens are assumed to be additive. Therefore the pathway-specific ELCR is estimated by summing the risks estimated for each COPC and for each pathway:

$$ELCR_{total} = \Sigma ELCR_{\mathrm{n}}$$

Where:

$ELCR_{\mathrm{n}}$ = chemical-specific excess lifetime cancer risk for chemical "n"
n = various individual carcinogenic COPCs

The overall receptor-specific $\mathrm{ELCR}_{\mathrm{total}}$ is the sum of the risk for all exposure pathways. Only one significant figure will be used for cumulative risk results for all exposure pathways.

2.5 UNCERTAINTY ANALYSIS

Uncertainty exists in a number of elements in the risk assessment process, including (but not limited to) models used to estimate mean concentrations, assumptions used to estimate chemical intake, and the toxicity of chemicals. Given the conservative or protective nature of the human health risk assessment process, cancer and non-cancer risk estimates are likely overestimated. Some of the uncertainties inherent and introduced into the risk assessment process will be discussed with focus on key factors believed to influence the risk assessment process and apply to risk management decisions. Uncertainties involved in each major step of the risk assessment process (i.e., hazard assessment, exposure assessment, toxicity assessment, and risk characterization) will be discussed.

Examples of elements that may be included in the uncertainty are listed below:

- Hazard Assessment
- Exclusion of non-detected chemicals in risk estimates

- Effect of elevated reporting limits
- Exposure Assessment
- Uncertainty associated with any modeled concentrations
- Toxicity Assessment
- Risk Characterization
- The presumed additivity of risks from multiple chemicals

Each element contributing to the uncertainty of the risk results will be discussed in terms of whether the impact would likely over- or underestimate risk. The degree of potential over- or underestimation will be assessed using qualitative terms such as low, moderate, high and extreme. For some factors of uncertainty, risk estimates may be either over-or underestimated. The following details an initial assessment of uncertainties in the HHRA.

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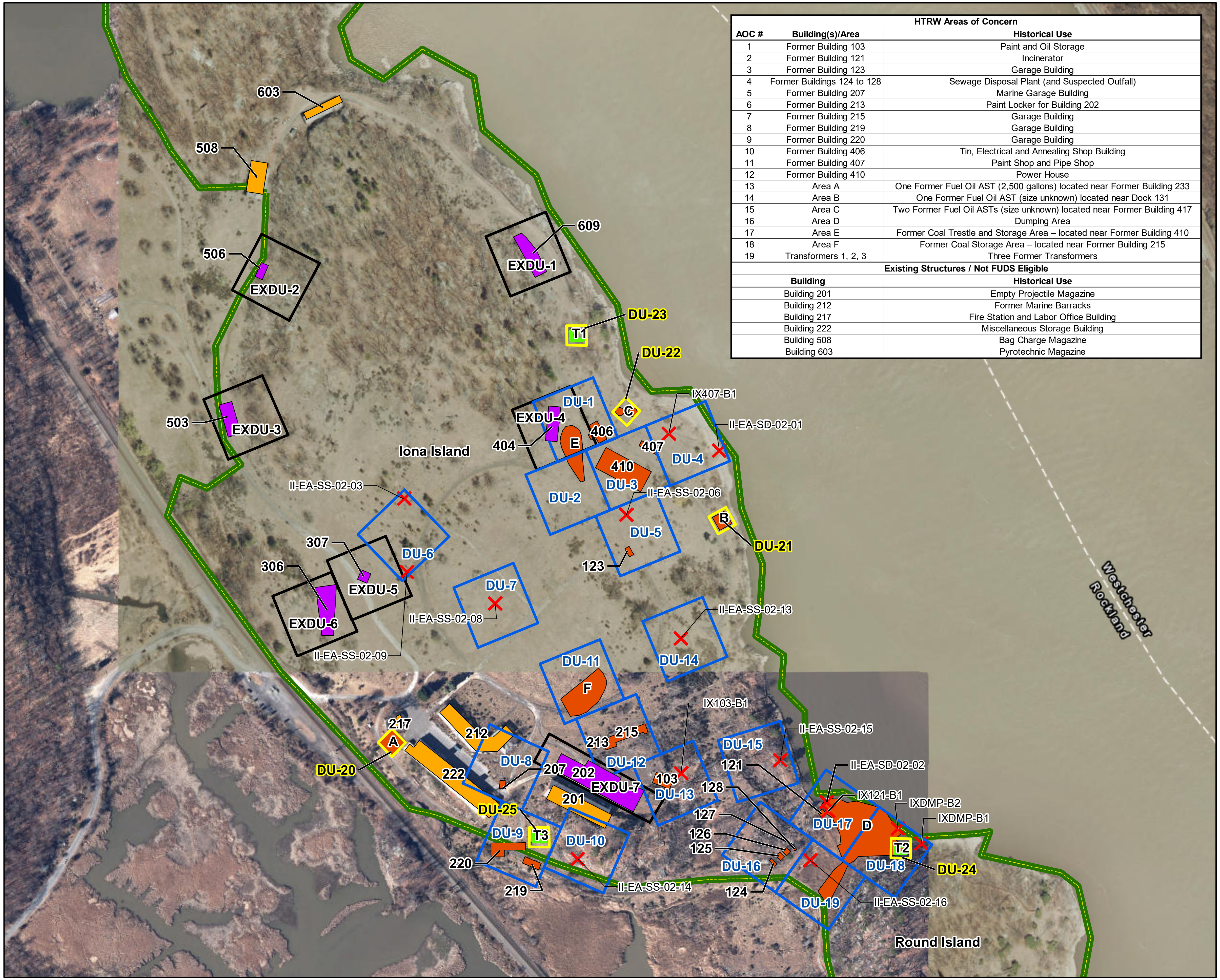
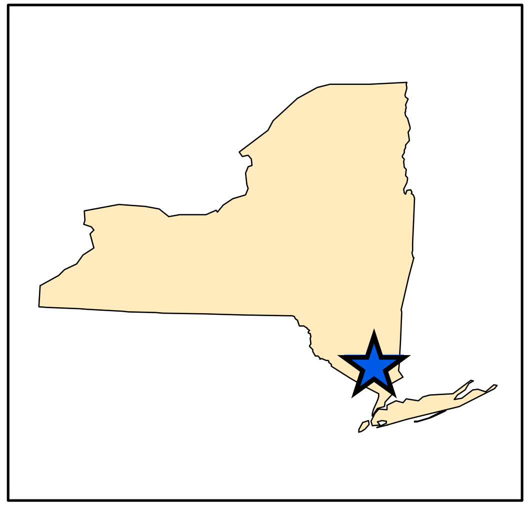


HTRW Areas of Concern		
AOC #	Building(s)/Area	Historical Use
1	Former Building 103	Paint and Oil Storage
2	Former Building 121	Incinerator
3	Former Building 123	Garage Building
4	Former Buildings 124 to 128	Sewage Disposal Plant (and Suspected Outfall)
5	Former Building 207	Marine Garage Building
6	Former Building 213	Paint Locker for Building 202
7	Former Building 215	Garage Building
8	Former Building 219	Garage Building
9	Former Building 220	Garage Building
10	Former Building 406	Tin, Electrical and Annealing Shop Building
11	Former Building 407	Paint Shop and Pipe Shop
12	Former Building 410	Power House
13	Area A	One Former Fuel Oil AST (2,500 gallons) located near Former Building 233
14	Area B	One Former Fuel Oil AST (size unknown) located near Dock 131
15	Area C	Two Former Fuel Oil ASTs (size unknown) located near Former Building 417
16	Area D	Dumping Area
17	Area E	Former Coal Trestle and Storage Area – located near Former Building 410
18	Area F	Former Coal Storage Area – located near Former Building 215
19	Transformers 1, 2, 3	Three Former Transformers

Existing Structures / Not FUDS Eligible	
Building	Historical Use
Building 201	Empty Projectile Magazine
Building 212	Former Marine Barracks
Building 217	Fire Station and Labor Office Building
Building 222	Miscellaneous Storage Building
Building 508	Bag Charge Magazine
Building 603	Pyrotechnic Magazine

VICINITY MAP



Legend

🟩	FUDS Boundary
🟥	HTRW Project Areas of Concern
🟩	FormerTransformers
🟧	Remaining Structure (Not FUDS Eligible)
✕	Previous Elevated Concentration of COPC
☐	200 ft x 200 ft DU
☐	60 ft x 60 ft DU
🟪	Former Buildings with Significant Potential for Explosive Hazard (Included in the HTRW RI pending direction of contracting offer)
☐	1 Acre Explosives Building DU

0 300 600
Feet
1 in = 300 ft

N

FIGURE 1
HTRW Project AOC Incremental Sampling Decision Units

HUMAN HEALTH RISK ASSESSMENT WORK PLAN

Aerial: ESRI ArcGIS Online Map Service

Map Date: 11/15/2019

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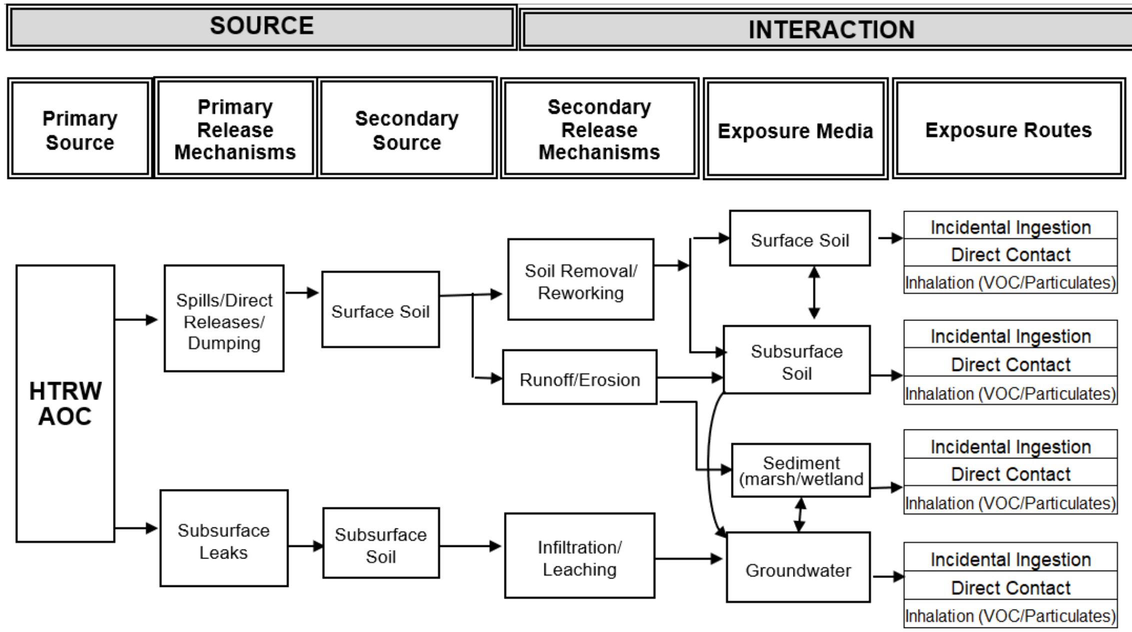

HUMAN RECEPTORS

Exposure Media	Exposure Routes	Current and Future Park Personnel	Future Construction Workers	Current and Future Trespassers	Current and Future Researchers	Current and Future Recreational Users	Current and Future Campers/Boy Scouts
Surface Soil	Incidental Ingestion	●	◑	●	●	●	●
	Direct Contact	●	◑	●	●	●	●
	Inhalation (VOC/Particulates)	●	◑	●	●	●	●
Subsurface Soil	Incidental Ingestion	○	◑	○	○	○	●
	Direct Contact	○	◑	○	○	○	●
	Inhalation (VOC/Particulates)	○	◑	○	○	○	●
Sediment (marsh/wetland	Incidental Ingestion	◑	○	◑	●	◑	◑
	Direct Contact	◑	○	◑	●	◑	◑
	Inhalation (VOC/Particulates)	○	○	○	○	○	○
Groundwater	Incidental Ingestion	○	◑	○	○	○	○
	Direct Contact	○	◑	○	○	○	○
	Inhalation (VOC/Particulates)	○	◑	○	○	○	○

LEGEND

- ● Complete Pathway; confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified).
- ◑ Potentially Complete Pathway; receptor and media interaction; however, the exposure may be limited, either due to the type of receptor or the nature of the source, and has not been confirmed.
- ○ Incomplete Pathway; no receptor and media interaction. No evaluation is conducted.

NOTES
Surface soil = defined as the interval from 0 to 6 inches bgs.
Subsurface soil = defined as the interval from 6 to 36 inches bgs.

EA Engineering, P.C. and Its Affiliate
EA Science and Technology

Iona Island Human Health Conceptual Site Model

Figure 2

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TABLE 1
REASONABLE MAXIMUM EXPOSURE PARAMETERS PROPOSED FOR IONA ISLAND NAVAL AMMUNITION DEPOT

						Recreational User					
Definition	Parameter	Units	Current/Future Park Personnel	Current/Future Researcher	Future Construction Worker	Adult	Adolescent (6 to 16 years)	Child (2-6 years)	Current/Future Adolescent Trespasser (12 to 18 years)	Current/Future Campers (Boy Scouts)	References
General Parameters											
Body Weight	BW	kg	80	80	80	80	56.8	16	57	45	USEPA 2011, 2014
Exposure Duration	ED	years	25	3	1	20	6	4	6	13	BPJ; USEPA 2011, 2014
Averaging Time	AT										
Noncarcinogenic		days	9,125	1,095	365	7,300	2,190	1,460	2,190	4,745	USEPA 1989
Carcinogenic		days	25,550	25,550	25,550	25,550	25,550	25,550	25,550	25,550	USEPA 1989
Surface and Subsurface Soil Incidental Ingestion Pathway											
Soil Incidental Ingestion Rate	IRS	mg/day	100	100	330	100	200	200	100	200	USEPA 1991, 2002, 2014
Soil Exposure Frequency	EF	days/year	160	52	275	31	31	31	16	20	BPJ; NYSDEC 2006; USEPA 2011, 2014
Conversion Factor	CF_1	kg/mg	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	USEPA 1989
Surface Soil Dermal Contact Pathway											
Skin Surface Area	SA	cm$^{2.}$	3,527	3,527	3,527	6,032	4,645	2,107	4,645	3,947	USEPA 2011, 2014
Skin Adherence Factor	AF	mg/cm^2	0.12	0.3	0.3	0.07	0.2	0.2	0.2	0.2	USEPA 2011, 2014
Soil Exposure Frequency	EF	days/year	160	52	275	31	31	31	16	20	BPJ; USEPA 2011, 2014
Dermal Absorption Factor	ABS	unitless	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	USEPA 2004
Conversion Factor	CF_1	kg/mg	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	USEPA 1989
Subsurface Soil Dermal Contact Pathway											
Skin Surface Area	SA	cm$^{2.}$	NA	NA	3,527	NA	NA	NA	NA	3,947	USEPA 2011, 2014
Skin Adherence Factor	AF	mg/cm^2	NA	NA	0.9	NA	NA	NA	NA	3.3	USEPA 2004
Soil Exposure Frequency	EF	days/year	NA	NA	275	NA	NA	NA	NA	20	BPJ; USEPA 2011, 2014
Dermal Absorption Factor	ABS	unitless	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	USEPA 2004
Conversion Factor	CF_1	kg/mg	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	USEPA 1989
Surface and Subsurface Soil Inhalation Pathway											
Particulate Emission Factor	PEF	m^3/kg	1.21E+09	1.21E+09	Site-specific	1.21E+09	1.21E+09	1.21E+09	1.21E+09	1.21E+09	NYSDEC 2006
Soil Exposure Frequency	EF	days/year	160	52	275	31	31	31	16	20	NYSDEC 2006; USEPA 2011
Exposure Time	ET	hour/day	8	8	11.5	4	4	4	4	24	BPJ; USEPA 1989, 2011
Conversion Factor	CF_2	ug/mg	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	USEPA 2009
Conversion Factor	CF_3	hours/day	24	24	24	24	24	24	24	24	USEPA 2009
Sediment Incidental Ingestion Pathway											
Sediment Incidental Ingestion Rate	IRS	mg/day	50	50	NA	50	50	50	50	50	USEPA 1991, 2002, 2014
Sediment Exposure Frequency	EF	days/year	80	52	NA	31	31	31	NA	20	BPJ; NYSDEC 2006; USEPA 2011, 2014
Conversion Factor	CF_1	kg/mg	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	USEPA 1989
Sediment Dermal Contact Pathway											
Skin Surface Area	SA	cm$^{2.}$	3,527	3,527	NA	6,032	4,645	2,107	4,645	3,947	USEPA 2011, 2014
Skin Adherence Factor	AF	mg/cm^2	0.9	0.9	NA	0.9	3.3	3.3	3.3	3.3	USEPA 2004
Sediment Exposure Frequency	EF	days/year	80	52	NA	31	31	31	16	20	USEPA 2011, 2014
Dermal Absorption Factor	ABS	unitless	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	USEPA 2004
Conversion Factor	CF_1	kg/mg	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	USEPA 1989
Groundwater Ingestion Pathway											
Groundwater Ingestion Rate	IRW	L/day	NA	NA	0.08	NA	NA	NA	NA	NA	USEPA 2011
Groundwater Exposure Frequency	EF	days/year	NA	NA	30	NA	NA	NA	NA	NA	BPJ

TABLE 1
REASONABLE MAXIMUM EXPOSURE PARAMETERS PROPOSED FOR IONA ISLAND NAVAL AMMUNITION DEPOT

Definition	Parameter	Units	Current/Future Park Personnel	Current/Future Researcher	Future Construction Worker	Recreational User			Current/Future Adolescent Trespasser (12 to 18 years)	Current/Future Campers (Boy Scouts)	References
						Adult	Adolescent (6 to 16 years)	Child (2-6 years)			
Groundwater Dermal Contact Pathway											
Skin Surface Area	SA	cm^{2}	NA	NA	3,527	NA	NA	NA	NA	NA	USEPA 2011, 2014
Exposure Time	ET	hour/day	NA	NA	11.5	NA	NA	NA	NA	NA	USEPA 2011, 2014
Permeability Coefficient	PC	cm/hour	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	USEPA 2004
Groundwater Exposure Frequency	EF	days/year	NA	NA	30	NA	NA	NA	NA	NA	USEPA 2011, 2014
Conversion Factor	CF_4	L/cm^3	NA	NA	0.001	NA	NA	NA	NA	NA	USEPA 1989

Notes:
NA = Not applicable

References:

BPJ = Best Professional Judgement
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Appendix E

Ecological Risk Assessment Work Plan

APPENDIX E
Ecological Risk Assessment Work Plan

Remedial Investigation
UFP-QAPP
Iona Island Naval Ammunition Depot
Formerly Used Defense Site
Stony Point, Rockland County, New York

Prepared for

United States Army Corps of Engineers
Baltimore District

Prepared by

EA Engineering, P.C. and Its Affiliate
EA Science and Technology
6712 Brooklawn Parkway, Suite 104
Syracuse, New York 13211

January 2020
Version: FINAL
EA Project No.: 63029587

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LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
Alion	Alion Science and Technology
AOC	Area of concern
AUF	Area use factor
BAF	Bioaccumulation factor
BERA	Baseline ecological risk assessment
Bluestone	Bluestone Environmental Group, Inc.
BTEX	Benzene, toluene, ethylbenzene, and xylenes
COPEC	Contaminant of potential ecological concern
CSM	Conceptual site model
DU	Decision unit
EA	EA Engineering, Science, and Technology, Inc., PBC
EcoSSL	Ecological soil screening level
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological risk assessment
FUDS	Formerly Used Defense Site
HMW	High molecular weight
HQ	Hazard quotient
ISM	Incremental sampling methodology
ITRC	Interstate Technology and Regulatory Council
kg/kg bw-d	Kilogram soil per kilogram body weight per day
LANL	Los Alamos National Laboratory
LMW	Low molecular weight
LOAEL	Lowest observed adverse effects levels
mg/kg	Milligram per kilogram
mg/kg bw-d	Milligrams soil per kilogram body weight per day
NAE	U.S. Army Corps of Engineers New England District
NMFS	National Marine Fisheries Service
NOAEL	No observed adverse effect levels
NYSDEC	New York State Department of Environmental Conservation

PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PDT	Project Delivery Team
QAPP	Quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RSLERA	Refined screening-level ecological risk assessment
SLERA	Screening-level ecological risk assessment
SMDP	Scientific Management Decision Point
SVOC	Semivolatile organic compound
TRV	Toxicity reference value
UCLM	Upper confidence limit of the mean
UFP	Uniform federal policy
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compound

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1. INTRODUCTION

This work plan describes the methodology that will be used to conduct the initial phase of the ecological risk assessment (ERA) at the Iona Island Naval Ammunition Depot Formerly Used Defense Site (FUDS). The ERA will evaluate the potential for adverse ecological effects from exposure to site-related contaminants of potential ecological concern (COPECs) detected in site media. The overall objective of the ERA is to quantitatively and qualitatively evaluate exposure and risks to ecological receptors, and to provide risk managers with information necessary to achieve management goals and evaluate remedial decisions, if necessary.

1.1 GENERAL APPROACH

The ERA will follow the procedures and methodologies set forth by the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE). Specific guidance documents that will be used to formulate the ERA include: *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997) and *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments EcoUpdate* (EPA 2001).

Additionally, the overarching USACE guidance documents that will be followed include *Risk Assessment Handbook Volume II: Environmental Evaluation* of the *USACE Engineering Manual 200-1-4* (USACE 2010), *Standard Scopes of Work for Environmental Risk Assessment* USACE Environmental Quality (USACE 2016), and *A Guide to Screening-Level Ecological Risk Assessment* (TriService Environmental Risk Assessment Working Group 2008). Additional documents will be used as necessary, including but not limited to the following:

- *Wildlife Exposure Factors Handbook.* Volumes 1 and 2. EPA/600/R-93/187. December 1993.
- *Guidelines for Ecological Risk Assessment.* EPA/630/R95/002F. April 1998.
- *Guidance for Developing Ecological Soil Screening Levels (EcoSSLs).* OSWER Directive 9285.7-55. Revised February 2007, including separate contaminant EcoSSL documents.
- *Framework for Metals Risk Assessment.* EPA 120/R-07/001. March 2007.

1.1.1 EPA's 8-Step Process

EPA's *Ecological Risk Assessment Guidance for Superfund* (EPA 1997) presents an 8-step ERA process (Figure 1). Steps 1 and 2 of the process include a screening-level ecological risk assessment (SLERA) where COPECs are identified in environmental media (e.g., soil) through a conservative screening process and risk estimates are calculated based on conservative, literature-based assumptions for exposure and toxicity.

If the results of the SLERA indicate potential adverse ecological effects, a scientific-management decision point (SMDP) allows the process to continue to a baseline ecological risk assessment (BERA), if warranted. The BERA consists of Step 3 (Problem Formulation) through Step 8 (Risk Management). Steps 4 through 6 entail additional site-specific data collection (e.g., analytical tissue data, toxicity testing, habitat evaluations, community analysis, population metrics). Step 7 consists of the Risk Characterization where ecological risks are calculated based on refined site-specific data.

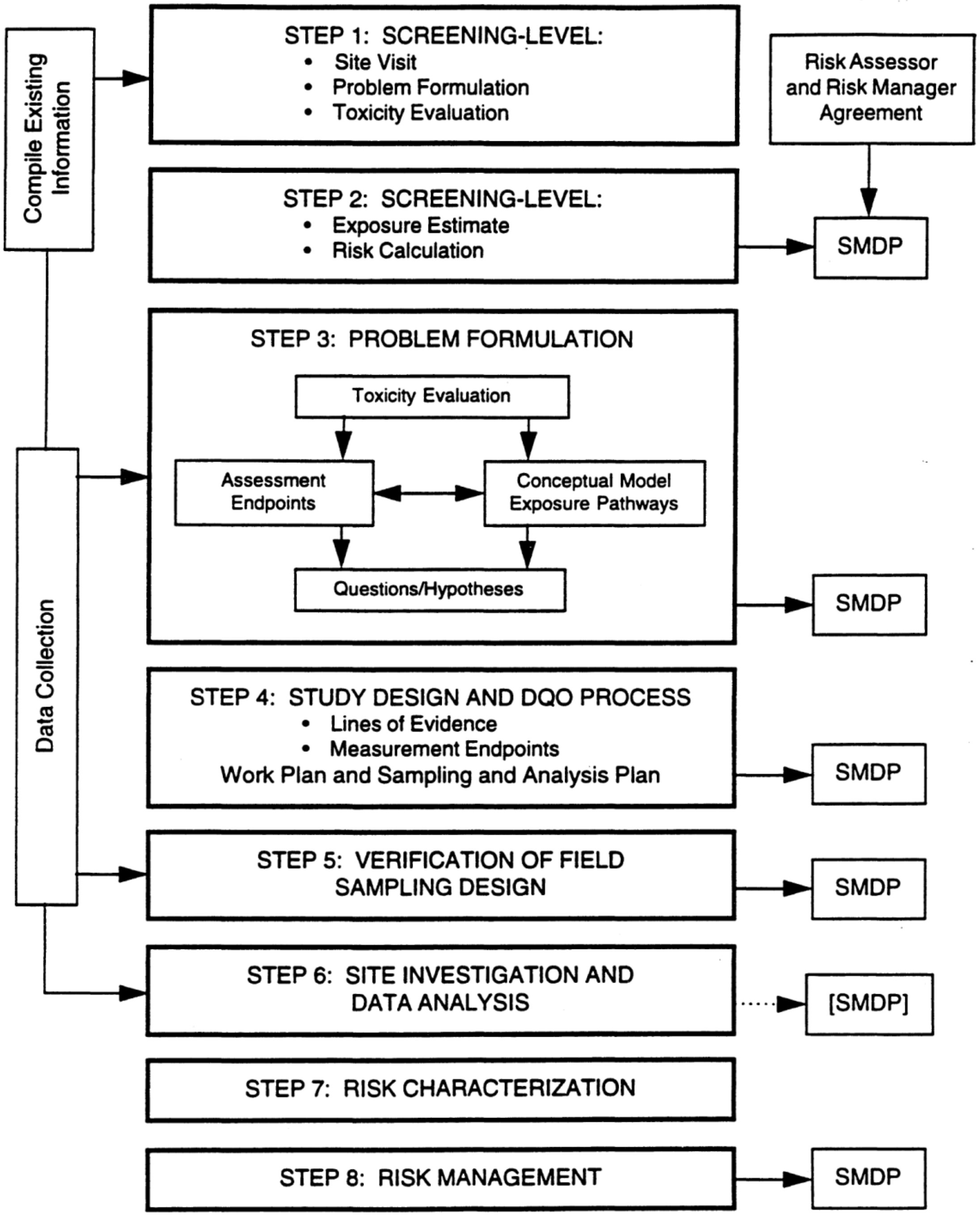
1.1.2 USACE Flowcharts

USACE New England District (NAE) has drafted ERA flowcharts (Attachment 1) to provide an additional step after the SLERA (Attachment 1, Flowchart D) to allow for less conservative assumptions and exposure parameters to be incorporated in a Refined SLERA (RSLERA) (Attachment 1, Flowchart E), similar to EPA's SLERA refinement (EPA 2001). The RSLERA considers spatial distribution of the data, statistical evaluations (e.g., outlier analysis), bioavailability, background, and other potential explanatory factors (e.g., pH, grain size, total organic carbon) to be incorporated into the evaluation. The NAE Project Delivery Team (PDT) developed these flowcharts to provide a breakdown of the process for project managers, team members, and communication purposes. The process is a two-step process, consisting of a screening level (preliminary and refined) and baseline assessment to evaluate ecological risks.

Step 1, Screening Level Risk Assessment (Attachment 1, Flowchart D): The screening level ecological risk assessment consists of preliminary and refined screening steps. The preliminary screen evaluates chemical concentrations against generic, conservative screening values. If potential risk exists after the preliminary evaluation, a refined screen (Attachment 1, Flowchart E) will be completed that incorporates more readily available site specific information such as adjustments to the exposure point concentration, toxicity information/effects, exposure scenarios, land use, and other input parameters that make the screen more site-specific. Only receptors/pathways that show potentially significant risk or for which insufficient information is available to address risk are carried through to the baseline assessment.

Step 2, Baseline Risk Assessment: If results of the RSLERA indicate potential risk, additional data will be collected as necessary (i.e., Phase II) to refine the potential risks in the baseline ecological risk assessment (BERA) for specific COPEC(s), media, and receptor(s) (Attachment 1, Flowchart F). Such data could include porewater data, toxicity testing, tissue analysis, population studies, and/or benthic community metrics to understand actual site-specific risk. Only those receptors remaining at the completion of the screening assessment are carried forward for further evaluation in the baseline assessment. The baseline assessment benefits from incorporating site-specific information collected as part of the remedial investigation.

A detailed discussion about the application of the USACE NEA ERA flowcharts to the Iona Island ERA can be found in Section 2.3 of this document, addressing each of the decision statements presented specific to this project.



SMDP = scientific management decision point

Figure 1 EPA's 8-Step Ecological Risk Assessment Process

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2. SCREENING-LEVEL PROBLEM FORMULATION

The screening-level problem formulation and ecological effects evaluation is part of the initial ecological risk screening assessment. As part of this step, the ecological conceptual site model (CSM) is developed. For this initial step, site-specific information for determining the nature and extent of contamination and for characterizing ecological receptors at the site is limited. The results of this step (Step 1) will be used in conjunction with exposure estimates in the preliminary risk calculation in Step 2.

2.1 ECOLOGICAL CONCEPTUAL SITE MODEL

During the screening-level problem formulation, an ecological CSM is developed to address five key issues:

1) The environmental setting and contaminants known or suspected to exist at the site

2) Fate and transport mechanisms that might exist at the site

3) Mechanisms of ecotoxicity associated with contaminants and categories of receptors that could be affected

4) Identification of complete exposure pathways

5) Selection of ecological endpoints to evaluate.

The following sections describe these five key issues that contribute to the development of the CSM, which is presented in Section 2.1.7:

2.1.1 Site Location

The Iona Island Naval Ammunition Depot FUDS property consists of approximately 124 total acres of land and inland water located on Iona Island and Round Island along the west side of the Hudson River, in the Town of Stony Point, Rockland County, New York (Figure 1 of the Uniform Federal Policy [UFP] Quality Assurance Project Plan [QAPP]). Iona Island is located within the Lower Hudson River Valley region, which includes Putnam, Rockland, and Westchester counties and is considered part of the Downstate New York region due to its geographical and cultural proximity to New York City.

Iona Island is located in Bear Mountain State Park on the east side of U.S. 202/Route 9W, 6 miles south/downstream of West Point Military Academy, 1 mile south/downstream of the Bear Mountain Bridge, and 41.2 miles north/upstream from the mouth of the Hudson River. Round Island, the southeastern part of Iona Island, was once cut off by marshes and was attached to Iona Island with fill in the early 20th century (New York State Department of Environmental Conservation [NYSDEC] and U.S. Department of Commerce 1992).

Iona Island is connected to the mainland by a narrow two-lane road off U.S. 202/Route 9W near Doodletown. The island is accessed by crossing active River Subdivision (CSX Transportation) railroad tracks and entering through an unmanned gate.

Iona Island is part of the much larger Hudson River National Estuarine Research Reserve and Significant Coastal Fish and Wildlife Habitat Area, managed under New York's Coastal Management Program (Alion Science and Technology [Alion] 2008). In addition, the Iona Island Marsh became a registered National Natural Landmark in 1971. The island is considered a bald eagle sanctuary (Levine 2011). Additional information on the site location and historical use is provided in Worksheet 10 of the UFP-QAPP.

2.1.2 Ecological Setting

Native vegetation within Iona Island's marsh is dominated by narrow leaf cattail (*Typha angustifolia*) with common reed (*Phragmites* spp.) and swamp rose mallow (*Hibiscus moscheutos*). Crack willow (*Salix fragilis*) is present at the mouth of Doodletown Brook within the tidal swamp. Compaction of soil, saltwater intrusion, and site disturbance have resulted in a significant presence of invasive species (estimated at 60 percent [%] of the vegetation on the island). Recent wetland restoration has been conducted onsite, with approximately 50% of the marsh restored from invasive species (including *Phragmites* spp.) to native vegetation such as cattails (Bluestone Environmental Group, Inc. [Bluestone] 2018).

Iona Island Marsh is especially important for marsh-nesting birds. Probable or confirmed breeding species include herons, least bittern (*Ixobrychus exilis*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), Virginia rail (*Rallus limicola*), belted kingfisher (*Ceryle alcyon*), marsh wren (*Cistothorus palustris*), and red-winged blackbird (*Agelaius phoeniceus*).

Resident wildlife species in the area include muskrat (*Ondatra zibethicus*), white-tailed deer (*Odocoileus virginianus*), box turtle (*Terrapene carolina*), northern water snake (*Nerodia sipedon*), timber rattlesnake (*Crotalus horridus*), red fox (*Vulpes vulpes*), rat snake (*Pantherophis* spp.) and green frog (*Rana clamitans*).

The upland terrestrial areas of the island consist of deciduous, rocky woodland communities including oaks (*Quercus* spp.), ashes (*Fraxinus* spp.), birches (*Betula* spp.), willows (*Salix* spp.), red maple (*Acer rubrum*), and elms (*Ulmus* spp.). The woodlands are maintained for their value as cover, perch sites, and buffer zones. Towards the center of the island where historical buildings once stood, open grasslands and low-lying shrubs dominate the landscape. Additional information on the ecological setting is provided in Worksheet 10 of the UFP-QAPP.

2.1.2.1 Threatened and Endangered Species

Threatened species are species that may become endangered if conditions surrounding the species begin, or continue, to deteriorate. Endangered species are species whose prospects for survival in an area are assumed to be in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, or disease. A species of special concern is any species that does not meet the criteria of an endangered or threatened species but is particularly vulnerable and could easily become an endangered, threatened, or extirpated species due to restricted distribution, low or declining numbers, specialized habitat needs or limits, or other factors. Special concern species are established by policy, not by regulation, and are used for planning and informational purposes; they do not have the legal weight of endangered and threatened species.

Bird species and their status for New York are provided in the following table.

Species	Common Name	Status
Haliaeetus luciocephalids	Bald eagle	Threatened
Ixobrychus exilis	Least bittern	Threatened
Setophaga cerulea	Cerulean warbler	Special Concern
Vermivora chrysoptera	Golden-winged warbler	Special Concern
Pandion haliaetus	Osprey	Special Concern
Circus cyaneus	Northern harrier	Threatened
Podilymbus podiceps	Pied-billed grebe	Threatened

The United States Fish and Wildlife Service (USFWS) identifies species that are known to or are believed to occur in Rockland County, New York and are provided in the following table.

Group	Species	Common Name	Status
Plants	*Isotria medeoloides*	Small whorled pogonia	Threatened
Mammals	*Myotis sodalis*	Indiana bat	Endangered
Mammals	*Myotis septentrionalis*	Northern long-eared bat	Threatened
Reptiles	*Clemmys muhlenbergii*	Bog turtle	Threatened

In addition, Atlantic sturgeon (*Acipenser oxyrhynchus*) and shortnose sturgeon (*Acipenser brevirostrum*) live primarily in the ocean but migrate to coastal rivers for spawning. In New York, spawning and nursery grounds for juveniles are located in the Lower Hudson River. Both species are classified as endangered by the National Marine Fisheries Service (NMFS) and are protected in the State of New York.

2.1.2.2 Shoreline Environment

Muddy sediments dominate the Hudson Highlands section of the Hudson River, where Iona Island lies. There is a complicated pattern of dynamic and depositional environments between the non-depositional bedrock outcrops, which are found along the river margins (Nitsche et al. 2007). Sediments in the tidal marshes and shallows west of Iona Island consist of peat and silt and are more than 100 feet deep (U.S. Department of Commerce et al. 1982).

The shoreline along the Hudson River shoreline of Iona Island consists primarily of riprap, gravel, cobbles, boulders, and exposed bedrock. The immediate shoreline north of the dumping area between Round Island and Iona Island contains a retaining wall that spans the shoreline and large boulders are present in the river.

The western and southern portions of the island are separated from the adjacent marshes by the active River Subdivision (CSX Transportation) railroad tracks. Additional information on the ecological setting and CSM are provided in Worksheet 10 of the UFP-QAPP.

2.1.3 Preliminary Contaminants of Potential Ecological Concern

Preliminary COPECs were identified during previous investigations and include the following in soil: metals, semivolatile organic compounds (SVOCs), and explosives. Polychlorinated biphenyls (PCBs) and select volatile organic compounds (VOCs)—benzene, toluene, ethylbenzene, and xylenes (BTEX)—are considered preliminary COPECs around potential source areas. Additional details regarding the historical use of the property and chemical data from previous investigations are provided in Worksheet 10 of the UFP-QAPP.

2.1.4 Fate and Transport Pathways

The potential primary release mechanisms for site-related contaminants from former buildings/structures at the Iona Island FUDS during operational use include accidental spills, direct releases to the ground, and improper disposal including dumping. These primary release mechanisms may have resulted in contamination of soil at and/or beneath former buildings/structures. The Iona Island Naval Ammunition Depot was deactivated in 1947, and the majority of buildings and structures, including building foundations, were demolished and removed. Soil onsite has been significantly reworked and removed during demolition of former structures and excavation and regrading following demolition.

Contaminants released through deposition may have remained in surface soil by adsorbing to soil particles. When released to the environment, constituents such as some metals and SVOCs including polycyclic aromatic hydrocarbons (PAHs) tend to sorb to soil, sediment, and other organic materials. Some toxic forms of metals (e.g., mercury) accumulate in animal tissue, while others (e.g., arsenic) accumulate in plants. Natural processes such as adsorption, ion exchange, complexation, and precipitation can cause metals to become immobilized and therefore not be bioavailable.

Contaminants in surface and shallow subsurface soil may have been transported to a range of exposure media (including air, subsurface soil, groundwater, surface water, and sediment) through secondary and tertiary release mechanisms. Secondary release mechanisms from surface and shallow subsurface soil to other media include the following:

- Infiltration and leaching to underlying subsurface soil and shallow groundwater
- Overland runoff and erosion into surface water and sediment
- Soil removal/reworking.

Reworking of surface and subsurface soil during demolition is a major pathway for constituents that bind to soil particles, such as metals and PAHs, to be widely dispersed across the site. For example, site demolition and regrading potentially released and mixed lead-based paint particles into the soil. While metals may generally sorb/bond to soils, very fine paint chips/particles would result in a more sporadic hit-or-miss distribution of contamination.

Due to the chemical properties of the site contaminants and time elapsed since potential releases, active physical processes such as diffusion and volatilization of VOCs would not be considered significant contributors to contaminant migration. Vapors and particulates in ambient air could be potential exposure media. However, due to the significant amount of vegetative cover present throughout the site, time since release, and chemical properties of the constituents, this transport pathway is unlikely to contribute to a significant exposure under current or future land use conditions. In addition, inhalation pathways are not significant for ecological receptors (EPA 2007a).

The types of contaminants previously detected or potentially present in site soils would be bound to soil particles but could migrate via advective transport (bulk movement) or desorption (leaching) with the flow of surface water or groundwater toward the adjacent marshes and the Hudson River. Desorption would be dependent on the solubility of the individual chemical and the properties of the soil. For example, explosives with high solubility such as 2,4-dinitrotoluene, could have leached into subsurface soil and groundwater, ultimately being deposited along the shoreline and into the sediments of the island.

Tertiary release mechanisms from contaminated secondary media may include the following:

- Discharge from groundwater to sediment and surface water
- Infiltration from subsurface soil and shallow groundwater to deeper bedrock groundwater
- Uptake of contaminants from abiotic media (e.g., soil) into prey tissue that is consumed by wildlife.

2.1.5 Exposure Pathway Analysis

In general, an exposure pathway consists of the following components:

- Source and mechanism of chemical release to the environment (e.g., spill)
- Environmental transport medium (e.g., surface soil)
- Point-of-contact with the contaminated medium (exposure point)
- Exposure route at the exposure point (e.g., dermal contact with surface soil).

If all four components are present (or potentially present), the pathway is considered complete (or potentially complete). Each pathway defines a unique mechanism by which potential receptors are directly or indirectly exposed to constituents. The following definitions are used to identify exposure pathways:

- ***Complete Exposure Pathway***—There is confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified). Exposure is evaluated quantitatively.

- ***Potentially Complete Pathway***—There is potential receptor and media interaction that may be anticipated.

- ***Incomplete Exposure Pathway***—There is no receptor and media interaction. No evaluation is conducted.

Media of concern and ecological receptors are evaluated to identify potential exposure routes linking the two and determine which pathways are complete and significant. The sections below identify the major routes of exposure and their applicability to each of the identified receptor groups. Exposure to groundwater is an incomplete pathway for terrestrial receptors because they are not exposed to groundwater. No freshwater surface waterbodies exist on the island.

2.1.5.1 Terrestrial Plants and Invertebrates

Terrestrial plants and invertebrates may be exposed to environmental media through direct contact. Plants may absorb chemicals from surface and subsurface soil via their roots. They may also absorb chemicals from air or airborne particles through their leaves; although the waxy surfaces of leaves limit this exposure. Soil invertebrates may be exposed to chemicals in soil through direct contact, and chemicals may be absorbed from soil through the skin. Some plant roots may exist in deeper soil layers and invertebrates such as earthworms have the potential to burrow deeper into the soil. Therefore, exposure pathways linking plants and soil invertebrates to surface and subsurface soil are complete and relevant for assessment. As part of the base of the food web, plants and invertebrates also provide food/prey items for foraging by upper-trophic level wildlife (e.g., birds and mammals).

2.1.5.2 Terrestrial Wildlife

The most significant exposure route for wildlife (i.e., birds and mammals) is ingestion of constituents in contaminated media (EPA 2007a), which includes surface soil and food items. Wildlife may ingest chemicals in environmental media by incidentally ingesting soil while grooming or foraging. Some constituents may bioaccumulate in animal tissues. Therefore, wildlife may also ingest constituents through the prey items that they consume as food. Ingestion of constituents in soil and/or food are considered complete and significant exposure pathways for wildlife.

Wildlife may be exposed to constituents in air or soil via direct contact during foraging. Wildlife has protective outer coverings such as feathers or fur that prevent or limit the dermal absorption of contaminants from environmental media (EPA 2005, U.S. Army Center for Health Promotion and Preventative Medicine [USACHPPM] 2004). EPA guidance identifies that, in most cases, dermal exposures are likely to be less significant than exposures through ingestion, and their evaluation involves considerable uncertainty (EPA 2007a, USACHPPM 2004). This exposure route is considered complete but relatively insignificant for wildlife.

Some mammals burrow into the soil to create dens. Some of the most common burrowing animals found in North America include mice, moles, prairie dogs, gophers, groundhogs, rabbits, bears, badgers, squirrels, and foxes. Burrows not only serve as a home for these creatures, but also benefit the environment by aerating the soil. As a result, these mammals may be exposed to and incidentally ingest both surface and subsurface soil. Foxes have been observed on the island and likely burrow in dens which were observed during a site visit in October 2018. As such, mammals evaluated in the SLERA are assumed to burrow into both surface and subsurface soil.

Inhalation is a potentially complete pathway for wildlife that may inhale contaminants that have volatilized or that are adsorbed to airborne particulates. EPA guidance indicates that, in general, inhalation pathways are likely to be insignificant compared to ingestion pathways (EPA 2007a).

In summary, ingestion of contaminants in soil and food are considered complete and significant exposure pathways for wildlife.

2.1.5.3 Aquatic Pathways

The characteristics of the Iona Island shoreline are currently unknown, including the types of resources and receptors that inhabit the area. A Phase I Shoreline Reconnaissance Survey will be conducted to characterize the shoreline and document resources and aquatic receptors. This survey will provide valuable information necessary to determine whether there is a need to conduct further site investigation and sampling and analysis on sediments to evaluate potential ecological risks.

For instance, much of the shoreline along the Hudson River consists of boulders and rip-rip and may not contain suitable sediments or benthic habitats to support organisms. In addition, it is unknown how much of a mudflat exists along the shoreline before the topography steeply drops off into the deeper channel of the river. The physical characteristics of the sediments along the shoreline are also unknown. Sediments consisting of fine grained and high organic matter (i.e.., total organic carbon [TOC]) are more likely to present a “sink” for historical constituents to which organisms could be exposed than sandier, large-grained sediments with low TOC that are less likely to accumulate historical constituents. As such, sediment samples collected along the shoreline will be evaluated for physical parameters including TOC and grain size. Additional details regarding the specific sampling plan are provided in Worksheet 11 of the UFP-QAPP.

Field reconnaissance consisting of a shoreline survey will be conducted as part of the Phase I investigation as depicted on Figure 11-2 of the UFP QAPP and provided as Attachment 3 to this Work Plan. Four areas have been identified for survey: the Hudson River Shoreline (Recon Area 1), the Iona Marsh Shoreline (Recon Area 2), the western FUDS boundary between Iona and Round Island (Recon Area 3), and the eastern and western sides of the active River Subdivision (CSX Transportation) railroad tracks (Recon Area 4). The survey will provide information as to the resources and aquatic receptors that may inhabit these areas. Such aquatic receptors could include fish, benthic invertebrates, and aquatic-feeding wildlife. These organisms could be exposed to constituents in sediment and/or surface water via ingestion. In addition, bottom-dwelling fish and benthic invertebrates could also be exposed to constituents in sediment via dermal absorption. Aquatic-feeding birds and mammals could consume constituents that have accumulated in sediments, benthic invertebrates, aquatic plants, and fish tissue.

The type of material/environment along the shoreline will be documented and photographed, including man-made structures such as riprap or retaining walls; exposed bedrock; gravel, cobble, or boulder shorelines; undercuts beneath the shoreline; and shallow, soft-bottom sediments that could provide significant habitat. The railroad bed will be investigated to evaluate the presence/absence of culverts or channels that could provide a conduit for transport of overland flow from Iona Island to the western shoreline. Potential pathways (e.g., culverts, drainage ways) leading off the island will be documented. Channel bathymetry and water depth at the shoreline will also be recorded to evaluate the presence of any mudflats or habitat areas that may exist before the river bottom drops off into the deeper navigation channel. Additional details regarding the Phase I Shoreline Reconnaissance Survey are discussed in the UFP-QAPP in Worksheets 10, 11, and 14.

2.1.6 Potential Ecological Receptors

Selection of representative ecological receptor species for evaluation is based primarily on the following:

- The likelihood of a species to use the site and the area immediately surrounding it
- The potential for exposure to constituents based on the feeding habits and life history of the organisms/feeding guild represented by the receptor species
- Life history and exposure information for the selected receptor species
- Toxicity information for the representative receptor species
- The societal importance of the species (e.g., threatened and/or endangered species, species of special concern).

Based on the ecological setting and media of concern discussed above, ecological receptors potentially present at the site include terrestrial organisms such as plants, soil invertebrates, mammals, and birds.

The proposed terrestrial receptors for evaluation are based on feeding guilds and include the following:

- Terrestrial plant community

- Terrestrial invertebrate community, as represented by earthworms (*Lumbricus terrestris*)
- Populations of herbivorous mammals, as represented by meadow vole (*Microtus pennsylvanicus*)
- Populations of insectivorous mammals, as represented by short-tailed shrew (*Blarina brevicauda*)
- Populations of insectivorous birds, as represented by American robin (*Turdus migratorius*)
- Populations of predatory (carnivorous) mammals, as represented by red fox (*Vulpes vulpes*)
- Populations of predatory (carnivorous) birds, as represented by red-tailed hawk (*Buteo jamaicensis*).

The bald eagle is a protected species that roosts along the Hudson River shoreline on Iona Island, especially during the winter months. Although they are primarily fish eaters, bald eagles will consume ducks and birds or whatever prey is available and easiest to obtain (including carrion). Since the habitat range for bald eagles is larger than for red-tailed hawks, as a conservative evaluation, populations of bald eagles will be represented by red-tailed hawks in the SLERA.

Reptiles and amphibians could inhabit upland areas of Iona Island. However, due to the lack of toxicological information, exposure factors, and ecological screening values for these species, only a qualitative evaluation of potential risks is possible.

Following the Phase I Shoreline Reconnaissance Survey, the aquatic receptors and complete exposure pathways in the preliminary aquatic ecological CSM will be updated as appropriate. This will help inform the collection of sediment data during the Phase II investigation if necessary.

A graphical representation of the terrestrial ecological CSM is depicted on Figure 10-8a of the UFP-QAPP; the preliminary aquatic ecological CSM is depicted on Figure 10-8b of the UFP-QAPP. The development CSMs are also presented as Attachment 2 to this work plan. The CSM is an iterative process and will be updated as necessary as new data are collected.

2.1.7 Conceptual Site Models

Problem formulation allows for the development of preliminary CSMs for both terrestrial and aquatic receptors at Iona Island. Integration of the five key factors in problem formulation has produced the preliminary terrestrial and aquatic ecological CSMs depicted n Figures 10-8a and 10-8b, respectively, of the UFP-QAPP. The CSMs are also presented as Attachment 2 to this work plan. These CSMs are preliminary and their development will be an iterative process, being updated when necessary as new data are collected.

2.2 PRELIMINARY ASSESSMENT AND MEASUREMENT ENDPOINTS

Screening-level assessment and measurement endpoints are identified for each representative receptor species evaluated at the site. EPA guidance stresses the importance of ecologically significant endpoints. According to EPA (1998), “Assessment endpoints are explicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes.” Failure to select appropriate assessment and measurement endpoints can result in the inability to answer the risk questions central to a SLERA. Several criteria are applicable for endpoint selection (Suter 2007, EPA 1998):

- Unambiguous Definition—Assessment endpoints should indicate a subject and a characteristic of the subject (e.g., fish reproduction).

- Accessibility to Prediction and Measurement—Assessment endpoints should be reliably predictable from measurements.

- Susceptibility to the Hazardous Agent/Stressor—Susceptibility of an organism (plant or animal) results from the combination of potential for exposure and the sensitivity to the concentrations of contaminants or other stressors of concern.

- Biological Relevance—Biological relevance of impacts to an individual organism is determined by the importance of the impact to higher levels of biological organization (e.g., populations or communities).

- Social Relevance and Policy Goals—Assessment endpoints should be of value to decision-makers and the public. The assessment endpoints should represent effects that would warrant consideration of site remediation or alteration of project plans. Assessment endpoint selection should also include endpoints that may be mandated legally (e.g., protected species).

For the Iona Island FUDS, the SLERA assessment endpoints include the following:

- Protection of terrestrial plant community from exposure to COPECs in surface and subsurface soil

- Protection of soil invertebrate community from exposure to COPECs in surface and subsurface soil

- Protection and maintenance (i.e., survival, growth, and reproduction) of populations of herbivorous mammals from exposure to COPECs in surface and subsurface soil

- Protection and maintenance (i.e., survival, growth, and reproduction) of populations of insectivorous birds from exposure to COPECs in surface soil

- Protection and maintenance (i.e., survival, growth, and reproduction) of populations of insectivorous mammals from exposure to COPECs in surface and subsurface soil

- Protection and maintenance (i.e., survival, growth, and reproduction) of populations of carnivorous (predatory) mammals from exposure to COPECs in surface and subsurface soil.

- Protection and maintenance (i.e., survival, growth, and reproduction) of populations of carnivorous (predatory) birds from exposure to COPECs in surface soil.

- Protection and maintenance (i.e., survival, growth, and reproduction) of populations of herptiles (reptiles and amphibians) from exposure to COPECs in surface and subsurface soil (qualitative evaluation due to minimal toxicological endpoints).

Screening-level measurement endpoints are measurable ecological characteristics that are related to the assessment endpoints (EPA 1998). Since it is difficult to "measure" assessment endpoints, measurement endpoints are selected to allow inference regarding the assessment endpoints described above. Measurement endpoints are used to assess the potential for effects on the assessment endpoints through their comparison to screening-level concentrations or toxicity values. Measurement endpoints selected are the following:

- Chemistry Data for Soil—As a part of the SLERA (Flowchart D in Attachment 1), the measurement of COPEC concentrations in surface and subsurface soil provides the means, when compared to conservative (based on chronic or no effects levels), ecotoxicological-based screening concentrations, for drawing inferences regarding the assessment endpoints for plants, soil invertebrates, reptiles, and amphibians.

- Modeled Doses of COPECs – As a part of the RSLERA (Flowchart E in Attachment 1), the estimated dose of COPECs ingested by wildlife (birds and mammals) using chemistry data in soil as compared to wildlife toxicity reference values (TRVs) provides the means for drawing inferences regarding the assessment endpoints for wildlife.

2.3 ECOLOGICAL RISK ASSESSMENT PROCESS

The ecological risk assessment will follow the process contained in flowcharts developed by USACE NAE and presented in Attachment 1 (Flowchart D, SLERA and Flowchart E, RSLERA). During the SLERA, COPECs are identified based on a conservative comparison of maximum concentrations to ecological soil screening levels (EcoSSLs). The RSLERA refines the potential exposure and risks using readily available toxicological data and receptor-specific assumptions.

2.3.1 Exposure Point Concentrations

As discussed in Worksheet 11 of the UFP-QAPP, incremental sampling methodology (ISM) will be used to collect surface and subsurface soil samples from decision units (DU) across the site. The use of ISM results in a more precise estimate of the average concentration within the DU as opposed to collecting multiple discrete samples in that same DU, and the data have much less variance, but fewer total samples. Resulting chemical analytical results provide an approximate estimate of the 95% upper confidence limit of the mean (UCLM) of the data for each DU. The 95% UCLM will be calculated for detected contaminants in soil and subsurface soil in each DU using the Interstate Technology and Regulatory Council (ITRC) (2012) calculator[1] and as discussed in Worksheets 11 and 14 of the UFP-QAPP. For non-detect data, a value equivalent to one-half the limit of detection will be used in the calculation.

An exposure point concentration (EPC) is defined as the concentration of a COPEC in site media to which a receptor may be exposed. For this SLERA, the EPC is represented by the maximum 95% UCLM, which is a realistic estimate of hot-spot exposures to organisms that may spend their entire lives in a small area. However, use of the maximum 95% UCLM EPCs to evaluate wildlife with large foraging ranges is conservative and likely to overestimate risks because it assumes that individual receptors spend 100% of their time inhabiting and feeding from the most contaminated DU at the Site. Consequently, for wildlife with a foraging range larger than a 200 by 200 foot DU (approximately 1 acre), the ITRC (2012) calculator[2] that includes area-weighting will be used to develop EPCs for these receptors. This same calculator will be used in the event that there is an Area of Concern (AOC) assessed as a separate smaller DU contained within a larger DU such that any potential releases from an AOC will be accounted for in risk calculations.

Finally, the use of ISM for exposure estimates affects one of the more common methods for assessing ecological risk. When discrete sample data are used (results of which have high variance and high numbers of samples for a given decision area), maximum results tend to be higher than a calculated UCLM. This is not the case with ISM because of the relatively low numbers of total samples (in this case three per DU), and the calculated UCLM almost always exceeds the maximum detected DU concentration. During a risk assessment based on discrete data, maximum detected concentrations are used in the SLERA to identify contaminants of concern, and UCLM concentrations are used in the RSLERA because UCLMs tend to be smaller than maximum detected concentrations. Because the Iona Island investigation is using ISM data, the UCLM based on ITRC calculators will be used as the EPC during both the SLERA and RSLERA, limiting the ability of an EPC to isolate chemicals that might drive risk at a site. The impacts of this effect are discussed further in the RSLERA description found in Section 2.3.3 of this document.

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[1] ITRC (2012) calculator is available at the following link: https://www.itrcweb.org/ism-1/documents/Calculate_95UCL_for_ISM.xls

[2] ITRC (2012) calculator using area-weighting is available at the following link: https://www.itrcweb.org/ISM-1/documents/Weighted_DU_Calculator_14Feb12.xls

2.3.2 Screening Level Ecological Risk Assessment (SLERA)

The SLERA represents a conservative initial assessment of potential risk and is consistent with Steps 1 and 2 of EPA’s 8-Step Ecological Risk Assessment Process (Figure 1) and the decision process depicted on Flowchart D (Attachment 1). The SLERA concludes with a list of COPECs to be further evaluated in the RSLERA. Specific questions that will be answered as part of the SLERA include:

1. Are the measured contaminants DoD-associated (Step D8)? For example, some metals are not associated with DoD activity, and will be excluded from the risk assessment.

2. Do site UCLM concentrations exceed background (Step D12)? Background Upper Prediction Limits (UPL) will be calculated as discussed in Worksheet No. 14 of the UFP-QAPP. Maximum measured site concentrations will be compared to the UPL. If the UPL is the similar to or higher than the site concentration, site concentrations will be considered to be similar background and the contaminant will be excluded from evaluation.

3. Are individual sample contaminant concentrations higher than the detection limits in 10% or less of the ISM samples (Step D14)? If the detection frequency is less than 10%, the contaminant will be excluded from evaluation unless there is evidence that the detection might be related to a release associated with site activities (e.g., explosives detected only in an area where handling of them may have occurred), or if the reported concentration is high enough to be considered lethal to organisms. The use of ISM and the fact some DUs have been established in AOC locations makes it unlikely that this will occur.

4. Do maximum contaminant UCLM concentrations exceed conservative benchmarks (Step D22)? Attachment 4 and Section 2.4.2 of this work plan provide conservative EcoSSLs for the protection of terrestrial plants, soil invertebrates, terrestrial mammals and birds. If site concentrations exceed the lowest EcoSSL, the contaminant will then be compared to receptor-specific EcoSSLs. If site concentrations exceed the EcoSSL or none is available for a receptor group, the contaminant will be considered a COPEC and be carried through to the RSLERA and evaluated for that receptor group. If site concentrations are lower than the most conservative benchmark, then potential risks are acceptable for all receptors, the contaminant is not a COPEC for any receptors, and no further evaluation is necessary.

At the conclusion of the SLERA, the list of COPECs will only include those analytes that are associated with the DoD, exceed background, are detected in greater than 10% of samples, are not associated with a potential source area, and maximum UCLM concentrations exceed the EcoSSL for a specific receptor group. An example summary table of COPECs at this stage would appear as follows:

COPEC	Terrestrial Plants	Soil Invertebrates	Mammals	Birds
Lead	X		X	X
Copper		X	X	X
High Molecular Weight PAHs		X	X	X
Benzene			X	

NOTES:
X = Identified as a COPEC to be carried into the RSLERA

2.3.3 Refined Screening Level Ecological Risk Assessment (RSLERA)

The RSLERA will examine the COPECs in light of less conservative, more site-specific and realistic assumptions consistent with refinements associated with Step 3a of EPA's 8-Step ERA Process and the decision process depicted on Flowchart E (Attachment 1). As discussed in Section 2.2, the measurement endpoints for protection of ecological receptors is population-level, not individual organisms. As long as there are sufficient numbers of a given species to maintain their existence, populations of ecological receptors maintain feedback mechanisms to keep sufficient numbers of them alive and well to maintain the population. For example, a population of American robins will reproduce and if there are sufficient resources to survive, their young will continue the population. If something occurs, such as a drought that could limit their food supply, some of the robins will die; however, sufficient numbers will remain to continue the population once the drought ends. Ecological receptors have various mechanisms to accomplish this, including reducing or increasing the numbers of young they rear and recruitment, which is the process where the same species living close to but not in the given habitat will move to the new area when an ecological niche needs to be filled. As such, more reasonable exposure and toxicological assumptions readily available from site background documents and reference documents are utilized in the RSLERA.

Assumptions to be refined for the list of COPEC/receptor combinations determined in the SLERA include:

- Refinement of exposure assumptions—As discussed above, generic mammals and birds were identified as being at potential risk from exposure; however, as discussed in Section 2.1.6, five guild-representative species have been identified:

  - Herbivorous mammals (meadow vole)
  - Insectivorous mammals (short-tailed shrew)
  - Insectivorous birds (American robin)
  - Predatory mammals (red fox)
  - Predatory birds (red-tailed hawk)

  Each of these guild-representative species consumes different food items, ingests different quantities of incidental soil due to their feeding habits, and have different ingestion rates. In the RSLERA, contaminant doses to these guild-representative receptors will be calculated based on their individual characteristics such that all receptors will be assessed.

- Central tendency concentration terms—In Section 2.3.1 the unique characteristics of ISM results compared to discrete sampling results are described, which negate the potential lowering of exposure concentrations (and subsequent doses) for an area. This is because UCLMs are used for exposure terms at all times. Consequently, central tendency concentration terms are consistent throughout the entire SLERA/RSLERA process.

- Site- and receptor-specific benchmarks (e.g., no observed adverse effect level [NOAEL] and lowest observed adverse effect level [LOAEL])—The SLERA process is conservative and is based on NOAELs. These represent the most conservative endpoint, in that no adverse effects were observed for the receptor at a given concentration or dose. When toxicological tests are performed the investigation looks for effects on growth or reproduction for a series of concentrations or doses. The lowest concentration or dose that elicits an adverse effect is call the LOAEL, and the NOAEL is defined as the next lowest tested concentration or dose performed during the test. This is often a multiple of the concentration or dose designated as a LOAEL (often 5X or 10X lower) and provides no indication as to where the NOAEL is in the NOAEL-LOAEL range. In the RSLERA receptor-specific risks associated with both NOAEL and LOAEL effects will be characterized and assessed with respect to population-level effects for the receptors.

Additional details on toxicological effects can be found in Section 3 and on exposure assumptions in Section 4.

2.3.4 Baseline Ecological Risk Assessment (BERA)

Should the results of the RSLERA indicate a potential for significant ecological risk, a BERA will be conducted following Flowchart F (Attachment 1).

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3. ECOLOGICAL EFFECTS EVALUATION

This section summarizes and presents information about toxicity associated with exposure to contaminants for the various ecological receptors to be assessed. An overview of bioavailability and toxicity is found in Section 3.1, conservative risk screening values to be used to identify COPECs during the SLERA are discussed in Section 3.2, and refined NOAEL/LOAELs to be used during the RSLERA are discussed in Section 3.3.

3.1 OVERVIEW OF BIOAVAILABILITY AND TOXICITY

The toxicity of chemicals is related to their bioavailability. Many contaminants may form complexes or compounds that bind them to soil and make them chemically inaccessible to ecological receptors. Alternatively, these elements and compounds may be present in forms that are easily dissolved and absorbed, or in forms that tend to bind to biological tissues. It is these forms of easily absorbed chemicals that are most toxic. Most TRVs are based on forms of chemicals that are readily bioavailable. The following sections provide broad toxicity profiles for metals and organic contaminants.

3.1.1 Metals

Metals are naturally occurring constituents in the environment and vary in concentrations across geographic regions. All environmental media have naturally occurring mixtures of metals. Since metals are naturally occurring, many organisms have evolved mechanisms to regulate accumulations, especially accumulations of essential metals. Some metals (e.g., copper, selenium, and zinc) are nutritionally essential elements at low levels but toxic at higher levels, and others (e.g., lead, arsenic, and mercury) have no known biological functions. For metals to become available for uptake into organisms and cause adverse effects, the metals must be freely dissolved. For example, aluminum toxicity is dependent on soil pH and is considered potentially toxic when the soil has pH less than 5.5. (EPA 2003a). Certain metal compounds bioaccumulate in tissues, and this bioaccumulation can be related to their toxicity (EPA 2007h).

Metals are neither created nor destroyed by biological or chemical processes, rather these processes can transform metals from one species to another (valence states) and can convert them between inorganic and organic forms. The form of the metal (chemical species, compound, matrix, and particle size) influences the metal's bioaccessibility, bioavailability, fate, and effects. The form of the metal is influenced by environmental properties, such as pH, particle size, moisture, redox potential, organic matter, cation exchange capacity, and acid volatile sulfides (EPA 2007h).

Metal speciation determines the behavior and toxicity of metals in the environment. Speciation refers to the occurrence of a metal in a variety of chemical forms. These forms may include free metal ions, metal complexes dissolved in solution and sorbed on solid surfaces, and metal species that have been coprecipitated in major metal solids or that occur in their own solids. The speciation of a metal affects not only its toxicity but also many other physical properties (EPA 2007h).

The primary soil factors controlling the potential bioavailability of metals are soil pH; the availability and characteristics of sorption sites on soil surfaces; and the content of iron, aluminum, soil organic matter, and clay mineral content. Toxicological benchmarks are often developed based on moderately bioavailable forms of metals; these benchmarks may overestimate toxicity for less bioavailable forms, or underestimate toxicity for more bioavailable forms. Acidity increases the bioavailability of many cationic metals, such as barium, chromium, copper, lead, vanadium, and zinc, which may become more soluble at pH below 5. Increasing the soil pH increases the sorption of metals to soil particles, making the metal less bioavailable. Some metals may also form complexes with iron oxides and hydroxides; this also causes the metals to be less bioavailable and less mobile.

3.1.2 Organic Compounds

Most organic compounds (e.g., PCBs and VOCs) are anthropogenic and do not occur naturally. PCBs are a group of synthetic organic chemicals that exist as oily liquids or solids and are colorless to light yellow. PCBs enter the environment as mixtures containing a variety of individual congeners and are often referred to by their trade name, Aroclor. For example, the name Aroclor 1254 means that the mixture of individual PCB congeners contains approximately 54% chlorine by weight, as indicated by the second two digits in the name. Since they don't burn easily and are good insulating materials, PCBs were used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in 1977 because there was evidence that PCBs accumulate in the environment and may cause harmful effects (ATSDR 2000).

Some organic compounds (e.g., PAHs) are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco and charbroiled meat. There are more than 100 different PAHs. PAHs generally occur as complex mixtures (for example, as part of combustion products such as soot), not as single compounds. A targeted list of 18 PAHs has been selected for sampling as part of this project. These PAHs were selected for evaluation because (1) more information is available; (2) they are suspected to be more toxic and exhibit harmful effects that are representative of PAHs as a whole; (3) there is a greater chance of exposure; and (4) these are PAHs identified as priority pollutants at Superfund Sites (ATSDR 1995).

The primary factors determining persistence, mobility, and fate of organic compounds are the following: (1) degradation, (2) volatilization, and (3) binding to soil. For example, PAHs may degrade over time into longer-lasting products by reacting with sunlight and other chemicals in the air, generally over a period of days to weeks. Breakdown in soil and water generally takes weeks to months and is caused primarily by the actions of microorganisms (ATSDR 1995). PCBs also degrade over long periods of time due to weathering. However, they do not readily break down in soil and may stay in the soil for months or years; generally, the more chlorine atoms that the PCBs contain, the more slowly they break down (ATSDR 2000).

Volatilization is another factor that may affect SVOCs (particularly low molecular weight [LMW] PAHs) and VOCs. Concentrations of these contaminants may decrease in soil over time due to transfer to and dispersion in the air. Therefore, volatilization is an important factor in eliminating these contaminants from soil. Expected contributions of these constituents to outdoor air pathways are insignificant because they dilute into the atmosphere at low concentrations.

Perhaps the most important factor affecting fate of organic compounds in soil is their affinity for binding to fine grained soils and organic matter. PCBs, particularly the higher chlorinated congeners, adsorb strongly to sediment and soil, where they tend to persist with half-lives of months to years. This decreases the mobility of these compounds, preventing them from dissolving in groundwater. However, while the hydrophobicity of these compounds may decrease solubility, it also increases the potential for uptake into the tissues of biota and the potential for bioaccumulation. Hydrophobic compounds may bioaccumulate and can biomagnify in fats and lipids within fish, invertebrates, or wildlife (EPA 2000). PCBs bioaccumulate in food chains and are stored in fatty tissues due to their stability and lipophilicity. Bioaccumulated PCBs are of particular relevance to human health because of their persistence in the body. Alternatively, some contaminants such as high molecular weight PAHs (e.g., benzo(a)pyrene) do not bioaccumulate significantly because they are large molecules and cannot transport easily into tissue cells.

3.2 ECOLOGICAL SOIL SCREENING LEVELS

As discussed above Attachment 4 presents EcoSSLs that will be used in the SLERA to screen the soil data and select COPECs for further evaluation. Values are presented for plants, soil invertebrates (i.e., earthworms), and generic mammals and birds. The values were compiled by EPA Region 4 from various sources including the following (in no particular order):

- EPA. 2007a. *Ecological Soil Screening Levels*. http://www.epa.gov/ecotox/ecossl/

- Efroymson, et al. 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-95/R4.

- Efroymson, et al. 1997b. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision*. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2. https://rais.ornl.gov/documents/tm126r21.pdf

- Efroymson, et al. 1997c. *Preliminary Remediation Goals for Ecological Endpoints*. Oak Ridge National Laboratory, Oak Ridge, TN. 50 pp. ES/ER/TM-162/R2 http://www.esd.ornl.gov/programs/ecorisk/documents/tm162

- Los Alamos National Laboratory (LANL). 2017. *ECORISK Database* Release 4.1. September 2017. http://www.lanl.gov/environment/protection/eco-risk-assessment.php

- ECOlogical Structure-Activity Relationship Model Version 2 (ECOSAR, EPA 2017) and the Region 4 food-web soil model (EPA 2018)

- EPA. 2003a. Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels.

The lowest screening level has been selected for the project action limit screening table in Worksheet 15 of the UFP-QAPP, and Attachment 4 shows conservative screening levels for plants, invertebrates, birds, and mammals that will be used to select COPEC during the SLERA.

3.3 TOXICITY REFERENCE VALUES

The RSLERA (Flowchart E, Attachment 1) allows for less conservative evaluations of potential risk compared to the SLERA. This section describes the TRVs that will be incorporated into the RSLERA including both no-level effects thresholds and low-level effects thresholds, as discussed in the following sections.

3.3.1 Plants

To assess the potential for COPECs to adversely affect the terrestrial plant community, maximum soil concentrations will be compared to concentration-based soil TRVs protective of plants. The first resource to be used will be EcoSSLs that are protective of plants (EPA 2005a-h, 2006, 2007a-g, 2008). The second resource for plant TRVs will be Efroymson et al. (1997a) who established values associated with a 20% reduction in growth, reproduction, or other measured toxicological endpoints. This level is consistent with other screening level benchmarks and the current regulatory approach. Both threshold effect levels, which are equivalent to a NOAEL, and probable effect levels, which are equivalent to a LOAEL, will be utilized in the RSLERA. Literature databases (e.g., Ecotox) and environmental scientific journals will also be searched, as necessary, for TRVs. Since few toxicity values have been developed for plants from organic chemicals, surrogate organic TRVs based on chemical functional groups and the types of molecules will be used to the extent possible for the evaluation of potential adverse effects to the terrestrial plant community.

3.3.2 Soil Invertebrates

Similar to plant TRVs, to assess the potential for COPECs to adversely affect the soil invertebrate community, maximum soil concentrations will be compared to concentration-based TRVs protective of soil invertebrates. The first resource to be used will be EcoSSLs protective of earthworms (EPA 2005a-h, 2006, 2007a-g, 2008) and then Efroymson et al. (1997b). TRVs from studies listed in Efroymson et al. (1997b) were established at a level associated with a 20% mortality or other measured toxicological endpoints for earthworms. Both threshold effect levels, which are equivalent to a NOAEL, and probable effect levels, which are equivalent to a LOAEL, will be utilized in the RSLERA. Literature databases (e.g., Ecotox) and environmental scientific journals will also be searched, as necessary, for TRVs. To the extent possible, surrogate organic chemical TRVs will be used for the evaluation of potential adverse effects to soil invertebrates.

3.3.3 Wildlife TRVs

COPECs identified as having the potential to adversely affect wildlife species (based on comparison to the avian and/or mammalian EcoSSLs) will be evaluated using dose-based TRVs. Two types of TRVs will be used, each corresponding to a different level of potential ecological impacts for mammals and birds. No Observed Adverse Effect Levels (NOAELs) are doses that have been shown to cause no adverse impacts in test species. The NOAELs will be derived from studies compiled for EPA's EcoSSLs (EPA 2005a-h, 2006, 2007a-g, 2008) and Oak Ridge National Laboratory (Sample et al. 1996). The Oak Ridge National Laboratory NOAELs were derived based on measurements of survival, growth, or reproduction in the laboratory. Values from EPA's EcoSSLs were derived through statistical analyses of results from multiple toxicological studies with multiple endpoints. NOAELs are conservative and highly protective and appropriate for use in a SLERA.

Lowest Observed Adverse Effects Levels (LOAELs) are the lowest concentrations at which adverse effects have been observed on individual test organisms. The severity of effects considered “low level” varies based on the study from which LOAELs are derived; in general, they correspond to minor changes in growth or reproduction. LOAELs are useful because there is considerable uncertainty associated with NOAELs. Since NOAELs are associated with no observed effects in a test study, it is uncertain whether the values are close to or far below the threshold value at which effects would first be observed. LOAELs thus serve to bound the range of NOAELs, and the threshold of toxic effects is considered to lie somewhere between the NOAEL and the LOAEL. Therefore, LOAELs will also be utilized as TRVs in the RSLERA.

In some cases, LOAELs are available from studies listed in EPA EcoSSL documents or by Oak Ridge National Laboratory (Sample et al. 1996). If there is no corresponding LOAEL value associated with the NOAEL value, the geometric mean of the LOAELs for growth and reproduction will be used; this approach is similar to that used to derive many EcoSSL NOAELs. In the absence of either NOAEL or LOAEL data for a specific receptor/COPEC, it will be assumed that the NOAEL is 10 times less than the LOAEL.

In general, COPECs are evaluated on an individual basis. However, combined effects will be evaluated for PAHs and PCBs. Toxicological studies have shown that PAHs can be grouped into HMW and LMW classifications and concentrations summed for comparison to benchmarks (EPA 2007e). If an individual PAH is not detected in a sample, it will be assumed that the concentration is zero for the purposes of summing LMW and HMW PAHs. Since Aroclor PCBs are mixtures of individual PCB congeners, toxicity from PCBs is evaluated based on a mixture of total PCBs.

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4. REFINED SCREENING-LEVEL EXPOSURE ESTIMATE AND RISK CALCULATION

As discussed in Section 2.3.3, the refined screening-level exposure estimate and risk calculation comprise the second step in the ecological risk screening for a site. At the conclusion of the RSLERA, the risk manager and risk assessment team will decide whether the RSLERA is adequate to determine that ecological threats are negligible, or if the process should continue to a BERA (Steps 3 through 7, Figure 1 and Flowchart F in Attachment 1). The SLERA and RSLERA will have served to identify exposure pathways and COPECs for the BERA by eliminating those contaminants and exposure pathways that pose negligible risks.

4.1 EXPOSURE EVALUATION FOR PLANTS AND INVERTEBRATES

To evaluate potential risks to plants and invertebrates, the surface and subsurface soil datasets will be combined. Consistent with EPA guidance (EPA 1997), the maximum 95% UCLM EPC will be compared to TRVs for plants and soil invertebrates. If the site concentration is greater than the TRV, there is the potential for adverse effects. Should potential risks to terrestrial plants or invertebrates be found, the nature and extent of these risks will be evaluated by comparing EPCs across the site to EcoSSLs.

4.2 EXPOSURE MODELING FOR WILDLIFE

Food web modeling will be used to derive dose-based exposure estimates for wildlife (populations of birds and mammals), which are then compared to literature-based TRVs. This section presents the methods that will be used to quantify the potential exposure of wildlife to contaminants via the ingestion of food and soil. The methods are based on equations presented in EPA (1993) and Sample et al. (1996). The equations and exposure parameters discussed below are consistent with EPA (1997) guidance and standard risk assessment practice. The food web modeling will be conducted for contaminants that have been selected as COPECs for birds and mammals, based on conservative EcoSSLs (Attachment 4) and screening conducted in Section 2. Generic categories of mammals and birds were used for the initial selection of COPECs in the SLERA. Exposure modeling conducted as part of the RSLERA will use appropriate literature-based, receptor-specific exposure parameters (Section 3.3.1).

4.2.1 Wildlife Exposure Parameters

Input parameters for the food web models include receptor-specific soil ingestion rates, food ingestion rates, body weights, foraging range, and fraction/proportion of diet. In general, this information and specific parameters can be found in the *Wildlife Exposure Factors Handbook* (EPA 1993) and other common sources. Table 1 provides the food web modeling exposure/input parameters for each wildlife receptor to be evaluated.

Table 1 Wildlife Exposure Parameters

Exposure Parameter	Value	Units	Notes
MEADOW VOLE (*Microtus pennsylvanicus*) Surrogate for Small Herbivorous Mammals			
Body Weight	0.033	Kg	Average of common range of weights (EPA 1993)
Food Ingestion Rate	0.031	g dry wt./g-day	Converted assuming 80% vegetation moisture
Food Ingestion Rate	0.15	g wet wt./g-day	Green and Millar 1987
Incidental Soil Ingestion Rate	2.00%	% of total mass of diet	Beyer et al. 1994
Habitat Range	1	Acre	Assumed (EPA 1993)
AMERICAN ROBIN (*Turdus migratorius*) Surrogate for Insectivorous Birds			
Body Weight	0.077	Kg	EPA 1993 (mean in Pennsylvania, Clench & Leberman 1978)
Food Ingestion Rate	0.18	kg dry wt./kg-day	Converted assuming 80% prey moisture
Food Ingestion Rate	0.89	kg wet wt./kg-day	EPA 1993 (mean in California, Skorupa & Hothem 1985)
Incidental Soil Ingestion Rate	10.50%	% of total mass of diet	Value base on woodcock (Sample and Suter 1994)
Habitat Range	1	Acre	Assumed (EPA 1993)
SHORT-TAILED SHREW (*Blarina brevicauda*) Surrogate for Small Carnivorous Mammals			
Body Weight	0.017	Kg	EPA 1993, average of reported range
Food Ingestion Rate	0.12	kg dry wt./kg-day	Converted assuming 80% prey moisture
Food Ingestion Rate	0.62	kg wet wt./kg-day	EPA 1993 (Ohio lab, Barrett & Stuek 1976)
Incidental Soil Ingestion Rate	13.00%	% of total mass of diet	Sample and Suter 1994
Habitat Range	1.00	Acre	Assumed (EPA 1993)
RED-TAILED HAWK (*Buteo jamaicensis*) Surrogate for Predatory Birds			
Body Weight	1.2	Kg	EPA 1993 (Ohio, Springer & Osborne 1983)
Food Ingestion Rate	0.02	kg dry wt./kg-day	Converted assuming 80% prey moisture
Food Ingestion Rate	0.1	kg wet wt./kg-day	Average of ingestion rates (EPA 1993)
Incidental Soil Ingestion Rate	0.0	% of total mass of diet	Sample and Suter 1994
Habitat Range	500 to >2,000	Acre	EPA 1993 (range presented)
RED FOX (*Vulpes vulpes*) Surrogate for Predatory Mammals			
Body Weight	4.5	Kg	Average of common range of weights (EPA 1993)
Food Ingestion Rate	0.028	kg dry wt./kg-day	Converted assuming 80% prey moisture
Food Ingestion Rate	0.14	kg wet wt./kg-day	Sample and Suter 1994
Incidental Soil Ingestion Rate	2.80%	% of total mass of diet	Value from Beyer et al. 1994
Habitat Range	125 - 740	Acre	EPA 1993 (range presented)

NOTES: % = Percent.
EPA = U.S. Environmental Protection Agency.
kg = Kilogram.
wt. = Weight.

4.2.2 Bioaccumulation Factors

Food prey tissue concentrations will be estimated from soil concentrations using bioaccumulation factors (BAFs) from the literature. A hierarchy will be used to select BAFs. In general, values will be selected from defensible, compilation- and consensus-based sources or sources that include validation models (e.g., EPA 2003b, 2005a-h, 2006, 2007a-g, 2008; Sample et al. 1998a,b) instead of values from single studies. First preference will be given to regression equations derived from paired field- or laboratory-based measurements of abiotic and biotic media. Second preference will be given to ratio-derived BAFs developed based on paired data of tissue concentrations compared to media concentrations, unless validation studies showed these to be preferable to regressions. Examples of regression and ratio-based BAF development can be found in Sample et al. (1998a and b). Third preference will be given to modeled equilibrium partitioning-derived BAFs based on physical or chemical characteristics. Plant metals uptake will be estimated based on Baes et.al. (1984) and Bechtel Jacobs (1998) similar to those used during EcoSSL development, and organic compounds using Travis and Arms (1988). If no values can be identified, a BAF of 1 on a dry-weight basis will be selected.

Bioaccumulation factors to be used for most metals and PAHs for all three prey items can be found in Attachment 5 Table 1 for plants, Table 2 for soil invertebrates, and Table 3 for small mammals along with the source of each BAF. If additional organic chemical COPEC are identified that are not listed, appropriate octanol-water partition coefficients (Log K_{ow}) will be located and the BAF calculated.

The following sections provide the equations to be used to calculate doses of COPECs to upper-trophic level wildlife receptors.

4.2.3 Ingestion of COPECs from Soil

Wildlife may ingest soil while foraging or grooming. Therefore, food web models account for incidental ingestion of soil. The following equation will be used to calculate the dose of COPEC wildlife would obtain from the ingestion of soil ($Dose_{soil}$, milligram per kilogram [mg/kg]), as noted in Equation 3-1:

Equation 3-1 $$Dose_{soil} = SI \times C_{soil}$$

Where:

$Dose_{soil}$ = COPEC concentration ingested per day from soil (milligrams soil per kilogram body weight per day [mg/kg bw-d])
SI = Soil ingestion rate (kilograms soil per kilogram body weight per day [kg/kg bw-d])
C_{soil} = COPEC concentration in soil (mg/kg).

In Table 1, percent soil ingestion values were obtained from the scientific literature for the terrestrial wildlife species of concern and multiplied by the food ingestion rates to estimate soil ingestion rates.

4.2.4 Ingestion of COPECs from Food

The following equation will be used to calculate the dose of COPEC that a terrestrial wildlife species could obtain from the ingestion of food ($Dose_{food/prey}$, mg/kg bw-d), as noted in Equation 3-2:

Equation 3-2 $$Dose_{food/prey} = FI \times (C_{soil} \times BAF)$$

Where:

$Dose_{food/prey}$ = COPEC concentration ingested per day from food (mg/kg bw-d)
FI = Food ingestion rate (kg/kg bw-d)
C_{soil} = COPEC concentration in soil (mg/kg)
BAF = Bioaccumulation factor (unitless)

4.2.5 Total COPEC Ingestion

The total dietary exposure doses ($Dose_{total}$, mg/kg bw-d) to wildlife for the evaluated COPECs will be estimated using Equation 3-3.

Equation 3-3 $$Dose_{total} = \left(Dose_{food/prey} + Dose_{soil}\right) \times SUF$$

Where:

$Dose_{total}$ = Total amount of COPEC ingested per day from food and soil (mg/kg bw-d)
$Dose_{food/prey}$ = Amount of COPEC ingested per day from food (mg/kg bw-d) refer to Equation 3-2
$Dose_{soil}$ = Amount of COPEC ingested per day from soil (mg/kg bw-d)
SUF = Site use factor (1 or less).

The site use factor (SUF) will be calculated based on the habitat range for the receptor shown in Table 1. For the receptors identified in Section 2.1.6, vole, shrew, and robin have habitat ranges that are approximately the size of each 1-acre DU. Alternatively, fox and hawk have habitat ranges that exceed the sum of all of the DUs, and in fact are larger than the island itself. Consequently, exposure areas for receptors will differ.

The total dietary intakes are then compared to TRVs to evaluate if adverse effects are possible from exposure to COPECs in food and soil.

4.3 RISK CALCULATION

A quantitative screening-level risk will be estimated using the exposure estimates and the toxicity values (EcoSSLs or TRVs). As noted earlier, for the screening-level risk calculation, the hazard quotient (HQ) approach is used to estimate risk by comparing EcoSSLs or TRVs to EPCs. The EcoSSLs are equivalent to a documented and/or best conservatively estimated chronic NOAEL. However, since the risk assessment focuses on evaluating risk to populations of organisms and not individuals, the LOAEL is a more appropriate benchmark used for comparison. Therefore, both a conservative evaluation against the NOAEL, or no effect levels, and an evaluation against the lowest effect levels, or LOAEL, will be conducted, as provided in Equation 3-4 below.

Equation 3-4

$$HQ = \frac{Dose}{TRV_{NOAEL\ or\ LOAEL}}\ or\ HQ = \frac{EPC}{EcoSSL}$$

Where:

HQ = Hazard quotient (unitless)
Dose = Estimated COPEC intake (mg/kg bw-d)
EPC = Exposure point concentration (mg/kg)
$TRV_{NOAEL\ or\ LOAEL}$ = Toxicity reference value NOAEL or LOAEL-based (mg/kg bw-d)
EcoSSL = Ecological soil screening level (mg/kg).

If HQs are greater than 1 for any receptor or COPEC, additional refinements will be conducted following the USACE Flowchart for the RSLERA (Flowchart E, Attachment 1). These evaluations could include, but are not limited to, the following:

- Outlier analysis of site data (Step E4) to determine if a site source could be impacting any given DU, or if an AOC contained within that DU may have released contaminants that could result in unacceptable risk.

- Bioaccessibility considerations, for example if the primary source of the contaminants is subsurface soil and the receptor is only exposed to surface soil (e.g., birds), then the receptor does not have a complete pathway to that contamination.

- LOAEL-based TRV comparison and interpretation (Step E6), as mentioned previously, the goal of ecological risk is to protect populations of organisms and not necessarily individual organisms. Consequently, LOAEL-based risks are appropriate, or at a minimum, the mid-point between the NOAEL- and LOAEL-based risks.

- Calculation of background risks (Step E7), although during the SLERA those contaminants that do not exceed background are excluded from further evaluation, it is not uncommon that even background concentrations can result in perceived high risk due to the conservative nature of the ecological risk process.

- Spatial distribution evaluation (Step E15), to determine if there may be hot-spots driving risk or general areas that have higher concentrations (and therefore risk) than others.

- Assessment of physical parameters (e.g., pH, percent moisture, total organic carbon, temperature) (Step E17) that may ameliorate risk. For example, aluminum toxicity is dependent upon soil pH; if the pH is greater than 5.5 the form aluminum takes is one that is minimally bioavailable and consequently not a concern for ecological receptors.

- Evaluation of the ecological significance/relevance of the benchmarks (Step E19), although for the most part as discussed in Section 3, the most common endpoints used to determine TRVs are growth and reproduction, there are other endpoints. For example, some organic chemicals (e.g., VOCs and PAHs) can also cause narcosis, which results in the organisms behaving abnormally and being preyed upon.

Finally, reptiles and amphibians have been identified as receptors of concern at the site; however, there is an absence of both toxicity data and exposure parameters for herptiles. Potential risks to these receptors will be addressed qualitatively, assuming that toxicity to these receptors is as conservative as the most sensitive species for which risks can be calculated.

5. UNCERTAINTY ASSESSMENT

At the conclusion of an ERA it is important to document sources of uncertainty associated with the assessment. This is because there are many conservative assumptions that are made during the process, from determining the appropriate exposure concentration to uncertainty factors that are built into the derivation of TRVs. The main areas of uncertainty associated with the ERA will be grouped under the following categories, each of which will be discussed:

- Environmental Sampling and Analysis
- Analysis of Chemical Data
- Analysis of Estimated Exposure and Toxicity Data
- Assessment of Risks.

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6. CONCLUSIONS AND RECOMMENDATIONS

Following any subsequent refinements conducted during the RSLERA, a recommendation will be made as to whether the ERA should proceed to a BERA or whether sufficient information has been collected to rule out potential ecological risks.

Additionally, if sufficient aquatic habitat and associated receptors are identified during the Phase I Shoreline Reconnaissance Survey, then the aquatic CSM will be updated as necessary to inform the Phase II investigation. An addendum to the UFP-QAPP will be prepared for the Phase II investigation.

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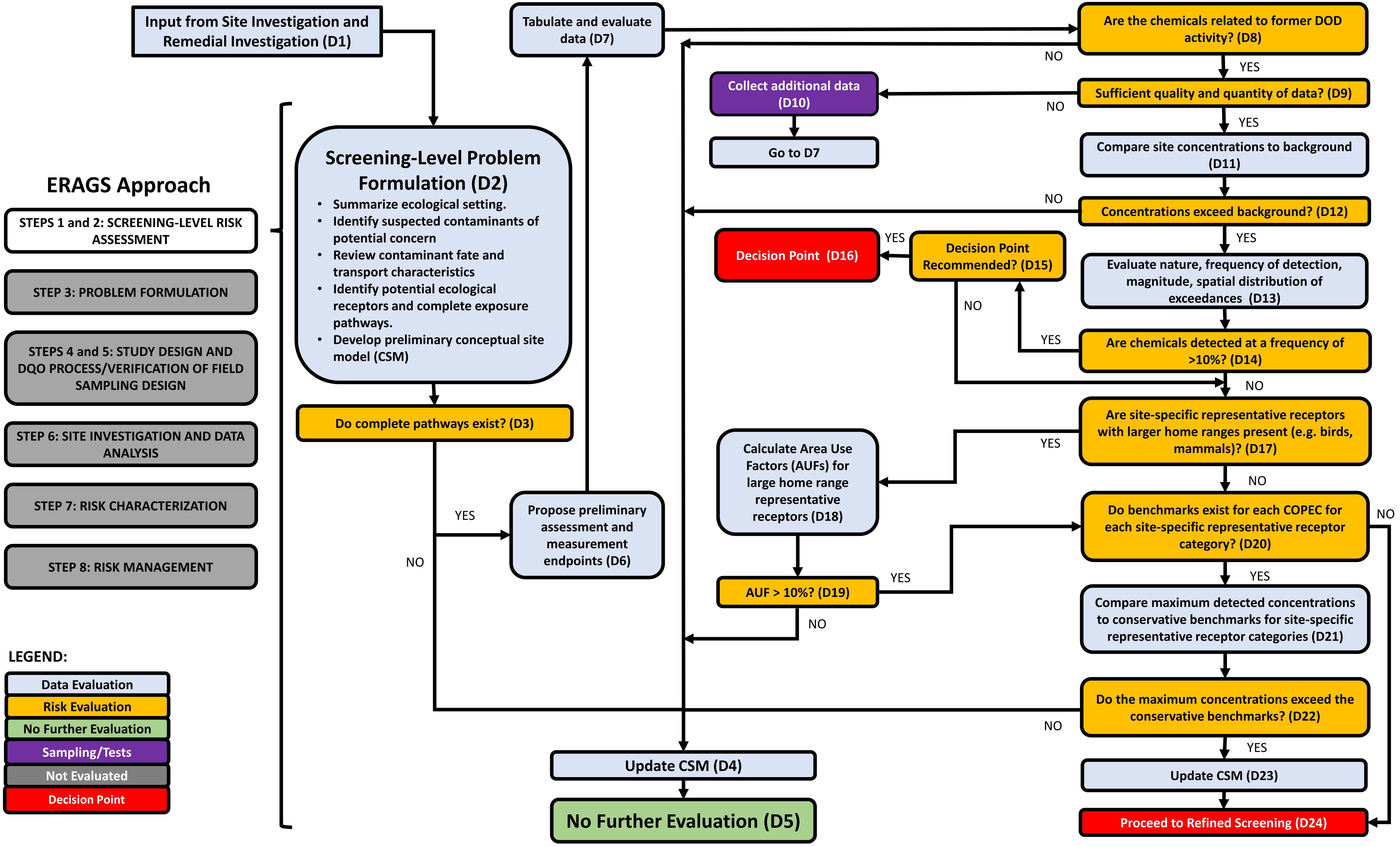
Attachment 1
USACE NAE Ecological Risk Assessment Flowcharts

Figure D: Iona Island Naval Ammunition Depot FUDS - Screening Level Ecological Risk Assessment (SLERA) Flow Chart



Input from Site Investigation and Remedial Investigation (D1)

Tabulate and evaluate data (D7)

Are the chemicals related to former DOD activity? (D8)

Sufficient quality and quantity of data? (D9)

Collect additional data (D10)

Go to D7

Compare site concentrations to background (D11)

Concentrations exceed background? (D12)

Evaluate nature, frequency of detection, magnitude, spatial distribution of exceedances (D13)

Are chemicals detected at a frequency of >10%? (D14)

Decision Point Recommended? (D15)

Decision Point (D16)

Are site-specific representative receptors with larger home ranges present (e.g. birds, mammals)? (D17)

Calculate Area Use Factors (AUFs) for large home range representative receptors (D18)

AUF > 10%? (D19)

Do benchmarks exist for each COPEC for each site-specific representative receptor category? (D20)

Compare maximum detected concentrations to conservative benchmarks for site-specific representative receptor categories (D21)

Do the maximum concentrations exceed the conservative benchmarks? (D22)

Update CSM (D23)

Proceed to Refined Screening (D24)

Screening-Level Problem Formulation (D2)

- Summarize ecological setting.
- Identify suspected contaminants of potential concern
- Review contaminant fate and transport characteristics
- Identify potential ecological receptors and complete exposure pathways.
- Develop preliminary conceptual site model (CSM)

Do complete pathways exist? (D3)

Propose preliminary assessment and measurement endpoints (D6)

Update CSM (D4)

No Further Evaluation (D5)

ERAGS Approach

STEPS 1 and 2: SCREENING-LEVEL RISK ASSESSMENT

STEP 3: PROBLEM FORMULATION

STEPS 4 and 5: STUDY DESIGN AND DQO PROCESS/VERIFICATION OF FIELD SAMPLING DESIGN

STEP 6: SITE INVESTIGATION AND DATA ANALYSIS

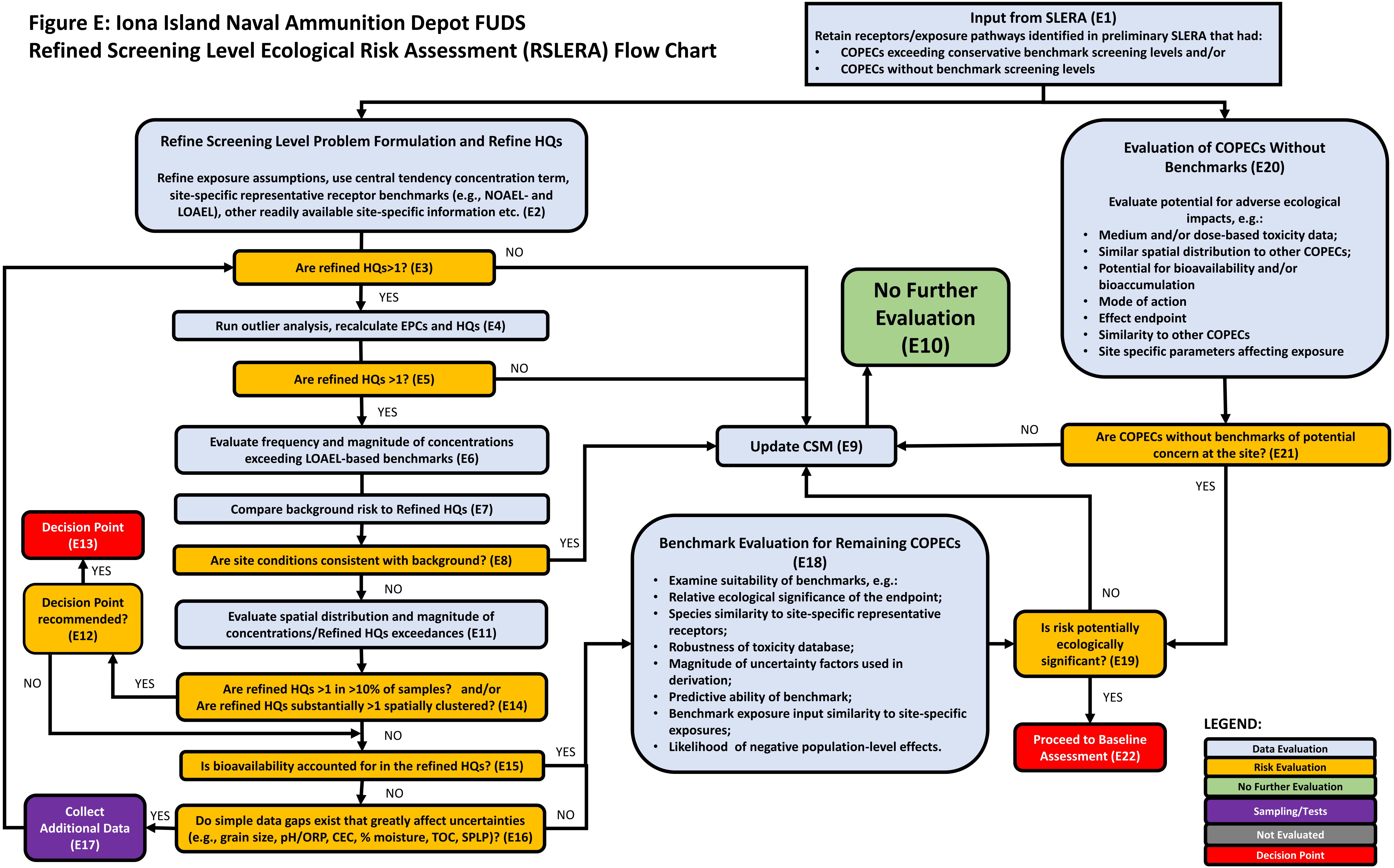
STEP 7: RISK CHARACTERIZATION

STEP 8: RISK MANAGEMENT

LEGEND:

Data Evaluation
Risk Evaluation
No Further Evaluation
Sampling/Tests
Not Evaluated
Decision Point

Figure E: Iona Island Naval Ammunition Depot FUDS
Refined Screening Level Ecological Risk Assessment (RSLERA) Flow Chart



Input from SLERA (E1)
Retain receptors/exposure pathways identified in preliminary SLERA that had:
- COPECs exceeding conservative benchmark screening levels and/or
- COPECs without benchmark screening levels

Refine Screening Level Problem Formulation and Refine HQs

Refine exposure assumptions, use central tendency concentration term, site-specific representative receptor benchmarks (e.g., NOAEL- and LOAEL), other readily available site-specific information etc. (E2)

Are refined HQs>1? (E3)

Run outlier analysis, recalculate EPCs and HQs (E4)

Are refined HQs >1? (E5)

Evaluate frequency and magnitude of concentrations exceeding LOAEL-based benchmarks (E6)

Compare background risk to Refined HQs (E7)

Are site conditions consistent with background? (E8)

Evaluate spatial distribution and magnitude of concentrations/Refined HQs exceedances (E11)

Are refined HQs >1 in >10% of samples? and/or
Are refined HQs substantially >1 spatially clustered? (E14)

Decision Point recommended? (E12)

Decision Point (E13)

Is bioavailability accounted for in the refined HQs? (E15)

Do simple data gaps exist that greatly affect uncertainties (e.g., grain size, pH/ORP, CEC, % moisture, TOC, SPLP)? (E16)

Collect Additional Data (E17)

No Further Evaluation (E10)

Update CSM (E9)

Evaluation of COPECs Without Benchmarks (E20)

Evaluate potential for adverse ecological impacts, e.g.:
- Medium and/or dose-based toxicity data;
- Similar spatial distribution to other COPECs;
- Potential for bioavailability and/or bioaccumulation
- Mode of action
- Effect endpoint
- Similarity to other COPECs
- Site specific parameters affecting exposure

Are COPECs without benchmarks of potential concern at the site? (E21)

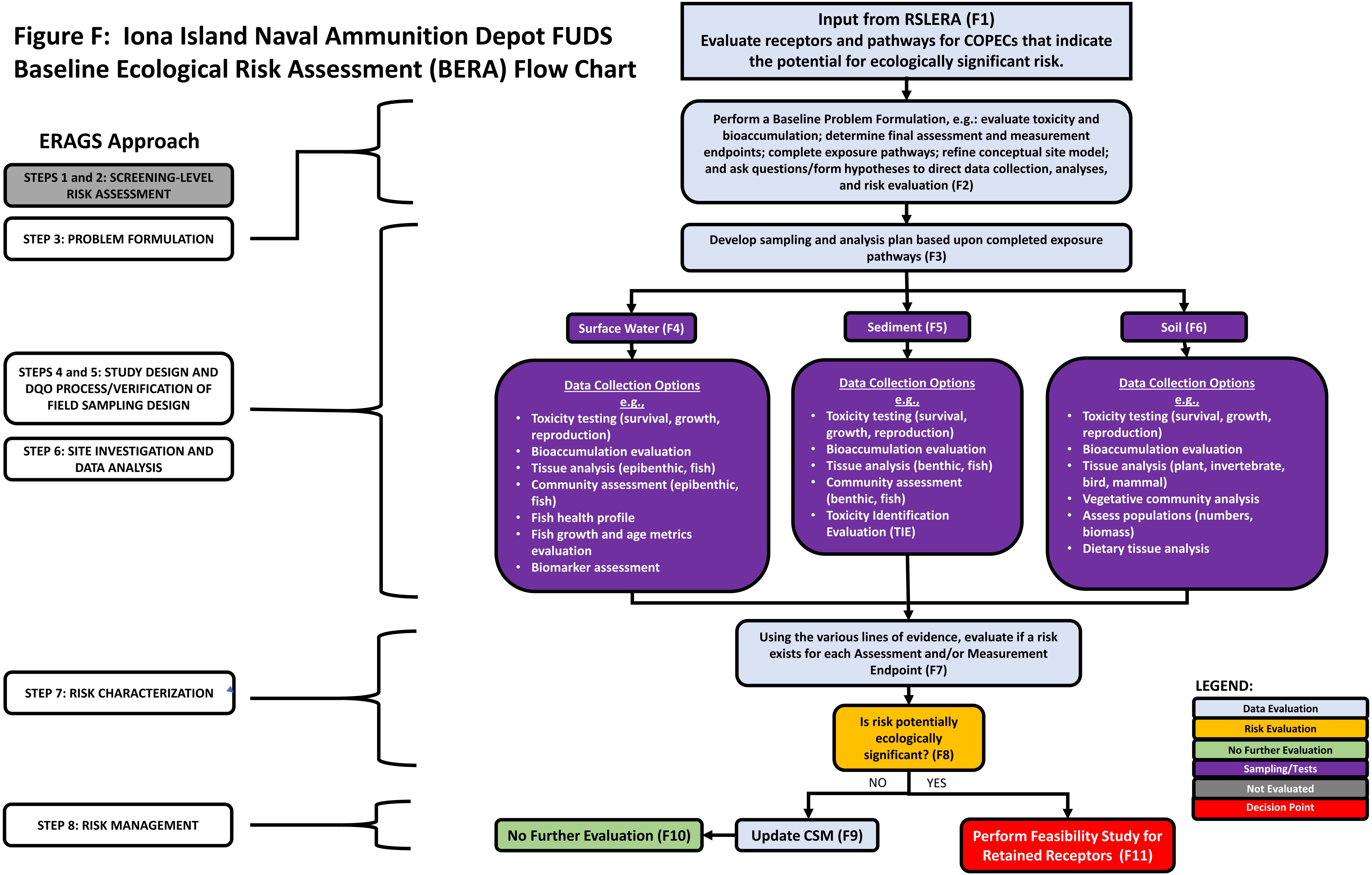
Benchmark Evaluation for Remaining COPECs (E18)
- Examine suitability of benchmarks, e.g.:
- Relative ecological significance of the endpoint;
- Species similarity to site-specific representative receptors;
- Robustness of toxicity database;
- Magnitude of uncertainty factors used in derivation;
- Predictive ability of benchmark;
- Benchmark exposure input similarity to site-specific exposures;
- Likelihood of negative population-level effects.

Is risk potentially ecologically significant? (E19)

Proceed to Baseline Assessment (E22)

LEGEND:
- Data Evaluation
- Risk Evaluation
- No Further Evaluation
- Sampling/Tests
- Not Evaluated
- Decision Point

Figure F: Iona Island Naval Ammunition Depot FUDS Baseline Ecological Risk Assessment (BERA) Flow Chart



Input from RSLERA (F1)
Evaluate receptors and pathways for COPECs that indicate the potential for ecologically significant risk.

ERAGS Approach

STEPS 1 and 2: SCREENING-LEVEL RISK ASSESSMENT

STEP 3: PROBLEM FORMULATION

Perform a Baseline Problem Formulation, e.g.: evaluate toxicity and bioaccumulation; determine final assessment and measurement endpoints; complete exposure pathways; refine conceptual site model; and ask questions/form hypotheses to direct data collection, analyses, and risk evaluation (F2)

STEPS 4 and 5: STUDY DESIGN AND DQO PROCESS/VERIFICATION OF FIELD SAMPLING DESIGN

STEP 6: SITE INVESTIGATION AND DATA ANALYSIS

Develop sampling and analysis plan based upon completed exposure pathways (F3)

Surface Water (F4)

Data Collection Options
e.g.,
- Toxicity testing (survival, growth, reproduction)
- Bioaccumulation evaluation
- Tissue analysis (epibenthic, fish)
- Community assessment (epibenthic, fish)
- Fish health profile
- Fish growth and age metrics evaluation
- Biomarker assessment

Sediment (F5)

Data Collection Options
e.g.,
- Toxicity testing (survival, growth, reproduction)
- Bioaccumulation evaluation
- Tissue analysis (benthic, fish)
- Community assessment (benthic, fish)
- Toxicity Identification Evaluation (TIE)

Soil (F6)

Data Collection Options
e.g.,
- Toxicity testing (survival, growth, reproduction)
- Bioaccumulation evaluation
- Tissue analysis (plant, invertebrate, bird, mammal)
- Vegetative community analysis
- Assess populations (numbers, biomass)
- Dietary tissue analysis

STEP 7: RISK CHARACTERIZATION

Using the various lines of evidence, evaluate if a risk exists for each Assessment and/or Measurement Endpoint (F7)

Is risk potentially ecologically significant? (F8)

NO

YES

STEP 8: RISK MANAGEMENT

No Further Evaluation (F10)

Update CSM (F9)

Perform Feasibility Study for Retained Receptors (F11)

LEGEND:
- Data Evaluation
- Risk Evaluation
- No Further Evaluation
- Sampling/Tests
- Not Evaluated
- Decision Point

Attachment 2
Ecological Conceptual Site Models

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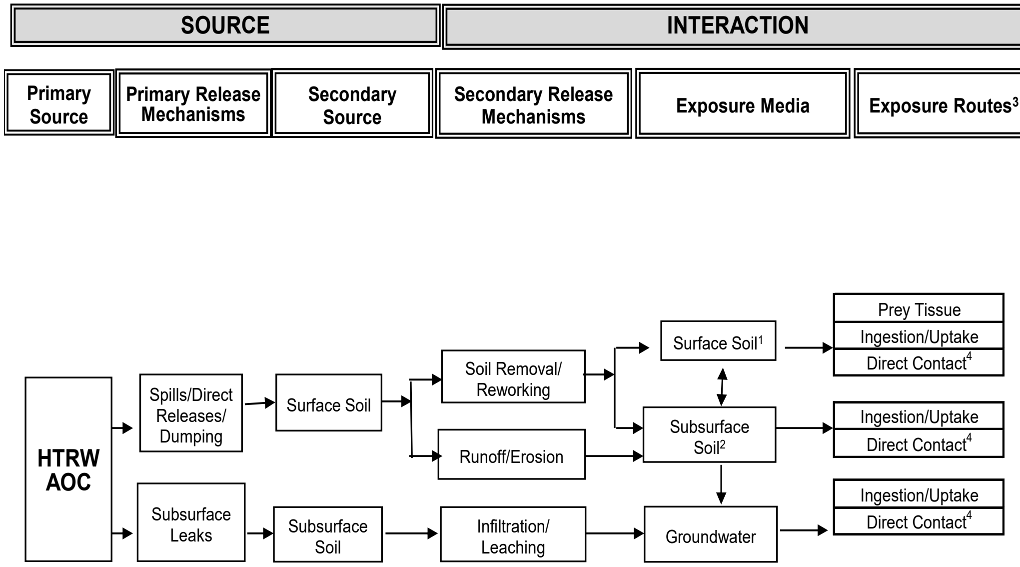

Terrestrial Habitats

Exposure Media	Exposure Routes	Terrestrial Plants	Soil Invertebrates	Herbivourous Mammals (e.g., meadow vole)[5]	Insectivorous Birds (e.g., American robin)	Insectivorous Mammals (e.g., short-tailed shrew)[5]	Predatory Birds (e.g., red-tailed hawk)	Predatory Mammals (e.g., red fox)[5]	Reptiles and Amphibians[6]
Surface Soil[1]	Prey Tissue	○	○	●	●	●	●	●	◑
	Ingestion/Uptake	●	●	●	●	●	●	●	◑
	Direct Contact[4]	●	●	◑	◑	◑	◑	◑	◑
Subsurface Soil[2]	Ingestion/Uptake	●	●	●	○	●	○	●	◑
	Direct Contact[4]	●	●	◑	○	◑	○	◑	◑
Groundwater	Ingestion/Uptake	○	○	○	○	○	○	○	○
	Direct Contact[4]	○	○	○	○	○	○	○	○

LEGEND

● Complete Pathway; confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified).

◑ Potentially Complete Pathway; there is potential receptor and media interaction that may be anticipated.

○ Incomplete Pathway; no receptor and media interaction. No evaluation is conducted.

NOTES

1. Surface soil = defined as the interval from 0 to 6 inches bgs.
2. Subsurface soil = defined as the interval from 6 to 36 inches bgs.
3. The inhalation pathway for volatile constituents is considered de minimus due to vegetatative cover and the volatility of the constituents and therefore is not shown in the CSM.
4. Direct contact pathways for mammals and birds is limited by fur and feathers and is considered incidental soil ingestion during grooming.
5. Mammals such as voles, shrews, and foxes may be exposed to subsurface soil during burrowing activities.
6. Reptiles and amphibians are evaluated qualitatively due to the lack of ecotoxicity values for these receptors.

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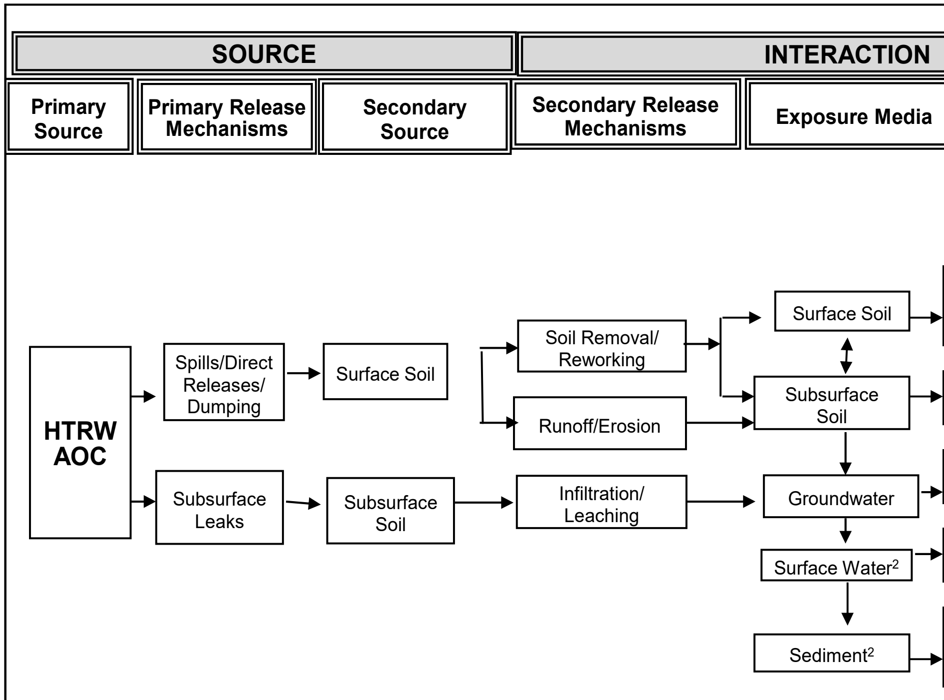
Iona Island Terrestrial Ecological Conceptual Site Model

Figure 10-8a



ECOLOGICAL RECEPTORS

Exposure Media	Exposure Routes	Aquatic Habitats					
		Aquatic Plants	Benthic Invertebrates	Water Column Invertebrates	Forage Fish (e.g., fathead minnow)	Predatory Fish (e.g., bass, carp)	Aquatic Birds and Mammals[3]
Surface Soil	Prey Tissue	○	○	○	○	○	○
	Ingestion/Uptake	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○
Subsurface Soil	Ingestion/Uptake	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○
Groundwater	Ingestion/Uptake	○	○	○	○	○	○
	Direct Contact	○	○	○	○	○	○
Surface Water[2]	Ingestion/Uptake	○	◑	◑	◑	◑	◑
	Direct Contact	○	◑	◑	◑	◑	◑
Sediment[2]	Prey Tissue	○	○	○	◑	◑	◑
	Ingestion/Uptake	◑	◑	○	◑	◑	◑
	Direct Contact	◑	◑	○	◑	◑	◑

LEGEND

● Complete Pathway; confirmed receptor and media interaction (i.e., a source, migration route, and receptor have been identified).

◑ Potentially Complete Pathway; there is potential receptor and media interaction that may be anticipated.

○ Incomplete Pathway; no receptor and media interaction. No evaluation is conducted.

NOTES

1. The CSM is preliminary and will be updated as additional information is collected. Confirmation of sufficient habitat and/or use by these receptors will be confirmed during a Phase I Shoreline Reconnaissance Survey.
2. Surface water and sediment are potentially complete exposure pathways because exposure to site-related constituents along the shoreline has not been confirmed.
3. Aquatic birds and mammals may include benthivorous and/or piscivorous wildlife.

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Iona Island Preliminary Aquatic Ecological Conceptual Site Model[1]

Figure 10-8b

Attachment 3
Phase I Shoreline Reconnaissance Survey

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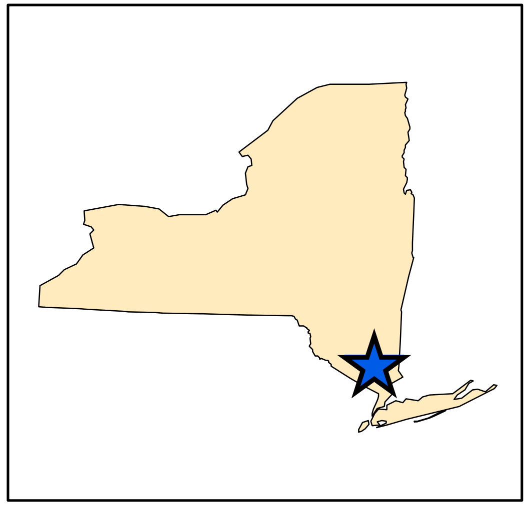
Western shoreline area between Iona Island and Round Island was filled by PIPC following transfer of the FUDS from the Navy in 1965.

VICINITY MAP



Legend

- ■ HTRW RI Footprints of Former Buildings/Structures
- ▨ Disturbed Ground/Fill Area
- ■ Upland
- ▦ Marsh/Wetland
- — 10-ft Topographic Contour

Phase I Shoreline Reconnaissance Areas

- — Recon Area 1 Hudson River Shoreline
- ▪▪▪ Recon Area 2 Iona Marsh Shoreline
- ▪▪▪ Recon Area 3 Western Shoreline Between Iona and Round Island
- ═ Recon Area 4 CSX Railroad Tracks (East and West Sides)

0 400 800
Feet
1 in = 400 ft

N

FIGURE 11-2
Phase I Shoreline Reconnaissance Survey Areas

UNIFORM FEDERAL POLICY
QUALITY ASSURANCE PROJECT PLAN
HAZARDOUS TOXIC AND RADIOACTIVE WASTE
PROJECT REMEDIAL INVESTIGATION

Aerial: ESRI ArcGIS Online Map Service

Map Date: 6/7/2019

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Attachment 4
Ecological Soil Screening Levels

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Attachment 2 - Ecological Soil Screening Levels - Adapted from EPA (2018)

					Receptor-Specifc Screening Levels							
CONSTITUENT	CAS	Screening Level (mg/kg)	Reference	Receptor	Plants	Reference	Soil Invertebrates	Reference	Mammals	Reference	Birds	Reference
Metals												
Aluminum	7429-90-5	Narrative	a	All	Narrative	a	Narrative	a				
Antimony	7440-36-0	0.27	a	All	5	b	78	a	0.27	a		
Arsenic	7440-38-2	6.8	a	All	18	a	6.8	c	46	a	43	a
Barium	7440-39-3	110	a	All	110	c	330	a	2,000	a	820	c
Beryllium	7440-41-7	2.5	c	All	2.5	c	40	a	21	a		
Cadmium	7440-43-9	0.36	a	All	32	a	140	a	0.36	a	0.77	a
Chromium - Total	7440-47-3	23	c	M, B					63	c	23	c
Chromium III	16065-83-1	26	a	M, B					34	a	26	a
Chromium VI	18540-29-9	0.34	c	All	0.35	c	0.34	c	130	a	140	c
Cobalt	7440-48-4	13	a	All	13	a			230	a	120	a
Copper	7440-50-8	28	a	All	70	a	80	a	49	a	28	a
Iron	7439-89-6	Narrative	a	All			Narrative	a				
Lead	7439-92-1	11	a	All	120	a	1,700	a	56	a	11	a
Manganese	7439-96-5	220	a	All	220	a	450	a	4,000	a	4,300	a
Mercury (total)	7439-97-6	0.013	c	All	0.3	b	0.05	c	1.7	c	0.013	c
Methylmercury	22967-92-6	0.00035	c	All			2.5	c	0.0031	c	0.00035	c
Nickel	7440-02-0	38	a	All	38	a	280	a	130	a	210	a
Selenium	7782-49-2	0.52	a	All	0.52	a	4.1	a	0.63	a	1.2	a
Silver	7440-22-4	4.2	a	All	560	a			14	a	4.2	a
Thallium	7440-28-0	0.05	c	All	0.05	c			0.42	c	4.5	c
Vanadium	7440-62-2	7.8	a	All	60	c			280	a	7.8	a
Zinc	7440-66-6	46	a	All	160	a	120	a	79	a	46	a
Volatile Organic Compounds (VOCs)												
Benzene	71-43-2	0.12	d	All			0.12	d	24	c		
Ethylbenzene	100-41-4	0.27	d	All			0.27	d	5.16	g		
Toluene	108-88-3	0.15	d	All	200	c	0.15	d	23	c		
Xylenes (total)	1330-20-7	0.1	d	All	100	c	0.1	d	1.4	c	41	c
Semivolatile Organic Compounds (SVOCs)												
1,2,3,4-Tetrachlorobenzene	634-66-2	10	e	SI			10	e				
1,2,4,5-Tetrachlorobenzene	95-94-3	0.18	d	All			0.18	d	2.02	g		
Hexachlorobenzene	118-74-1	0.079	c	All	10	c	10	c	0.2	c	0.079	c
Pentachlorobenzene	608-93-5	0.5	g	All			20	e	0.5	g		
Dichlorophenols (2,3-), (2,4-), (2,5-), (2,6-)	120-83-2	0.05	d	All			0.05	d	87.5	g		
3,4-Dichlorophenols (3,4-), (3,5-)	95-77-2	20	e	P, SI	20	b	20	e				
2,4,5-Trichlorophenol	95-95-4	4	b	P, SI, M	4	b	9	e	14.1	g		
2,4,6-Trichlorophenol	88-06-2	9.94	g	SI, M			10	e	9.94	g		
2,3,4,5-Tetrachlorophenol	4901-51-3	20	e	SI			20	e				
Tetrachlorophenols (2,3,4,6-), (2,3,5,6-)	58-90-2	0.04	d	All			0.04	d	0.2	g		
Chlorophenols (2-), (4-)	95-57-8	0.06	d	All			0.06	d	0.54	c	0.39	c
3-Chlorophenol	108-43-0	7	e	P, SI	7	b	10	e				
2,4-Dimethylphenol	105-67-9	0.04	d	SI			0.04	d				
2,4-Dinitrophenol	51-28-5	0.061	g	All	20	b	0.15	d	0.061	g		
4-Nitrophenol	100-02-7	5.12	g	SI, M			7	e	5.12	g		
2-Methylphenol (Cresol, o-)	95-48-7	0.1	d	All	0.67	c	0.1	d	580	c		
3-Methylphenol (Cresol, m-)	108-39-4	0.09	d	All	0.69	c	0.09	d	3.49	g		
4-Methylphenol (Cresol, p-)	106-44-5	0.08	d	All			0.08	d	163	g		
Nonylphenol	25154-52-3	1.27	d	SI			1.27	d				
Pentachlorophenol (PCP)	87-86-5	2.1	a	All	5	a	31	a	2.8	a	2.1	a
Phenol	108-95-2	0.79	c	All	0.79	c	1.8	c	37	c		
2-Amino-4,6-dinitrotoluene	35572-78-2	14	c	SI, M, P	14	c	43	c	16	c		
4-Amino-2,6-dinitrotoluene	19406-51-0	12	c	SI, M, P	33	c	18	c	12	c		
1,3- Dinitrobenzene	99-65-0	0.034	d	All			0.034	d	0.072	c	0.079	c
2,4-Dinitrotoluene	121-14-2	6	c	SI, M, P	6	c	18	c	14	c		
2,6-Dinitrotoluene	606-20-2	4	c	All			30	c	4	c	52	c
HMX (Octahydro-tetranitro-1,3,5,7-tetrazocine)	2691-41-0	16	c	SI, M, P	2,700	c	16	c	290	c		
Nitroglycerine	55-63-0	13	c	SI, M, P	21	c	13	c	70	c		
2-Nitrotoluene	88-72-2	0.19	d	All			0.19	d	9.8	c		
3-Nitrotoluene	99-08-1	0.13	d	All			0.13	d	12	c		
4-Nitrotoluene	99-99-0	0.14	d	All			0.14	d	21	c		
PETN (Pentaerythrite-tetranitrate)	78-11-5	2.2	d	SI, M			2.2	d	100	c		
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	121-82-4	2.3	c	All	45.9	h	8.4	c	16	c	2.3	c
Tetryl (Methyl-2,4,6-trinitrophenylnitroamine)	479-45-8	0.018	d	All	25	h	0.018	d	1.5	c		
1,3,5-Trinitrobenzene	99-35-4	0.3	h	All	0.3	h	10	c				
2,4,6-Trinitrotoluene (TNT)	118-96-7	7.5	c	All	62	c	32	c	95	c	7.5	c
1,1'-Biphenyl	92-52-4	0.2	d	All	60	b	0.2	d				
3,3'- Dichlorobenzidine	91-94-1	0.03	d	All			0.03	d	0.646	g		
Benzoic acid	65-85-0	0.01	d	All			0.01	d	1	c		
Benzyl Alcohol	100-51-6	0.002	d	All			0.002	d	120	c		
Carbazole	86-74-8	0.07	d	All			0.07	d	79	c		
Dibenzofuran	132-64-9	0.15	d	All	6.1	c	0.15	d				

Attachment 2 - Ecological Soil Screening Levels - Adapted from EPA (2018)

					Receptor-Specifc Screening Levels							
CONSTITUENT	**CAS**	**Screening Level (mg/kg)**	**Reference**	**Receptor**	**Plants**	**Reference**	**Soil Invertebrates**	**Reference**	**Mammals**	**Reference**	**Birds**	**Reference**
Hexachlorobutadiene	87-68-3	0.009	d	All			0.009	d	0.04	g		
Hexachlorocyclopentadiene	77-47-4	0.001	d	All	10	b	0.001	d	0.755	g		
N-Nitrosodiphenylamine	86-30-6	0.545	g	All			20	e	0.545	g		
Nitrobenzene	98-95-3	2.2	c	SI, M			2.2	c	4.8	c		
Pentachloronitrobenzene	82-68-8	0.09	d	All			0.09	d	11	c	0.7	c
Bis(2-ethylhexyl) phthalate	117-81-7	0.02	c	All			8.4	d	0.6	c	0.02	c
Butylbenzyl phthalate	85-68-7	0.59	d	All			0.59	d	90	c		
Diethylphthalate	84-66-2	0.25	d	All	100	c	0.25	d	3,600	c		
Dimethylphthalate	131-11-3	0.35	d	All			10	c	38	c		
Di-n-butyl phthalate	84-74-2	0.011	c	All	160	c	0.22	d	180	c	0.011	c
Di-n-octyl phthalate	117-84-0	0.91	c	All			303	d	0.91	c		
Low Molecular Weight PAHs												
Acenaphthene	83-32-9	See Total			0.25	c	0.38	d	130	c		
Acenaphthylene	208-96-8	See Total					0.34	d	120	c		
Anthracene	120-12-7	See Total			6.8	c	0.0015	d	210	c		
Fluorene	86-73-7	See Total					3.7	c	250	c		
1-Methylnaphthalene	90-12-0	See Total					0.14	d				
2-Methylnaphthalene	91-57-6	See Total					0.11	d	16	c		
2,6-Dimethyl naphthalene	581-42-0	See Total					0.44	d				
2,3,5-Trimethylnaphthalene	2245-38-7	See Total					0.13	d				
Naphthalene	91-20-3	See Total			1.0	c	0.16	d	9.6	c	3.4	c
1-Methylphenanthrene	832-69-9	See Total					0.5	d				
Phenanthrene	85-01-8	See Total					5.5	c	11	c		
Total LMWPAHs	-	**29**	a	All			29	a	100	a		
High Molecular Weight PAHs												
Benzo(a)anthracene	56-55-3	See Total			18	c	4.69	d	3.4	c	0.73	c
Benzo(b)fluoranthene	205-99-2	See Total			18	c	2.7	d	44	c		
Benzo(k)fluoranthene	207-08-9	See Total					0.13	d	71	c		
Benzo(ghi)perylene	191-24-2	See Total					0.07	d	25	c		
Benzo(a)pyrene	50-32-8	See Total					0.13	d	62	c		
Benzo(e)pyrene	192-97-2	See Total					0.25	d				
Chrysene	218-01-9	See Total					5.18	d	3.1	c		
Dibenzo(a,h)anthracene	53-70-3	See Total					0.06	d	14	c		
Fluoranthene	206-44-0	See Total					10	c	22	c		
Indeno(1,2,3-cd)pyrene	193-39-5	See Total					0.08	d	71	c		
Perylene	198-55-0	See Total					0.17	d				
Pyrene	129-00-0	See Total					10	c	23	c	33	c
Total HMWPAHs	-	**1.1**	a	M			18	a	1.1	a		
Polychlorinated Biphenyls (PCBs)												
PCBs (total)	1336-36-3	0.041	c	All	40	b	0.33	d	0.371	f	0.041	c
Other												
2-Nitroaniline	88-74-4	0.02	d	SI, M			0.02	d	5.3	c		
Diphenylamine	122-39-4	1.01	g	All			1.1	d	1.01	g	10	c
Trichlorofluoromethane	75-69-4	16.4	g	M					16.4	g		

Notes:

Screening values in mg/kg.
All - ESV for protection of all receptors
B - ESV for protection of birds
M - ESV for protection of mammals
P - ESV for protection of plants
SI - ESV for protection of soil invertebrates
LMWPAHs have less than 4 rings
HMWPAHs have 4 or more rings

Table Sources:

a - USEPA (2007): Ecological Soil Screening Levels. http://www.epa.gov/ecotox/ecossl/

b - Efroymson, R.A., M.E. Will, G.W. Suter, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-95/R4.

c - Los Alamos National Laboratory (LANL). 2017. ECORISK Database Release 4.1. September 2017. http://www.lanl.gov/environment/protection/eco-risk-assessment.php (µg/kg dw)

d - ECOSAR & Region 4 soil model. See text Section 6.3.

e - Efroymson, R.A., M.E. Will, and G.W. Suter. 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2. https://rais.ornl.gov/documents/tm126r21.pdf

f - Efroymson, R.A., G.W. Suter, II, B.E. Sample, and D.S. Jones. 1997c. Preliminary Remediation Goals for Ecological Endpoints. Oak Ridge National Laboratory, Oak Ridge, TN. 50 pp. ES/ER/TM-162/R2 http://www.esd.ornl.gov/programs/ecorisk/documents/tm162

g - EPA Region 5 RCRA Ecological Screening Levels (2003).

Attachment 5
Prey Bioaccumulation Factors

Table 1
Uptake Models Relating Concentrations in Soil to Concentrations in Plants

	Food Item (Plant) Uptake			
Chemical	**Uptake Model[A, B, C]**	**BAF/Equation (mg/kg dry wt. to mg/kg dry wt.)**	**Log K_{ow}**	**Source**
Metals				
Aluminum	Uptake Factor	4.00E-03	--	Baes et al. 1984
Antimony	Uptake Factor	2.00E-01	--	Baes et al. 1984
Arsenic	Log Linear	ln(dry plant conc, mg/kg) = (-1.992+0.564*ln(soil conc))	--	Bechtel Jacobs 1998
Barium	Uptake Factor	1.50E-01	--	Baes et al. 1984
Beryllium	Uptake Factor	1.00E-02	--	Baes et al. 1984
Cadmium	Log Linear	ln(dry plant conc, mg/kg) = (-0.476+0.546*ln(soil conc))	--	Bechtel Jacobs 1998
Chromium	Uptake Factor	7.50E-03	--	Baes et al. 1984
Cobalt	Uptake Factor	2.00E-02	--	Baes et al. 1984
Copper	Log Linear	ln(dry plant conc, mg/kg) = (0.669+0.394*ln(soil conc))	--	Bechtel Jacobs 1998
Lead	Log Linear	ln(dry plant conc, mg/kg) = (-1.328+0.561*ln(soil conc))	--	Bechtel Jacobs 1998
Manganese	Uptake Factor	2.50E-01	--	Baes et al. 1984
Mercury	Log Linear	ln(dry plant conc, mg/kg) = (-0.996+0.544*ln(soil conc))	--	Bechtel Jacobs 1998
Nickel	Log Linear	ln(dry plant conc, mg/kg) = (-2.224+0.748*ln(soil conc))	--	Bechtel Jacobs 1998
Selenium	Log Linear	ln(dry plant conc, mg/kg) = (-0.678+1.104*ln(soil conc))	--	Bechtel Jacobs 1998
Silver	Uptake Factor	4.00E-01	--	Baes et al. 1984
Thallium	Uptake Factor	4.00E-03	--	Baes et al. 1984
Vanadium	Uptake Factor	5.50E-03	--	Baes et al. 1984
Zinc	Log Linear	ln(dry plant conc, mg/kg) = (1.575+0.555*ln(soil conc))	--	Bechtel Jacobs 1998a
PAHs				
2-Methylnaphthalene	Uptake Factor	2.74E-01	3.72E+00	Regression from Travis and Arms 1988
Acenaphthylene	Uptake Factor	2.04E-01	3.94E+00	Regression from Travis and Arms 1988
Anthracene	Uptake Factor	1.18E-01	4.35E+00	Regression from Travis and Arms 1988
Benzo(a)Anthracene	Uptake Factor	1.70E-02	5.81E+00	Regression from Travis and Arms 1988
Benzo(a)Pyrene	Uptake Factor	1.14E-02	6.11E+00	Regression from Travis and Arms 1988
Benzo(b)Fluoranthene	Uptake Factor	1.14E-02	6.11E+00	Regression from Travis and Arms 1988
Benzo(g,h,i)Perylene	Uptake Factor	5.19E-03	6.70E+00	Regression from Travis and Arms 1988
Benzo(k)Fluoranthene	Uptake Factor	1.14E-02	6.11E+00	Regression from Travis and Arms 1988
Chrysene	Uptake Factor	2.50E-02	5.52E+00	Regression from Travis and Arms 1988
Dibenzo(a,h)Anthracene	Uptake Factor	5.19E-03	6.70E+00	Regression from Travis and Arms 1988
Fluoranthene	Uptake Factor	5.48E-02	4.93E+00	Regression from Travis and Arms 1988
Fluorene	Uptake Factor	1.84E-01	4.02E+00	Regression from Travis and Arms 1988
Indeno(1,2,3-Cd)Pyrene	Uptake Factor	5.19E-03	6.70E+00	Regression from Travis and Arms 1988
Naphthalene	Uptake Factor	5.70E-01	3.17E+00	Regression from Travis and Arms 1988
Phenanthrene	Uptake Factor	1.18E-01	4.35E+00	Regression from Travis and Arms 1988
Pyrene	Uptake Factor	5.48E-02	4.93E+00	Regression from Travis and Arms 1988
Total LMW PAHs	Uptake Factor	1.04E-01	--	Average of individual PAH biotransfer factors calculated via regression from Travis and Arms 1988
Total HMW PAHs	Uptake Factor	1.04E-01	--	Average of individual PAH biotransfer factors calculated via regression from Travis and Arms 1988

Table 1
Uptake Models Relating Concentrations in Soil to Concentrations in Plants

	Food Item (Plant) Uptake			
Chemical	**Uptake Model[A, B, C]**	**BAF/Equation (mg/kg dry wt. to mg/kg dry wt.)**	**Log K_{ow}**	**Source**
Total PAHs	Uptake Factor	1.04E-01	--	Average of individual PAH biotransfer factors calculated via regression from Travis and Arms 1988
SVOCs (random selection, dependent on what is detected)				
6-Methyl Chrysene	Uptake Factor	1.20E-02	6.07E+00	Regression from Travis and Arms 1988
Acetophenone	Uptake Factor	4.20E+00	1.67E+00	Regression from Travis and Arms 1988
Benzaldehyde	Uptake Factor	3.98E+00	1.71E+00	Regression from Travis and Arms 1988
Bis(2-ethylhexyl)phthalate	Uptake Factor	5.48E-04	8.39E+00	Regression from Travis and Arms 1988
Butyl benzyl phthalate	Uptake Factor	6.17E-02	4.84E+00	Regression from Travis and Arms 1988
Caprolactam	Uptake Factor	1.61E+01	6.60E-01	Regression from Travis and Arms 1988
Carbazole	Uptake Factor	5.26E-01	3.23E+00	Regression from Travis and Arms 1988
Dalapon	Uptake Factor	4.14E+00	1.68E+00	Regression from Travis and Arms 1988
Diethyl phthalate	Uptake Factor	1.14E+00	2.65E+00	Regression from Travis and Arms 1988
Hexane	Uptake Factor	4.86E-01	3.29E+00	Regression from Travis and Arms 1988
n-Butyl Alcohol	Uptake Factor	1.27E+01	8.40E-01	Regression from Travis and Arms 1988
Phenol	Uptake Factor	5.19E+00	1.51E+00	Regression from Travis and Arms 1988
VOCs				
Benzene	Uptake Factor	2.74E+00	1.99E+00	Regression from Travis and Arms 1988
Ethylbenzene	Uptake Factor	6.87E-01	3.03E+00	Regression from Travis and Arms 1988
Toluene	Uptake Factor	1.32E+00	2.54E+00	Regression from Travis and Arms 1988
Xylenes (m & p)	Uptake Factor	6.34E-01	3.09E+00	Regression from Travis and Arms 1988
Xylenes (o)	Uptake Factor	6.34E-01	3.09E+00	Regression from Travis and Arms 1988
Xylenes (Total)	Uptake Factor	5.85E-01	3.15E+00	Regression from Travis and Arms 1988

NOTES:

A - Equation types:
Uptake Factor: [ConcBio] = m x [ConcSoil]
Log linear: [ConcBio] = 10b*[ConcSoil]m

B - Uptake factor for organics derived using the following equations from Travis & Arms 1988 (equation 5, pg 273): Log Upfp = 1.588 - (0.578)(Log Kow)
UpF_p = plant uptake factor
K_{ow} = octanol-water partitioning coefficient
Log K_{ow} values from KOWWIN program from EPI suite.

C - Uptake factor for inorganics derived using the following equations from Bechtel Jacobs 1998: ln(plant) = B0 + B1(ln(soil concentration))
B0 = Constituent-specific intercept based on tissue type
B1 = Constituent-specific slope based on tissue type
Data for B0 and B1 are presented in Bechtel Jacobs 1998, Table 7, pg. 22.
Log Kow for m, p-xylenes = average of m-xylene and p-xylene Log Kow

Table 2
Uptake Models Relating Concentrations in Soil to Concentrations in Soil Invertebrates

Chemical	Food Item (Worm) Uptake		
	Uptake Model$^{A, B, C}$	BAF/Equation (mg/kg dry wt. to mg/kg dry wt.)	Source
Metals			
Aluminum	Uptake Factor	1.18E-01	90% UF, Sample et al 1998a
Antimony	Uptake Factor	1.00E+00	Default
Arsenic	Log Linear	ln(dry worm conc, mg/kg) = (1.421+0.706*ln(soil conc))	Sample et al. 1998a
Barium	Uptake Factor	1.60E-01	90% UF, Sample et al 1998a
Beryllium	Uptake Factor	1.18E+00	90% UF, Sample et al 1998a
Cadmium	Log Linear	ln(dry worm conc, mg/kg) = (2.114+0.795*ln(soil conc))	Sample et al. 1998a
Chromium	Log Linear	ln(dry worm conc, mg/kg) = (2.481+-0.067*ln(soil conc))	Sample et al. 1998a
Cobalt	Uptake Factor	2.91E-01	90% UF, Sample et al 1998a
Copper	Log Linear	ln(dry worm conc, mg/kg) = (1.675+0.264*ln(soil conc))	Sample et al. 1998a
Iron	Uptake Factor	7.80E-02	90% UF, Sample et al 1998a
Lead	Log Linear	ln(dry worm conc, mg/kg) = (0.218+0.807*ln(soil conc))	Sample et al. 1998a
Manganese	Log Linear	ln(dry worm conc, mg/kg) = (0.809+0.682*ln(soil conc))	Default
Mercury	Log Linear	ln(dry worm conc, mg/kg) = (0.684+0.118*ln(soil conc))	Sample et al. 1998a
Nickel	Log Linear	ln(dry worm conc, mg/kg) = (3.677-0.26*ln(soil conc))	Sample et al. 1998a
Selenium	Log Linear	ln(dry worm conc, mg/kg) = (0.075+0.733*ln(soil conc))	Sample et al. 1998a
Silver	Uptake Factor	1.53E+01	90% UF, Sample et al 1998a
Thallium	Uptake Factor	1.00E+00	Default
Vanadium	Uptake Factor	8.80E-01	90% UF, Sample et al 1998a
Zinc	Log Linear	ln(dry worm conc, mg/kg) = (4.449+0.328*ln(soil conc))	Sample et al. 1998a
PAHs			
2-Methylnaphthalene	Uptake Factor	2.00E-01	Beyer and Stafford 1993
Acenaphthylene	Uptake Factor	2.20E-01	Beyer and Stafford 1993
Anthracene	Uptake Factor	3.20E-01	Beyer and Stafford 1993
Benzo(a)Anthracene	Uptake Factor	2.70E-01	Beyer and Stafford 1993
Benzo(a)Pyrene	Uptake Factor	3.40E-01	Beyer and Stafford 1993
Benzo(b)Fluoranthene	Uptake Factor	2.10E-01	Beyer and Stafford 1993
Benzo(g,h,i)Perylene	Uptake Factor	1.50E-01	Beyer and Stafford 1993
Benzo(k)Fluoranthene	Uptake Factor	2.10E-01	Beyer and Stafford 1993
Chrysene	Uptake Factor	4.40E-01	Beyer and Stafford 1993
Dibenzo(a,h)Anthracene	Uptake Factor	4.90E-01	Beyer and Stafford 1993
Fluoranthene	Uptake Factor	3.70E-01	Beyer and Stafford 1993

Table 2
Uptake Models Relating Concentrations in Soil to Concentrations in Soil Invertebrates

Chemical	**Food Item (Worm) Uptake**		
	Uptake Model[A, B, C]	**BAF/Equation (mg/kg dry wt. to mg/kg dry wt.)**	**Source**
Fluorene	Uptake Factor	2.00E-01	Beyer and Stafford 1993
Indeno(1,2,3-Cd)Pyrene	Uptake Factor	4.10E-01	Beyer and Stafford 1993
Naphthalene	Uptake Factor	2.10E-01	Beyer and Stafford 1993
Phenanthrene	Uptake Factor	2.80E-01	Beyer and Stafford 1993
Pyrene	Uptake Factor	3.90E-01	Beyer and Stafford 1993
Total LMW PAHs	Uptake Factor	3.00E-01	Beyer and Stafford 1993, value for total PAHs
Total HMW PAHs	Uptake Factor	3.00E-01	Beyer and Stafford 1993, value for total PAHs
Total PAHs	Uptake Factor	3.00E-01	Beyer and Stafford 1993
SVOCs (random selection, dependent on what is detected)			
6-Methyl Chrysene	Uptake Factor	1.00E+00	Default
Acetophenone	Uptake Factor	1.00E+00	Default
Benzaldehyde	Uptake Factor	1.00E+00	Default
Bis(2-ethylhexyl)phthalate	Uptake Factor	1.00E+00	Default
Butyl benzyl phthalate	Uptake Factor	1.00E+00	Default
Caprolactam	Uptake Factor	1.00E+00	Default
Carbazole	Uptake Factor	1.00E+00	Default
Dalapon	Uptake Factor	1.00E+00	Default
Diethyl phthalate	Uptake Factor	1.00E+00	Default
Hexane	Uptake Factor	1.00E+00	Default
n-Butyl Alcohol	Uptake Factor	1.00E+00	Default
Phenol	Uptake Factor	1.00E+00	Default
VOCs			
Benzene	Uptake Factor	1.00E+00	Default
Ethylbenzene	Uptake Factor	1.00E+00	Default
Toluene	Uptake Factor	1.00E+00	Default
Xylenes (m & p)	Uptake Factor	1.00E+00	Default
Xylenes (o)	Uptake Factor	1.00E+00	Default
Xylenes (Total)	Uptake Factor	1.00E+00	Default

A - The default uptake factor for chemicals were no information was available was assumed to be 1.

B - Equation types:
Uptake Factor: [ConcBio] = m x [ConcSoil]
Log linear: [ConcBio] = 10b*[ConcSoil]m

C - Uptake factor derived using the following equations from Sample, et. al 1998a:
ln(earthworm) = B0 + B1(ln(soil concentration))
B0 = Constituent-specific intercept based on tissue type
B1 = Constituent-specific slope based on tissue type
Data for B0 and B1 are presented in Sample, et. Al 1998a, Table 12, pg. 33.

Table 3
Uptake Models Relating Concentrations in Soil to Concentrations in Small Mammals

Chemical	Food Item (Small Mammal) Uptake			
	Uptake Model	**UF/BTF/Equation (mg/kg dry wt. to mg/kg dry wt.)**	**Log K_{ow}**	**Source**
Metals				
Aluminum	Uptake Factor	7.32E-02	--	Sample et al. 1998b
Antimony	Uptake Factor	1.00E+00	--	Default
Arsenic	Log Linear	ln(dry mammal conc, mg/kg) = (-4.8471+0.8188*ln(soil conc))	--	Sample et al. 1998b
Barium	Log Linear	ln(dry mammal conc, mg/kg) = (-1.412+0.7*ln(soil conc))	--	Sample et al. 1998b
Beryllium	Uptake Factor	1.00E+00	--	Default
Cadmium	Log Linear	ln(dry mammal conc, mg/kg) = (-0.4306+0.4865*ln(soil conc))	--	Sample et al. 1998b
Calcium	Uptake Factor	1.48E-04	--	90%UF from Sample et al. 1998b
Chromium	Log Linear	ln(dry mammal conc, mg/kg) = (-1.4599+0.7338*ln(soil conc))	--	Sample et al. 1998b
Chromium, hexavalent	Log Linear	ln(dry mammal conc, mg/kg) = (-1.4599+0.7338*ln(soil conc))	--	Sample et al. 1998b
Cobalt	Uptake Factor	1.00E-01	--	90%UF from Sample et al. 1998b
Copper	Log Linear	ln(dry mammal conc, mg/kg) = (2.042+0.1444*ln(soil conc))	--	Sample et al. 1998b
Iron	Uptake Factor	4.24E-03	--	90% UF, Sample et al 1998b
Lead	Log Linear	ln(dry mammal conc, mg/kg) = (0.0761+0.4422*ln(soil conc))	--	Sample et al. 1998b
Magnesium	Uptake Factor	9.93E-01	--	90% UF, Sample et al 1998b
Manganese	Uptake Factor	5.87E-02	--	90% UF, Sample et al 1998b
Mercury	Uptake Factor	1.92E-01	--	Sample et al. 1998b
Nickel	Log Linear	ln(dry mammal conc, mg/kg) = (-0.2462+0.4658*ln(soil conc))	--	Sample et al. 1998b
Potassium	Uptake Factor	4.24E-03	--	90%UF from Sample et al. 1998b
Selenium	Log Linear	ln(dry mammal conc, mg/kg) = (-0.4158+0.3764*ln(soil conc))	--	Sample et al. 1998b
Silver	Uptake Factor	5.01E-01	--	90% UF, Sample et al 1998b
Sodium	Uptake Factor	1.17E-02	--	90% UF, Sample et al 1998b
Thallium	Uptake Factor	1.23E-01	--	90%UF from Sample et al. 1998b
Vanadium	Uptake Factor	1.79E-01	--	Sample et al. 1998b
Zinc	Log Linear	ln(dry mammal conc, mg/kg) = (4.4713+0.0738*ln(soil conc))	--	Sample et al. 1998b
PAHs				
2-Methylnaphthalene	Biotransfer Factor	0.00E+00	3.72E+00	EPA 2007i
Acenaphthylene	Biotransfer Factor	0.00E+00	3.94E+00	EPA 2007i
Anthracene	Biotransfer Factor	0.00E+00	4.35E+00	EPA 2007i
Benzo(a)Anthracene	Biotransfer Factor	0.00E+00	5.81E+00	EPA 2007i
Benzo(a)Pyrene	Biotransfer Factor	0.00E+00	6.11E+00	EPA 2007i
Benzo(b)Fluoranthene	Biotransfer Factor	0.00E+00	6.11E+00	EPA 2007i
Benzo(g,h,i)Perylene	Biotransfer Factor	0.00E+00	6.70E+00	EPA 2007i
Benzo(k)Fluoranthene	Biotransfer Factor	0.00E+00	6.11E+00	EPA 2007i
Chrysene	Biotransfer Factor	0.00E+00	5.52E+00	EPA 2007i
Dibenzo(a,h)Anthracene	Biotransfer Factor	0.00E+00	6.70E+00	EPA 2007i
Fluoranthene	Biotransfer Factor	0.00E+00	4.93E+00	EPA 2007i
Fluorene	Biotransfer Factor	0.00E+00	4.02E+00	EPA 2007i
Indeno(1,2,3-Cd)Pyrene	Biotransfer Factor	0.00E+00	6.70E+00	EPA 2007i
Naphthalene	Biotransfer Factor	0.00E+00	3.17E+00	EPA 2007i
Phenanthrene	Biotransfer Factor	0.00E+00	4.35E+00	EPA 2007i
Pyrene	Biotransfer Factor	0.00E+00	4.93E+00	EPA 2007i
Total LMW PAHs	Biotransfer Factor	0.00E+00	--	EPA 2007i
Total HMW PAHs	Biotransfer Factor	0.00E+00	--	EPA 2007i

Table 3
Uptake Models Relating Concentrations in Soil to Concentrations in Small Mammals

Chemical	Food Item (Small Mammal) Uptake			
	Uptake Model	UF/BTF/Equation (mg/kg dry wt. to mg/kg dry wt.)	Log K_{ow}	Source
Total PAHs	Biotransfer Factor	0.00E+00	--	EPA 2007i
SVOCs (random selection, dependent on what is detected)				
6-Methyl Chrysene	Biotransfer Factor	1.18E-01	6.07E+00	Regression from Travis and Arms 1988
Acetophenone	Biotransfer Factor	4.70E-06	1.67E+00	Regression from Travis and Arms 1988
Benzaldehyde	Biotransfer Factor	5.15E-06	1.71E+00	Regression from Travis and Arms 1988
Bis(2-ethylhexyl)phthalate	Biotransfer Factor	2.47E+01	8.39E+00	Regression from Travis and Arms 1988
Butyl benzyl phthalate	Biotransfer Factor	6.95E-03	4.84E+00	Regression from Travis and Arms 1988
Caprolactam	Biotransfer Factor	4.59E-07	6.60E-01	Regression from Travis and Arms 1988
Carbazole	Biotransfer Factor	1.71E-04	3.23E+00	Regression from Travis and Arms 1988
Dalapon	Biotransfer Factor	4.81E-06	1.68E+00	Regression from Travis and Arms 1988
Diethyl phthalate	Biotransfer Factor	4.49E-05	2.65E+00	Regression from Travis and Arms 1988
Hexane	Biotransfer Factor	1.96E-04	3.29E+00	Regression from Travis and Arms 1988
n-Butyl Alcohol	Biotransfer Factor	6.95E-07	8.40E-01	Regression from Travis and Arms 1988
Phenol	Biotransfer Factor	3.25E-06	1.51E+00	Regression from Travis and Arms 1988
VOCs				
Benzene	Biotransfer Factor	9.89E-06	1.99E+00	Regression from Travis and Arms 1988
Ethylbenzene	Biotransfer Factor	1.08E-04	3.03E+00	Regression from Travis and Arms 1988
Toluene	Biotransfer Factor	3.48E-05	2.54E+00	Regression from Travis and Arms 1988
Xylenes (m & p)	Biotransfer Factor	1.24E-04	3.09E+00	Regression from Travis and Arms 1988
Xylenes (o)	Biotransfer Factor	1.24E-04	3.09E+00	Regression from Travis and Arms 1988
Xylenes (Total)	Biotransfer Factor	1.42E-04	3.15E+00	Regression from Travis and Arms 1988

Biotransfer factor:

Derived using the following equations from Travis & Arms 1988 (equation 2, pg. 272): Log UpFsm = -7.6 + log Kow

UpF_{sm} = small mammal uptake factor

K_{ow} = octanol-water partitioning coefficient

Log K_{ow} values for most chemicals are from Syracuse Research Corporation (http://www.syrres.com/esc/est_kowdemo.htm)

Biotransfer factors were divided by 0.25 to account for wet weight to dry weight conversion.

Appendix F

Laboratory Certifications

Appendix F

Laboratory Certifications

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

TESTAMERICA DENVER
4955 Yarrow Street
Arvada, CO 80002
Roxanne Sullivan   Phone: 303-736-0100
www.testamericainc.com

ENVIRONMENTAL

Valid To: October 31, 2019   Certificate Number: 2907.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality Systems Manual for Environmental Laboratories), and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, ICP/MS, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, Ion Chromatography, Misc.- Electronic Probes (pH, O_2), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), Titrimetry, Total Organic Carbon, Total Organic Halide

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Metals			
Aluminum	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Antimony	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Arsenic	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Barium	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Beryllium	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Boron	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Cadmium	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Calcium	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Chromium	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Cobalt	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Copper	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Iron	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Lead	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Lithium	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Magnesium	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Manganese	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Mercury	EPA 200.7	EPA 7470A	EPA 7471A/7471B
Molybdenum	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Nickel	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Potassium	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Selenium	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Silica	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Silicon	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Silver	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Sodium	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Strontium	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Thallium	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Tin	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Titanium	EPA 200.7	EPA 6010B/6010C	EPA 6010B/6010C
Vanadium	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Zinc	EPA 200.7/200.8	EPA 6010B/6010C EPA 6020/6020A	EPA 6010B/6010C EPA 6020/6020A
Nutrients			
Nitrate (as N)	By calculation	EPA 300.0 EPA 9056/9056A By calculation	EPA 9056/9056A By calculation
Nitrate-nitrite (as N)	EPA 353.2	EPA 300.0 EPA 353.2 EPA 9056/9056A	EPA 9056/9056A
Nitrite (as N)	EPA 353.2 SM 4500-NO_2 B	EPA 300.0 EPA 353.2 EPA 9056/9056A SM 4500-NO_2 B	EPA 353.2 EPA 9056/9056A
Orthophosphate (as P)	----------------------	EPA 300.0 EPA 9056/9056A	EPA 9056/9056A
Total Phosphorus	----------------------	EPA 6010B/6010C	EPA 6010B/6010C
Demands			
Total Organic Carbon	----------------------	EPA 9060/9060A	EPA 9060/9060A

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Total Organic Halides	----------------------	EPA 9020B	--------------------------
Wet Chemistry			
Alkalinity (Total Bicarbonate, Carbonate, and Hydroxide Alkalinty)	SM 2320B-1997	SM 2320B	SM 2320B
Ammonia	EPA 350.1	EPA 350.1	--------------------------
Biological Oxygen Demand	SM 5210B	SM 5210B	--------------------------
Bromide	----------------------	EPA 300.0 EPA 9056/9056A	EPA 9056/9056A
Chloride	----------------------	EPA 300.0 EPA 9056/9056A	EPA 9056/9056A
Chemical Oxygen Demand	EPA 410.4	EPA 410.4	--------------------------
Conductivity	----------------------	EPA 9050/9050A	EPA 9050/9050A
Cyanide	----------------------	EPA 9012A/9012B	EPA 9012A/9012B
Ferrous iron	SM 3500Fe B, D	SM 3500Fe B, D	--------------------------
Fluoride	----------------------	EPA 300.0 EPA 9056/9056A	EPA 9056/9056A
Hexavalent chromium	----------------------	EPA 7196A	--------------------------
pH	----------------------	EPA 9040B/9040C	EPA 9045C/9045D
Oil and Grease (HEM and SGT-HEM)	----------------------	EPA 1664A/1664B	EPA 9071B
Percent moisture	----------------------	----------------------------	ASTM D2216
Perchlorate	----------------------	EPA 6860	EPA 6860
Phenols	----------------------	EPA 9066	--------------------------
Solids, total	SM 2540B	SM 2540B	SM 2540B
Solids, Total Suspended	SM 2540D	SM 2540D	SM 2540D
Solids, Total Dissolved	SM 2540C	SM 2540C	SM 2540C
Sulfate	----------------------	EPA 300.0 EPA 9056/9056A	EPA 9056/9056A
Sulfide, total	----------------------	EPA 9034	EPA 9034
Sulfide	----------------------	EPA 9030B	EPA 9030B
Total Kjeldahl Nitrogen	----------------------	EPA 351.2	--------------------------
Purgeable Organics (volatiles)			
Acetone	EPA 624	EPA 8260B	EPA 8260B
Acetonitrile	----------------------	EPA 8260B	EPA 8260B
Acrolein	EPA 624	EPA 8260B	EPA 8260B
Acrylonitrile	EPA 624	EPA 8260B	EPA 8260B
Allyl Chloride	----------------------	EPA 8260B	EPA 8260B
tert-Amyl Methyl Ether			
Benzene	EPA 624	EPA 8260B/8260B SIM EPA 8021B AK101/OK DEQ GRO	EPA 8260B EPA 8021B AK101/OK DEQ GRO
Bromobenzene	----------------------	EPA 8260B	EPA 8260B
Bromochloromethane	----------------------	EPA 8260B	EPA 8260B
Bromodichloromethane	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Bromoform	EPA 624	EPA 8260B	EPA 8260B
Bromomethane	EPA 624	EPA 8260B	EPA 8260B
Butadiene	----------------------	EPA 8260B SIM	EPA 8260B SIM
2-Butanone	EPA 624	EPA 8260B	EPA 8260B
n-Butyl alcohol	----------------------	EPA 8260B EPA 8015B/8015C	EPA 8260B EPA 8015B/8015C
tert-Butyl alcohol (2-Methyl-2-propanol)	----------------------	EPA 8260B EPA 8260B SIM	EPA 8260B
n-Butylbenzene	----------------------	EPA 8260B	EPA 8260B
sec-Butylbenzene	----------------------	EPA 8260B	EPA 8260B
tert-Butylbenzene	----------------------	EPA 8260B	EPA 8260B
Carbon disulfide	EPA 624	EPA 8260B	EPA 8260B
Carbon tetrachloride	EPA 624	EPA 8260B	EPA 8260B
Chlorobenzene	EPA 624	EPA 8260B EPA 8021B	EPA 8260B EPA 8021B
2-Chloro-1,3-butadiene	----------------------	EPA 8260B	EPA 8260B
Chloroethane	EPA 624	EPA 8260B	EPA 8260B
2-Chloroethyl vinyl ether	EPA 624	EPA 8260B	EPA 8260B
Chloroform	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
1-Chlorohexane	----------------------	EPA 8260B	EPA 8260B
Chloromethane	EPA 624	EPA 8260B	EPA 8260B
Chloroprene	----------------------	EPA 8260B	EPA 8260B
4-Chlorotoluene	----------------------	EPA 8260B	EPA 8260B
2-Chlorotoluene	----------------------	EPA 8260B	EPA 8260B
Cyclohexane	----------------------	EPA 8260B	EPA 8260B
Cyclohexanone	----------------------	EPA 8260B	EPA 8260B
Dibromochloromethane	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
1,2-Dibromo-3-chloropropane (DBCP)	EPA 624	EPA 8260B EPA 8011	EPA 8260B EPA 8011
Dibromochloromethane	----------------------	EPA 8260B	EPA 8260B
Dichlorodifluoromethane	EPA 624	EPA 8260B	EPA 8260B
Dibromomethane	EPA 624	EPA 8260B	EPA 8260B
1,2 Dibromoethane (EDB)	EPA 624	EPA 8260B EPA 8011	EPA 8260B EPA 8011
1,2-Dichlorobenzene	EPA 624	EPA 8260B EPA 8021B	EPA 8260B EPA 8021B
1,3-Dichlorobenzene	EPA 624	EPA 8260B EPA 8021B	EPA 8260B EPA 8021B
1,4-Dichlorobenzene	EPA 624	EPA 8260B EPA 8021B	EPA 8260B EPA8021B
cis-1,4-Dichloro-2-butene	----------------------	EPA 8260B	EPA 8260B
trans-1,4-Dichloro-2-butene	----------------------	EPA 8260B	EPA 8260B
1,1-Dichloroethane	EPA 624	EPA 8260B	EPA 8260B
1,2-Dichloroethane	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
1,1-Dichloroethene	EPA 624	EPA 8260B	EPA 8260B
1,2-Dichloroethene	EPA 624	EPA 8260B	EPA 8260B

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
cis-1,2-Dichloroethene	EPA 624	EPA 8260B	EPA 8260B
trans-1,2-Dichloroethene	EPA 624	EPA 8260B	EPA 8260B
Dichlorofluoromethane	----------------------	EPA 8260B	EPA 8260B
1,2-Dichloropropane	EPA 624	EPA 8260B	EPA 8260B
1,3-Dichloropropane	----------------------	EPA 8260B	EPA 8260B
2,2-Dichloropropane	----------------------	EPA 8260B	EPA 8260B
1,1-Dichloropropene	----------------------	EPA 8260B	EPA 8260B
1,3-Dichloropropene	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
cis-1,3-Dichloropropene	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
trans-1,3-Dichloropropene	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
Diethyl ether	----------------------	EPA 8260B	EPA 8260B
Di-isopropylether	----------------------	EPA 8260B	EPA 8260B
1,4-Dioxane	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
Ethanol	----------------------	EPA 8260B EPA 8015B/8015C	EPA 8260B EPA 8015B/8015C
Ethyl acetate	----------------------	EPA 8260B	EPA 8260B
Ethyl benzene	EPA 624	EPA 8260B EPA 8021B AK101/OK DEQ GRO	EPA 8260B EPA 8021B AK101/OK DEQ GRO
Ethyl methacrylate	----------------------	EPA 8260B	EPA 8260B
Ethyl tert-butyl ether	----------------------	----------------------------	--------------------------
Ethylene glycol	----------------------	EPA 8015C	EPA 8015C
Gas Range Organics (GRO)	----------------------	EPA 8015B/8015C/8015D/ AK101/OK DEQ GRO	EPA 8015B/8015C/8015D/ AK101/OK DEQ GRO
Hexane	EPA 624	EPA 8260B	EPA 8260B
2-Hexanone	EPA 624	EPA 8260B	EPA 8260B
Hexachlorobutadiene	----------------------	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
Isobutyl alcohol (2-Methyl-1-propanol)	----------------------	EPA 8260B EPA 8015B/8015C	EPA 8260B EPA 8015B/8015C
Isopropyl alcohol	----------------------	EPA 8260B	EPA 8260B
Isopropylbenzene	----------------------	EPA 8260B	EPA 8260B
1,4-Isopropyltoluene	----------------------	EPA 8260B	EPA 8260B
Iodomethane	----------------------	EPA 8260B	EPA 8260B
Methacrylonitrile	----------------------	EPA 8260B	EPA 8260B
Methanol	----------------------	EPA 8015B/8015C	EPA 8015B/8015C
Methyl acetate	----------------------	EPA 8260B	EPA 8260B
Methyl cyclohexane	----------------------	EPA 8260B	EPA 8260B
Methylene chloride	EPA 624	EPA 8260B	EPA 8260B
Methyl ethyl ketone (MEK)	----------------------	EPA 8260B	EPA 8260B
Methyl isobutyl ketone	----------------------	EPA 8260B	EPA 8260B
Methyl methacrylate	----------------------	EPA 8260B	EPA 8260B
Methyl tert-butyl ether (MtBE)	EPA 624	EPA 8260B EPA 8021B OK DEQ GRO	EPA 8260B EPA 8021B OK DEQ GRO

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
4-Methyl-2-pentanone (MIBK)	EPA 624	EPA 8260B	EPA 8260B
Naphthalene	EPA 624	EPA 8260B OK DEQ GRO	EPA 8260B OK DEQ GRO
2-Nitropropane	----------------------	EPA 8260B	EPA 8260B
2,2' Oxybisethanol	----------------------	EPA 8015C	EPA 8015C
2-Pentanone	----------------------	EPA 8260B	EPA 8260B
Propionitrile	----------------------	EPA 8260B	EPA 8260B
n-Propylbenzene	----------------------	EPA 8260B	EPA 8260B
Propylene glycol	----------------------	EPA 8015C	EPA 8015C
Styrene	EPA 624	EPA 8260B	EPA 8260B
1,1,1,2-Tetrachloroethane	EPA 624	EPA 8260B	EPA 8260B
1,1,2,2-Tetrachloroethane	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
Tetrachloroethene	EPA 624	EPA 8260B	EPA 8260B
Tetrahydrofuran	----------------------	EPA 8260B	EPA 8260B
Toluene	EPA 624	EPA 8260B EPA 8021B AK101/OK DEQ GRO	EPA 8260B EPA 8021B AK101/OK DEQ GRO
Total Petroleum Hydrocarbons (TPH)	EPA 1664A/1664B	EPA 1664A/1664B	--------------------------
1,2,3-Trichlorobenzene	----------------------	EPA 8260B	EPA 8260B
1,1,1-Trichloroethane	EPA 624	EPA 8260B	EPA 8260B
1,1,2-Trichloroethane	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
Trichloroethene	EPA 624	EPA 8260B/8260B SIM	EPA 8260B
Trichlorofluoromethane	EPA 624	EPA 8260B	EPA 8260B
1,2,3-Trichlorobenzene	----------------------	EPA 8260B	EPA 8260B
1,2,4-Trichlorobenzene	----------------------	EPA 8260B	EPA 8260B
1,2,3-Trichloropropane	EPA 624	EPA 8260B EPA 8011	EPA 8260B EPA 8011
1,1,2-Trichloro-1,2,2-trifluoroethane	----------------------	EPA 8260B	EPA 8260B
Triethylene glycol	----------------------	EPA 8015C	EPA 8015C
1,2,3-Trimethylbenzene	----------------------	EPA 8260B	EPA 8260B
1,2,4-Trimethylbenzene	----------------------	EPA 8260B	EPA 8260B
1,3,5-Trimethylbenzene	----------------------	EPA 8260B	EPA 8260B
Vinyl acetate	EPA 624	EPA 8260B	EPA 8260B
Vinyl chloride	EPA 624	EPA 8260B EPA 8260B SIM	EPA 8260B EPA 8260B SIM
Xylenes, total	EPA 624	EPA 8260B EPA 8021B AK101/OK DEQ GRO	EPA 8260B EPA 8021B AK101/OK DEQ GRO
1,2-Xylene (o-Xylene)	EPA 624	EPA 8260B EPA 8021B AK101/OK DEQ GRO	EPA 8260B EPA 8021B AK101/OK DEQ GRO
m+p-Xylene	EPA 624	EPA 8260B EPA 8021B AK101/OK DEQ GRO	EPA 8260B EPA 8021B AK101/ K DEQ GRO
Methane	----------------------	RSK-175	----------------------

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Ethane	---------------------	RSK-175	---------------------
Ethylene (Ethene)	---------------------	RSK-175	---------------------
Acetylene	---------------------	RSK-175	---------------------
Acetylene ethane	---------------------	RSK-175	---------------------
Extractable Organics (semivolatiles)			
Acenaphthene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Acenaphthylene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Acetophenone	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
2-Acetylaminofluorene	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
Alachlor	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
4-Aminobiphenyl	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
Aniline	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Anthracene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Aramite	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
Atrazine	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
Azobenzene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Benzaldehyde	---------------------	EPA 8270C 8270D	EPA 8270C/8270D
Benzidine	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Benzoic acid	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Benzo(a)anthracene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo(b)fluoranthene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo(k)fluoranthene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo(ghi)perylene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzo(a)pyrene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Benzyl alcohol	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
1,1-Biphenyl	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
bis (2-Chloroethoxy) methane	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
bis (2-Chloroethyl) ether	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
bis (2-Chloroisopropyl) ether (2,2’Oxybis(1-chloropropane)	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
bis (2-Ethylhexyl) phthalate	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
4-Bromophenyl phenyl ether	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
butyl Benzyl phthalate	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
2-sec-butyl-4,6-Dinitrophenol	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
Caprolactam	---------------------	EPA 8270C/8270D	EPA 8270C/8270D
Carbazole	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
4-Chloroanilene	---------------------	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Chlorobenzilate	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
4-chloro-3-Methylphenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
1-Chloronaphthalene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2-Chloronaphthalene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
2-Chlorophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
4-Chlorophenyl phenyl ether	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Chrysene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Cresols	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Diallate	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Dibenzo (a,h) anthracene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Dibenzofuran	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
1,2-Dichlorobenzene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
1,3-Dichlorobenzene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
1,4-Dichlorobenzene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
3,3’-Dichlorobenzidine	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
2,4-Dichlorophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
2,6-Dichlorophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Diethyl phthalate	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Dimethoate	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
3,3-Dimethylbenzidine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
p-Dimethylaminoazobenzene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
7,12-Dimethylbenz(a)anthracene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
alpha-,alpha-Dimethylphenethylamine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dimethylphenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Dimethyl phthalate	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
di-n-butyl Phthalate	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
di-n-octyl Phthalate	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
1,3-Dinitrobenzene	----------------------	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
1,4-Dinitrobenzene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dinitrophenol	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
2,4-Dinitrotoluene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
2,6-Dinitrotoluene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
1,4-Dioxane	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Diphenylamine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
1,2-Diphenylhydrazine	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Disulfoton	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Diesel Range Organics (DRO)	----------------------	EPA 8015B/8015C/ AK102/8015D/OK DEQ DRO	EPA 8015B/8015C/ AK102/8015D/OK DEQ DRO
ethyl Methanesulfonate	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Famphur	----------------------	EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Fluoroanthene	EPA 625	EPA 8270C/8270D EPA8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Fluorene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Hexachlorobenzene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Hexachlorobutadiene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorocyclopentadiene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Hexachloroethane	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Hexachloropropene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Indeno (1,2,3-cd) pyrene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
Isodrin	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Isophorone	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Isosafrole	----------------------	EPA 8270C/8270D	EPA 8270 C/8270D
Methapyrilene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
3-Methylcholanthrene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2-methyl-4,6-Dinitrophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
methyl Methane sulfonate	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
1-Methylnaphthalene	----------------------	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
2-Methylnaphthalene	----------------------	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
2-Methylphenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
3+4-Methylphenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Naphthalene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
1,4-Naphthoquinone	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
1-Naphthylamine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2-Naphthylamine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2-Nitroaniline	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
3-Nitroaniline	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
4-Nitroaniline	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Nitrobenzene	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
2-Nitrophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
4-Nitrophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Nitroquinoline-1-oxide	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodiethylamine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodimethylamine	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
N-Nitrosodi-n-butylamine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodi-n-propylamine	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM	EPA 8270C/8270D EPA 8270C SIM/8270D SIM
N-Nitrosodiphenylamine	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosomethylethylamine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosomorpholine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
N-Nitrosopiperidine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosopyrrolidine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
5-nitro-o-Toluidine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2,2-oxybis(1-chloropropane)	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Parathion, methyl	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Parathion, ethyl	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Pentachlorobenzene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Pentachloroethane	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Pentachloronitobenzene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Pentachlorophenol	EPA 625	EPA 8270C/8270D EPA 8270C SIM/8270D SIM EPA 8321A/8321B	EPA 8270C/8270D EPA 8270C SIM/8270D SIM EPA 8321A/8321B
Phenacetin	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Phenanthrene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Phenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Phorate	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
2-Picoline	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Pronamide	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Pyrene	EPA 625	EPA 8270C/8270D EPA 8270D SIM	EPA 8270C/8270D EPA 8270D SIM
Pyridine	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
Safrole	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Sulfotepp	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
1,2,4,5-Tetrachlorobenzene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
2,3,4,6-Tetrachlorophenol	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Thionazin	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
o-Toluidine	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
1,2,4-Trichlorobenzene	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
2,4,5-Trichlorophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
2,4,6-Trichlorophenol	EPA 625	EPA 8270C/8270D	EPA 8270C/8270D
o,o,o-triethyl Phosphorothioate	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
1,3,5-Trinitrobenzene	----------------------	EPA 8270C/8270D	EPA 8270C/8270D
Motor Oil (Residual Range Organics)	----------------------	EPA 8015B/8015C/8015D AK103/OK DEQ RRO	EPA 8015B/ 8015C/8015D AK103/ OK DEQ RRO
Pesticides/Herbicides/PCBs			
Aldrin	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Atrazine	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Azinophos ethyl	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Azinophos methyl	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
alpha-BHC	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
beta-BHC	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
delta-BHC	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
gamma-BHC	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Bolstar	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
alpha-Chlordane	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
gamma-Chlordane	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Chlordane (technical)	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Chloropyrifos	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Coumaphos	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
2,4-D	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
Dalapon	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
2,4-DB	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
4,4’-DDD	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
4,4’-DDE	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
4,4’-DDT	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Demeton-O	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Demeton-S	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Demeton, total	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Diazinon	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Dicamba	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
Dichlorovos	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Dichloroprop	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
Dieldrin	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Dimethoate	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Dinoseb	----------------------	EPA 8151A EPA 8321A	EPA 8321A
Disulfoton	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Endosulfan I	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Endosulfan II	EPA 608	EPA 8081A /8081B	EPA 8081A/8081B
Endonsulfan sulfate	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Endrin	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Endrin aldehyde	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Endrin ketone	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
EPN	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Ethoprop	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Ethyl Parathion	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Famphur	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Fensulfothion	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Fenthion	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Heptachlor	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Heptachlor epoxide	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Hexachlorobenzene	----------------------	EPA 8081A/8081B	EPA 8081A/8081B
Malathion	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
MCPA	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
MCPP	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA8321A
Merphos	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Methoxychlor	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Methyl parathion	----------------------	EPA 8141A/8141B	EPA 8141A/8141B

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Mevinphos	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Naled	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
PCB-1016 (Arochlor)	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1221	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1232	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1242	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1248	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1254	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1260	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1262	EPA 608	EPA 8082/8082A	EPA 8082/8082A
PCB-1268	EPA 608	EPA 8082/8082A	EPA 8082/8082A
Total PCBs	EPA 608	EPA 8082/8082A	EPA 8082/8082A
Phorate	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Phosmet	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Propazine	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Ronnel	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Simazine	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Stirophos	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Sulfotepp	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
2,4,5-T	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
Thionazin	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Tokuthion	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
2,4,5-TP	----------------------	EPA 8151A EPA 8321A	EPA 8151A EPA 8321A
Toxaphene	EPA 608	EPA 8081A/8081B	EPA 8081A/8081B
Trichloronate	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
o,o,o-triethylphos Phorothioate	----------------------	EPA 8141A/8141B	EPA 8141A/8141B
Explosives			
1,3,5-Trinitrobenzene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
1,3-Dinitrobenzene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
2,4,6-Trinitrotoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
3,5-Dinitroaniline	----------------------	EPA 8330B	EPA 8330B
2,4-Dinitrotoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
2,6-Dinitroltoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
2-amino-4,6-Dinitrotoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
2-Nitrotoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
3-Nitrotoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
4-amino-2,6-Dinitrotoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
4-Nitrotoluene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
Nitrobenzene	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
Nitroglycerin	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
HMX (octahydro-1,3,5,7-tetrabitro-1,3,5,7-Tetrazocine)	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
Pentaerythritoltetranitrate (PETN)	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
Picric acid	----------------------	EPA 8330A/8330B	EPA 8330A/8330B
RDX (hexahydro-1,3,5-trinitro-1,3,5-Triazine)	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
Tetryl (methyl 2,4,6-Trinitrophenylnitramine	----------------------	EPA 8330A/8330B EPA 8321A/8321B	EPA 8330A/8330B EPA 8321A/8321B
Explosives LC/MS/MS			
1,3,5-Trinitrobenzene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
1,3-Dinitrobenzene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
2,4,6-Trinitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
3,5-Dinitroaniline	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
2,4-Diamino-4-nitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
2,4-Dinitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
2,6-Diamino-6-nitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
2,6-Dinitroltoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
2-Amino-4,6-Dinitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
2-Nitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
3-Nitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
4-Amino-2,6-Dinitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
4-Nitrotoluene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
DNX (hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine)	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
MNX (hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine)	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
Nitrobenzene	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
Nitroglycerin	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
HMX (octahydro-1,3,5,7-tetrabitro-1,3,5,7-Tetrazocine)	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
Pentaerythritoltetranitrate (PETN)	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
RDX (hexahydro-1,3,5-trinitro-1,3,5-Triazine)	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
Tetryl (methyl 2,4,6-Trinitrophenylnitramine	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
TNX (hexahydro-1,3,5-trinitroso-1,3,5-triazine)	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
Tris(o-cresyl)phosphate	----------------------	EPA 8321A/8321B	EPA 8321A/8321B

Parameter/Analyte	**Non-Potable Water**	**Solid Hazardous Waste (Water)**	**Solid Hazardous Waste (Solid)**
Chemical Warfare Agents			
Thiodiglycol (2,2’-Thiodiethanol)	----------------------	EPA 8321A/8321B	EPA 8321A/8321B
Hazardous Waste Characteristics			
Conductivity	----------------------	EPA 9050A	EPA 9050A
Corrosivity	----------------------	EPA 9040B/9040C	EPA 9045C/9045D
Paint filter liquids test	----------------------	EPA 9095A	EPA 9095A
Synthetic Precipitation Leaching Procedure (SPLP)	----------------------	EPA 1312	EPA 1312
Toxicity Characteristic Leaching Procedure	----------------------	EPA 1311	EPA 1311
Organic Prep Methods			
Separatory funnel liquid-liquid extraction	----------------------	EPA 3510C	--------------------------
Continuous liquid-liquid extraction	----------------------	EPA 3520C	--------------------------
Soxhlet extraction	----------------------	----------------------------	EPA 3540C
Microwave extraction	----------------------	----------------------------	EPA 3546
Ultrasonic extraction	----------------------	----------------------------	EPA 3550B/3550C
Waste dilution	----------------------	EPA 3580A	EPA 3580A
Solid phase extraction	----------------------	EPA 3535A	--------------------------
Volatiles purge and trap	----------------------	EPA 5030B	EPA 5030A EPA 5035/5035A
Organic Cleanup Procedures			
Florisil cleanup	----------------------	EPA 3620B	EPA 3620B
Florisil cleanup	----------------------	EPA 3620C	EPA 3620C
Sulfur cleanup	----------------------	EPA 3660A	EPA 3660A
Sulfuric acid/Permanganate cleanup	----------------------	EPA 3665A	EPA 3665A
Metals Digestion			
Acid digestion total recoverable or dissolved metals	----------------------	EPA 3005A	--------------------------
Acid digestion for total metals	----------------------	EPA 3010A	--------------------------
Acid digestion for total metals	----------------------	EPA 3020A	--------------------------
Acid digestion of sediments, sludges and soils	----------------------	----------------------------	EPA 3050B

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program), accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

WYOMING STORAGE TANK PROGRAM

Parameter/Analyte	**Method**
Metals	
Cadmium	EPA 6010C
Chromium	EPA 6010C
Lead	EPA 6010C
Wet Chemistry	
Hexavalent chromium	EPA 7196A
Pureable Organics (volatiles)	
tert-Amyl Methyl Ether	EPA 8260B
Benzene	EPA 8260B EPA 8021B
tert-Butyl alcohol (2-Methyl-2-propanol)	EPA 8260B
1,2-Dichloroethane	EPA 8260B
Di-isopropylether	EPA 8260B
Ethyl benzene	EPA 8260B EPA 8021B
Ethyl tert-butyl ether	EPA 8260B
Gas Range Organics (GRO)	EPA 8015C
Methyl tert-butyl ether (MTBE)	EPA 8260B EPA 8021B
Naphthalene	EPA 8260B EPA 8021B
Toluene	EPA 8260B EPA 8021B
Xylenes, total	EPA 8260B EPA 8021B
1,2-Xylene	EPA 8260B EPA 8021B
M+P-Xylene	EPA 8260B EPA 8021B
Extractable Organics (semivolatiles)	
Diesel Range Organics (DRO)	EPA 8015C (WY: C10-C32)
Organic Prep Methods	
Volatiles purge and trap	EPA 5030B (water) /5030A (solids)

Accredited Laboratory

A2LA has accredited

TESTAMERICA DENVER

Arvada, CO

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.1 of the DoD Quality System Manual for Environmental Laboratories (QSM), accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 30th day of October 2017.

President & CEO
For the Accreditation Council
Certificate Number 2907.01
Valid to October 31, 2019
Revised August 13, 2018

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

Katahdin Analytical Services, LLC
600 Technology Way
Scarborough, ME 04074

has been assessed by ANAB and meets the requirements of international standard

ISO/IEC 17025:2005

and the

US Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V 5.1)

while demonstrating technical competence in the field of

TESTING

Refer to the accompanying Scope of Accreditation for information regarding the types of activities to which this accreditation applies

L2223
Certificate Number

ANAB Approval

Certificate Valid Through: 02/01/2022
Version No. 004   Issued: 01/16/2019

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 AND DOD QUALITY SYSTEMS MAUAL FOR ENVIRONMENTAL LABORATORIES (DOD QSM V 5.1)

Katahdin Analytical Services, LLC

600 Technology Way
Scarborough, ME 04074
Leslie Dimond
207-874-2400

TESTING

Valid to: **February 1, 2022**　　Certificate Number: **L2223**

Environmental

Non-Potable Water

Technology	Method	Analyte
GC/ECD	EPA 8081B	2, 4`-DDD
GC/ECD	EPA 8081B	2, 4`-DDE
GC/ECD	EPA 8081B	2, 4`-DDT
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDD
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDE
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDT
GC/ECD	EPA 608; EPA 8081B	Aldrin
GC/ECD	EPA 608; EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane/cis-chlordane
GC/ECD	EPA 608; EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Cis-Nonaclor
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 608; EPA 8081B	delta-BHC
GC/ECD	EPA 608; EPA 8081B	Dieldrin
GC/ECD	EPA 608; EPA 8081B	Endosulfan I
GC/ECD	EPA 608; EPA 8081B	Endosulfan II
GC/ECD	EPA 608; EPA 8081B	Endosulfan sulfate

Non-Potable Water

Technology	Method	Analyte
GC/ECD	EPA 608; EPA 8081B	Endrin
GC/ECD	EPA 608; EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane/trans-Chlordane
GC/ECD	EPA 608; EPA 8081B	Heptachlor
GC/ECD	EPA 608; EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 608; EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	trans-Nonachlor
GC/ECD	EPA 608; EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)

Non-Potable Water

Technology	Method	Analyte
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5’-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3’, 4, 4’, 5, 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5’-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4’, 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4’, 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB

Non-Potable Water

Technology	Method	Analyte
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D MOD	Diesel range organics (DRO)
GC/FID	EPA 8015C/D MOD	Total Petroleum Hydrocarbon (TPH)
GC/FID	EPA 8015C/D MOD	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	CT ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromo-3-chloropropane
GC/FID	RSK-175	Methane Ethane Ethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 1-Trichloroethane
GC/MS	EPA 624; 8260B/C; EPA 524.2	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 2-Trichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1-Dichloropropene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromoethane (EDB)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3, 5-Trimethylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3-Dichloropropane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C; EPA 524.2	2, 2-Dichloropropane
GC/MS	EPA 8260B/C; EPA 524.2	2-Butanone
GC/MS	EPA 624; EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C; EPA 524.2	2-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	2-Hexanone
GC/MS	EPA 8260B/C; EPA 524.2	4-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C; EPA 524.2	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 624; EPA 8260B/C	Acrolein
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Acrylonitrile

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C; EPA 524.2	Allyl chloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C; EPA 524.2	Bromobenzene
GC/MS	EPA 8260B/C; EPA 524.2	Bromochloromethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromodichloromethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromoform
GC/MS	EPA 8260B/C; EPA 524.2	Carbon disulfide
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Carbon tetrachloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C; EPA 524.2	cis-1, 2-Dichloroethene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	Cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dibromochloromethane
GC/MS	EPA 8260B/C; EPA 524.2	Dibromomethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dichlorodifluoromethane
GC/MS	EPA 8260B/C; EPA 524.2	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C; EPA 524.2	Ethyl methacrylate
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C; EPA 524.2	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C; EPA 524.2	Isopropyl benzene
GC/MS	EPA 8260B/C; EPA 524.2	m p-xylenes
GC/MS	EPA 8260B/C	Methyl acetate
GC/MS	EPA 8260B/C	Methacrylonitrile
GC/MS	EPA 624; EPA 8260B/C	Methyl bromide (Bromomethane)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C	Methyl methacrylate
GC/MS	EPA 8260B/C; EPA 524.2	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methylene chloride
GC/MS	EPA 8260B/C; EPA 524.2	Naphthalene
GC/MS	EPA 8260B/C; EPA 524.2	n-Butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	n-Propylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	o-Xylene
GC/MS	EPA 8260B/C	Pentachloroethane
GC/MS	EPA 8260B/C; EPA 524.2	p-Isopropyltoluene
GC/MS	EPA 8260B/C; EPA 524.2	Propionitrile
GC/MS	EPA 8260B/C; EPA 524.2	sec-butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C; EPA 524.2	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Tetrachloroethene (Perchloroethylene)
GC/MS	EPA 8260B/C; EPA 524.2	Tetrahydrofuran

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Toluene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 2-Dichloroethylene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C; EPA 524.2	trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichloroethene (Trichloroethylene)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Vinyl chloride
GC/MS	EPA 624; EPA 8260B/C	Xylene
GC/MS	EPA 8260B/C SIM	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethene
GC/MS	EPA 8260B/C SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C SIM	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C SIM	1,2-Dibromoethane
GC/MS	EPA 8260B/C SIM	1,2-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,2-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,3-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,3-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,4-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	2-Hexanone

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C SIM	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C SIM	Benzene
GC/MS	EPA 8260B/C SIM	Bromodichloromethane
GC/MS	EPA 8260B/C SIM	Carbon Disulfide
GC/MS	EPA 8260B/C SIM	Carbon Tetrachloride
GC/MS	EPA 8260B/C SIM	Chloroform
GC/MS	EPA 8260B/C SIM	Chloromethane
GC/MS	EPA 8260B/C SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Dibromochloromethane
GC/MS	EPA 8260B/C SIM	Ethylbenzene
GC/MS	EPA 8260B/C SIM	Isopropylbenzene
GC/MS	EPA 8260B/C SIM	Hexachlorobutadiene
GC/MS	EPA 8260B/C SIM	Methylene chloride
GC/MS	EPA 8260B/C SIM	m,p-Xylene
GC/MS	EPA 8260B/C SIM	o-Xylene
GC/MS	EPA 8260B/C SIM	Tetrachloroethene
GC/MS	EPA 8260B/C SIM	Toluene
GC/MS	EPA 8260B/C SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	Trans-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Trichloroethene
GC/MS	EPA 8260B/C SIM	Trichlorofluoromethane
GC/MS	EPA 8260B/C SIM	Vinyl Chloride
GC/MS	EPA 8260B/C SIM	Xylenes (total)
GC/MS	EPA 8270C/D	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1, 3, 5-Trinitrobenzene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 625; EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dimethylphenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrotoluene (2, 4-DNT)
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 6-Dinitrotoluene (2, 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 625; EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 625; EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 625; EPA 8270C/D	2-Methyl-4 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3-Methylcholanthrene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl
GC/MS	EPA 625; EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 625; EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Chlorophenyl phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	3, 4-Methylphenol
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7, 12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine
GC/MS	EPA 625; EPA 8270C/D	Acenaphthene
GC/MS	EPA 625; EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 625; EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 625; EPA 8270C/D	Benzidine
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 625; EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Benzo(g h i)perylene
GC/MS	EPA 625; EPA 8270C/D	Benzo(k)fluoranthene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	1,1-Biphenyl
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethyl) ether
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane)
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl)adipate
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625; EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 625; EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 625	Dibenzo(a,c)anthracene
GC/MS	EPA 625; EPA 8270C/D	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran
GC/MS	EPA 8270C/D	Diethyladipate
GC/MS	EPA 625; EPA 8270C/D	Diethyl phthalate
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 625; EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Ethyl methacrylate

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 625; EPA 8270C/D	Fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Fluorene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobutadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 625; EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 625; EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methy methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 625; EPA 8270C/D	Naphthalene
GC/MS	EPA 625; EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodimethylamine
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 625; EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 625	Perylene
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 625; EPA 8270C/D	Phenanthrene
GC/MS	EPA 625; EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 625; EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 625; EPA 8270C/D	3, 3’-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3’-Dimethylbenzidine
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	Pyrene
HPLC/UV	EPA 8330A/B	1, 3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A/B	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4, 6 -Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	4-Amino-2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene
HPLC/UV	EPA 8330A/B	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A/B	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitroguanidine
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A/B	Tetryl
CVAA	EPA 245.1; EPA 7470A	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 200.7; EPA 6010C/D	Aluminum
ICP/AES	EPA 200.7; EPA 6010C/D	Antimony
ICP/AES	EPA 200.7; EPA 6010C/D	Arsenic
ICP/AES	EPA 200.7; EPA 6010C/D	Barium
ICP/AES	EPA 200.7; EPA 6010C/D	Beryllium
ICP/AES	EPA 200.7; EPA 6010C/D	Boron

Non-Potable Water

Technology	Method	Analyte
ICP/AES	EPA 200.7; EPA 6010C/D	Cadmium
ICP/AES	EPA 200.7; EPA 6010C/D	Calcium
ICP/AES	EPA 200.7; EPA 6010C/D	Chromium
ICP/AES	EPA 200.7; EPA 6010C/D	Cobalt
ICP/AES	EPA 200.7; EPA 6010C/D	Copper
ICP/AES	EPA 200.7; EPA 6010C/D	Iron
ICP/AES	EPA 200.7; EPA 6010C/D	Lead
ICP/AES	EPA 200.7; EPA 6010C/D	Magnesium
ICP/AES	EPA 200.7; EPA 6010C/D	Manganese
ICP/AES	EPA 200.7; EPA 6010C/D	Molybdenum
ICP/AES	EPA 200.7; EPA 6010C/D	Nickel
ICP/AES	EPA 200.7; EPA 6010C/D	Potassium
ICP/AES	EPA 200.7; EPA 6010C/D	Selenium
ICP/AES	EPA 200.7; EPA 6010C/D	Silicon
ICP/AES	EPA 200.7; EPA 6010C/D	Silver
ICP/AES	EPA 200.7; EPA 6010C/D	Sodium
ICP/AES	EPA 6010C/D	Strontium
ICP/AES	EPA 200.7; EPA 6010C/D	Thallium
ICP/AES	EPA 200.7; EPA 6010C/D	Tin
ICP/AES	EPA 200.7; EPA 6010C/D	Titanium
ICP/AES	EPA 200.7; EPA 6010C/D	Vanadium
ICP/AES	EPA 200.7; EPA 6010C/D	Zinc
ICP/MS	EPA 200.8; EPA 6020A/B	Aluminum
ICP/MS	EPA 200.8; EPA 6020A/B	Antimony
ICP/MS	EPA 200.8; EPA 6020A/B	Arsenic
ICP/MS	EPA 200.8; EPA 6020A/B	Barium
ICP/MS	EPA 200.8; EPA 6020A/B	Beryllium
ICP/MS	EPA 200.8; EPA 6020A/B	Boron
ICP/MS	EPA 200.8; EPA 6020A/B	Cadmium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/MS	EPA 200.8; EPA 6020A/B	Calcium
ICP/MS	EPA 200.8; EPA 6020A/B	Chromium
ICP/MS	EPA 200.8; EPA 6020A/B	Cobalt
ICP/MS	EPA 200.8; EPA 6020A/B	Copper
ICP/MS	EPA 200.8; EPA 6020A/B	Iron
ICP/MS	EPA 200.8; EPA 6020A/B	Lead
ICP/MS	EPA 200.8; EPA 6020A/B	Magnesium
ICP/MS	EPA 200.8; EPA 6020A/B	Manganese
ICP/MS	EPA 200.8; EPA 6020A/B	Molybdenum
ICP/MS	EPA 200.8; EPA 6020A/B	Nickel
ICP/MS	EPA 200.8; EPA 6020A/B	Potassium
ICP/MS	EPA 200.8; EPA 6020A/B	Selenium
ICP/MS	EPA 200.8; EPA 6020A/B	Silver
ICP/MS	EPA 200.8; EPA 6020A/B	Sodium
ICP/MS	EPA 6020A/B	Strontium
ICP/MS	EPA 200.8; EPA 6020A/B	Thallium
ICP/MS	EPA 200.8; EPA 6020A/B	Tin
ICP/MS	EPA 200.8; EPA 6020A/B	Titanium
ICP/MS	EPA 200.8; EPA 6020A/B	Tungsten
ICP/MS	EPA 200.8	Uranium
ICP/MS	EPA 200.8; EPA 6020A/B	Vanadium
ICP/MS	EPA 200.8; EPA 6020A/B	Zinc
IC	EPA 300.0; EPA 9056A	Chloride
IC	EPA 300.0; EPA 9056A	Fluoride
IC	EPA 300.0; EPA 9056A	Nitrate as N
IC	EPA 300.0; EPA 9056A	Nitrite as N
IC	EPA 300.0; EPA 9056A	Nitrate + Nitrite
IC	EPA 300.0; EPA 9056A	Orthophosphate as P
IC	EPA 300.0; EPA 9056A	Sulfate

Non-Potable Water

Technology	Method	Analyte
IC	SOP CA-776	Lactic Acid
IC	SOP CA-776	Acetic Acid
IC	SOP CA-776	Propionic Acid
IC	SOP CA-776	Formic Acid
IC	SOP CA-776	Butyric Acid
IC	SOP CA-776	Pyruvic Acid
IC	SOP CA-776	i-Pentanoic Acid
IC	SOP CA-776	Pentanoic Acid
IC	SOP CA-776	i-Hexanoic Acid
IC	SOP CA-776	Hexanoic Acid
Titration	EPA 310.1; SM 2320B	Alkalinity
Caculation	SM 2340B	Hardness
Gravimetric	EPA 1664A; EPA 9070A	Oil and Grease, Oil and Grease with SGT
Gravimetric	SM 2540B/C/D	Solids
ISE	EPA 120.1; SM 2510B	Conductivity
ISE	SM 2520B	Practical Salinity
ISE	SM 4500F- C	Fluoride
ISE	SM 4500H+ B	pH
ISE	SM 5210B	TBOD / CBOD
Physical	EPA 1010A	Ignitability
Physical	EPA 9040C	pH
Titration	SM 2340C	Hardness
Titration	SM 4500SO$_3$ B	Sulfite
Titration	EPA 9034; SM 4500-S^{2-} F	Sulfide
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
IR	EPA 9060A; SM 5310B	Total organic carbon
Turbidimetric	EPA 180.1; SM 2130B	Turbidity
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 335.4; EPA 9012B; SM 4500-CN G	Amenable cyanide

Non-Potable Water

Technology	Method	Analyte
UV/VIS	EPA 350.1; SM 4500-NH3 H	Ammonia as N
UV/VIS	SM 3500Fe D	Ferrous Iron
UV/VIS	EPA 351.2	Kjeldahl nitrogen - total
UV/VIS	EPA 353.2; SM 4500-NO3 F	Nitrate + Nitrite
UV/VIS	EPA 353.2; SM 4500-NO3 F	Nitrate as N
UV/VIS	EPA 353.2; SM 4500-NO3 F	Nitrite as N
UV/VIS	EPA 365.2; SM 4500-P E	Orthophosphate as P
UV/VIS	EPA 365.4	Phosphorus total
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	EPA 410.4	COD
UV/VIS	EPA 420.1; EPA 9065	Total Phenolics
UV/VIS	SM 4500-Cl G	Total Residual Chlorine
UV/VIS	SM 5540C	MBAS
UV/VIS	EPA 7196A; SM 3500-Cr D	Chromium VI
UV/VIS	EPA 9012B; EPA 335.4	Total Cyanide
UV/VIS	EPA 9251; SM 4500-Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
Preparation	**Method**	**Type**
Cleanup Methods	EPA 3640A	Gel Permeation Clean-up
Cleanup Methods	EPA 3630C	Silica Gel
Cleanup Methods	EPA 3660B	Sulfur Clean-Up
Cleanup Methods	EPA 3665A	Sulfuric Acid Clean-Up
Organic Preparation	EPA 3510C	Separatory Funnel Extraction
Organic Preparation	EPA 3520C	Continuous Liquid-Liquid Extraction
Inorganic Preparation	EPA 3010A	Hotblock
Volatile Organic Preparation	EPA 5030C	Purge and Trap

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	2,4`-DDD
GC/ECD	EPA 8081B	2,4`-DDE
GC/ECD	EPA 8081B	2,4`-DDT
GC/ECD	EPA 8081B	4, 4`-DDD
GC/ECD	EPA 8081B	4, 4`-DDE
GC/ECD	EPA 8081B	4, 4`-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane/cis-chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	Cis-Nonachlor
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane/trans-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	Trans-Nonachlor
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 5', 6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5’-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3’, 4, 4’, 5, 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5’-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4’, 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4’, 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D MOD	Diesel range organics (DRO)
GC/FID	EPA 8015C/D MOD	Total Petroleum Hydrocarbons (TPH)
GC/FID	EPA 8015C/D MOD	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	MA DEP EPH EPA 3546	Extractable Petroleum Hydrocarbons Microwave Extraction Preparation
GC/FID	CT-ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260B/C	1, 1, 1-Trichloroethane
GC/MS	EPA 8260B/C	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C	1, 1-Dichloroethane
GC/MS	EPA 8260B/C	1, 1-Dichloroethylene
GC/MS	EPA 8260B/C	1, 1-Dichloropropene
GC/MS	EPA 8260B/C	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 2-Dibromoethane
GC/MS	EPA 8260B/C	1, 2-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 2-Dichloroethane
GC/MS	EPA 8260B/C	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 3, 5-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 3-Dichloropropane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C	2, 2-Dichloropropane
GC/MS	EPA 8260B/C	2-Butanone
GC/MS	EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C	2-Chlorotoluene
GC/MS	EPA 8260B/C	2-Hexanone
GC/MS	EPA 8260B/C	4-Chlorotoluene
GC/MS	EPA 8260B/C	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 8260B/C	Acrolein
GC/MS	EPA 8260B/C	Acrylonitrile
GC/MS	EPA 8260B/C	Allyl chloride
GC/MS	EPA 8260B/C	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C	Bromobenzene
GC/MS	EPA 8260B/C	Bromochloromethane
GC/MS	EPA 8260B/C	Bromodichloromethane
GC/MS	EPA 8260B/C	Bromoform
GC/MS	EPA 8260B/C	Carbon disulfide
GC/MS	EPA 8260B/C	Carbon tetrachloride
GC/MS	EPA 8260B/C	Chlorobenzene
GC/MS	EPA 8260B/C	Chloroethane
GC/MS	EPA 8260B/C	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C	cis-1, 2-Dichloroethene
GC/MS	EPA 8260B/C	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	cis-1,3-Dichloro-2-butene

Solid and Chemical Waste

Technology	Method	Analyte
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 8260B/C	Dibromochloromethane
GC/MS	EPA 8260B/C	Dibromomethane
GC/MS	EPA 8260B/C	Dichlorodifluoromethane
GC/MS	EPA 8260B/C	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B/C	Ethyl methacrylate
GC/MS	EPA 8260B/C	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether
GC/MS	EPA 8260B/C	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C	Isopropyl benzene
GC/MS	EPA 8260B/C	m p-xylenes
GC/MS	EPA 8260B/C	Methyl acetate
GC/MS	EPA 8260B/C	Methacrylonitrile
GC/MS	EPA 8260B/C	Methyl bromide (Bromomethane)
GC/MS	EPA 8260B/C	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C	Methyl methacrylate
GC/MS	EPA 8260B/C	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 8260B/C	Methylene chloride
GC/MS	EPA 8260B/C	Naphthalene
GC/MS	EPA 8260B/C	n-Butylbenzene
GC/MS	EPA 8260B/C	n-proplybenzene
GC/MS	EPA 8260B/C	o-Xylene
GC/MS	EPA 8260B/C	pentachloroethane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	p-Isopropyltoluene
GC/MS	EPA 8260B/C	Propionitrile
GC/MS	EPA 8260B/C	sec-butylbenzene
GC/MS	EPA 8260B/C	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 8260B/C	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260B/C	Tetrahydrofuran
GC/MS	EPA 8260B/C	Toluene
GC/MS	EPA 8260B/C	trans-1, 2-Dichloroethylene
GC/MS	EPA 8260B/C	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C	Trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 8260B/C	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260B/C	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate
GC/MS	EPA 8260B/C	Vinyl chloride
GC/MS	EPA 8260B/C	Xylene
GC/MS	EPA 8270C/D	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1, 3, 5-Trinitrobenzene
GC/MS	EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine

Solid and Chemical Waste

Technology	Method	Analyte
GC/MS	EPA 8270C/D	1,1-Biphenyl
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dimethylphenol
GC/MS	EPA 8270C/D	2, 4-Dinitrophenol
GC/MS	EPA 8270C/D	2, 4-Dinitrotoluene (2 4-DNT)
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 8270C/D	2, 6-Dinitrotoluene (2 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methyl-4, 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3, 3`-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3’-Dimethylbenzidine
GC/MS	EPA 8270C/D	3,4-Methylphenol
GC/MS	EPA 8270C/D	3-Methylcholanthrene
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g h i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	bis(2-Chloroethyl) ether
GC/MS	EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane))
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 8270C/D	Bis(2-Ethylhexyl)adipate
GC/MS	EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 8270C/D	Dibenzofuran
GC/MS	EPA 8270C/D	Diethyl phthalate
GC/MS	EPA 8270C/D	Diethyladipate
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methacrylate
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 8270C/D	Hexachlorobutadiene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methyl methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine
GC/MS	EPA 8270C/D	n-Nitrosodimethylamine
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine
GC/MS	EPA 8270C/D	O, O, O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2-pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 8270C/D	Pentachlorophenol

Solid and Chemical Waste

Technology	Method	Analyte
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol

Solid and Chemical Waste

Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol
GC/MS	EPA 8270C/D SIM	Pyrene
HPLC/UV	EPA 8330A	1 ,3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330A	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4, 6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene
HPLC/UV	EPA 8330A	3-Nitrotoluene

Solid and Chemical Waste

Technology	Method	Analyte
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene
HPLC/UV	EPA 8330A	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A	Tetryl
HPLC/UV	EPA 8330A	Nitroguanidine
HPLC/UV	EPA 8330B	1, 3, 5-Trinitrobenzene
HPLC/UV	EPA 8330B	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330B	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330B	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330B	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4, 6 –Dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,6,Dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene
HPLC/UV	EPA 8330B	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330B	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330B	Tetryl

Solid and Chemical Waste

Technology	Method	Analyte
HPLC/UV	EPA 8330B	Nitroguanidine
CVAA	EPA 7471B	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 6010C/D	Aluminum
ICP/AES	EPA 6010C/D	Antimony
ICP/AES	EPA 6010C/D	Arsenic
ICP/AES	EPA 6010C/D	Barium
ICP/AES	EPA 6010C/D	Beryllium
ICP/AES	EPA 6010C/D	Boron
ICP/AES	EPA 6010C/D	Cadmium
ICP/AES	EPA 6010C/D	Calcium
ICP/AES	EPA 6010C/D	Chromium
ICP/AES	EPA 6010C/D	Cobalt
ICP/AES	EPA 6010C/D	Copper
ICP/AES	EPA 6010C/D	Iron
ICP/AES	EPA 6010C/D	Lead
ICP/AES	EPA 6010C/D	Magnesium
ICP/AES	EPA 6010C/D	Manganese
ICP/AES	EPA 6010C/D	Molybdenum
ICP/AES	EPA 6010C/D	Nickel
ICP/AES	EPA 6010C/D	Potassium
ICP/AES	EPA 6010C/D	Selenium
ICP/AES	EPA 6010C/D	Silicon
ICP/AES	EPA 6010C/D	Silver
ICP/AES	EPA 6010C/D	Sodium
ICP/AES	EPA 6010C/D	Strontium
ICP/AES	EPA 6010C/D	Thallium
ICP/AES	EPA 6010C/D	Tin
ICP/AES	EPA 6010C/D	Titanium

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
ICP/AES	EPA 6010C/D	Vanadium
ICP/AES	EPA 6010C/D	Zinc
ICP/MS	EPA 6020A/B	Aluminum
ICP/MS	EPA 6020A/B	Antimony
ICP/MS	EPA 6020A/B	Arsenic
ICP/MS	EPA 6020A/B	Barium
ICP/MS	EPA 6020A/B	Beryllium
ICP/MS	EPA 6020A/B	Boron
ICP/MS	EPA 6020A/B	Cadmium
ICP/MS	EPA 6020A/B	Calcium
ICP/MS	EPA 6020A/B	Chromium
ICP/MS	EPA 6020A/B	Cobalt
ICP/MS	EPA 6020A/B	Copper
ICP/MS	EPA 6020A/B	Iron
ICP/MS	EPA 6020A/B	Lead
ICP/MS	EPA 6020A/B	Magnesium
ICP/MS	EPA 6020A/B	Manganese
ICP/MS	EPA 6020A/B	Molybdenum
ICP/MS	EPA 6020A/B	Nickel
ICP/MS	EPA 6020A/B	Potassium
ICP/MS	EPA 6020A/B	Selenium
ICP/MS	EPA 6020A/B	Silver
ICP/MS	EPA 6020A/B	Sodium
ICP/MS	EPA 6020A/B	Strontium
ICP/MS	EPA 6020A/B	Thallium
ICP/MS	EPA 6020A/B	Tin
ICP/MS	EPA 6020A/B	Titanium
ICP/MS	EPA 6020A/B	Tungsten
ICP/MS	EPA 6020A/B	Vanadium

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
ICP/MS	EPA 6020A/B	Zinc
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate as N
IC	EPA 9056A	Nitrite as N
IC	EPA 9056A	Orthophosphate
IC	EPA 9056A	Sulfate
Gravimetric	EPA 9071A/B	Oil and Grease, Oil and Grease with SGT
Physical	EPA 1010A	Ignitability
Physical	EPA 9045D	pH
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
Titration	Walkley-Black	Total Organic Carbon
IR	Lloyd Kahn	Total organic carbon
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 350.1; SM 4500-NH3 H	Ammonia as N
UV/VIS	EPA 9251; SM 4500-Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	SM 3500-Fe D	Ferrous Iron
Cleanup Methods	EPA 3630C	Silica Gel
UV/VIS	EPA 7196	Chromium VI
UV/VIS	EPA 7196A	Chromium VI
UV/VIS	EPA 9012B	Total cyanide
Grain Size	ASTM D422	
Preparation	**Method**	**Type**
Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure
Cleanup Methods	EPA 3660B	Sulfur Clean-up

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
Cleanup Methods	EPA 3620C	Florsil Clean-up
Cleanup Methods	EPA 3630C	Silica Gel Clean-up
Cleanup Methods	EPA 3640A	GPC Clean-up
Organic Preparation	EPA 3540C	Soxhlet Extraction
Organic Preparation	EPA 3545A	Pressurized Fluid Extraction
Organic Preparation	EPA 3546	Microwave Extraction Preparation for EPA 8082A, 8081B and 8270C, D, 8015C/D
Organic Preparation	EPA 3550C	Sonication
Inorganics Preparation	EPA 3050B	Hotblock
Inorganics Preparation	EPA 3060A	Alkaline Digestion
Volatile Organics Preparation	EPA 5035/5035A	Closed System Purge and Trap

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	1, 1, 1-Trichloroethane
GC/MS	EPA TO-15	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA TO-15	1, 1, 2-Trichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethylene
GC/MS	EPA TO-15	1, 2, 4-Trichlorobenzene
GC/MS	EPA TO-15	1, 2, 4-Trimethylbenzene
GC/MS	EPA TO-15	1, 2-Dibromoethane (EDB)
GC/MS	EPA TO-15	1, 2-Dichlorobenzene
GC/MS	EPA TO-15	1, 2-Dichloroethane
GC/MS	EPA TO-15	1, 2-Dichloroethenes (Total)
GC/MS	EPA TO-15	1, 2-Dichloropropane
GC/MS	EPA TO-15	1, 3, 5-Trimethylbenzene
GC/MS	EPA TO-15	1, 3-Butadiene

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	1, 3-Dichlorobenzene
GC/MS	EPA TO-15	1, 4-Dichlorobenzene
GC/MS	EPA TO-15	1, 4-Dioxane
GC/MS	EPA TO-15	1,1,2-Trichloro1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA TO-15	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
GC/MS	EPA TO-15	1,4-Difluorobenzene
GC/MS	EPA TO-15	2,2,4-Trimethylpentane
GC/MS	EPA TO-15	2-Butanone
GC/MS	EPA TO-15	2-Chlorotoluene
GC/MS	EPA TO-15	2-Hexanone
GC/MS	EPA TO-15	2-Propanol
GC/MS	EPA TO-15	3-Chloropropene (Allyl chloride)
GC/MS	EPA TO-15	4-Ethyltoluene
GC/MS	EPA TO-15	4-Methyl-2-pentanone
GC/MS	EPA TO-15	Acetone
GC/MS	EPA TO-15	Acrolein
GC/MS	EPA TO-15	Benzene
GC/MS	EPA TO-15	Benzyl chloride
GC/MS	EPA TO-15	Bromochloromethane
GC/MS	EPA TO-15	Bromodichloromethane
GC/MS	EPA TO-15	Bromoform
GC/MS	EPA TO-15	Carbon disulfide
GC/MS	EPA TO-15	Carbon tetrachloride
GC/MS	EPA TO-15	Chlorobenzene
GC/MS	EPA TO-15	Chloroethane
GC/MS	EPA TO-15	Chloroform
GC/MS	EPA TO-15	Cis-1, 2-Dichloroethene
GC/MS	EPA TO-15	Cis-1, 3-Dichloropropene
GC/MS	EPA TO-15	Cyclohexane

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	Dibromochloromethane
GC/MS	EPA TO-15	Dichlorodifluoromethane (Freon 12)
GC/MS	EPA TO-15	Ethanol
GC/MS	EPA TO-15	Ethyl acetate
GC/MS	EPA TO-15	Ethylbenzene
GC/MS	EPA TO-15	Hexachlorobutadiene
GC/MS	EPA TO-15	Isopropyl alcohol
GC/MS	EPA TO-15	Isopropylbenzene
GC/MS	EPA TO-15	m, p-Xylene
GC/MS	EPA TO-15	Methyl bromide (Bromomethane)
GC/MS	EPA TO-15	Methyl chloride (Chloromethane)
GC/MS	EPA TO-15	Methyl methacrylate
GC/MS	EPA TO-15	Methyl tert-butyl ether
GC/MS	EPA TO-15	Methylene chloride
GC/MS	EPA TO-15	Naphthalene
GC/MS	EPA TO-15	n-Heptane
GC/MS	EPA TO-15	n-Hexane
GC/MS	EPA TO-15	o-Xylene
GC/MS	EPA TO-15	Propene
GC/MS	EPA TO-15	Styrene
GC/MS	EPA TO-15	tert-Butyl alcohol
GC/MS	EPA TO-15	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA TO-15	Tetrahydrofuran
GC/MS	EPA TO-15	Toluene
GC/MS	EPA TO-15	trans-1, 2-Dichloroethylene
GC/MS	EPA TO-15	trans-1, 3-Dichloropropylene
GC/MS	EPA TO-15	Trichloroethene (Trichloroethylene)
GC/MS	EPA TO-15	Trichlorofluoromethane (Freon 11)
GC/MS	EPA TO-15	Vinyl acetate
GC/MS	EPA TO-15	Vinyl bromide

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	Vinyl chloride
GC/MS	EPA TO-15	Xylenes (Total)
GC/MS	MA DEP APH	Aliphatic C5-C8 range
GC/MS	MA DEP APH	Aliphatic C9-C12 range
GC/MS	MA DEP APH	Aromatic C9-C10 range
GC/MS	MA DEP APH	1,3-Butadiene
GC/MS	MA DEP APH	Benzene
GC/MS	MA DEP APH	Ethylbenzene
GC/MS	MA DEP APH	m+p-Xylene
GC/MS	MA DEP APH	Methyl tert-butyl ether
GC/MS	MA DEP APH	Naphthalene
GC/MS	MA DEP APH	o-Xylene
GC/MS	MA DEP APH	Toluene

Biological Tissue		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	4, 4`-DDD
GC/ECD	EPA 8081B	4, 4`-DDE
GC/ECD	EPA 8081B	4, 4`-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane/cis-Chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Cis-Nonaclor
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin

Biological Tissue		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane/trans-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	trans-Nonachlor
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5’-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)

Biological Tissue		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene

Biological Tissue		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol
GC/MS	EPA 8270C/D SIM	Pyrene
ICP/AES	EPA 6010C/D	Aluminum
ICP/AES	EPA 6010C/D	Antimony

Biological Tissue		
Technology	**Method**	**Analyte**
ICP/AES	EPA 6010C/D	Arsenic
ICP/AES	EPA 6010C/D	Barium
ICP/AES	EPA 6010C/D	Beryllium
ICP/AES	EPA 6010C/D	Boron
ICP/AES	EPA 6010C/D	Cadmium
ICP/AES	EPA 6010C/D	Calcium
ICP/AES	EPA 6010C/D	Chromium
ICP/AES	EPA 6010C/D	Cobalt
ICP/AES	EPA 6010C/D	Copper
ICP/AES	EPA 6010C/D	Iron
ICP/AES	EPA 6010C/D	Lead
ICP/AES	EPA 6010C/D	Magnesium
ICP/AES	EPA 6010C/D	Manganese
ICP/AES	EPA 6010C/D	Molybdenum
ICP/AES	EPA 6010C/D	Nickel
ICP/AES	EPA 6010C/D	Potassium
ICP/AES	EPA 6010C/D	Selenium
ICP/AES	EPA 6010C/D	Silver
ICP/AES	EPA 6010C/D	Sodium
ICP/AES	EPA 6010C/D	Thallium
ICP/AES	EPA 6010C/D	Tin
ICP/AES	EPA 6010C/D	Vanadium
ICP/AES	EPA 6010C/D	Zinc
ICP/MS	EPA 6020A/B	Aluminum
ICP/MS	EPA 6020A/B	Antimony
ICP/MS	EPA 6020A/B	Arsenic
ICP/MS	EPA 6020A/B	Barium
ICP/MS	EPA 6020A/B	Beryllium
ICP/MS	EPA 6020A/B	Boron
ICP/MS	EPA 6020A/B	Cadmium

Biological Tissue		
Technology	**Method**	**Analyte**
ICP/MS	EPA 6020A/B	Calcium
ICP/MS	EPA 6020A/B	Chromium
ICP/MS	EPA 6020A/B	Cobalt
ICP/MS	EPA 6020A/B	Copper
ICP/MS	EPA 6020A/B	Iron
ICP/MS	EPA 6020A/B	Lead
ICP/MS	EPA 6020A/B	Magnesium
ICP/MS	EPA 6020A/B	Manganese
ICP/MS	EPA 6020A/B	Molybdenum
ICP/MS	EPA 6020A/B	Nickel
ICP/MS	EPA 6020A/B	Potassium
ICP/MS	EPA 6020A/B	Selenium
ICP/MS	EPA 6020A/B	Silver
ICP/MS	EPA 6020A/B	Sodium
ICP/MS	EPA 6020A/B	Thallium
ICP/MS	EPA 6020A/B	Tin
ICP/MS	EPA 6020A/B	Vanadium
ICP/MS	EPA 6020A/B	Zinc
CVAA	EPA 7471B	Mercury

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2223.

Vice President

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Appendix G

Laboratory Standard Operating Procedures

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Polychlorinated Biphenyls (PCBs) by GC/ECD (SW846 Method 8082 and 8082A)	DV-GC-0021
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Acid Digestion of Solids (EPA 3050B)	DV-IP-0015
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Appendix G

Laboratory Standard Operating Procedures

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TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Denver

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Title: Polychlorinated Biphenyls (PCBs) by GC/ECD [SW846 Methods 8082 and 8082A]

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1.0 Scope and Application

1.1 This SOP describes the procedure for the determination of concentrations of polychlorinated biphenyls (PCB) as Aroclors using the methodology prescribed in EPA SW-846 Method 8082 and 8082A.

1.2 This procedure is applicable to the gas chromatography analysis of extracts of aqueous, solid, and oil samples. When utilized for the analysis of oils, additional cleanup procedures may be required. This procedure also defines the conditions required when using a large volume injection.

1.3 This SOP does not include the procedures for extracting environmental samples. Refer to TestAmerica SOPs DV-OP-0006, DV-OP-0007, DV-OP-0015 and DV-OP-0016 for sample preparation procedures. Refer to SOP DV-OP-0012 for waste dilutions.

1.4 Additional information is provided in this SOP for the inclusion of the analysis of polychlorinated terphenyls (PCT) by the same protocols used for the determination of Aroclors.

1.5 This SOP does not include the determination of the concentration of PCB congeners.

1.6 Analytes, Matrix(s), and Reporting Limits

Tables 1 and LVI-1 list the specific Aroclors that are determined using this procedure and their associated reporting limits (RLs).

2.0 Summary of Method

2.1 Preparation

2.1.1 Aqueous Samples

PCBs are extracted from a one-liter aqueous sample with methylene chloride using a separatory funnel (SW-846 Method 3510). The extract is evaporated to approximately 25 mL and exchanged to hexane. The final extract volume is 10 mL, however depending on special client requirements the final extract volume can also be 1 mL or 5 mL. The extraction procedure is detailed in SOP DV-OP-0006.

2.1.2 LVI Aqueous Samples

PCBs are extracted from a 250 mL aqueous sample to a final volume of 5 mL with hexane (SW-846 Method 3510). The extraction procedure is detailed in SOP DV-OP-0006.

2.1.3 Solid Samples

PCBs are extracted from solid materials using either sonication or microwave extraction. If sonication extraction is selected the samples are extracted with a 50:50 Acetone:Methlyene Chloride mixture, concentrated down to approximately 25 mL, exchanged with hexane, and brought to a 10 mL final volume. See DV-OP-0016 and DV-OP-0007 for details. If microwave extraction is selected the samples are extracted with a 50:50 Acetone:Hexane mixture, and concentrated down to a 10 mL final volume. See DV-OP-0015 and DV-OP-0007 for details.

2.1.4 Oil Samples

Oil samples are typically prepared by diluting 1 gram of sample to a final volume of 10 mL with hexane. The extraction procedure is detailed in SOP DV-OP-0012.

2.1.5 Wipe Samples

Wipes are typically collected using either filter paper or gauze. These samples can then be extracted using the procedure outlined in SOP DV-OP-0016.

2.1.6 Cleanup Procedures

Cleanup options are discussed in Section 4 below. Instructions for performing various cleanup procedures are detailed in SOP DV-OP-0007. All cleanups that are performed must be documented in an NCM.

2.2 Analysis

Samples are analyzed using a gas chromatograph with dual electron capture detectors (ECDs). Specific Aroclor mixtures are identified by the pattern of peaks compared to chromatograms of reference standards. The concentrations of Aroclors in the sample extract are determined using an internal standard calibration. Second column confirmation is only performed when requested by the client or as a program requirement. Work under the DoD/DOE QSM program and method 8082A require second column confirmation. The presence of multiple peaks that are characteristic of an aroclor in the sample serves as confirmation of analyte presence.

3.0 Definitions

3.1 Polychlorinated biphenyls (PCBs): PCBs are a class of organic compounds with 1 to 10 chlorine atoms attached to biphenyl, with a general chemical formula of $C_{12}H_{10-x}Cl_x$. There are 209 possible congeners.

3.2 Aroclor: PCBs were produced as technical mixtures by the chlorination of biphenyl. Production processes were designed to produce mixtures with characteristic chlorine contents. In the United States, most of the PCBs in the environment are in the form of Aroclors, which were produced by Monsanto from the 1930s through 1977. Each Aroclor mixture is identified by a four-digit number, the first two digits of which indicate the number of carbons in the biphenyl ring, i.e., 12, and the second two of which indicate the weight percent of chlorine. For example, Aroclor 1254 has

12 carbons and 54% by weight chlorine. The exception is Aroclor 1016, which has 12 carbons and 42% by weight chlorine.

NOTE: Each specific Aroclor produces a characteristic gas chromatographic pattern that represents the relative amounts of PCB congeners in the formulation. The formulation of the mixtures from batch to batch was fairly consistent, but never exactly the same. In almost all cases, the gas chromatogram can be used as a fingerprint to identify the specific Aroclor. Exceptions occurred for Aroclors 1254 and 1221. In each case, at least one batch was produced under different conditions, which resulted in an Aroclor mixture with the same approximate chlorine content, but with a significantly different distribution of congeners. These odd batches of 1254 and 1221 produce chromatographic patterns that are very different from the typical formulations. Standards for these odd batch Aroclors can be used to aid in the qualitative identification of Aroclors in environmental samples.

3.3 AR1660: Laboratory designation for the mixture of Aroclors 1016 and 1260.

3.4 AR2154: Laboratory designation for the mixture of Aroclors 1221 and 1254.

3.5 AR3262: Laboratory designation for the mixture of Aroclors 1232 and 1262.

3.6 AR4268: Laboratory designation for the mixture of Aroclors 1242 and 1268.

3.7 Polychlorinated Terphenyls: Polychlorinated terphenyls (PCTs) are chemically related to PCBs with the exception that PCTs have an additional phenyl group. The PCTs included in this analysis are AR 5432, AR 5442, and AR 5460. The preparation and analysis is treated the same as for the PCB Aroclor analysis.

4.0 Interferences

4.1 Hydrocarbons can co-elute and thereby mask the Aroclor pattern. The laboratory uses acid cleanup with concentrated sulfuric acid to remove hydrocarbons from solid and oil sample extracts, and for water samples when extracts have noticeable color or whenever there is clear evidence of interferences in the initial sample chromatograms. Acid cleanup removes low-to-medium molecular weight polar organic interferences from sample extracts. Detailed instructions for performing acid cleanup are provided in SOP DV-OP-0007.

All QC is brought through the cleanup process and reported with the samples. An aliquot of all samples and QC is set aside and not brought through the cleanup process. If the QC is out of criteria due to the cleanup process then the QC that wasn't brought through the cleanup process will be analyzed and used to verify the batch for the samples not brought through clean-up.

4.2 Sulfur will interfere and can be removed using procedures described in SOP DV-OP-0007.

4.3 Contamination by carryover can occur when a low concentration sample is analyzed after a high concentration sample. Generally any sample that has a concentration greater than the highest calibration point will warrant consideration for carryover. Any affected samples are re-analyzed.

4.4 Interferences in the GC analysis arise from many compounds amenable to gas chromatography that give a measurable response on the electron capture detector.

4.4.1 Phthalate esters, which are common plasticizers, can pose a major problem in the determinations. Interferences from phthalates are minimized by avoiding contact with any plastic materials.

4.4.2 Single-component chlorinated pesticides, if present, may co-elute with individual PCB congeners and interfere with the identification and/or quantitation of the aroclors. This can be addressed by analyzing a chlorinated pesticide mixed standard prior to an initial calibration to identify where potential interferences might occur.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (M-E-001 DV), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.2 Specific Safety Concerns or Requirements

5.2.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.2.2 The gas chromatograph contains zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

5.2.3 There are areas of high voltage in the gas chromatograph. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

5.2.4 All ^{63}Ni sources shall be leak tested every six months, or in accordance with the manufacturer's general radioactive material license. All ^{63}Ni sources shall be inventoried every six months. If a detector is missing, the TestAmerica Denver Radiation Safety Officer and the TestAmerica Corporate EH&S Director shall be immediately notified and a letter sent to the Colorado Department of Public Health and Environment. Always use proper procedures for the safe handling of radioactive materials when working on the GC parts that come into direct contact with the ECD.

5.3 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Materials with Serious or Significant Hazard Rating

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Acetone	Flammable	1000 ppm (TWA)	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Hexane	Flammable Irritant	500 ppm (TWA)	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm (TWA) 125 ppm (STEL)	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Hydrogen gas	Explosive	None	The main hazard is flammability. Exposure to moderate concentrations may cause dizziness, headache, nausea, and unconsciousness. Exposures to atmospheres less than 8 to 10% oxygen will bring about sudden unconsciousness, leaving individuals unable to protect themselves. Lack of sufficient oxygen may cause serious injury or death.
Sulfuric Acid	Corrosive Carcinogen	1 mg/m3	Inhalation may cause irritation of the respiratory tract with burning pain of the nose and throat, coughing, wheezing, shortness of breath, and pulmonary edema. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Causes skin burns. Causes severe eye burns. May cause irreversible eye injury, blindness, permanent corneal opacification.

(1) Always add acid to water to prevent violent reactions.
(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Instrumentation

A gas chromatographic system with dual columns and dual ECD (^{63}Ni) detectors, and a data system capable of measuring peak area and/or height. The current instruments that are in use for this analysis are HP6890N-instrument P3 and HP5890 Series II- instrument W. Instrument R- HP5890 Series II may be used on occasion.

6.2 Computer Software and Hardware

Please refer to the master list of documents and software located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls (or current revision) for the current software and hardware to be used for data processing.

6.3 Columns

6.3.1 Primary Column: Rtx CLP Pest, 30 m x 0.32 mm id, 0.5 µm coating.

6.3.2 Secondary Column: Rtx CLP Pest II, 30 m x 0.32 mm id, 0.25 µm coating.

6.3.3 Additional columns that can be used for confirmation include 30m x 0.32mm id HP-5 or HP-1701.

6.4 Supplies

6.4.1 Autosampler vials, crimp caps with PTFE-faced septa.

6.4.2 Y-splitter, septa, guard columns, ferrules, Agilent deactivated injection port liners, Siltek glass wool.

6.4.3 Microsyringes, various sizes, for standards preparation, sample injection, and extract dilution.

6.4.4 Various class A volumetric flasks from 5 mL to 250 mL.

7.0 Reagents and Standards

7.1 Reagents

7.1.1 Acetone, 99.4% for organic residue analysis. Each lot is tested for purity prior to use per SOP S-T-001.

7.1.2 Hexane, pesticide grade. Each lot is tested for purity prior to use per SOP S-T-001.

7.1.3 Carrier Gas: ≥ 99.99999% pure hydrogen

7.1.4 Make-up Gas: ≥ 99.99980% pure nitrogen

7.2 Stock Standards

7.2.1 All standards are subject to verification using a second-source standard before they are used for sample analysis. This process is described in SOP DV-QA-0015.

7.2.2 All standards must be refrigerated at 0-6 ºC. All stock standards must be protected from light. Stock standard solutions should be brought to room temperature before use.

7.2.3 Stock standards are monitored for signs of degradation or evaporation. The standards must be replaced annually from the date of opening or earlier if the vendor indicates an earlier date.

7.2.4 Dilutions from stock standards cannot have a later expiration date than the date assigned to the parent stock solutions. The standards must be replaced at least every six months, or sooner if comparison with check standards indicates a problem.

7.3 PCB and Surrogate Stock Calibration Standards

7.3.1 Stock A (AR_(*Aroclor #*)_RES

For each of the Aroclors listed in Tables 1 and LVI-1, a commercially prepared stock standard solution is obtained. Each stock standard contains the specific Aroclor in pesticide-grade hexane (or in some cases, isooctane) at a concentration of 1,000 µg/mL. The current vendor is RESTEK (PCB/Catalog#) AR1016/32006, AR1221/32007, AR1232/32008, AR1242/32009, AR1248/32010, AR1254/32011, AR1260/32012, AR1262/32409, and AR1268/32410, other vendors may be used.

Surrogate Stock B (AR_SURR_RES)

A commercially prepared stock standard solution is obtained that contains the surrogate compounds tetrachloro-m-xylene (TCMX) and decachlorobiphenyl (DCB) in acetone, at a concentration of 200 µg/mL. The current vendor is RESTEK catalog #32000, other vendors may be used.

Internal Standard Stock

A commercially prepared stock standard solution is obtained that contains the internal standard 1-bromo-2-nitrobenzene in acetone, at a concentration of 1000 µg/mL. The current vendor is RESTEK catalog #32279, other vendors may be used.

7.3.2 PCT Stock

A commercially prepared stock standard solution is obtained that contains the individual PCT compounds at a concentration of 35 ug/mL in hexane. The current vendor is Accustandard and the catalog numbers are AR 5432

T432S, AR 5442 T442S, and AR 5460 T460S. Equivalent standards from other vendors and at other concentrations may be used.

7.4 Intermediate and Working Level Calibration Standard Solutions

7.4.1 Stock C (Level 7 Calibration) Standard Solutions

(AR_*(aroclor #)***_L***(level)*

A Stock C standard solution is prepared for the various Aroclors or combination of Aroclors as summarized in the following table. In each case, the Stock C standard solution is also the highest concentration (i.e., Level 7) calibration standard.

Stock C (Level 7)	Recipe	Conc (µg/mL)	Final Vol (mL)	Final Concentrations (µg/mL)	
AR_1660	0.1 mL of Aroclor 1016 Stock A	1000	100	Aroclor 1016	1.0
	0.1 mL of Aroclor 1260 Stock A	1000		Aroclor 1260	1.0
	0.025 mL of surrogate Stock B	200		TCMX	0.05
				DCB	0.05
AR_2154	0.1 mL of Aroclor 1221 Stock A	1000	100	Aroclor 1221	1.0
	0.1 mL of Aroclor 1254 Stock A	1000		Aroclor 1254	1.0
AR_3262	0.1 mL of Aroclor 1232 Stock A	1000	100	Aroclor 1232	1.0
	0.1 mL of Aroclor 1262 Stock A	1000		Aroclor 1262	1.0
AR_4268	0.1 mL of Aroclor 1242 Stock A	1000	100	Aroclor 1242	1.0
	0.1 mL of Aroclor 1268 Stock A	1000		Aroclor 1268	1.0
AR_1248	0.1 mL of Aroclor 1248 Stock A	1000	100	Aroclor 1248	1.0

ARHVI_*(aroclor #)***_L***(level)*

Stock C (Level 7)	LVI Recipe	Conc (µg/mL)	Final Vol (mL)	Final Concentrations (µg/mL)	
AR_1660	0.05 mL of Aroclor 1016 Stock A	1000	100	Aroclor 1016	0.5
	0.05 mL of Aroclor 1260 Stock A	1000		Aroclor 1260	0.5
	0.0125 mL of surrogate Stock B	200		TCMX	0.025
				DCB	0.025
AR_2154	0.05 mL of Aroclor 1221 Stock A	1000	100	Aroclor 1221	0.5
	0.05 mL of Aroclor 1254 Stock A	1000		Aroclor 1254	0.5
AR_3262	0.05 mL of Aroclor 1232 Stock A	1000	100	Aroclor 1232	0.5
	0.05 mL of Aroclor 1262 Stock A	1000		Aroclor 1262	0.5
AR_4268	0.05 mL of Aroclor 1242 Stock A	1000	100	Aroclor 1242	0.5
	0.05 mL of Aroclor 1268 Stock A	1000		Aroclor 1268	0.5

Stock C (Level 7)	LVI Recipe	Conc (µg/mL)	Final Vol (mL)	Final Concentrations (µg/mL)	
AR_1248	0.05 mL of Aroclor 1248 Stock A	1000	100	Aroclor 1248	0.5

7.4.2 AR_1660 Calibration Levels

A total of 7 calibration standards are prepared for AR_1660 as summarized in the following table. As needed, the following table can be used to prepare calibration standards for any of the Aroclors, but only the AR_1660 calibration standards include the surrogates. In all cases, measured volumes of the Stock C standard are diluted using pesticide-grade hexane to the final volume indicated in the following table.

Level	Vol of Stock C Used (mL)	Final Volume (mL)	Final PCB Conc (µg/mL)	Final Surrogate Conc (µg/mL)*
1	0.25	10	0.025	0.00125
2	0.5	10	0.050	0.0025
3	1.0	10	0.10	0.005
4	2.5	10	0.25	0.0125
5 (CCV)	5.0	10	0.50	0.025
5 (CCV) 1660 mix only	12.5	25	0.5	0.025
6	7.5	10	0.75	0.0375
7 (Stock C)	--	--	1.0	0.0500

* Surrogates are in the AR_1660 calibration solutions only. None of the other Aroclor calibration solutions contain the surrogate compounds.

LVI Level	Vol of LVI Stock C Used (mL)	Final Volume (mL)	Final PCB Conc (µg/mL)	Final Surrogate Conc (µg/mL)*
1	0.25	10	0.0125	0.00063
2	0.5	10	0.025	0.00125
3	1.0	10	0.05	0.0025
4	2.5	10	0.125	0.0625
5 (CCV)	5.0	10	0.25	0.0125
5 (CCV) 1660 mix only	12.5	25	0.25	0.0125
6	7.5	10	0.375	0.0188
7 (Stock C)	--	--	0.50	0.0250

* Surrogates are in the AR_1660 calibration solutions only. None of the other Aroclor calibration solutions contain the surrogate compounds.

7.4.3 Working Single-Point PCB Calibration Standards

The Level 5 standard in the table above is used for single-point calibrations of the individual Aroclors. These standards are also used as pattern recognition standards.

7.4.4 Polychlorinated Terphenyl Calibration Levels

A total of 7 calibration standards are prepared for PCTs as summarized in the following table. As needed, the following table can be used to prepare calibration standards for any of the PCTs. The level 7 standard is prepared from the stocks described in section 7.3.3 by diluting 1 mL of the stock to 35 mL final volume with hexane. The final concentration of the level 7 standard is 1.0 ug/mL. In all cases, measured volumes of the Level 7 standard are diluted using pesticide-grade hexane to the final volume indicated in the following table.

Level	Vol of Level 7 Used (mL)	Final Volume (mL)	Final PCT Conc (µg/mL)
1	0.25	10	0.025
2	0.5	10	0.05
3	1	10	0.10
4	2.5	10	0.25
5 (CCV)	5	10	0.50
6	7.5	10	0.75

7.5 Second-Source Standards for Initial Calibration Verification (ICV)

These standards are purchased from a vendor different from the one that supplied the stock calibration standards.

7.5.1 Second-Source Stock A' Aroclor Standard Solutions (AR_*(aroclor#)*_RESss

Commercially prepared solutions in pesticide-grade hexane (or isooctane) are routinely obtained for Aroclors 1016 and 1260. The Aroclor concentration in each solution is 1000 µg/mL. A second source may be obtained for the other Aroclors, if necessary. The current second source is RESTEK (PCB/Catalog#) AR1221/32007.sec; AR1016/1260/32039.sec; AR1232/32008.sec; AR1242/32009.sec; AR1248/32010.sec; AR1254/32011.sec; AR1262/32409.sec; AR1268/32410.sec, other vendors may be used.

Second source surrogate

A commercially prepared solution is obtained containing TCMX and DCB each at a concentration of 200 ug/mL. The current second source surrogate is Restek 32000.

Working Level ICV AR_*(aroclor#)*_ICV

The working level second source ICV standard is prepared by combining 0.025 mL of Aroclor 1016 Stock A', 0.025 mL of Aroclor 1260 stock A', and

0.00625 mL of the surrogate second source stock and diluting to a final volume of 100mL with pesticide grade hexane. This results in a concentration of 0.25 ug/mL for each of the Aroclors and 0.0125 ug/mL for each surrogate. If a second source verification standard is prepared for any of the Aroclors other than the AR_1660 mixture, the surrogates are not added to that mix.

7.5.2 PCT Second Source Stock and working level.

7.5.2.1 A commercially prepared solution of each of the PCT mixes is obtained from a different vendor and typically prepared at a concentration of 100 ug/mL in hexane. The current second source vendors and catalog numbers are AR 5432 Chem Services F290RPS, AR 5442 Chem Services F860RPS, and AR 5460 Chem Services F292RPS. Other vendors may be used.

7.5.2.2 The working level PCT standard is prepared at a concentration of 0.25 ug/mL by diluting 0.025 mL of each stock to a final volume of 10 mL.

7.6 Continuing Calibration Verification Standard (CCV), 0.5 µg/mL

The working CCV solution is the same as the Level 5 initial calibration standard, as shown in the table in Section 7.4.2.

7.7 RL Standard

The lowest concentration calibration standard (i.e., Level 1) is used as the RL Standard.

7.8 Laboratory Control Standard (LCS) Spiking Solution (AR1660)

NOTE: The LCS/MS spiking solution (8082LCS) is prepared and used as part of the scope of the organic preparation SOPs DV-OP-0006, DV-OP-0012, DV-OP-0015, and DV-OP-0016. The following information is provided for reference only.

In general the LCS is made up at a concentration of 2 µg/mL in a water-soluble solvent such as acetone. For oil samples extracted by waste-dilution, the standard is made in hexane. The standard contains Aroclors 1016 and 1260 only. Typically 1 mL of this standard is added to 1 liter of water samples, 30 g of soil samples, or 1 g of oil samples. The current LCS vendor is Restek at a concentration of 1000ug/ml. The solution is prepared by diluting 0.5 ml of this stock into 250 ml with acetone solvent.

7.9 Matrix Spike (MS) Spiking Solution:

The working matrix spike solution is the same as the LCS spike solution. Matrix spike samples are prepared by adding 1.0 mL of the working solution to a second one-liter aliquot of the selected aqueous sample, or to a 30-gram subsample of the selected soil sample. The MS duplicate (MSD) is prepared in the same way using a third aliquot of the selected sample.

7.10 Surrogate Spike Solution

7.10.1 Stock Surrogate Spike Solution:

A commercially prepared solution containing 200 µg/mL each of decachlorobiphenyl (DCB) and tetrachloro-m-xylene (TCMX) in acetone is purchased. The current source is Restek 32000.

7.10.2 Working Surrogate Spike Solution (8081/82 Surr)

NOTE: Samples are spiked with the surrogate compounds during sample preparation, which is described in the organic preparation SOPs DV-OP-0006, DV-OP-0012, DV-OP-0015 and DV-OP-0016. The following information is provided for reference only.

The working level surrogate solution is made up to contain DCB and TCMX at a concentration of 0.2 µg/mL. For water and soil samples the solution is made in a water-soluble solvent like acetone. For all oil samples extracted by waste dilution the solution is made in hexane.

7.11 Internal Standard Spiking solution 1 *µ*g/mL (BNB IS)

An intermediate stock (BNB stock) at 10 µg/mL is prepared by diluting 1 mL of the commercial Internal Standard Stock from Section 7.3 to a final volume of 100 mL in hexane. The Internal standard spiking solution is then prepared by diluting 10 mL of this intermediate to a final volume of 100 mL. Every standard, QC sample, and client sample is spiked with 0.1 mL of the internal standard spiking solution into 1 mL. For the LVI preparation 0.05 mL of internal standard is spiked into 1 mL of sample or standard.

7.12 Primer Mix

The primer mix typically consists of a mixture of CCV standards and/or old calibration standards. The concentrations of the components of the primer mix are not critical. The primer mix is injected one or more times prior to analyzing standards and samples to ensure that the chromatographic system is stable, i.e., that retention times are reproducible.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time[2]	Reference
Water[1]	Amber glass	1 Liter	Cool, $\leq$ 6°C	1 Year to extraction 40 days to analysis	SW-846

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time[2]	Reference
Water[3]	Amber glass	250 mL	Cool, ≤ 6°C	1 Year to extraction 40 days to analysis	SW-846
Solid	Glass	8 oz	Cool, ≤ 6°C	1 Year to extraction 40 days to analysis	SW-846

[1] To achieve routine reporting limits, a full one liter of sample is required. Additional one-liter portions are needed to satisfy the requirements for matrix spikes and duplicate matrix spikes.

[2] California, Connecticut, Pennsylvania and South Carolina do not allow the 1 year holding time. For work performed in these states, the extraction holding time is 7 days for water and 14 days for solid.

[3] Samples collected in 250 mL bottles will be extracted by SW846 method 3510 followed by analysis using the LVI procedure described in this SOP.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD/DOE QSM 5.0or 5.1 unless otherwise stated. Any deviation or exceptions from QSM 5.0 or 5.1 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). The current MDL value is maintained in the TestAmerica Denver LIMS. In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on an instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 13 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. A batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The minimum batch QC in each run is an acceptable method blank or instrument/calibration blank. See QA Policy DV-QA-003P for further details. For DoD QSM 4.2 or DOD/DOE QSM 5.0 or 5.1, the MS/MSD must be from the project site and if insufficient sample to analyze the MS/MSD pair is available, this is documented in an NCM and an LCSD is performed.

9.4 Method blank

A method blank is prepared and analyzed with each batch of samples. The method blank consists of reagent water (for aqueous sample batches) or Ottawa sand (for solid sample batches) to which the surrogate compounds are added. The method blank is subject to the entire extraction and analysis process. The method blank must be analyzed on every instrument that is used to analyze the samples from the batch.

Acceptance Criteria:	The method blank must not contain any analyte of interest at or above one-half the reporting limit (RL) or above one-tenth of the concentration found in the associated samples. See section 9.7 for further evaluation of the surrogate in the MB.
Corrective Action:	If the method blank exceeds allowable levels, the source of the contamination must be investigated and all associated samples that produced detections for the contaminant must be re-extracted and reanalyzed. Any samples that produce concentrations more than 10 times the concentration of the same compound as the blank contaminant may be reported with proper flagging and narration. Method Blanks for South Carolina compliance work MUST be below the RL.

9.5 Laboratory Control Sample (LCS)

One LCS is prepared and analyzed with each batch of samples. The LCS is prepared as described in Section 7.8. The LCS is subject to the entire extraction and analysis process.

Acceptance Criteria:	The LCS recovery must be within the established control limits. The laboratory's standard control limits are set at ±

3 standard deviations around the historical mean, unless project requirements dictate otherwise. Current control limits are maintained in LIMS. South Carolina requires the LCS to recover within limits of 70-130%.

Corrective Action: If recoveries are not within the established limits, the analytical system is out of control and corrective action must occur. All associated samples must be re-extracted and reanalyzed. If the LCS exceeds the upper control limit then all samples that do not contain detections for the affected compound may be reportable with client consent and proper flagging and narration. Note that exceptions for an out of control LCS are not allowed for DoD/DOE QSM 5.0 or 5.1 projects unless prior approval is indicated in the projects instructions.

9.6 Matrix Spike (MS) and Matrix Spike Duplicate Samples (MSD)

One MS/MSD pair is required with each analytical batch. Note that some programs (e.g., North Carolina and South Carolina) require preparation and analysis of an MS/MSD pair at a 10% frequency. Preparation of the MS is described in Section 7.9. The MSD is another aliquot of the sample selected for the MS that is spiked in the same manner as the MS. For DoD QSM 4.2 or DOD/DOE QSM 5.0 or 5.1, the MS/MSD must be from the project site and if insufficient sample to analyze the MS/MSD pair is available, this is documented in an NCM but no LCSD is performed.

Acceptance Criteria: The MS and MSD recoveries and the relative percent difference (RPD) between the MS and MSD results must be within the established control limits. Percent recovery control limits are set at ± 3 standard deviations around the historical mean of the LCS recovery data, unless otherwise dictated by the client or project. The RPD control limit is set at 3 standard deviations above the mean of the historical data.

NOTE: DOD/DOE QSM 5 limits apply to projects performed under this program.

Corrective Actions: The information obtained from MS data are sample/matrix specific and are not normally used to determine the validity of the entire batch. If the MS and/or MSD recovery falls outside of the established control limits, the bracketing CCV and batch LCS recoveries must be within control limits in order to accept results for the associated samples. The following corrective actions are required for MS/MSD recovery failures to rule out lab error:

- Check calculation and instrument performance;
- Verify, if possible, that the MS and MSD were spiked correctly (e.g., very low or very high recoveries);

- Consider objective evidence of matrix interference (e.g., heterogeneous sample, interfering peaks seen on chromatograms, or interference demonstrated by prior analyses);
- Flag the data for any results outside of acceptance limits.
- For any single RPD failure, check calculations; verify, if possible, that the MS and MSD were spiked correctly; check instrument performance; consider objective evidence of matrix interference or sample inhomogeneity; and flag the data.
- If both the parent sample and associated matrix spike results are over range the parent and the spikes shall be diluted by the same amount and the results from the reanalysis reported for both. If the analyte concentration in the parent sample is greater than four times the concentration of spike added, then spike recovery results are not compared to control limits, and the recovery is either reported as “NC” (not calculated) or with a qualifier flag to indicate that the spike was less than four times the analyte concentration in the sample. If the dilution will cause the spike to be less than two times the reporting limit, the MS/MSD do not need to be diluted and the recovery reported as “NC” (not calculated).
- For MS/MSD that serve as batch QC, if the parent sample result is within the calibration range and the MS/MSD results are above the calibration range, the results are reported with the MS/MSD result being flagged as an over-range measurement (e.g., the E-flag qualifier).
- If the MS/MSD are client requested, the parent sample result is within calibration range and the MS/MSD results are above the calibration range, the sample and spike should be diluted, keeping in mind that we need to assess whether or not the dilution will best serve the client’s needs. Consult with the PM as needed. Both the parent sample and MS/MSD samples must have the same dilution factor. Some EDDs do not accept data that are at different dilution factors.
- If the native analyte concentration in the MS/MSD sample exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated) and the appropriate qualifier flags are added.

NOTE: See Denver Policy Memorandum P16-001 and Corporate Policy Memorandum CA-Q-QM-013 for more detail.

NOTE: Some client programs require reanalysis to confirm matrix interferences. Check special project requirements for this corrective action.

9.7 Surrogates

Each field sample, QC sample, and each calibration standard that is used for the AR_1660 initial calibration, is spiked with surrogate compounds decachlorobiphenyl (DCB) and trichloro-m-xylene (TCMX). The surrogate spike solution is prepared as described in Section 7.10.

Acceptance Criteria: The surrogate recoveries must be within the established control limits, which are set at ± 3 standard deviations around the historical mean, unless project requirements dictate otherwise.

Corrective Action: If recoveries of the surrogates in blanks are outside of the control limits, check for calculation or instrument problems. High recoveries might be acceptable if the surrogate recoveries for the samples and other QC in the batch are acceptable. Low surrogate recoveries in the blank require re-extraction and reanalysis of the associated samples especially those that have detections for the targeted compounds that are found in the blank. Samples that are ND and have the surrogates in control may be reportable with proper flagging and NCM.

For field samples, surrogate recovery is calculated and reported for DCB only. TCMX may also be added. However, if both surrogate compounds are added, and recoveries calculated, and either surrogate fails to fall within the control limits, corrective actions are required (this also applies to programs that require the use of only one surrogate). Samples with surrogate recoveries that are above the upper control limit may be reportable with flagging and narration if they do not have reportable detections. See SOP DV-QA-003P for further evaluation.

If matrix interference is not obvious from the initial analysis, it is only necessary to re-extract and reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effects, as long as the extraction/instrument system is proven to be working properly.

9.8 Internal standard

Acceptance Criteria:	The internal standard recoveries must be within -50% to 200% for standard solutions of the recovery established by the midpoint of the ICAL or the opening CCV for the run on days when an ICAL is not analyzed. DOD/DOE QSM 5.0 does not have criteria for internal standards. The above criteria is used. DOD/DOE QSM 5.1 uses the above criteria.
Corrective Action:	If the internal standard response is outside of this range then the samples must be diluted until the recoveries are in control. Failure to meet this criteria in a CCV requires reanalysis of the standard and all affected samples analyzed in the bracket previous to the standard and after the standard. Recalibration is necessary if control cannot be established. For DOD/DOE QSM 5.1, if corrective action fails in field samples, the data must be qualified and explained in the case narrative. Flagging is not appropriate for failed standards.

10.0 Calibration and Standardization

10.1 TestAmerica Denver gas chromatograph instrument systems are computer controlled to automatically inject samples and process the resulting data.

10.1.1 Use the ChemStation chromatography data system to set up GC conditions for calibration. See Tables 2 and LVI-2 for typical operating conditions. The conditions described in Table LVI-2 are to be used when performing the large volume injection approach.

10.1.2 Transfer calibration standard solutions into autosampler vials and load into the GC autosampler. Use the Chrom worklist to set up the analytical sequence.

10.1.3 Transfer unprocessed calibration data to the Chrom database for processing. After processing the calibration data, print the calibration report and review it using the calibration review checklist (GC and HPLC Data Review Checklist - ICAL). Submit the calibration report to a qualified peer or the group leader for final review. The completed calibration checklist is scanned and stored in the documents section of each analytical batch.

10.2 A new calibration curve must be generated initially, after major changes to the system, or when continuing calibration criteria cannot be met. Major changes include installation of new columns.

10.3 Initial Calibration (ICAL)

10.3.1 Detailed information regarding calibration models and calculations can be found in Corporate SOP CA-Q-P-003 *Calibration Curves and the Selection* *of Calibration Points* and under the public folder, *Arizona Calibration Training*.

10.3.2 An internal standard calibration using seven concentration levels of the AR_1660 mixture is routinely performed. (At least five calibration levels are required.) This provides concentration levels for Aroclor 1016, Aroclor 1260, and the surrogate compounds DCB and TCMX.

10.3.2.1 Prior to the analysis of the ICAL the resolution for the triplet towards the end of the Aroclor 1260 chromatogram for peaks 1&2 and peaks 2&3 must be <75% on one of the two columns used for the analysis.

10.3.2.2 See Tables 3 and LVI-3 for Calibration Levels. Calibration levels defined in Table LVI-3 are appropriate when the large volume injection approach is used.

10.3.2.3 The initial calibration block must include at least one level with Aroclor 1016 analyzed separately for pattern recognition purposes. This run is <u>not</u> part of the actual calibration.

10.3.2.4 Prior to analysis of the initial calibration standards it is recommended that a chlorinated pesticide standard (Method 8081) be analyzed as a locater standard to identify potential interferences in samples due to the presence of chlorinated pesticides.

10.3.3 All initial calibration points must be analyzed without any changes to instrument conditions, and all points must be analyzed within 24 hours.

10.3.4 The calibration curves for Aroclors 1016 and 1260 and the surrogate compounds are modeled either as average response factors or as calibration curves using a systematic approach to selecting the optimum calibration function.

10.3.5 The calibration for each of the other Aroclors (see Table 1 or LVI-1) is initially determined using a single, mid-level calibration standard. As needed, the laboratory may generate a multi-point calibration for other commonly detected Aroclors, such as 1221, 1254, and 1248. When additional multi-point calibrations are developed for the other Aroclors, a second-source ICV standard is also analyzed. When Aroclors are detected, they must be re-analyzed after an acceptable calibration curve (minimum five points) and its verification (ICV) are obtained.

NOTE: Samples from sites known to be contaminated with specific Aroclors should be analyzed using a multi-point calibration curve for the identified Aroclors. This information is provided to the analyst through special instructions in LIMS.

NOTE: Generally, it is NOT acceptable to remove points from a calibration for the purposes of meeting calibration criteria. If calibration acceptance criteria are not met, the normal corrective action is to examine conditions such as instrument maintenance and accuracy of the preparation of the calibration standards. Any problems found must be fixed and documented in the run log or maintenance log. Then the calibration standard(s) must be reanalyzed

10.3.6 If no problems are found or there is documented evidence of a problem with a calibration point (e.g., obvious mis-injection explained in the run log), then one point might be rejected, but only if all of the following conditions are met:

10.3.6.1 The rejected point is the highest or lowest on the curve, i.e., the remaining points used for calibration must be contiguous; and

10.3.6.2 The lowest remaining calibration point is still at or below the project reporting limit; and

10.3.6.3 The highest remaining calibration point defines the upper concentration of the working range, and all samples producing results above this concentration are diluted and reanalyzed; and

10.3.6.4 The calibration must still have the minimum number of calibration levels required by the method, i.e., five levels for calibrations modeled with average response factors or linear regressions, or six levels for second-order curve fits.

10.3.6.5 If a data point is rejected, it must be documented on the calibration checklist, in the sequence log and on an NCM which is filed with each project that is reported from the calibration.

10.3.7 The high and low standard for the initial calibration of the AR_1660 mixture defines the acceptable quantitation range for all of the Aroclors. The low calibration standard must be at or below the RL. If a sample extract contains any Aroclor at a concentration that exceeds the upper range of the calibration, then the extract must be diluted with hexane and reanalyzed.

10.3.8 Select 5 major peaks in the analyte pattern (only 3 peaks are usable for Aroclor 1221). The peaks that are chosen should have responses that are at least 25% of the response for the largest peak in the Aroclor pattern, with the exception of Aroclor 1268 where the requirement is 10%. Try to include one peak that is unique (differs in size or location relative to the other common Aroclors) to the Aroclor being quantitated. Calculate the response of each of the major peaks for each Aroclor, and use these responses independently, averaging the resultant concentrations found in samples for a final concentration result. When using this option, it is appropriate to remove peaks that appear to be co-eluting with contaminant peaks from the quantitation (i.e., peaks that are significantly larger than would be expected from the rest of the pattern).

NOTE: A minimum of three accurate peaks must be used to quantify an Aroclor (two for Aroclor 1221).

10.4 Internal Standard Calibration

Internal standard calibration involves the comparison of an instrument response (e.g., peak area or peak height) from the target compound in the sample to the response of the internal standard compound, which is added to the sample or sample extract prior to injection. The same concentration of internal standard is added to each initial calibration standard. For each calibration level, the response factor, RF, is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$ *Equation 1*

Where:

A_s = Peak area (or height) of the analyte or surrogate.
A_{is} = Peak area (or height) of the internal standard.
C_s = Concentration of the analyte or surrogate, in µg/L.
C_{is} = Concentration of the internal standard, in µg/L.

10.5 Establishing the Calibration Function

Calibrations are modeled either as average response factors or as linear regression curves, using a systematic approach to select the optimum calibration function. Start with the simplest model, i.e., a straight line through the origin and progress through the other options until calibration acceptance criteria are met. For dual column analysis the initial calibration criteria must be met on both columns.

10.5.1 Linear Calibration Using Average Response Factor

The response factor is a measure of the slope of the calibration line, assuming that the line passes through the origin. Under ideal conditions, the factors calculated for each calibration level will not vary with the concentration of the standard. In practice, some variation can be expected. When the variation, measured as the relative standard deviation, is relatively small (e.g., ≤ 20%), the use of the straight line through the origin model is generally appropriate.

NOTE: For samples requiring adherence to SW 846 Methods 8000B and 8000D (including South Carolina compliance work), forcing through zero is NOT allowed.

10.5.1.1 The average response factor is calculated as follows:

$$\overline{RF} = \frac{\sum_{i=1}^{n} RF_i}{n}$$ Equation 2

Where:

RF_i = The response factor for the ith calibration level.
n = The number of calibration levels.

10.5.1.2 The relative standard deviation (RSD) is calculated as follows:

$$RSD = \frac{SD}{\overline{\overline{RF}}} \times 100\% \qquad \text{Equation 3}$$

Where SD is the standard deviation of the average RF, which is calculated as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(RF_i - \overline{RF}\right)^2}{n-1}} \qquad \text{Equation 4}$$

10.5.2 Evaluation of the Average Response Factor

Plot the calibration curve using the average RF as the slope of a line that passes through the origin. Examine the residuals, i.e., the difference between the actual calibration points and the plotted line. Particular attention should be paid to the residuals for the highest points, and if the residual values are relatively large, a linear regression should be considered.

Acceptance Criteria: The RSD must be ≤ 20%. SW-846 Method 8000B allows evaluation of the grand average across all compounds, but some programs (e.g., DoD/DOE QSM, Arizona and South Carolina require evaluation of each compound individually). Check project requirements.

Corrective Action: If the RSD exceeds the limit, linearity through the origin cannot be assumed, and a least-squares linear regression should be attempted.

10.5.3 Linear Calibration Using Least-Squares Regression

Calibration using least-squares linear regression produces a straight line that does not pass through the origin. The calibration relationship is constructed by performing a linear regression of the instrument response (peak area or peak height) versus the concentration of the standards. The instrument response is treated is the dependent variable (y) and the concentration as the independent variable (x). The regression produces the slope and intercept terms for a linear equation in the following form:

$$y = ax + b \qquad \text{Equation 5}$$

Where:

y = Instrument response (peak area or height).
x = Concentration of the target analyte in the calibration standard.

a = Slope of the line.
b = The y-intercept of the line.

For an internal standard calibration, the above equation takes the following form:

$$\frac{A_s C_{is}}{A_{is}} = aC_s + b \qquad \textit{Equation 6}$$

To calculate the concentration in an unknown sample extract, the regression equations 5 and 6 are solved for concentration, resulting in the following equations, where x and C_s are now the concentration of the target analyte in the unknown sample extract:

$$x = \frac{y-b}{a} \qquad \textit{Equation 7}$$

$$C_s = \frac{\left[\frac{A_s C_{is}}{A_{is}} - b\right]}{a} \qquad \textit{Equation 8}$$

10.5.4 Evaluation of the Linear Least-Squares Regression Calibration Function

With an unweighted linear regression, points at the lower end of the calibration curve have less weight in determining the curve than points at the high concentration end of the curve. For this reason, inverse weighting of the linear function is recommended to optimize the accuracy at low concentrations. Note that the August 7, 1998 EPA memorandum “Clarification Regarding Use of SW-846 Methods”, Attachment 2, Page 9, includes the statement “The Agency further recommends the use of this for weighted regression over the use of an unweighted regression.”

Acceptance Criteria: To avoid bias in low level results, the absolute value of the y-intercept must be significantly less than the reporting limit (RL), and preferably less than the MDL.

Also examine the residuals, but with particular attention to the residuals at the bottom of the curve. If the intercept or the residuals are large, the calibration should be repeated since a higher order regression is not allowed for this method.

The linear regression must have a correlation coefficient (r) ≥ 0.99. Some programs (e.g., DoD QSM 4.2) require a correlation coefficient ≥ 0.995. DoD/DOE QSM 5.0 and 5.1 require r^2 >0.99.

Corrective Action: If the correlation coefficient falls below the acceptance limit, the linear regression is unacceptable and the calibration should be repeated since a higher order regression is not allowed for this method.

10.5.5 Second-order regressions and polynomial regression fits of third order or higher are not allowed for this method.

10.10.1 Acceptance criteria independent of calibration model

10.10.1.1 Either of the procedures Percent Error or Relative Standard Error (RSE) may be used to determine calibration function acceptability for linear and non-linear curves. Both evaluate the difference between the measured and the true amounts or concentrations used to create the model.

$$\% \, Error = \frac{xi - x'i}{xi} x \, 100$$

Where: $x'i$ = measured amount of the analyte at calibration level *i* in mass or concentration units and xi = the true amount of the analyte at calibration level *i* in mass or concentration units.
% Error should be ≤ 30%. For some data uses ≤ 50% may be acceptable for the lowest calibration point.

Calculation of Relative Standard Error:

$$RSE = 100 \, x \sqrt{\sum_{i=1}^{n} \left[\frac{x_i' - x_i}{x_i} \right]^2 \Big/ (n-p)}$$

Where: *Xi* = True amount of the calibration level I, in mass or concentration units
X'i = measured amount of analyte in calibration level I, in mass or concentration units
p = number of terms in the fitting equation (average = 1), linear – 2, quaratic – 3)
n = number of calibration points
RSE acceptance criteria for the calibration model is the same as the RSD limit for CF or RF in the determinative method. IF not defined in the method, use ± 20%.

10.6 Second-Source Initial Calibration Verification (ICV)

An ICV is prepared for each multipoint calibration. The stock standards are obtained from a source different than that of the standards used for the calibration. The preparation of the ICV standard is described in Section 7.5. The concentration of each Aroclor in the ICV is 0.25 µg/mL; the concentration of each surrogate is 0.125 µg/mL. The ICV standard is analyzed immediately following the completion of the initial calibration. If any changes are made to the calibration curve types then the ICV must be recalculated to the final form of the ICAL.

Acceptance Criteria: The result for the target analyte(s) in the ICV standard must be within ± 15% of the expected value. Method 8082A and DOD/DOE QSM 5.0 and 5.1 allow a control of ± 20%.

Corrective Action: If this is not achieved, the ICV standard, calibration standards, and instrument operating conditions should be checked. Correct any problems and rerun the ICV standard. If the ICV still fails to meet acceptance criteria, then repeat the ICAL.

10.7 Continuing Calibration Verification (CCV), 0.50 ug/mL, LVI 0.25 ug/mL.

10.7.1 12-Hour Calibration Verification

The 12-hour calibration verification sequence consists of, at a minimum, an instrument blank and the mid-level calibration standard. The 12-hour calibration verification sequence must be analyzed within 12 hours of the start of the initial calibration and at least once every 12 hours thereafter when samples are being analyzed. If more than 12 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with a 12-hour calibration sequence.

NOTE: It is not necessary to run a CCV standard at the beginning of the sequence if samples are analyzed immediately after the completion of the initial calibration.

10.7.2 The mid-level calibration standard is analyzed as the continuing calibration verification (CCV) standard (see Section 7). At a minimum, this is analyzed after every 20 samples, including matrix spikes, LCSs, and method blanks. It may be appropriate to analyze a mid-level standard more frequently than every 12 hours. Some programs, specifically DoD/DOE QSM 5.0 and 5.1, require a CCV after every 10 field samples and at the end of the run. If 12 hours elapse, analyze the 12-hour standard sequence instead. Unless the program specifically requires a closing CCV (as above for DOD and DOE), a closing CCV is not required when using an internal standard. Check the projects requirements regarding the closing CCV.

If an aroclor other than 1016 or 1260 is identified in any sample then a CCV for the identified aroclor must be analyzed within 12 hours of the samples analysis. This CCV must meet proper CCV criteria.

For DOD/DOE QSM 5.0 or 5.1, the CCVs for aroclors other than 1016 and 1260 are only required before sample analysis.

10.7.3 RL Standard

It may be appropriate to analyze a standard prepared at or very near the reporting limit (RL) for the method between every 10 sample injections (see Section 7.7). This standard can be used to rule out false negatives in client samples in cases where the %D for one or more of the analytes in a bracketing CCV falls below the lower acceptance limit and the samples contain no analytes above the reporting limit. The results for the RL standard are not evaluated unless the previous CCV fails acceptance criteria or in the case of matrix effect to confirm the ability to see at the reporting limit.

NOTE: This procedure is not used when Method 8000C/D or DOD/DOE QSM 5.0 or 5.1 are required.

10.7.4 Acceptance Criteria for Continuing Calibration Verification (CCV)

10.7.4.1 Detected Analytes (≥ RL)

For any analyte detected at or above the reporting limit (RL) in client samples, the percent difference (%D) for that analyte in the preceding and following CCVs (i.e., bracketing CCVs) or 12-hour calibration, on the column used for quantitation, must be within ± 15%. Method 8082A and DOD/DOE QSM 5.0 and 5.1 require control of ± 20%. If a confirmation column is required (see Section 12.5), the CCV criteria must be met on both columns in order to confirm a detection. Both surrogates must pass in the CCV.

In some cases, the nature of the samples being analyzed may be the cause of a failing %D. When the %D for an analyte falls outside of acceptance criteria in the CCV, and that analyte is detected in any or all of the associated samples, then those samples must be reanalyzed to prove a matrix effect. If the drift is repeated in the reanalysis, the analyst must generate an NCM for this occurrence to explain that the drift was most likely attributable to the sample matrix and that the samples may be diluted and reanalyzed to minimize the effect; if so desired by the client. Dilution will typically be required to meet DOD 4.2 or DoD/DOE QSM 5.0 or 5.1 criteria.

Refer to Section 12 for which result to report.

The %D is calculated as follows:

$$\%D = \frac{\text{Measured Conc} - \text{Theoretical Conc}}{\text{Theoretical Conc}} \times 100 \qquad \text{Equation 8}$$

10.7.4.2 Analytes Not Detected (< RL)

For any analyte not detected (ND) in client samples, the %D for that analyte in the bracketing CCVs should also be within acceptance criteria.

However, if the CCV %D exceeds the upper control of the acceptance criteria and the sample results are ND, it still may be possible to report sample results. In this case, the client should be consulted and an NCM written. Note that exceptions to an out of control CCV are not allowed for DoD/DOE QSM 5.0 or 5.1 unless prior approval is noted in the project instructions.

If the CCV %D falls below acceptance criteria and sample results are ND, but the target analytes are detected in the RL Standard, it may still be possible to report sample results, since the detection of the analyte(s) in the RL Standard indicate that there was sufficient sensitivity to detect the analyte(s) in the samples. In this case, the client should be consulted and an NCM written. This would only be used in cases where the matrix is affecting CCV recovery and dilution of the affected sample(s) is not an alternative.

DoD/DOE QSM 5.0 or 5.1 requires recalibration and reanalysis of all affected samples since the last acceptable CCV. As an alternative, the laboratory may analyze two additional consecutive CCVs within one hour of the failed CCV. If both pass, then the samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate: then reanalyze all affected samples since the last acceptable CCV.

If a DoD or DOE client accepts TestAmerica's Technical Specifications for DoD/DOE QSM work, samples that have no detections when a CCV has recoveries above the project acceptance limits would be reported with a case narrative comment, in addition to applying any data qualifier flags required by the project.

10.8 Retention Time (RT) Windows

10.8.1 Determine the retention time (RT) windows for the 5 major peaks selected for each Aroclor (3 peaks for Aroclor 1221). The AR1016 windows will be used to establish retention time windows for AR1221, AR1016, AR1232, AR1242, and AR1248. The AR1260 windows will be used to establish retention time windows for AR1254, AR1260, AR1262, and AR1268.

10.8.2 Determine new RT windows each time a new column is installed or annually.

10.8.3 Evaluate the deviation from expected retention time for each analyte in at least three CCV and/or LCS samples spread over at least 72 hours.

10.8.4 If three days of analytical data are not available, use a default RT window of 0.01 minutes. At the end of the batch evaluate all CCVs and LCS in the batch. If necessary, widen the window such that all analytes fall within the RT window. Reprocess the batch using the new RT windows.

10.8.5 Multiply the maximum deviation by 1.5. This is the retention time window, unless the result is less than 0.01 min, in which case the window is set at 0.01 min. For example, if the maximum RT deviation for a specific analyte is 0.008 min, then the RT window is set at ± 0.012 min.

NOTE: For the Aroclors, the maximum deviation must be evaluated for each of the 3-5 major peaks used for sample calculations.

10.8.6 Retention time windows for analytes of interest must not overlap.

10.9 Ongoing Evaluation of Retention Time Windows

10.9.1 Evaluate the retention time windows on an ongoing basis. The center of the RT window is updated on the first CCV of the day. All analytes for all subsequent CCVs, LCS and matrix spikes must fall within the retention time window (except as discussed below).

10.9.1.1 Matrix spike analytes may fall outside the retention time window if there is a large non-target pak coeluting with the analyte in the matrix spike.

10.9.2 If any analytes fall outside the retention time window in CCVs, LCS or matrix spikes (except as discussed above for matrix spikes) then the RT windows for those analytes shall be widened to the minimum degree required for the analyte to fall within the RT window. All samples in the batch shall be reprocessed with the new RT window, and the wider RT window shall remain in place for subsequent batches.

10.9.3 Retention time windows should be reliably narrower than ± 0.03 min. If RT windows wider than this are necessary, the instrument should be evaluated and maintenance performed as needed. Subsequent to maintenance, RT windows shall be narrowed to the extent that is consistent with the data obtained. Method 8000B requires a new retention time window study be performed annually or when the analytical column from a new vendor or different stationary phase is used. 8000C and 8000D also require a new study when the column is clipped during maintenance.

10.9.4 Sample Retention Time Criteria

The surrogate must fall within the established RT window. Target analyte peaks must be within the established RT window to be reported as such. If the surrogate RT indicates a RT shift, it may be possible to accept a target analyte peak if it has shifted in the same direction as the surrogate peak. The presence of a definitive aroclor pattern will be positive evidence of a hit and may supersede RT window criteria. An NCM should be written to explain this case.

10.9.5 Daily Retention Time Windows

The centers of the retention time windows are adjusted at the beginning of each analytical sequence based on the daily initial CCV or the RT marker mix.

11.0 Procedure

11.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

11.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

11.3 Sample Preparation

11.3.1 Sample preparation for aqueous samples is described in SOP DV-OP-0006.

11.3.2 Sample preparation for solid samples is described in SOPs DV-OP-0016 and DV-OP-0015.

11.3.3 Cleanup and concentration of sample extracts are described in SOP DV-OP-0007. Note that it is highly recommended that all samples be checked for sulfur and cleaned up if necessary before the samples are analyzed on the instrument. Sulfur can contaminate the column and hinder the quantification of certain compounds.

11.3.4 For water samples, a 1 L extraction is brought to a final extract volume in hexane of 10 mL. For water samples extracted from a 250 mL volume and analyzed by the LVI method the final volume is 5 mL.

11.3.5 For solid samples, a 30 g sample is brought to a final volume of 10 mL of hexane.

11.3.6 Wipe samples are processed as a modified soil and the final volume of these extracts is 10 mL of hexane.

11.3.7 Oil samples are processed as a waste. Typically 1 g of oil is brought to 10 mL with hexane.

11.3.8 Use hexane to dilute sample extracts, if necessary.

11.4 Instrument Troubleshooting and Maintenance

Before the start of any daily sequence the instrument system should be evaluated for possible maintenance.

11.4.1 If the previous run ended with a failing continuing calibration then the system should be maintained to bring it back into control.

11.4.2 The injector septum should be changed after about 200 injections have been completed.

11.4.3 If the last CCV that was analyzed indicated a high response then a simple liner change is typically sufficient to bring the system back into control.

11.4.4 Analysis of a few solvent blanks or a system bake out may be necessary to drive out any residual contamination on the column.

11.4.5 A reduced response may indicate that the system needs to be evaluated for leaks.

11.4.6 Poor peak shape may necessitate clipping a loop out of the analytical column. If this fails to solve the peak shape problem then replacement of the columns may be indicated. The goal is to maintain the system as close to top condition as possible as was observed when new columns and injector parts were installed.

11.4.7 Re-calibration should not be used to correct for maintenance related issues. Always document any maintenance procedure in the maintenance logbook.

11.5 Gas Chromatography

Chromatographic conditions for this method are presented in Tables 2 and LVI-2. Use the ChemStation interface to establish instrument operating conditions for the GC. Raw data obtained by the ChemStation software is transferred to the Chrom DB database for further processing. The data analysis method, including peak processing and integration parameters, calibration, RT windows, and compound identification parameters, is set up in the Chrom DB software.

11.6 Sample Introduction

All extracts and standards are allowed to warm to room temperature before injection. An autosampler is used to introduce samples into the chromatographic system by direct injection of 1 or 2 µL of the sample extract. For LVI analysis 2 µL of sample extract is introduced into the chromatographic system. Samples, standards, and QC samples must be introduced using the same procedure. Use the Chrom worklist to set up and run the analytical sequence. Sample injection and analysis are automated and may proceed unattended.

11.7 Analytical Sequence

An analytical sequence starts with a minimum five-level initial calibration (ICAL) or a daily calibration verification. Refer to Tables 3 and LVI-3 for the calibration levels used.

11.7.1 The daily calibration verification includes analysis of the 12-hour calibration sequence (Section 10.7.1) and updating the retention time windows (Section 10.8.7)

11.7.2 If there is a break in the analytical sequence of greater than 12 hours, a new analytical sequence must be started with a daily calibration verification. Any samples that were not bracketed by a closing CCV (when required) must be reanalyzed in the new 12 hour sequence.

11.7.3 The following is a typical analytical sequence for routine sample analysis:

- Primer (Injection of any standard that contains any of the analytes to establish the stability of the chromatographic system.)
- RT marker mix.
- Hexane instrument blank.
- Daily initial CCV (Unless an ICAL is performed, which is immediately followed by the second-source initial calibration verification.)
- 10 sample injections (The first set of samples analyzed usually includes the method blank and the LCS, and may include matrix spikes.)
- CCV
- Followed by cycles of 10 sample injections and a CCV, as needed
- Closing CCV, instrument blank, and RL Standard

11.8 Retention Times

The centers of the RT windows determined in section 10.8 are adjusted to the RT of each individual peak as determined in the 12-hour calibration verification. The RT window must be updated at the beginning of each analytical sequence.

11.9 When a sample result exceeds the upper calibration range, then that sample extract is diluted to obtain a result in the upper half of the calibration range and reanalyzed. Any samples that were analyzed immediately following the high sample are evaluated for carryover. Typically carryover is not observed until the sample concentration is well above the upper calibration level. If the samples had target analyte detections at or above the RL, the samples must be reanalyzed to rule out carryover.

11.10 Upon completion of the analytical sequence, transfer the raw chromatography data to the Chrom database for further processing. Review chromatograms online and determine whether manual data manipulations are necessary. All manual integrations must be justified and documented. See DV-QA-011P for requirements for manual integration. Manual integrations may be processed using an automated macro, which prints the before and after chromatograms and the reason for the change, and attaches the analyst's electronic signature. Alternatively, the manual integration may be processed manually. In the latter case, print both the both the before and after chromatograms and record the reason for the change and initial and date the after chromatogram. Before and after chromatograms must be of sufficient scale to allow an independent reviewer to evaluate the manual integration. These chromatograms must be scanned into the documents section of the LIMS system.

11.11 Compile the raw data for all the samples and QC samples in a batch. The analytical batch is defined as containing no more than 20 samples, which include field samples and the MS and MSD.

11.11.1 The data package should consist of the checklist, sequence(s), ICAL cover, ICAL summary and history used for data quantitation and the prep batch paperwork.

11.11.2 Perform a level 1 data review and document the review on the data review checklist, GC Data Review Checklist/Batch Summary (See SOP DV-QA-0020.)

11.11.3 Submit the data package and review checklist to the Data Review Group for the level 2 review. All manual integrations must be evaluated by the peer reviewer and this review must be documented by date and initial on the level 2 review checklist. The level 2 review is documented on the review checklist initiated at the level 1 review. The data review process is explained in SOP DV-QA-0020.

12.0 Calculations / Data Reduction

12.1 Detailed equations can be found in the Corporate SOP CA-Q-P-003 *Calibration Curves and the Selection of Calibration Points* and under the public folder, *Arizona Calibration Training*.

12.2 Qualitative Identification of Aroclors

Retention time windows are used for identification of Aroclors, but the “fingerprint” produced by major peaks of those analytes in the standard is used in tandem with the retention times for identification. The ratios of the areas of the major peaks are also taken into consideration. Identification may be made even if the retention times of the peaks in the sample fall outside of the retention time windows of the standard, if in the analyst’s judgment the fingerprint (retention time and peak ratios) resembles the standard chromatogram. A NCM must be written to explain the deviation from the expected RT criteria. Project specific allowance for DoD/DOE QSM 5.0 or 5.1 is required for the TestAmerica approach to the RT shift for aroclors such that the retention time shift occurs at a later point in the sequence. Samples with detections must be reanalyzed after the analysis of a retention time marker for any aroclors that are detected and show a RT shift unless project specific requirements allow for reporting data with a NCM.

12.3 Quantitation of Aroclors

Quantitation of Aroclors is accomplished using 5 major peaks (3 peaks for Aroclor 1221). If there is an interference that affects the accuracy of results, the analyst may use as few as 3 major peaks (2 peaks for Aroclor 1221). The same peaks that are used for sample quantitation must be used for standards and QC quantitation.

12.4 Second column confirmation of Aroclors is performed only when requested by the client, because the appearance of the multiple peaks in the sample usually serves as a confirmation of analyte presence.

NOTE: DoD/DOE QSM 5.0 and 5.1 projects require the use of second-column confirmation of Aroclors unless the project work plans (SOW, SAP, QAPP, etc.) specify single-column analysis.

NOTE: South Carolina requires second column confirmation.

NOTE: Method 8082A indicates that second column confirmation is necessary when the sample composition is not well characterized.

12.5 Dual Column Quantitation

NOTE: This section is included for those clients/projects that require dual column confirmation.

12.5.1 A primary column is designated when dual column analysis is performed. If the continuing calibration fails for one of the columns then the appropriate corrective action must be taken. The result from the primary column is normally reported. The result from the secondary (confirmatory) column is reported if any of the following is true:

12.5.1.1 There is obvious chromatographic interference on the primary column.

12.5.1.2 The difference between the result for the primary column and the result for the secondary column is > 40% and chromatographic interference is evident on the primary column.

12.5.1.3 For DoD QSM 4.2 or DOD/DOE QSM 5.0 work, calibration and QC criteria for the second column are the same as for the initial or primary column analysis.

12.5.2 Dual Column Results With > 40% RPD

12.5.2.1 If the relative percent difference (RPD) between the responses on the two columns is greater than 40%, the higher of the two results is reported unless there is obvious interference documented on the chromatogram. Method 8000C/D requires that the lower result be reported. For DOD/DOE QSM 5.0 or 5.1, use project-specific or method requirements to determine reporting convention. If none specified, report from the primary column.

12.5.2.2 If there is visible positive interference, e.g., co-eluting peaks, elevated baseline, etc., for one column and not the other, then report the results from the column without the interference with the appropriate data qualifier flag, footnote, and/or narrative comment in the final report.

12.5.2.3 If there is visible positive interference for both columns, then report the lower of the two results with the appropriate flag, footnote, and/or narrative comment in the final report.

12.5.2.4 The RPD between two results is calculated using the following equation:

$$\%RPD = \frac{|R_1 - R_2|}{\frac{1}{2}(R_1 + R_2)} \times 100\% \qquad \textit{Equation 14}$$

Where R_1 is the result for the first column and R_2 is the result for the second column.

12.5.3 Reporting Total Aroclors for dual column reporting or from multiple runs.If dual column quantitation is requested or if the results from the individual Aroclors are in multiple runs, then total aroclors will be calculated from the primary results only using the TALS method code Total_PCB.

12.6 Surrogate Recovery

12.6.1 Surrogate recovery results are calculated and reported for decachlorobiphenyl (DCB).

12.6.2 In cases where the addition of the surrogate tetrachloro-*m*-xylene (TCMX) is required, its recovery is calculated and reported. In cases where both surrogates are added and recoveries calculated, the recovery of each surrogate is evaluated and corrective action must be taken if either surrogate recovers outside of the established control limits and matrix interference is not evident. Depending on project requirements, corrective action may be necessary only if DCB and TCMX are both outside of acceptance limits.

12.7 Calibration Range and Sample Dilutions

12.7.1 If the concentration of any analyte exceeds the working range as defined by the calibration standards, then the sample must be diluted and reanalyzed. Dilutions should target the most concentrated analyte in the upper half (over 50% of the high level standard) of the calibration range. Samples that were analyzed immediately following the high sample must be evaluated for carryover. If the samples have results at or above the RL for any analyte, they must be reanalyzed to rule out carryover unless other objective evidence indicates that the detection is not the result of carryover. Such evidence may include an observation where carryover was not observed when blanks or other samples were analyzed after a sample with similar high concentration or when the detection in the sample with suspected carryover is much higher than the expected amount of the carryover (i.e., the suspect sample’s concentration is similar to or higher than the sample run previous to it). It may also be necessary to dilute samples because of matrix interferences.

12.7.2 If the initial diluted run has no hits or hits below 20% of the calibration range, and the matrix allows for analysis at a lesser dilution, then the sample must be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.

12.7.3 Guidance for Dilutions Due to Matrix Interference

If the sample is initially run at a dilution and only minor matrix peaks are present, then the sample should be reanalyzed at a more concentrated dilution. Analyst judgment is required to determine the most concentrated dilution that will not result in instrument contamination. Ideally, the dilution chosen will make the response of the matrix interferences equal to approximately half the response of the mid-level calibration standard.

12.7.4 Reporting Dilutions

Some programs (e.g., South Carolina, DoD and DOE) and some projects require reporting of multiple dilutions (check Method Comments in LIMS). In other cases, the most concentrated dilution with no target compounds above the calibration range will be reported.

12.8 Interferences are Observed in Samples

12.8.1 Dual column analysis does not entirely eliminate interfering compounds. Complex samples with high background levels of interfering organic compounds can produce false positive and/or false negative results. The analyst must use appropriate judgment to take action as the situation warrants.

12.8.2 Suspected Negative Interferences

If peak detection is prevented by interferences, further cleanup should be attempted. Elevation of reporting levels and/or lack of positive identification must be addressed in the case narrative.

12.8.3 Suspected Positive Interferences

If no further cleanup is reasonable and interferences are evident that are suspected of causing false positive results, consult with the laboratory Project Manager to determine if analysis using additional confirmation techniques is appropriate for the project. Use of additional confirmation columns is another possible option. At a minimum, the Data Review Template prepared by the analyst should include the following comment for inclusion in the case narrative:

“Based on review of the chromatograms for samples __________, it is my opinion that the evident interferences may be causing false results.

Date ________________ Analyst __________________________”

12.9 Identifying and Reporting PCBs

12.9.1 In samples where the PCB pattern matches an individual Aroclor reasonably well, the samples should be quantified and reported as usual. When there are numerous PCB peaks present but there are no good matches to any individual Aroclor, choose the Aroclor (or Aroclors) that most closely match the sample and quantify the peaks as that Aroclor. The sample should not be reported as “not detect” based solely on the absence of a good match to a single Aroclor mixture. Multiple Aroclors should only be reported if their patterns are reasonably well separated. For example, 1232 and 1254 could be reported together, but not 1242 and 1248. See Attachment 1 for additional information on identifying Aroclors.

NOTE: When reporting and quantifying PCBs that do not closely match an Aroclor standard, it is absolutely essential and mandatory that this is explained in the report narrative. The analyst must write a NCM to explain their judgment for reporting PCBs in these instances.

12.9.2 Some example text that can be used in the report narrative is presented below:

Sample XXXX appears to contain PCBs based on the presence of numerous PCB peaks. However, due to weathering or other environmental processes, the PCBs in the sample do not closely match any of the Aroclor standards we use to calibrate our instruments. We quantified and reported the sample as Aroclor ZZZZ (or as a mixture of Aroclors ZZZZ and YYYY). Due to the poor match with the Aroclor standard(s), there is increased qualitative and quantitative uncertainty associated with this result. This approach is consistent with the guidance in section 7.9.3 of SW846 method 8082A. If these results do not meet the needs of your project then we would suggest a further analysis of the sample. Depending on the objectives, this may include congener-specific analysis by 8082A; or analysis by a more specific method (e.g., method 1668 or an adaptation of method 8270) for PCB congeners or PCB homolog totals.

12.9.3 Sample Matrix Issues

12.9.3.1 In some cases when analyzing for multi-component analytes, the sample matrix is so complex that it would obliterate any possible pattern that would allow us to identify the analyte. When this happens, it is true that the analyte is not detected at the normal detection limit. However, it is true that we could not have detected the analyte at the normal detection limit. Even if the analyte was present, we would not be able to recognize it.

12.9.3.1 When this occurs, the sample must be analyzed at a dilution that would allow us to detect the analyte, and the reporting limit should be the one appropriate for that dilution. Reporting a non-detect at the normal reporting limit is not an acceptable practice.

12.9.3.2 Some clients may insist on ND reporting if the patterns are not clear. In that event, add information to the project file to indicate that the information in this guidance have been communicated to the client, together with the client's instructions. In addition, in the event of a poor match to patterns, a narrative comment as suggested in the previous paragraph is still required.

12.9.4 Background on PCBs

12.9.4.1 PCBs were widely used in a variety of products prior to being banned in the 1970's. The most common usages were in electric motors and transformers. They were manufactured by gas phase chlorination of a biphenyl molecule. The nomenclature, in general, describes the weight percent of chlorine in the final product. Thus, Aroclor 1254 was produced by chlorinating a quantity of biphenyl until the resulting product was 54% chlorine by weight. Aroclor 1242 was 42% chlorine by weight.

12.9.4.2 PCBs were manufactured in batch processes, so there were slight variations between batches, but in general each Aroclor had a very reproducible pattern of chlorinated biphenyl isomers (congeners). With few exceptions, when we detect PCBs in the environment the initial contaminant was one of the Aroclors.

12.9.4.3 The one exception to the nomenclature of the Aroclors is Aroclor 1016. In the 1960's researchers started to find PCBs in fish tissue in the Great Lakes. The primary congeners appearing in the fish were pentachlorobiphenyls. The manufactures of PCBs devised a synthetic process that created an Aroclor with very similar properties to Aroclor 1242, but minimized the formation of pentachlorobiphenyl molecule. Aroclor 1016 41% chlorine by weight and as result it can be difficult to distinguish from 1242.

12.9.4.4 While the pattern of congeners was quite reproducible in the pure products once in the environment the pattern changes. The lesser chlorinated PCBs are more water soluble and are more volatile, while the more highly chlorinated PCBs bind to solids and sediments more strongly. As examples, landfill gas condensates tend to have a bias toward the lesser chlorinated congeners because they are more volatile. River sediments near source of PCBs tend to have a bias toward the more highly chlorinated congeners because the accompanying lesser chlorinated congeners were more water soluble. Downstream from the source of contamination, however, there will be a bias toward the less chlorinated congeners because the more heavily chlorinated congeners were trapped in the sediments near the outfall. Anaerobic and aerobic microbial degradation reduce the concentrations of some congeners and an increase in concentrations of others. Although they are rarely the primary mechanisms, oxidative and photolytic processes are also selective, impacting some congeners more than others.

12.9.4.5 As a result, PCBs in the environment rarely have an exact match to the Aroclor standards that we use to calibrate our instruments. There is inevitably some level of judgment required to choose the Aroclor that has the best match to the sample in questions. Sometimes this is straightforward, but other times the judgment is difficult and can be controversial. In the worst cases, we can have situations where there are clearly PCB peaks throughout a chromatogram, but there is no good match with any of the Aroclors. It is recommended that at a minimum there must be some peak groupings present that are characteristic of an aroclor pattern in order to indicate a positive detection.

12.10 Calculations

12.10.1 Concentration of Analyte in Sample Extract

Depending on the calibration function used, the concentration of the analyte in the sample extract is calculated as follows (see Section 10.5 for details on establishing the calibration function):

12.10.1.1 Average Response Factor:

$$C_e = \frac{A_e}{RF} \qquad \text{Equation 12}$$

12.10.1.2 Linear Regression:

$$C_e = \frac{[A_e - b]}{a} \qquad \text{Equation 13}$$

Where:

C_e = Concentration of the analyte in the sample extract (ng/mL).
A_e = Peak area for the analyte in the sample extract injection.
b = y-intercept of the calibration fit.
a = Slope of the calibration fit.

12.10.2 Concentration of Analyte in Original Sample

The concentration of the analyte in the original sample is calculated as follows:

$$C_{sample} = \frac{C_e}{1000\,\frac{ng}{\mu g}} \times \frac{V_e}{V_s} \times DF \qquad \text{Equation 14}$$

Where:

C_{sample} = Concentration of analyte in original sample (μg/L or μg/kg).
C_e = Concentration of analyte in sample extract injected in GC (ng/mL).
$1000\,\frac{ng}{\mu g}$ = Factor to convert ng/mL to μg/mL.
V_e = Volume of sample extract (mL).
V_s = Volume (or weight) of original sample (L or kg).
DF = Dilution Factor (post extraction dilutions)

12.10.3 LCS and Surrogate Spike Recovery Calculation

LCS and surrogate spike recoveries are calculated using the following equation:

$$\%\text{Recovery} = \frac{\text{Concentration (or amount) found}}{\text{Concentration (or amount) spiked}} \times 100\% \qquad \textit{Equation 15}$$

12.10.4 MS and MSD Recovery Calculation

Matrix spike recoveries are calculated as follows:

$$\text{MS or MSD \%Recovery} = \left(\frac{SSR - SR}{SA}\right) \times 100\% \qquad \textit{Equation 16}$$

Where:

SSR = Measured concentration in spiked sample.
SR = Measured concentration in unspiked sample.
SA = Concentration of spike added to sample.

12.10.5 MS/MSD RPD Calculation

The relative percent difference between the MS and MSD is calculated as follows:

$$\%RPD = \frac{|R_1 - R_2|}{\frac{1}{2}(R_1 + R_2)} \times 100\% \qquad \textit{Equation 17}$$

Where *R1* is the result for the MS and *R2* is the result for the MSD.

12.11 All data are subject to two levels of review, which is documented on a checklist, as described in SOP DV-QA-0020.

13.0 Method Performance

13.1 Method Detection Limit Study (MDL)

An initial method detection limit study is performed for each analyte and each sample matrix type in accordance with Policy CA-Q-S-006. Each of the other aroclors have an MDLV performed annually to verify the MDL For DoD, DOE and Texas TRRP projects, AR_1660 MDLVs and LOQVs are performed quarterly. MDLs and LOQs are stored in LIMS.

13.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

13.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

13.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

13.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.2.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

13.2.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.1 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 <u>Pollution Control</u>

14.1 It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Environmental Health and Safety Manual (M-E-001 DV) for “Waste Management and Pollution Prevention.

14.2 Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, “Waste Management and Pollution Prevention”, of the Environmental Health and Safety Manual, and DV-HS-001P, “Waste Management Program.”

15.2 The following waste streams are produced when this method is carried out:

15.2.1 Waste hexane solvent: Flammable Solvent – Waste Stream C

15.2.2 Vials containing extracts in hexane: Expired Extract Vials – Waste Stream A

15.2.3 Concentrated sulfuric acid and hexane from sample cleanup: Concentrated Acids with Organics - Waste Stream V

15.2.4 Expired reagents and standards – Contact Waste Coordinator

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.2.5 Samples containing polychlorinated biphenyls (PCB’s) at concentrations $\geq$50 ppm are regulated under the Toxic Substance Control Act (TSCA) and must be segregated from all other waste streams. Analysts are responsible for contacting the Group Leader, Sample Control, and the Waste Coordinator immediately if a sample falls into the TSCA category.

16.0 References / Cross-References

16.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

16.1.1 Method 3510C, Separatory Funnel Liquid-Liquid Extraction, Revision 3, December 1996.

16.1.2 Method 3550B, Ultrasonic Extraction, Revision 2, December 1996.

16.1.3 Method 3550C, Ultrasonic Extraction, Revision 3, February 2007.

16.1.4 Method 3546, Microwave Extraction, Revision 0, February 2006.

16.1.5 Method 3580A, Waste Dilution, Revision 1, July 1992.

16.1.6 Method 3660B, Sulfur Cleanup, Revision 2, December 1996.

16.1.7 Method 3665A, Sulfuric Acid/Permanganate Cleanup, Revision 1, December 1996.

16.1.8 Method 8082, Polychlorinated Biphenyls (PCBs) by Gas Chromatography, Revision 0, December, 1996.

16.1.9 Method 8082A, Polychlorinated Biphenyls (PCBs) by Gas Chromatography, Revision 1, February 2007

16.1.10 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

16.1.11 Method 8000C, Determinative Chromatographic Separations, Revision 3, March 2003.

16.1.12 Method 8000D, Determinative Chromatographic Separations, Revision 4, July 2014.

16.1.13 Method 8000D, Determinative Chromatographic Separations, Revision 5, March 2018.

16.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/25/2010.

16.3 Department of Defense/Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories, Final Version 5.0, July 2013.

16.4 Department of Defense/Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories, Version 5.1, July 2017

17.0 Method Modifications

Item	Method	Modification
1	8000B	Method 8000 allows for use of a second order or third order calibration curve. TestAmerica Denver does not allow for any curvilinear calibrations for the analysis of Aroclors.
2	8000C/D	Method 8000C and D require that new retention time windows be established if a GC column has been shortened during maintenance. Given the matrices of the samples the laboratory receives, and the number of times the GC column may require clipping, TestAmerica Denver does not perform an RT study after clipping a column. RT studies done by the laboratory show that, historically, RT windows have not been greater than the method allowed 0.03 minutes. The lab defaults to a 0.03 minute RT window as allowed by the method.

18.0 Attachments

Table 1: Analyte List and Standard Reporting Limits
Table 2: Typical Instrument Conditions
Table 3: Calibration Levels (µg/mL)
Table 1-LVI: Analyte List and Standard Reporting Limits using Large Volume Injection
Table 2-LVI: Typical Instrument Conditions using Large Volume Injection
Table 3-LVI: Calibration Levels (µg/mL) using Large Volume Injection
Attachment 1: Aroclor Identification 101
Attachment 2: Example of Minimum Resolution Requirement for Aroclor 1260 Triplet

19.0 Revision History

Revision 14, October 31, 2018

- Added references to SW 846 Method 8000D
- Added explanations and calculations for % Error and Relative Standard Error
- Added method modification applicable to RT study requirements after column clipping
- Added references to South Carolina requirements
- Correct last sentence in the copyright information
- Updated the MDL SP number

Revision 13, July 31, 2018

- Annual Review

Revision 12, June 30, 2017

- Annual Review
- Updated references to DOD/DOE QSM 5.1 throughout in addition to existing QSM 5.0.
- Revised section 9.3 to reflect current requirements under DOD/DOE QSM that if no MS/MSD available, LCSD is performed in addition to LCS.

- Revised section 10.7.2 to reference both 1016 and 1260 rather than the combined nomenclature used internally by the laboratory.
- Updated Section 11.11.13 to reflect current practice for documenting review of manual integrations.
- Added references to section 16 for Method 8000D and DOD/DOE QSM 5.1.

Revision 11, June 3, 2016

- Annual Review
- Adjusted source references and concentrations in Section 7 as required to reflect current practice
- Updated Section 9.1 to reflect current practice
- Updated Section 9.6 to reflect current policy for over-range MS/MSD.
- Added “midpoint” to IS acceptance criteria in Section 9.8 to clarify standard used for evaluation of IS and updated acceptance window for IS recovery.
- Corrected resolution requirement criteria in Section 10.3.2.1
- Updated reference to corporate SOP on calibration curves in Section 10.3.1 and 12.1. Document was revised and number was changed.
- Added sentence to section 10.3.5 to reflect that all quantitations of identified aroclors are performed using a calibration curve (minimum five points).
- Added clarification to Section 10.3.8 for minimum height of peaks selected for quantitation relative to the largest peak in the aroclor (except 1268 at 10%)
- Added clarifications to paragraphs in Section 10.7.4.1
- Revised Section 10.8 and 10.9 to comply with Policy CA-T-P-005 for determining RT windows. This is intended to assist in minimizing false positive results.
- Revised language in Section 12.2 to explain when analyst interpretation of PCBs with a RT shift can be used
- Revised Section 13 to reflect current practice
- Replaced calibration factor with response factor throughout as this is now an internal standard method
- Editorial and formatting changes throughout

Revision 10, April 30, 2015

- Annual Review
- Added Internal Standard quantitation method throughout including
    - Section 7.3.1 – added description of internal standard stock
    - Section 7.11: IS solution,
    - Section 9.8: IS Acceptance criteria and corrective action
    - Section 10.3.2: Note regarding resolution check for Aroclor 1260
    - Section 10.4: Internal Standard Calibration
    - Incorporated equations for IS throughout Section 10.5
    - Added to section 10.7.2 that closing CCV may not be required with use of IS
    - Added requirement to run CCV for any identified aroclor if other than 1660
    - Section 10.8.7: Added use of RT marker for all representative aroclor peaks
- Corrected statement in Section 10.8.9 regarding shift noted by surrogate
- Added in Section 10.8.10 that RT windows can be set by RT marker
- Made additions to Section 11.7 for Analytical Sequence based on IS method
- Removed original Item 1 in Method Modifications table; renumbered.
- Added new Attachment 2

Revision 9, June 30, 2014

- Annual Review
- Updated the following sections to add include more detail and/or reflect correct practices. Sections: 1.2, 1.3, 2.1.2, 4.1, 6.1, 7.3.1, 7.4.1 (table), 7.4.2 (table), 7.5.1, 7.8, 9.1.2, 9.3, 9.5 (corrective action), 9.6 (corrective action), 10.1.2, 10.1.3, 10.3.6.4, 10.4, 10.5.4 (acceptance criteria), 10.6, 10.7.2, 10.7.4.1, 10.7.4.2, 11.5, 11.6, 11.9, 11.10.3, 12.2 and 12.3
- Corrected formatting and grammatical errors
- Added section 11.4 – Troubleshooting
- Additional references added to section 16
- Added total Aroclor calculation when summing individual Aroclors from dual column or different runs to section 12.5.3

Revision 8, October 30, 2013

- Updated sections 7.3,and 7.5 for the use of standard/standards
- Updated section 7.4.2 to correct table for CCV preparation
- Updated section 10.7 to add LVI CCV concentration
- Updated Table 2 and 2-LVI for injection volumes
- Added LVI tables to section 7.4

Revision 7, June 30, 2013

- Added section 2.1.2
- Added statement to Section 2.2 regarding use of 2nd column confirmation for DoD and method 80082A while presences of multiple peaks characteristic of an aroclor otherwise serve as confirmation when 2nd column is not required.
- Added sentence to Section 5.1.4 regarding procedures for handling radioactive materials
- Updated columns specified in Section 6.3
- Added injection port liners to section 6.4.2
- Added requirements for sample containers and sample volume for LVI to section 8.0
- Added clarifications to Corrective Action Section in Section 9.7 for evaluation and reporting of samples based on surrogate recoveries.
- Replaced references to Target software with Chrom software to reflect current practice
- Added dilution solvent (hexane) and extract final volumes for each matrix analyzed to section 10.3
- Removed note regarding restriction of use of Grand Mean as Method 8082 does not use the grand mean approach to CCV acceptance
- Added requirements for initial and final volume for LVI (Section 11.3.4)
- Added requirements for LVI injection volume (4 µL) to Section 11.5
- Added requirement for reporting lower result by Method 8000C (Section 12.5.2.1)
- Removed statement in section 12.9.2 duplicated in section 12.9.3.3
- Revised Table 2 to reflect current practice
- Revised Tables 1-LVI, 2-LVI, and 3-LVI to reflect current practice

Revision 6, June 15, 2012

- Added Tables 1-LVI, 2-LVI, and 3-LVI for large volume injection

Revision 5.1, January 16, 2012

- Changed extraction holding time for water and solid to 1 year with exclusion for California, Connecticut, Pennsylvania and South Carolina (Section 8).
- Reformatted paragraphs throughout

Revision 5, December 2011

- Combined SOP DV-GC-0021 and DV-GC-0030 Rev. 0.2. Upon implementation of this revision of SOP DV-GC-0021, SOP DV-GC-0030 will be deactivated.
- Added details for analysis of polychlorinated terphenyls by this procedure (sections 1, 3, 7 and Table 1).
- Updated Section 6 to include reference to master list of documents, software and hardware and volumetric flasks.
- Updated refrigerator temperature references from 4 ± 2°C to 0-6°C throughout.
- Updated vendors and catalog numbers for standards (Section 7)
- Updated Section 9 for consistency with SOP DV-QA-003P.
- Added calibration section to describe calibration models.
- Revised Procedure (new section 11) to be consistent with other SOPs revised in the last year.
- Added detail about review process (Section 11.8)
- Revised Calculations section (new section 12) to address dual column quantitation, sample dilution, and recovery calculations.
- Revised section numbers for previous sections 12-18.
- Updated Method Modifications section
- Revised Table 1 and Table 2

Earlier revision histories have been archived and are available upon request.

Table 1. Analyte List and Standard Reporting Limits

Compound	Water Reporting Limit (µg/L)	Soil Reporting Limit (µg/kg)
Aroclor 1016	1.0	33
Aroclor 1221	1.0	47
Aroclor 1232	1.0	33
Aroclor 1242	1.0	33
Aroclor 1248	1.0	33
Aroclor 1254	1.0	33
Aroclor 1260	1.0	33
Aroclor 1262	1.0	33
Aroclor 1268	1.0	33
PCT 5432	0.5	50
PCT 5442	0.5	75
PCT 5460	0.5	50

Table 2. Typical Instrument Conditions

Parameter	Recommended Conditions
Injection Port Temperature:	250 ^{o}C
Detector Temperature:	325 ^{o}C
Temperature Program:	Instrument W 125 ^{o}C for 1 minute 25 ^{o}C/min to 175 ^{o}C 10 ^{o}C/min to 275 ^{o}C 30 ^{o}C/min to 320 ^{o}C for 5 minutes Instrument P3 125 ^{o}C for 1.25 minutes 30 ^{o}C/min to 180 ^{o}C 12 ^{o}C/min to 280 ^{o}C 15 ^{o}C/min to 320 ^{o}C for 2.6 minutes
Column 1:	CLPI, 30 m x 0.32 mm id, 0.5 µm
Column 2:	CLPII, 30 m x 0.32 mm id, 0.25 µm
Injection:	2 µL 8082, 4 µL 8082 LVI
Carrier Gas:	Hydrogen
Make-up Gas:	Nitrogen
Y-splitter:	Restek or J&W or Supelco glass tee, single gooseneck liner

Table 3. Calibration Levels (μg/mL)

Aroclors	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Aroclor 1016	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1221	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1232	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1242	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1248	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1254	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1260	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1262	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Aroclor 1268	0.025	0.05	0.1	0.25	0.5	0.75	1.0
Surrogates are included in the AR_1660 calibration mix at the following levels:							
Tetrachloro-m-xylene	0.00125	0.0025	0.005	0.0125	0.025	0.0375	0.05
Decachlorobiphenyl	0.00125	0.0025	0.005	0.0125	0.025	0.0375	0.05

Table 1-LVI. Analyte List and Standard Reporting Limits for Large Volume Injection

Compound	Water Reporting Limit (μg/L)
Aroclor 1016	1.0
Aroclor 1221	1.0
Aroclor 1232	1.0
Aroclor 1242	1.0
Aroclor 1248	1.0
Aroclor 1254	1.0
Aroclor 1260	1.0
Aroclor 1262	1.0
Aroclor 1268	1.0
PCT 5432	NA
PCT 5442	NA
PCT 5460	NA

Table 2-LVI. Typical Instrument Conditions for Large Volume Injection

Parameter	Recommended Conditions
Injection Port Temperature:	250 °C
Detector Temperature:	325 °C
Temperature Program:	Instrument P3 125 °C for 1.25 minutes 30 °C/min to 180 °C 12 °C/min to 280 °C 15 °C/min to 320 °C for 2.6 minutes
Column 1:	Restek Rtx-CLPesticides 30m X 0.32 mm id, 0.5 µm (Cat# 11139 or equivalent)
Column 2:	Restek Rtx-CLPesticides2 30m X 0.32 mm id, 0.5 µm(Cat# 11324 or equivalent)
Injection Volume:	1 µL 8082, 2 µL 8082 LVI
Carrier Gas:	Hydrogen
Make-up Gas:	Nitrogen
Y-splitter:	Restek Universal Presstight Connector (Cat# 20400 or equivalent)
Injection Port Liner:	Agilent 5190-2293 90011 or equivalent

Table 3-LVI. Calibration Levels (µg/mL) for Large Volume Injection

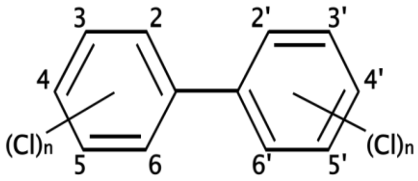
Aroclors	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Aroclor 1016	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1221	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1232	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1242	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1248	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1254	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1260	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1262	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Aroclor 1268	0.0125	0.025	0.050	0.125	0.250	0.375	0.50
Surrogates are included in the AR_1660 calibration mix at the following levels:							
Tetrachloro-m-xylene	0.00063	0.00125	0.0025	0.00625	0.0125	0.0188	0.025
Decachlorobiphenyl	0.00063	0.00125	0.0025	0.00625	0.0125	0.0188	0.025

Attachment 1.

Aroclor identification 101

It can be difficult to correctly identify which Aroclor is present in a sample. This document provides a few guidelines. We are calling this document Aroclor identification 101 not because it is simple, but because Aroclor identification 201 and 301 (mixed, weathered Aroclors) are much more difficult still (sort of like P-Chem!)

First, we should consider what Aroclors actually are: They are mixtures of polychlorinated biphenyls.



Each phenyl ring can accommodate between zero and 5 chlorines. There are 209 possible isomers with 1-10 chlorines (the surrogate decachlorobiphenyl is the fully chlorinated molecule). Of these, about 130 are present in various Aroclor mixes, accounting for the complexity of the chromatograms. The first two digits of the Aroclor number refers to the number of carbon atoms, the last two refer to the degree of chlorination. Thus Aroclor 1248 has 12 carbon atoms in each molecule, and 48% chlorine by mass. So, as the last two digits increase, the overall degree of chlorination increases, the volatility decreases, and the pattern of peaks moves later in the chromatogram. Arochlor 1248 consists of approximately 1% monochlorobiphenyl, 13% dichlorobiphenyl, 45% trichlorobiphenyl, 31% tetrachlorobiphenyl and 10% pentachlorobiphenyl.

It is estimated that 1.25 billion pounds of PCBs were produced until Monsanto ceased production in 1977. PCBs are very persistent, so much of this material is still present in the environment.

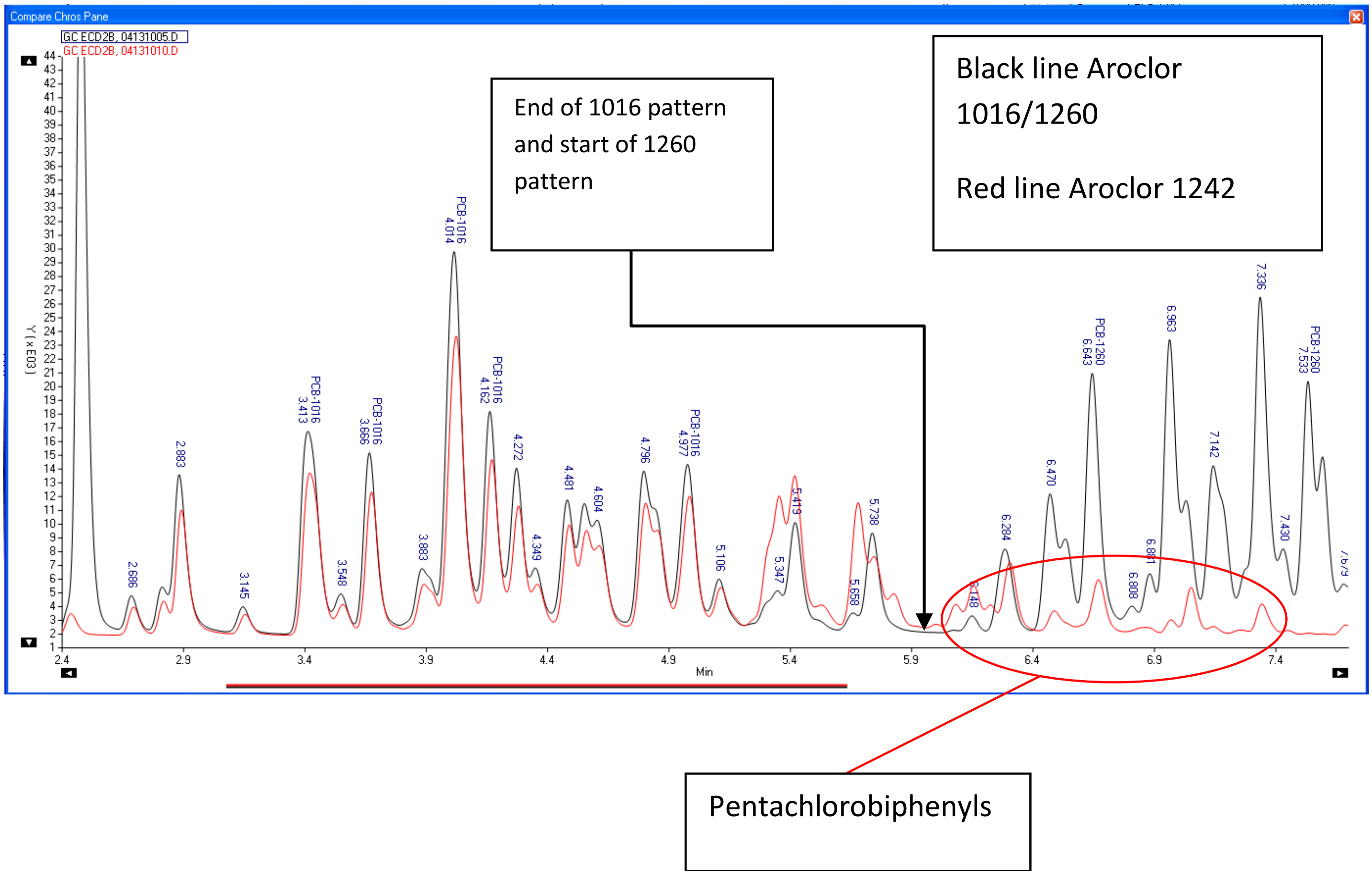
Example Chromatograms

In the following examples I'll refer to retention times frequently – your retention times will of course be different because of different chromatographic conditions but the same principles apply.

Attachment 1. Aroclor Identification 101 (Continued)

The first example considers Aroclor 1016 vs. 1242. Note that the early part of the chromatograms (2.5 – 5.3 minutes) are virtually identical. The key difference is the presence of some later eluting peaks (6.2-7.3 minutes in this chromatogram) in 1242 that are not present in 1016. This difference is masked by the fact that Aroclor 1260 is also present in this standard. Most labs analyze standards of 1016 and 1260 together – there is nothing wrong with this but it is a good idea to periodically (one run with each initial calibration?) analyze them separately so that you have a good idea of the two separate patterns.

The story of 1016 is interesting – in the early 1970’s PCBs were starting to be found in fish in the Great Lakes. The more heavily chlorinated biphenyls were bioaccumulating more and were of greatest concern. So, Monsanto attempted to modify the manufacturing process to reduce the amount of pentachlorobiphenyls in Aroclor 1242, while still keeping the overall degree of chlorination similar. They were successful in this regard – Aroclor 1242 has about 10% pentachlorobiphenyls which show up between 6 and 7.4 minutes in the chromatogram below. Aroclor 1016 has 42% by weight chlorine (it does not follow the standard naming convention) but has no pentachlorobiphenyls.



End of 1016 pattern and start of 1260 pattern

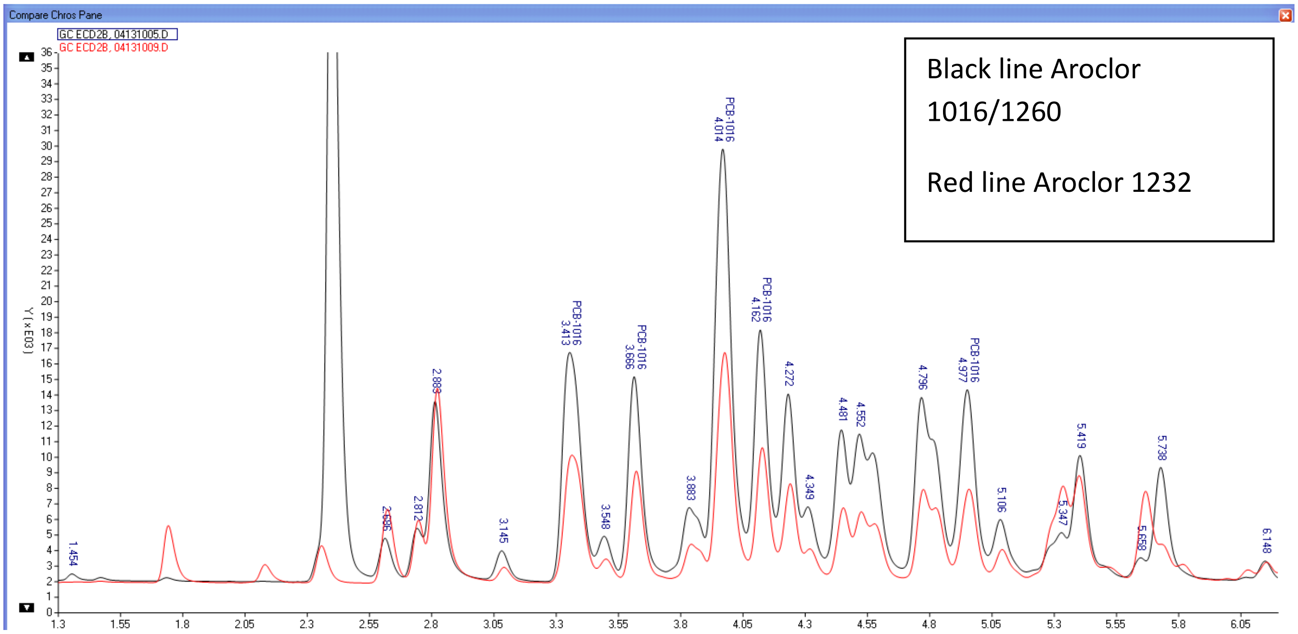
Black line Aroclor 1016/1260

Red line Aroclor 1242

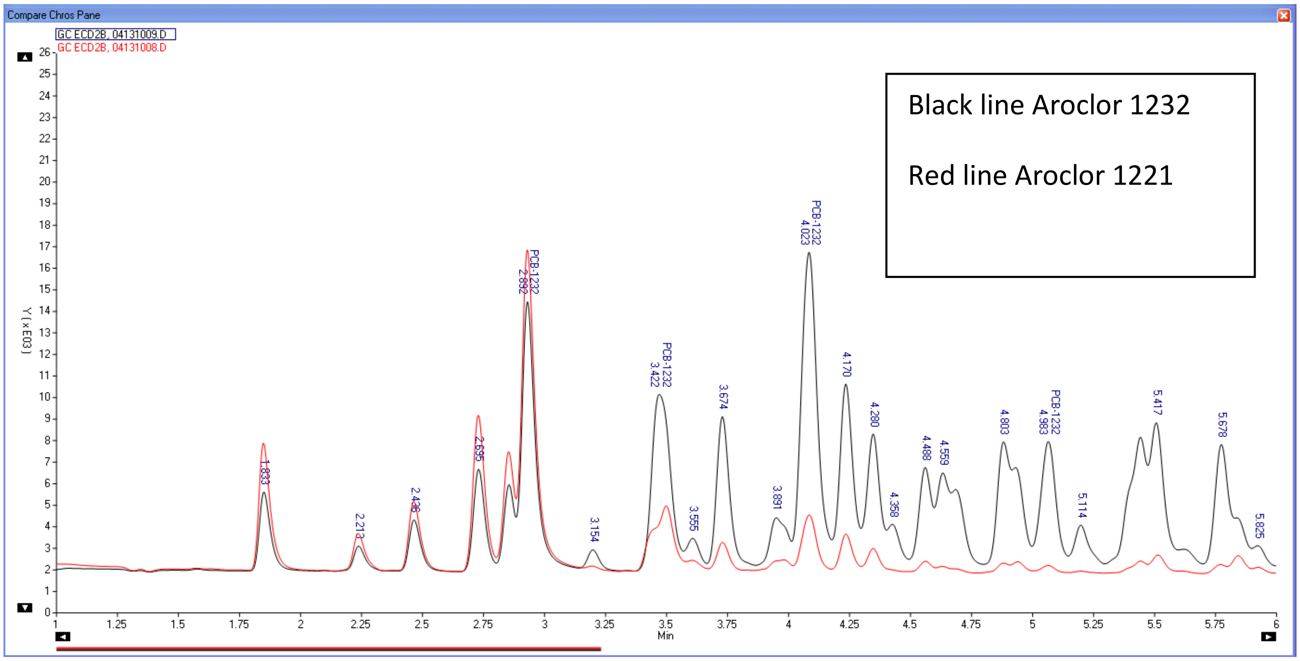
Pentachlorobiphenyls

Attachment 1. Aroclor Identification 101 (Continued)

Here is 1016 vs. 1232. These are even more similar (the large peak at around 2.35 min is TCMX) but note the very early peaks present in 1232 and not in 1016, and also note that the front end is stronger in 1232 for example in 1232 the peak at 2.88 min is about the same size as those at 4.79 and 4.97, whereas in 1016 the later peaks are twice as large.

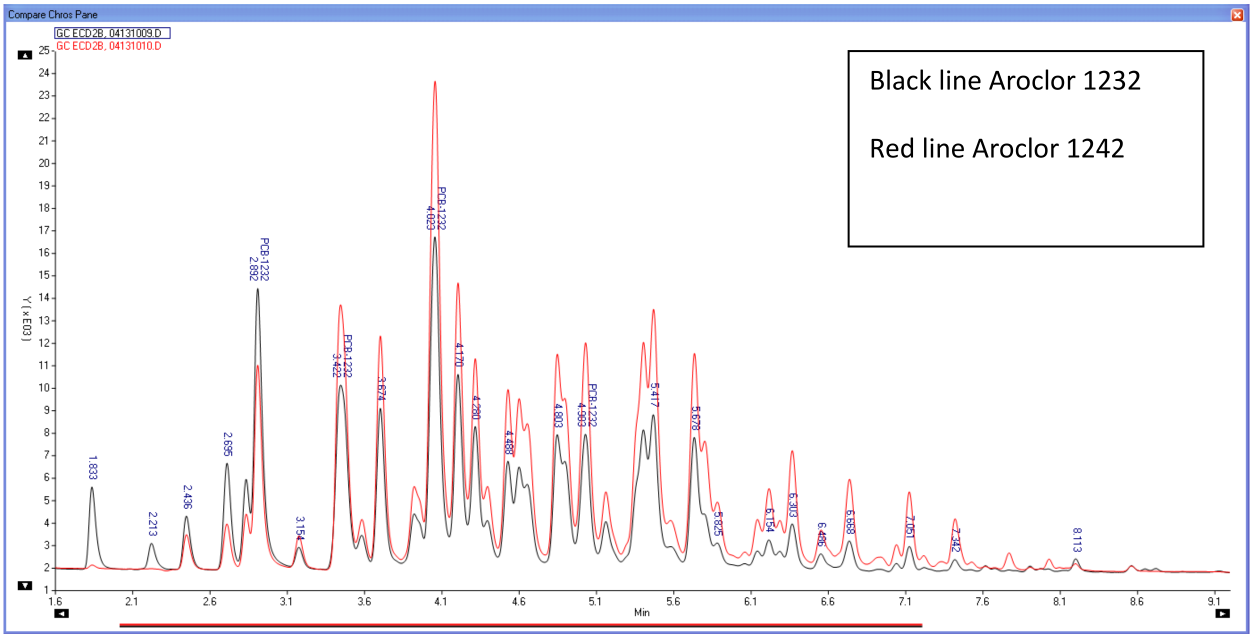


For 1221 vs. 1232, the front end of the chromatogram is identical, but 1232 has later peaks that are not present in 1221.

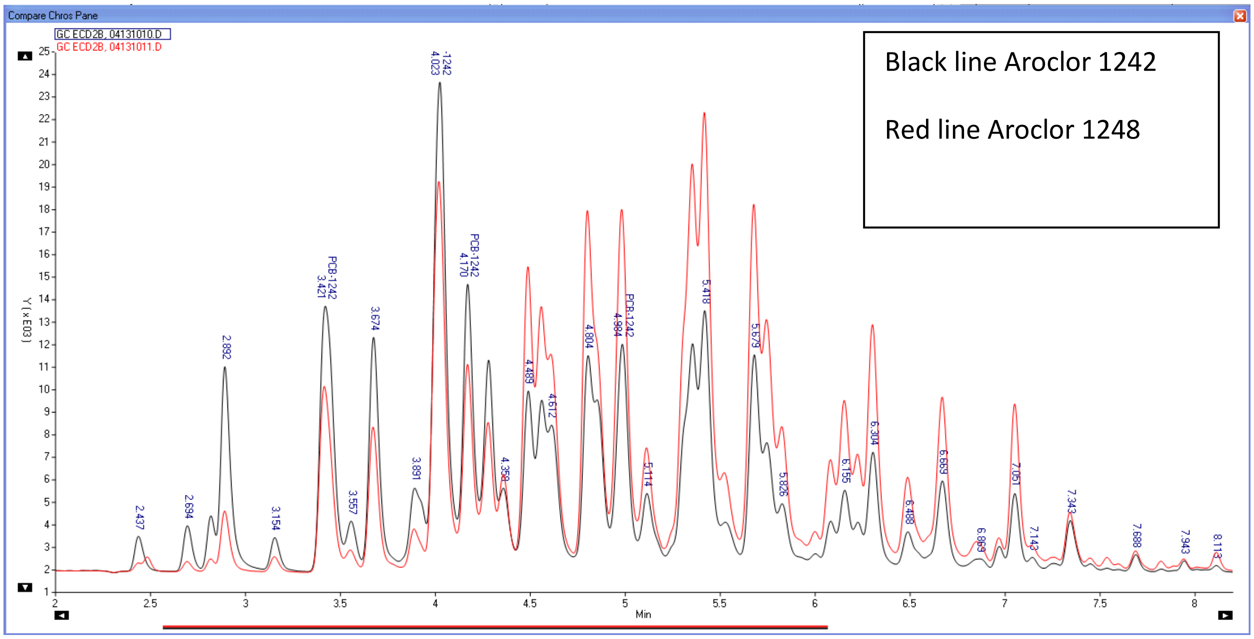


Attachment 1. Aroclor Identification 101 (Continued)

1232 and 1242 are best distinguished by the early peaks in 1232 (1.83, 2.13) that are not present in 1242. Also note that the peak at 2.89 is twice the height of that at 5.41 in 1232, whereas the 5.41 peak is slightly higher in 1242. This relative size of the front and back end of the envelope is a key tool for distinguishing Aroclors.

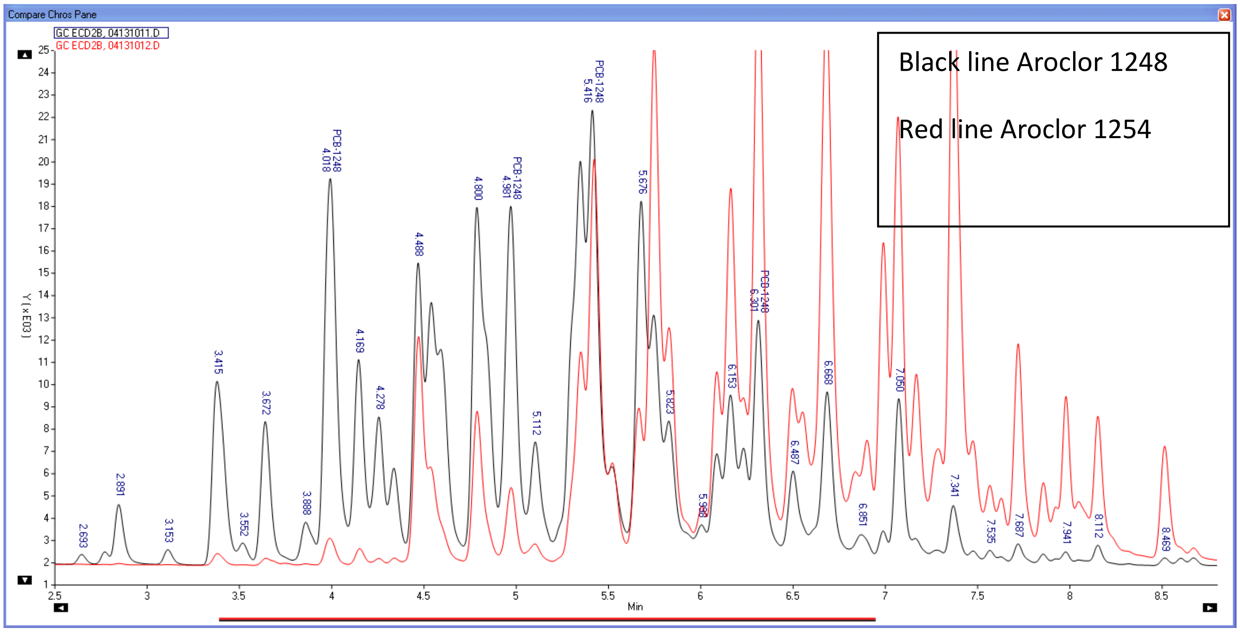


Aroclors 1242 and 1248 both have all of the same peaks, so the relative strength of the front and back of the envelope is the only way to distinguish. For example, in 1242, the peak at 3.42 is larger than that at 5.67, whereas for 1248, the 5.67 peak is considerably larger than the 3.42 peak.



Attachment 1. Aroclor Identification 101 (Continued)

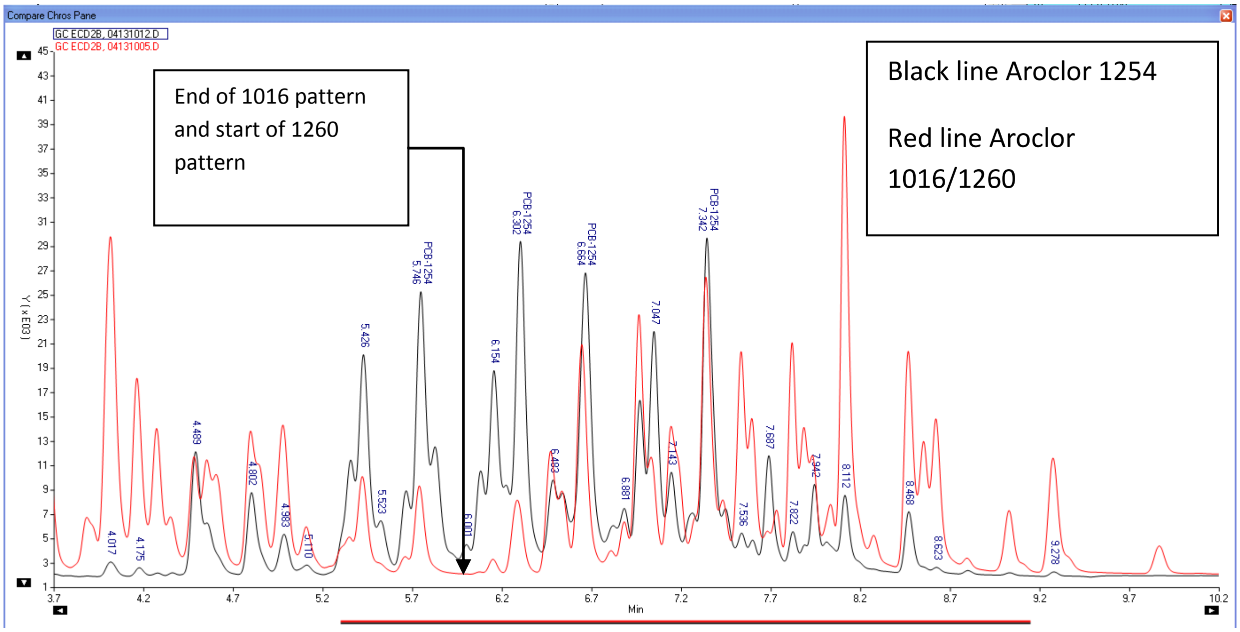
1248 vs 1254 is a relatively easy case, the front end of the envelope is much stronger in 1248.



Black line Aroclor 1248

Red line Aroclor 1254

The 1254 vs. 1260 chromatograms are again a little masked by the inclusion of 1016 in the 1260 standard (peaks up to 5.9 min in the 1260 chromatogram actually belong to 1016). Keeping this in mind, the presence of peaks at 5.42 and 5.74 indicates 1254. The relative strength of peaks in the 7.5-9.3 range indicates 1260.



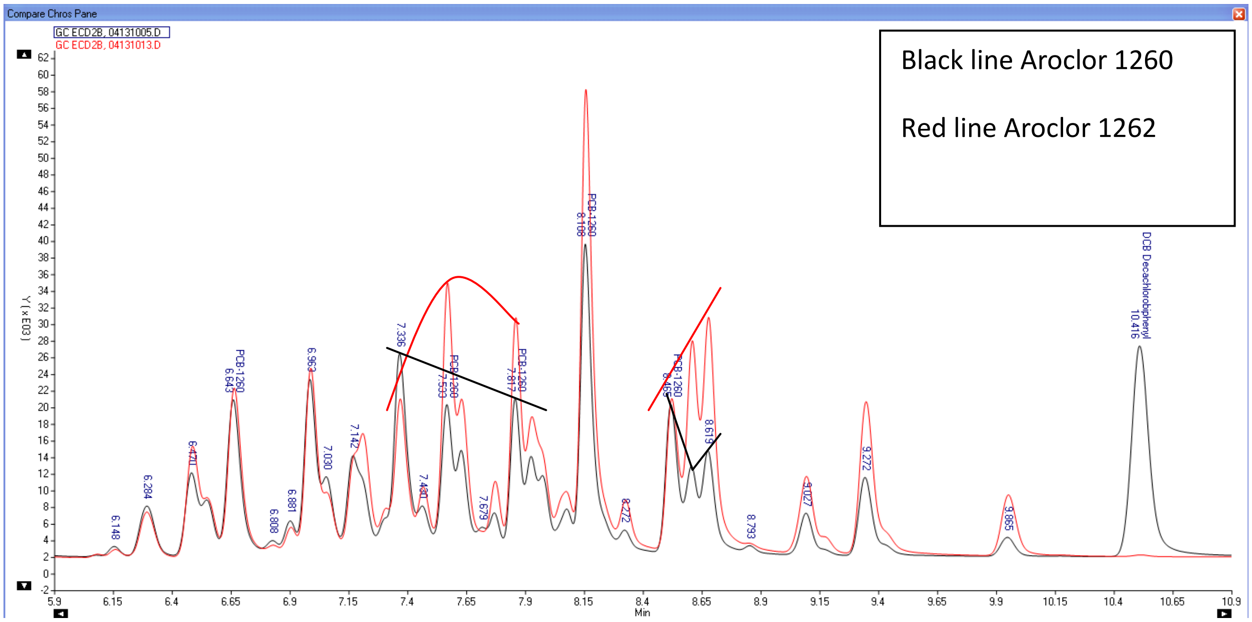
End of 1016 pattern and start of 1260 pattern

Black line Aroclor 1254

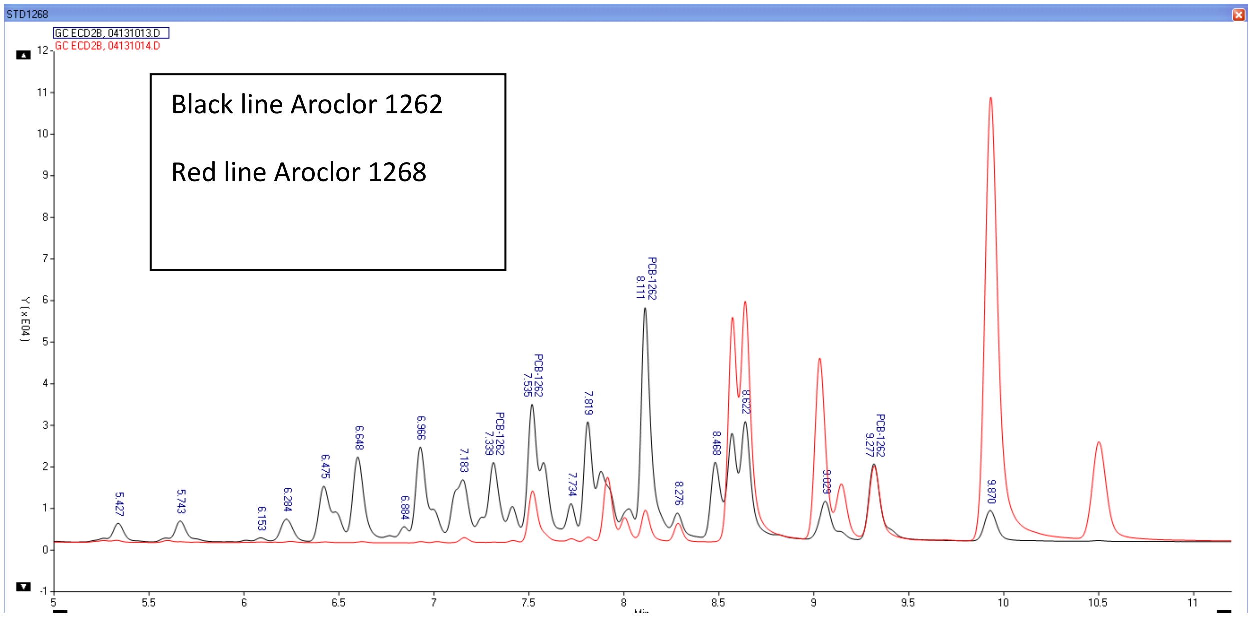
Red line Aroclor 1016/1260

Attachment 1. Aroclor Identification 101 (Continued)

Many labs do not analyze for 1262, perhaps just as well since it is certainly challenging to distinguish from 1260. However, the shape of the envelope is again the key. Note that in 1262 the peaks around 8.6 minutes are as large as that at 6.96, whereas they are only half the size in 1260. Also note the shape of the envelope for the peaks in the 7-8 minute range – bow shaped for 1262 and a straight declining line for 1260. The envelope shape is also quite different in the 8.4-8.7minute range.

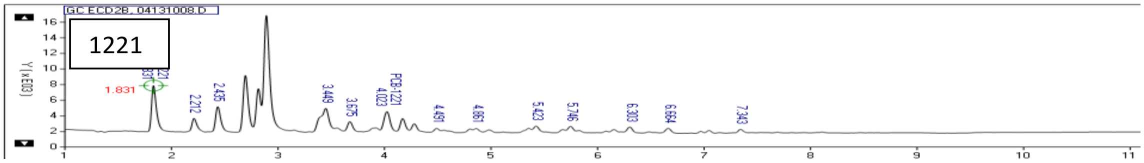


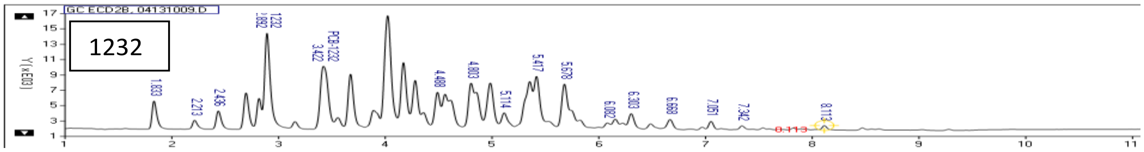
The really strong peak at 9.87 and the lack of much of a pattern between 6.0 and 7.5 minutes are good indicators of 1268.

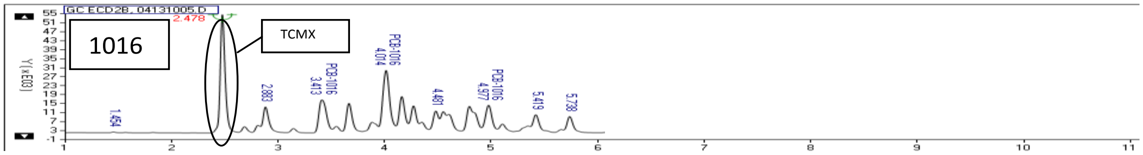


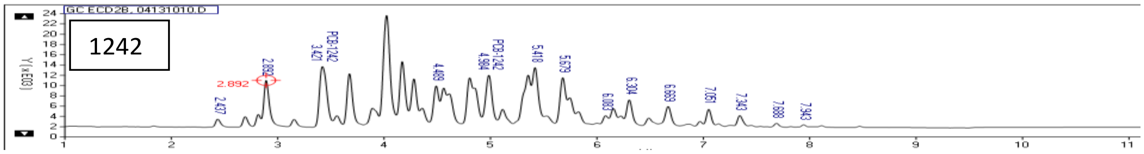
Attachment 1. Aroclor Identification 101 (Continued)

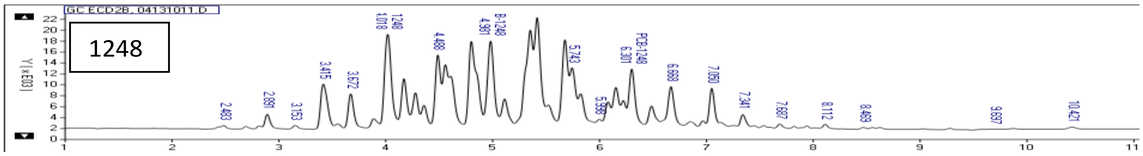
AROCLOR PATTERNS

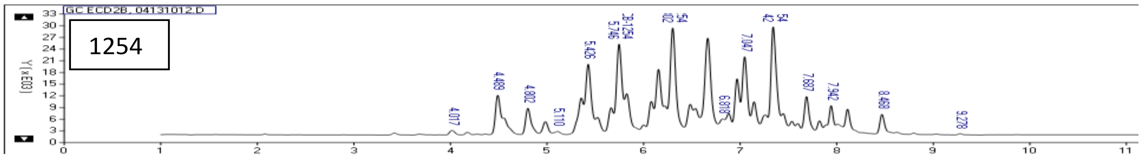


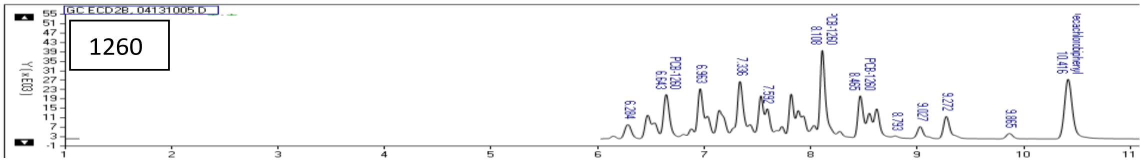


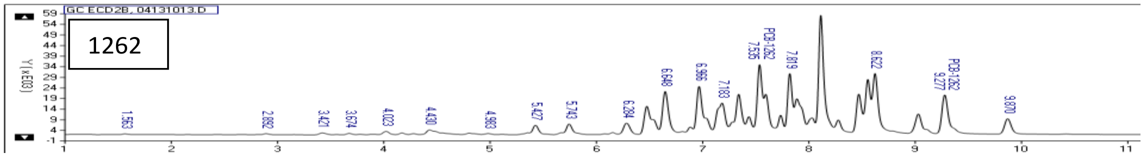


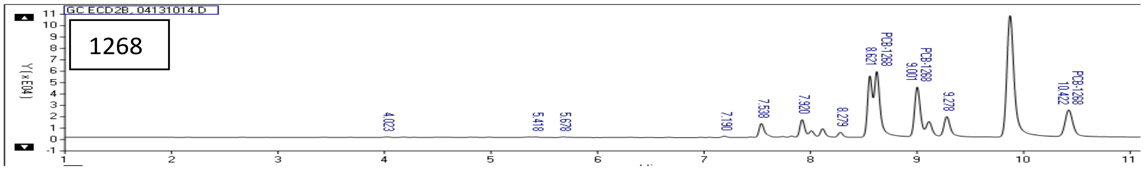






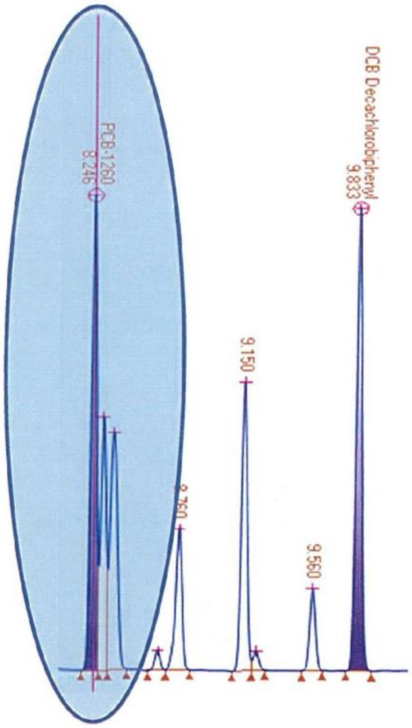






Attachment 2.
Example of Minimum Resolution Requirement for Aroclor 1260 Triplet

(See Work Instruction CA-T-WI-003 for more information)



The circled triplet of peaks is observed towards the end of the 1260 pattern on columns such as CLP 1. Minimum resolution (degree of overlap) requirement between peak 1 / 2 and peak 2 / 3 is <75%. This chromatogram shows overlap of about 50% between peak 2 and 3, and 30% between peak 1 and 2.

Resolution (degree of overlap) is calculated as

[Height of the valley / (Sum of the two peak heights / 2)] x 100%

Work Instruction No. CA-T-WI-003, dated 31 Mar 2015

TestAmerica Denver

Electronic Document Cover

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TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Electronic Copy Only

Title: Nitroaromatic and Nitroamine Explosive Compounds by High Performance Liquid Chromatography (HPLC) [SW-846 8330A & 8330B]

Approvals (Signature/Date):

7/30/18
Richard Clinkscales Date
Technical Specialist

Doug Gomer 7/27/18
Doug Gomer Date
Health & Safety Manager / Coordinator

Roxanne Sullivan 7/31/18
Roxanne Sullivan Date
Quality Assurance Manager

7/30/18
Richard Clinkscales Date
Laboratory Director

Facility Distribution No. ___________ **Distributed To:**______________________

1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the determination of nitroaromatic and nitroamine explosive residues by high performance liquid chromatography (HPLC) using dual columns and dual UV wavelengths. This includes analysis in water, soil, and sediment matrices. The instrumental analysis is based on EPA Methods 8330A and 8330B.

1.2 This SOP does not include the extraction procedures. For those details, please refer to DV-OP-0017 *Solid Phase Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from water samples by SW-846 3535A* and DV-OP-0018 *The Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples by SW-846 8330A and 8330B.*

1.3 On occasion, clients may request modifications to this SOP. Requests for modifications must be received in writing and will be communicated to the laboratory through method comments in the LIMS. Significant method changes require a work instruction signed by both the client and TestAmerica Denver management and the Quality Assurance Manager. (See SOPs DV-QA-001P and DV-QA-0010.)

1.4 Application of 8330A versus 8330B

1.4.1 This procedure is for analysis by either Method 8330A or 8330B. The most important differences in the two source methods are the more rigorous sample collection and preparation measures in 8330B, which are designed to produce more representative results. The more rigorous 8330B process is specifically intended to complement the multi-increment field sampling process described in Appendix A of 8330B. If multi-increment or equivalent systematic sampling processes are not employed in the field, then the extra laboratory homogenization and subsampling effort 8330B requires (see details in DV-OP-0018) may add little or no improvement in the overall precision of results.

1.4.2 For soil analysis a sample size of 2 g is used for 8330A and a sample size of 10 grams is used for 8330B.

1.4.3 8330A only describes the cyano (CN) column for confirmation. 8330B gives the option of either cyano (CN) or pheny-hexyl columns for confirmation. Because it provides better sensitivity and resolution, TestAmerica Denver routinely confirms using the Phenomenex Luna Phenyl-Hexyl column for both methods.

1.4.4 8330B also added compounds to the potential analyte list. TestAmerica Denver offers all of the compounds shown in Appendix 1 of this SOP by both methods, except 3,5-dinitroaniline, which is only analyzed by 8330B.

1.5 Analytes, Matrix(s), and Reporting Limits

1.5.1 The list of analytes, CAS numbers, abbreviations and TA-Denver's standard reporting limits can be found in Appendix 1.

1.5.2 The working ranges of this method are as follows:

Analytes	8330A Soil (2g prep)	8330B Soil (10g prep)	Water
All Analytes except nitroglycerin and PETN	0.2 µg/g – 25 µg/g	0.08 µg/g – 10 µg/g	0.2 µg/L - 25 µg/L
Nitroglycerin and PETN	2.0 µg/g – 250 µg/g	0.80 µg/g – 100 µg/g	2.0 µg/L - 250 µg/L

2.0 Summary of Method

2.1 Instrument calibration is performed by external standardization using a minimum of five concentration levels.

2.2 An acetic acid and phosphate buffer in water / methanol gradient program is used for HPLC separation (see details in Section 7.8.10 and Appendix 4). Compounds are tentatively identified based on retention time and detection by the UV detector using the primary Agilent Poroshell 120 EC-C18 column. Confirmation is performed by the UV detector using a Phenomenex Luna Phenyl-Hexyl column (see Appendix 4 for instrument conditions).

3.0 Definitions

3.1 Explosives: As used in this SOP, the term "explosives" refers specifically to the analytes listed in Appendix 1. These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.2 Definition of terms used in this SOP may be found in the Glossary section of the TestAmerica Denver Quality Assurance Manual (QAM) and in SOP QA-DV-003P.

4.0 Interferences

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by running method blanks.

4.2 Contamination by carryover can occur when a low-concentration sample is analyzed immediately following a high-concentration sample. This potential is minimized by continuously flushing the needle with solvent. If contamination is suspected, the sample should be re-aliquoted and re-analyzed.

4.3 Co-elution of target analytes with non-target analytes can occur, resulting in false positives or biased high results.

4.4 Co-elution between target analytes can occur when high concentrations of individual compounds are present in samples, see Section 12.2.3.5 for details.

4.5 The inclusion of vegetation is not recommended given the nature of the detector and different uses the data will potentially support (USACE comment – Issue #306 TA Denver Audit Database; DOD/DOE QSM 5.0 and 5.1 both state to exclude vegetation).

4.6 Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. All samples expected to contain tetryl should not be exposed to temperatures above room temperature. (Reference: EPA Method 8330A & 8330B, Section 4.3) Elution solvent for the SPE cartridges is also acidified to help preserve tetryl in sample extracts.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual (RSM) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately.

5.1.2 If a sample is expected to have an explosive concentration ≥2% (but less than 10%), the EH&S Coordinator and Group Leader shall be notified before any work is performed. Additional safety precautions may be implemented as required due to high concentrations of explosives.

WARNING: Soil samples with explosive concentrations greater than 2% <u>cannot</u> be accepted by the laboratory unless they have a moisture content of 25% or greater. Under no circumstances shall a soil sample with an explosive concentration greater than 10% be accepted by the laboratory.

5.1.3 Soil samples with high concentrations (between 2 and 10%) of explosives should not be ground using a mortar and pestle. Visual observation of a soil samples is important prior to grinding samples. Any samples containing metal fragments, powders, waxy appearing pieces, or other suspicious material should be brought to the attention of the Group Leader and the EH&S Coordinator before proceeding with the procedure. Bypassing the grinding step and proceeding to solvent dilution is an alternative for samples that are determined to be unsafe to grind.

5.2 Primary Materials Used

The following is a list of materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not contain all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
Acetonitrile	Flammable Poison	40 ppm – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Glacial Acetic Acid	Corrosive Poison Flammable Liquid and Vapor	10 ppm - TWA	Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Can cause serious damage to skin, including redness, pain, and burns. Contact with eyes may cause severe damage followed by loss of sight.
Methanol	Flammable Poison Irritant	200 ppm - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.
Phosphoric Acid	Corrosive	1 ppm - TWA	Ingestion can cause severe burns to the throat, mouth, and stomach, abdominal pain and nausea. Severe exposures by ingestion can lead to shock, circulatory collapse, and death. Inhalation is not an expected hazard unless misted. Corrosive, contact with skin or eyes can cause redness, pain, severe burns, blurred vision, and permanent eye damage.
Sodium hydroxide	Corrosive Poison	2 mg/m^3	Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat, runny nose. Contact with

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
			skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes and can cause burns that may result in permanent impairment of vision, even blindness with greater exposures.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 HPLC System

HPLC, equipped with a pump capable of achieving 6000 psi, a 100 µL loop injector, and a Diode Array Detector (DAD) or Multi-Wavelength Detector (MWD), Hewlett Packard Model 1100, or equivalent.

6.1.2 Primary Column: Reverse phase HPLC column, Agilent Poroshell 120, EC-C-18, 4.6mm x 150mm (2.7 µm) or equivalent.

6.1.3 Confirmation Column: Phenomenex Luna Phenyl-Hexyl reverse phase HPLC column, 15 cm x 4.6 mm (3 µm) or equivalent.

6.1.4 Hewlett Packard HPLC Chem Station for instrument control.

6.2 Supplies

6.2.1 Glass vials, various sizes.

6.2.1.1 Amber glass, 8.0 mL and 12.0 mL, with Teflon-lined screw caps, for the storage of standards.

6.2.1.2 Crimp-top vial with caps for analysis, 1.8 mL.

6.2.2 Disposable pipettes, used for non-quantitative transfers only.

6.2.3 Volumetric flasks, various sizes.

6.2.4 Hamilton syringes, various sizes.

6.3 Computer Software and Hardware

Please refer to the master list of documents and software located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and

Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Stock Standards

7.1.1 Stock standards are purchased as certified solutions or prepared from 100%, neat materials. Stock standard solutions are stored at -10 °C to -20 °C, or per vendor instructions. All stock standards must be protected from light and should be brought to room temperature before using.

7.1.2 Stock standard solutions must be replaced after 1 year or sooner if comparison with check standards prepared from an independent source indicates a problem. Expiration times for all standards are measured from the time the standard is prepared or from the time that the standard ampoule is opened, if the standard is supplied in a sealed ampoule.

7.1.3 3,5-Dinitroaniline is purchased at a concentration of 100 μg/mL in acetonitrile, equivalent to the High-Level Calibration Mix. This standard is added directly to the Intermediate Level Calibration Standard. (Section 7.4).

7.1.4 PETN and Nitroglycerin are purchased as separate individual standards at a concentration of 1000 μg/mL in acetonitrile. These standards are added directly to the Intermediate Level Calibration Standard (Section 7.4).

7.1.5 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene are purchased as separate individual standards at a concentration of 100 μg/mL in acetonitrile, equivalent to the High-Level Calibration Mix. These standards are added directly to the Intermediate Level Calibration Standard (Section 7.4).

7.1.6 MNX is purchased as a pre-weighed neat standard and comes in powder form. A quantitative transfer is performed and the final concentration calculated for the high level MNX standard. The volume of this standard used for intermediate stock preparation will vary depending on the initial weight of MNX sent. This is the only known source of MNX and we do not currently have a second source for this compound.

7.2 Volume Measurements for all Standards Preparation

The volume of stock and intermediate standard solutions used in subsequent dilutions is measured using Hamilton syringes appropriate for the volume being measured and accurate to 2%. Standards are prepared either by (1) using a syringe to measure the standard solution and bringing to volume with the appropriate solvent in a Class A volumetric flask, or by (2) measuring the volumes of both the standard solution and the solvent using a calibrated syringe or Class A pipette and combining them in a vial.

7.3 High-Level Calibration Mix, Prepared from Stock Standards

This high level standard must be replaced every 1 year or sooner if comparison with check standards prepared from independent sources indicates a problem.

A solution is prepared to contain most standard analytes at a concentration of 100 µg/mL each in acetonitrile (see details in standards database instructions). Nitroglycerin, PETN, 3,5-Dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene are purchased as separate stock standards, and are not included in this mixture. They are added to the intermediate level standards in section 7.4.

7.4 Intermediate Level Calibration Standards

8330IntermStk: Prepare a 20 µg/mL solution (nitroglycerin and PETN at 200 µg/mL) from the high-level calibration mix (see Section 7.3) by diluting 1.0 ± 0.02 mL of the High-Level Calibration mix along with 1.0 ± 0.02 mL each of stock standards of nitroglycerin and PETN to a final volume of 5.0 mL in acetonitrile. The shelf life of this material is 6 months.

8330_ADDs: Prepare a 20 µg/mL solution from stock standards by diluting 1.0 ± 0.02 mL each of stock standards of 3,5 -dinitroaniline, 2,4-diamino-6-nitrotoluene, and 2,6-diamino-4-nitrotoluene to a final volume of 5.0 mL in acetonitrile. The shelf life of this material is 6 months.

7.5 Working Level Standards for Calibration Curve

Prepare calibration standards by diluting the intermediate standard solutions as shown in the table below using the 75%:25% (v/v) acidic water:ACN solution (described in Section 7.8.7). These standards must be prepared fresh on the day of calibration and refrigerated if not used immediately. All volumes are measured using the appropriately sized Hamilton syringe.

7.5.1 On the primary (C18) column, the 8330IntermStk and 8330_ADDs standards must be calibrated using separate sets of calibration standards due to co-elutions with other target compounds. The intermediate standards are prepared at the same concentration; therefore, the calibrations are made with the same volumes of intermediate stock and solvent in the following table.

7.5.2 On the confirmation (phenyl-hexyl) column, the intermediate full-list and intermediate 3,5-dinitroaniline stocks can be combined into the same calibration standards and follow the "Confirmation (Phenyl-Hexyl) Column Calibration" recipes in the following table.

Recommended Calibration Levels

Calibration Level	Final Concentration (µg/mL)		Primary (C18) Column Calibration		Confirmation (Phenyl-Hexyl) Column Calibration	
	Standard Analytes	*NG & PETN*	*Vol. Intermediate (µL)*	*Vol. Solvent (µL)*	*Vol. EACH Intermediate (µL)*	*Vol. Solvent (µL)*
8	2.5	25.0	125 ± 1	875 ± 9	125 ± 1	750 ± 9
7	1.0	10.0	50 ± 0.5	950 ± 10	50 ± 0.5	900 ± 10
6	0.7	7.0	35 ± 0.4	965 ± 10	35 ± 0.4	930 ± 10
5	0.4	4.0	20 ± 0.2	980 ± 10	20 ± 0.2	960 ± 10
4*	0.25	2.5	12.5 ± 0.1	988 ± 10	12.5 ± 0.1	975 ± 10
3	0.1	1.0	5 ± 0.05	995 ± 10	5 ± 0.05	990 ± 10
2	0.05	0.5	2.5 ± 0.02	998 ± 10	2.5 ± 0.02	995 ± 10
1	0.02	0.2	20 ± 0.1 µL of Level 7	980 ± 10	20 ± 0.1 µL of Level 7	980 ± 10

- **Level 4 concentration is used for the daily and continuing calibrations.**
- **Nitroglycerine and PETN are 10X higher than the other analytes in all calibration levels.**

7.6 Extractions Standards

7.6.1 LCS Spike Solution

The LCS spike solution is prepared at a working level concentration of 10 µg/mL (nitroglycerin and PETN at 100 µg/mL) in acetonitrile. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible.

This standard contains all explosives target compounds except 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene.

7.6.2 3,5-Dinitroaniline LCS Solution

The 3,5-DNA LCS solution is prepared at a working level concentration of 10 µg/mL in acetonitrile. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible. This standard is used only for method 8330B and is spiked into separate LCS and MS/MSD samples. This compound cannot be completely resolved from tetryl and nitrobenzene on the primary column.

7.6.3 Diamino LCS Solution

The Diamino LCS solution is prepared at a working level concentration of 10 µg/mL in acetonitrile of 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible. This standard is only added when these compounds are specifically requested by the client. They are added to a separate LCS/MS/MSD. They are spiked into the same LCS/MS/MSD as 3,5 DNA if the client requests all three compounds.

7.6.4 Working Level Surrogate (1,2-Dinitrobenzene) Solution

The 8330 surrogate solution is prepared at a working level concentration of 10 µg/mL in acetonitrile. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible.

7.7 Second Source Initial Calibration Verification Solution

The second source standard must be obtained from a different source than the standards used for initial calibration. This standard is used to verify the accuracy of the calibration standards.

NOTE: There is currently no second source available for MNX.

7.7.1 Working-Level Second Source Mix

Prepare a solution containing all compounds except 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene at a concentration of 0.40 µg/mL (nitroglycerin and PETN at 4.0 µg/mL). A separate solution containing 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene is prepared at a concentration of 0.40 µg/mL when analyzing on the primary (C18) column; the standards can be combined for analysis on the confirmation (phenyl-hexyl) column. These solutions are prepared using the 75%:25% (v/v) acidic water:ACN solution (described in Section 7.8.7). These standards must be prepared fresh on the day of calibration. All volumes are measured using the appropriately sized Hamilton syringe.

7.8 Reagents

7.8.1 Reagent Water

For method blanks and laboratory control samples reagent water is generated by an ELGA water purification system. The performance of the water polishing system is checked daily and recorded per SOP DV-QA-0026.

7.8.2 HPLC Grade Water

7.8.3 Acetonitrile, CH_3CN (ACN) - HPLC grade

7.8.4 Methanol - HPLC grade

7.8.5 Glacial Acetic Acid – Reagent Grade

7.8.6 85% Phosphoric acid, H_3PO_4 – Reagent Grade.

7.8.7 Acidified Water (75%) : Acetonitrile Solution (25%)

TALS Reagent: 8330AcidH2O

Take 250 mL of acetonitrile (ACN), and bring to 1.0 L with Elga or HPLC-grade water. Acidify the solution to a pH of approximately 3 by adding 20 drops (1 mL) of 85% phosphoric acid (H_3PO_4).

7.8.8 Acidified Calcium Chloride, $CaCl_2$ Solution, 5 g/L

TALS Reagent: CaCL2 Sol

Place 5 ± 0.05 g of reagent grade $CaCl_2$ into a one-liter volumetric flask containing approximately 500 mL of deionized water. Swirl the solution until the $CaCl_2$ is dissolved. Add approximately 1 mL of 85% H_3PO_4 to acidify the solution and bring to volume with deionized water.

7.8.9 Sodium Phosphate Buffer Stock

TALS Reagent: 8330bufferstk

Slowly add 115.29 grams of 85% phosphoric acid (molecular weight = 97.9924 g/mol) to approximately 500 mL of water in a 1 L beaker. Place a stir bar in the beaker and the beaker in an ice bath on top of a magnetic stirrer. Slowly add 150 mL of 10 M (10 M = 10 N) sodium hydroxide, allowing time for the mixture to cool down between additions. Transfer to a 1 L volumetric flask and bring to volume with Elga or HPLC-grade water. The final pH of this solution should be 7.2.

7.8.10 Buffer Eluents for Analysis:

Make up the HPLC eluents for each column as described in Sections 7.8.10.1 and 7.8.10.2. The pH of the working eluents *must* be modified by the analyst by changing the volume of glacial acetic acid added to ensure compound resolution. This is particularly necessary when the column is replaced, to ensure that picric acid does not co-elute with any other target compound. Increasing the concentration (or volume added) of glacial acetic acid will result in greater retention of picric acid. The eluent can only be adjusted at the start of an initial calibration, not with the CCVs. The calculated retention time windows should account for the drift of any specific analyte.

7.8.10.1 Working Eluent for Primary (C18) Column:

Combine 1 L of water, 1 mL of Sodium Phosphate Buffer Stock solution (Section 7.8.9), and 50 μL of Glacial Acetic acid to adjust the pH of the buffer to approximately 6.5. Make fresh at least weekly or more often as needed.

7.8.10.2 Working Eluent for Confirmation (Phenyl-Hexyl) Column:

Combine 1 L of water, 2 mL of Sodium Phosphate Buffer Stock solution (Section 7.8.9), and enough glacial acetic acid (approximately 65-95 μL) so that picric acid does not co-elute with MNX or RDX. The pH of the buffer should be adjusted to approximately 6.5. Make fresh before each run.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Aqueous Samples

Water samples should be collected in duplicate 500 mL amber glass bottles with Teflon-lined caps.

8.2 Soil and Sediment Samples

8.2.1 For method 8330A, soil samples should be collected in eight-ounce wide mouth jars with Teflon-lined caps.

8.2.2 For method 8330B, it is not uncommon to receive samples of 1 kg or more. Samples may be shipped in wide mouth jars or clean plastic bags.

8.3 Samples and sample extracts must be stored in amber glass containers at ≤ 6°C from the time of collection through analysis, except during drying.

8.4 Soil and sediment samples should be air dried at ambient temperature until dry enough to sieve. See DV-OP-0018 for details. Once the sample is air dried, the sample can be stored at room temperature.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Water	Amber glass	1 Liter (2 x 500 mL)	Cool; ≤ 6°C	7 Days to Extraction 40 Days to Analysis	SW846 8330A
Soil	Glass / plastic	4 grams (8330A) / up to 1 kg (8330B)	Cool; ≤ 6°C	14 Days to Extraction 40 Days to Analysis	SW846 8330A/B

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD/DOE QSM 5.0 and 5.1 unless otherwise stated.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each column on which the associated samples are analyzed. See QC Policy DV-QA-003P for further details.

9.3 Method Blank (MB)

A method blank (MB) must be prepared and analyzed with each batch of samples. The MB consists of reagent water for aqueous samples, and Ottawa sand for soil samples, with surrogates added. The MB is created at the time of extraction after the samples have been dried, sieved, and ground and is then carried through all extraction and analysis steps. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data. See section 9.9 for the use of the grinding blank for Method 8330B solids samples.

Acceptance Criteria: The MB must not contain any analyte of interest at or above one-half the RL or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

MBs are evaluated on each column on which associated samples are analyzed, when confirmation data are required. If there is a detection on either column in the MB, then detections for that target compound are suspect in associated samples. See Appendix 4 for guidance on interpretation of confirmation data to assess acceptance of the MB.

Corrective Action: If the method blank does not meet the acceptance criteria, the source of contamination must be investigated and measures taken to correct, minimize, or eliminate the problem. Reanalyze and/or reprepare all samples associated with a failed method blank.

If the MB acceptance criteria are not met and re-preparation and reanalysis are not possible, then the sample data associated with the unacceptable MB must be qualified. This nonconformance must be addressed in the project or case narrative and the client must be notified.

9.4 Laboratory Control Sample (LCS)

One LCS must be analyzed with each batch of samples (up to 20 samples). The LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. For water samples, the LCS is prepared by spiking the analytes of interest into reagent water. For soil samples, the LCS is prepared by spiking the analytes of interest into Ottawa sand. The LCS is created at the time of sample extraction after the samples have been dried, sieved and ground. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines. The LCS must be analyzed on the confirmation column. If there is insufficient volume to prepare an MS/MSD, and LCSD must also be prepared and analyzed.

Acceptance Criteria: The LCS recovery for each spiked analyte must be within established control limits. Laboratory default control limits are calculated as ± 3 standard deviations around the mean of historical data, as described in SOP DV-QA-003P. For DOD/DOE work, QSM limits are applied unless project specific limits are requested by the client. When no QSM limits are available, laboratory historical limits are applied. Control limits are maintained in the LIMS.

In accordance with the TNI 2009 Standard a marginal exceedance within ± 4 standard deviations is allowed for one of the analytes. This is based on the number of analytes typically spiked for this method, which is between 11 and 30. These acceptance criteria may be superseded by project-specific limits, as applicable.

Corrective Action: If recoveries for all spiked analytes are not within the acceptance limits, including the one allowed marginal exceedance, the analytical system is out of control and corrective action must occur. Generally this requires re-extraction and reanalysis of all associated samples. If the LCS is biased high and all associated samples are ND, not detected, it may be possible to report results with an NCM (see requirements for individual programs and clients).

9.5 Matrix Spike Sample (MS) and Matrix Spike Duplicate (MSD)

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. The soil matrix spikes are created at the time of extraction. Spikes and surrogate compounds are added after the sample has been dried, sieved, and ground. One MS/MSD pair must be processed for each preparation batch (up to 20 samples). The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Samples identified as field blanks, equipment blanks, or rinse blanks cannot be used for MS/MSD analysis.

Acceptance Criteria: The spike recoveries must fall within established control limits. The relative percent difference (RPD) between the MS and MSD must be less than or equal to the established RPD limit. LCS limits are used for MS/MSD evaluation. Control limits are maintained in the LIMS. For DoD/DOE work, QSM limits are applied if available unless project specific limits are requested by the client. The RPD limit for DoD/DOE QSM 5.0 and 5.1 work is 30% for Method 8330A and 20% for Method 8330B.

Corrective Action: The information obtained from MS data are sample/matrix specific and are not normally used to determine the validity of the entire batch. If the MS and/or MSD recovery falls outside of the established control limits, the bracketing CCV and batch LCS recoveries must be within control limits in order to accept results for the associated samples. The following corrective actions are required for MS/MSD recovery failures to rule out lab error:

- Check calculation and instrument performance;
- Verify, if possible, that the MS and MSD were spiked correctly (e.g., very low or very high recoveries);
- Consider objective evidence of matrix interference (e.g., heterogeneous sample, interfering peaks seen on chromatograms, or interference demonstrated by prior analyses);
- Flag the data for any results outside of acceptance limits.
- For any single RPD failure, check calculations; verify, if possible, that the MS and MSD were spiked correctly; check instrument performance; consider objective evidence of matrix interference or sample inhomogeneity; and flag the data.
- If both the parent sample and associated matrix spike results are over range the parent and the spikes shall be diluted by the same amount and the results from the reanalysis reported for both. If the analyte concentration in the parent sample is greater than four times the concentration of spike added, then spike recovery results are not compared to control limits, and the recovery is either reported as "NC" (not calculated) or with a qualifier flag to indicate that the spike was less than four times the analyte concentration in the sample. If the dilution will cause the spike to be less than two times the reporting limit, the MS/MSD do not need to be

diluted and the recovery reported as “NC” (not calculated).

- For MS/MSD that serve as batch QC, if the parent sample result is within the calibration range and the MS/MSD results are above the calibration range, the results are reported with the MS/MSD result being flagged as an over-range measurement (e.g., the E-flag qualifier).
- If the MS/MSD are client requested, the parent sample result is within calibration range and the MS/MSD results are above the calibration range, the sample and spike should be diluted, keeping in mind that we need to assess whether or not the dilution will best serve the client’s needs. Consult with the PM as needed. Both the parent sample and MS/MSD samples must have the same dilution factor. Some EDDs do not accept data that are at different dilution factors.
- If the native analyte concentration in the MS/MSD sample exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated) and the appropriate qualifier flags are added.

NOTE: See Denver Policy Memorandum P16-001 and Corporate Policy Memorandum CA-Q-QM-013 for more detail.

NOTE: Some client programs require reanalysis to confirm matrix interferences. Check special project requirements for this corrective action.

9.6 Surrogates

Each calibration standard, field sample, and QC sample is spiked with the surrogate compound 1,2-dinitrobenzene. The surrogate is added to field samples and QC samples before the first extraction step for all matrices.

Acceptance Criteria: The recovery of the surrogate must fall within established statistical limits, which are based on historical data.

Corrective Action: If recoveries for surrogates in blanks or LCSs are outside of the control limits, check for calculation or instrument problems and reprepare and reanalyze the associated samples.

For samples with failing surrogate recoveries the decision to reanalyze or flag the data should be made as required by the project.

If matrix interference is obvious from observation of chromatograms or other objective evidence, reanalysis is unlikely to produce new or more useful information. If the matrix interference is not obvious from the initial analysis, it is only necessary to reprepare and reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effect, so long as the extraction/instrument system is proven to be working properly.

9.7 Sample Duplicate

NOTE: Method 8330B requires the preparation of both a soil duplicate and a soil triplicate. See Section 9.8.

Although not typically required for organic analyses, a duplicate sample may be required for project-specific quality control. In this case, a sample duplicate is a second aliquot of one of the samples in the batch. Field blanks cannot be used for duplicate testing. The results for duplicates are reported separately, and cannot be averaged when reporting results. Sample duplicate results are used to evaluate the precision of the method. As such, results should be greater than or equal to the RL for a valid statistical comparison.

Acceptance Criteria: The RPD between the sample and the sample duplicate results must be less than the established limit.

Corrective Action: Results for samples that do not meet acceptance limits, particularly if due to difficulties in subsampling, shall be discussed in the final report case narrative, after client notification and agreement.

9.8 Sample Replicates

Replicate analyses are not part of the laboratories standard quality control samples. Method 8330B requires the preparation and analysis of sample duplicate and triplicate for soil samples ground by the ring and puck or ball mill. The lab will extract triplicate aliquots after grinding on the client designated sample. If a sample is not designated by the client, the lab will select the sample. The lab will determine the %RSD as defined below. Results for the %RSD as well as the individual replicate results will be reported to the client. The %RSD for results above the LOQ must be $\leq$ 20%, including DoD/DOE samples.

The percent relative standard deviation (%RSD) is calculated as follows:

$$\%RSD = \frac{s}{\overline{C}} \times 100\% \qquad \text{Equation 1}$$

Where s is the standard deviation of the average concentration ($\overline{C}$) and is calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n}(C_i - \overline{C})^2}{n-1}} \qquad \text{Equation 2}$$

In the event that the laboratory is requested to perform the evaluation of field replicate precision, three field replicates designated by the client will be processed through the entire homogenization and extraction steps. The %RSD for these replicates will be calculated as indicated above and reported to the client.

9.9 Grinding Blank (GB)

Refer to SOP DV-OP-0018 for details on how the grinding blanks for soils by method 8330B are prepared. The laboratory composites the grinding blanks to prepare and analyze one grinding blank per batch, consistent with DOD/DOE QSM 5.0. DOD/DOE QSM 5.1 requires only one grinding blank per batch of samples, processed after the LCS (if ground) or after a client identified sample with known contamination, or at the end of the batch.

Acceptance Criteria: The grinding blank must not contain any analyte of interest at or above one-half of the RL or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

Corrective Action: Per the method, the entire client sample is ground initially. Therefore, it is not possible to re-grind client samples if the grinding blank fails. Sample results will be reported with an NCM (see requirements for individual programs).

If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. The potential carry-over between samples associated with a contaminated grinding blank producing positive results for the same contaminant must be described in a non-conformance memo and discussed in the final report case narrative.

9.10 Grinding LCS (LCSSRM)

Refer to SOP DV-OP-0018 for details on how the grinding LCS for soils by method 8330B is prepared. The grinding LCS is spiked by an outside vendor, and then ground with the associated samples. One grinding LCS per batch is required.

Acceptance Criteria: The grinding LCS recovery for each spiked analyte must be within established control limits. Control limits are maintained in the LIMS.

Corrective Action: Per the method, the entire client sample is ground initially. Therefore, it is not possible to re-grind client samples if the grinding LCS fails. Sample results will be reported with an NCM (see requirements for individual programs).

If the surrogate compound recovers below control limits, or every compound recovers outside of control limits, but at approximately the same percentage, this could be an indication of a bad extraction (post-grinding). Associated samples will be sent for re-extraction and re-analysis.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Extraction of Water Samples – *Please reference DV-OP-0017 for details*

Samples are extracted using a 500 mL initial volume and are concentrated to a 5 mL final volume.

10.4 Extraction of Soil Samples – *Please reference DV-OP-0018 for details*

10.4.1 Samples for method 8330A are extracted using a 2 g initial weight and delivered to the analytical group with a 10 mL final volume. Samples for method 8330B are extracted using a 10 g initial weight and delivered to the analytical group with a 20 mL final volume.

10.4.2 TALS prep batches for soils will show a final volume of 20 mL for 8330A extracts, and 40 mL for 8330B extracts. These final volumes include the 1:1 dilutions with the acidified calcium chloride done by the analyst prior to instrument analysis. (See Section 10.5.2.)

10.5 HPLC Analysis

10.5.1 HPLC Startup: All electronic equipment should be allowed to warm up for 30 minutes. During this period, at least 15 void volumes of mobile phase are passed through the column. Continue until the detector's baseline has stabilized.

10.5.2 Prior to analysis, soil extracts (or a portion of the extract) must be diluted exactly 1:1 with the acidified calcium chloride solution that is described in section 7.8.8.

10.5.3 Analyze the samples using the chromatographic conditions given in Appendix 5. All positive measurements above the method detection limit observed on the primary C18 column are confirmed by injection of the sample extract onto the confirmation Phenyl-Hexyl column. The MB and LCS must be analyzed on the confirmation column if samples are analyzed on that column. The MS and MSD must be analyzed on the confirmation column if the parent sample is analyzed on the confirmation column. Many EDDs require the parent and MS/MSD results be from the same analytical batch. For DoD/DOE work, calibration and QC criteria are the same as for primary column analysis. QC must pass on both columns when confirmation analysis is performed for DoD or DOE.

10.5.4 Analytes are introduced by direct injection of the extract. Samples, standards, and QC samples must be introduced using the same procedure.

10.5.5 It has been demonstrated that water samples with total concentrations of 16,000 μg/L can yield low recoveries due to saturation of the extraction cartridge. The client should be contacted to determine if re-extraction using a smaller sample aliquot size is required for samples with concentrations in this range. The low extraction recovery may meet the client's action limit, such that a re-extraction may not be necessary to prevent possible laboratory contamination.

10.5.6 Analytical Sequence

10.5.6.1 The analytical sequence starts with either an initial calibration or a Continuing Calibration Verification (CCV). If the sequence begins with a CCV, the center of the retention time window is set based on the initial CCV in the sequence. Do not reset the retention times with the bracketing CCV.

10.5.6.2 The CCV includes analyzing standards that contain all target analytes. If 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and

2,6-diamino-4-nitrotoluene are not target compounds, it is not required to analyze a CCV for these analytes.

10.5.6.3 If there is a break in the analytical sequence greater than 12 hours since the analysis of a CCV standard, a new CCV standard must be analyzed before proceeding with the sequence.

10.5.7 Retention Time Windows

10.5.7.1 Retention time windows must be determined for all analytes. Make an injection of all analytes of interest each day for a three-day period. Calculate the standard deviation of the three retention times for each analyte (relative retention times may also be used). The width of the retention time window for each analyte is defined as ± three times the standard deviation.

NOTE: Determination of retention time windows using the 72-hour study is required for DoD/DOE work. A retention time window report can be generated in the Control Chart Module in TALS.

10.5.7.2 The chromatograms in Appendices 5 and 6 summarize the estimated retention times on both the C18 and Phenyl-Hexyl columns for many of the compounds analyzed using this method.

10.5.7.3 The center of the retention time window is the retention time from the last of the three standards. The centers of the windows are updated with the mid-point of the initial calibration, and each subsequent initial CCV (i.e., the CCV that begins the analytical sequence.) The widths of the windows will remain the same until new windows are generated following the installation of a new column.

10.5.7.4 If the retention time window, as calculated above, is less than ± 0.035 minutes for the C18 column or less than ± 0.07 minutes for the phenyl hexyl column, use ± 0.035 or ± 0.07 minutes as the retention time window. This allows for slight variations in retention times caused by sample matrix.

10.5.7.5 The laboratory must calculate new retention time windows each time a new column is installed or at least annually. Until these standards have been run on the new column, the retention time windows from the old column may be used, but updated with the retention times from the new initial calibration.

10.5.8 Daily Retention Time Windows

The center of the retention time window is adjusted to the retention time of each analyte, as determined in each initial calibration or each initial CCV.

Note: Chromatographic conditions, including the exact makeup of the eluent are determined at the time of the initial calibration and shall not be changed until the next initial calibration.

Corrective Action:

If there are shifts in retention times for target compounds between CCVs that are outside the established retention time window (see Section 10.5.7), all samples analyzed after the last compliant standard must be reanalyzed unless the following conditions are met for any compound that elutes outside the retention time window:

- The retention time of that compound in the standard must be within the retention time range equal to twice the original window, as determined by the opening CCV of a bracket, and
- The retention time of the compound must be shifted in the same direction as the surrogate and by approximately the same amount.

If these two conditions are met, reset the window and reprocess the data.

10.6 Calibration Range and Dilutions

10.6.1 If the concentration of any analyte exceeds the working range as defined by the calibration standards, then the sample must be diluted and reanalyzed. Dilutions should target the most concentrated analyte in the upper half (between the CCV and highest standard) of the calibration range.

10.6.2 Samples that are analyzed immediately following a sample with an unusually high concentration of explosives must be evaluated for carryover. The potential for carryover is minimized in the analytical system by continuously flushing the HPLC needle with solvent. If contamination is suspected, the sample should be re-aliquoted and re-analyzed.

10.6.3 Guidance for Dilutions Due to Matrix Interference:

It may also be necessary to dilute samples because of matrix interferences. If the sample is initially run at a dilution and only minor matrix peaks are present, then the sample should be reanalyzed at a more concentrated dilution. Analyst judgment is required to determine the most concentrated dilution that will not result in instrument contamination. Ideally, the dilution chosen will make the response of the matrix interferences equal to approximately half the response of the mid-level calibration standard.

10.6.4 Reporting Dilutions

Some projects require reporting of multiple dilutions (check method comments in the LIMS). In other cases, the lowest dilution with no target compounds above the calibration range will be reported. In general, a maximum of two dilutions will be reported; one at the lowest dilution and one in which the most concentrated target analyte is in the upper half of the calibration range.

10.7 Instrument Maintenance and Troubleshooting

10.7.1 Minor instrument maintenance may include back flushing the column, changing the guard cartridge, and changing the frit on the front end of the column.

10.7.2 The solvent channel on which the buffer is run should be rinsed weekly with pure water followed by pure methanol and finally pure water again before reloading the buffer in order to prevent the buildup of salts and prevent bacterial growth in the system.

10.7.3 A cleanup method is provided in the instrument software to remove the buffer from the column. It should be run as the last injection of any run sequence. The buffer solution should not be left on the column for extended periods when the instrument is not in use or decreased column lifetime will be observed.

10.7.4 Noisy baseline, particularly noticeable in RL level standards and MDLV samples, is normally due to a noisy UV Lamp. If the noise is sufficient to interfere with the quantitation of these samples, the lamp should be replaced and the instrument recalibrated. Less commonly, noisy baselines are the result of dirty flow cell windows, which should be cleaned or replaced according the manufacturer’s instructions.

10.7.5 Unstable retention times are normally due to a malfunction somewhere in the flow path of the instrument. Likely sources are the active inlet valve, outlet ball valve, multichannel gradient valve or purge valve. Dirty solvent inlet filters can starve the pump and may also result in unstable retention times.

11.0 Instrument Calibration

11.1 Detailed calibration equations can be found in the corporate SOP CA-Q-P-003, *Calibration Curves and the Selection of Calibration Points* and under the public folder, Arizona Calibration Training.

11.2 Instrument QC

11.2.1 External calibration is used for this analysis. Prepare standards containing each analyte of interest at a minimum of five concentration levels. The low level standard should be at or below the reporting limit. The other standards define the working range of the detector. Recommended calibration levels are given in Appendix 2.

11.2.2 A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include a new column and any changes in instrument operating parameters (including solvent flows, replacement of a detector lamp, replacement of the flow cell windows, etc.).

11.2.3 With the exception noted in Section 11.2.4 below, it is NOT acceptable to remove points from the calibration curve for the purpose of meeting criteria, unless the points are the highest or lowest on the curve AND the reporting limit and/or linear range is adjusted accordingly. In any event, at least 5 points must be included in a linear calibration curve and at least 6 points for a second order calibration curve.

11.2.4 A level may be removed from the calibration if the reason can be clearly documented (i.e., a broken vial or an injection error). A minimum of five levels must remain in the calibration for a linear model and six for a second order model. The documentation must be retained with the initial calibration.

11.3 Initial Calibration

Calibrations are modeled either as average response factors or as calibration curves, using a systematic approach to selecting the optimum calibration function in order as follows. When calibration acceptance criteria cannot be met for a model, appropriate corrective action must be taken. This may include processing the data using another model, instrument maintenance and or re-preparation of standards followed by recalibration.

11.3.1 The following requirements must be met for any calibration to be used:

11.3.1.1 Response must increase with increasing concentration.

11.3.1.2 Calibration curves will not be forced through the origin.

11.3.1.3 The absolute value of the intercept of the curve at zero response should ideally be less than the MDL for the analyte. At a minimum the intercept must be less than ½ the on-column equivalent of the reporting limit.

11.3.2 Linear Calibration Using Average Calibration Factors

11.3.2.1 External standard calibration using average calibration factors involves the comparison of instrument response (e.g., peak area or peak height) from the target compounds in the sample to the responses of the target compounds in the calibration standards. The ratio of the detector response to the concentration of target analyte in the calibration standard is defined as the calibration factor (CF), as follows:

$$CF = \frac{R_x}{C_s} \qquad \textit{Equation 3}$$

Where:

R_x = Response for analyte

C_s = Concentration in calibration standard, μg/mL

11.3.2.2 For each target analyte, calculate the average calibration factor ($\overline{CF}$) as follows:

$$\overline{CF} = \frac{\sum_{i=1}^{n} CF_i}{n} \qquad \textit{Equation 4}$$

Where:

n = Number of calibration levels

CF_i = Calibration factor for the i^{th} level

11.3.2.3 The calibration relationship can be graphically represented as a line through the origin with a slope equal to the average calibration factor.

11.3.2.4 The relative standard deviation (RSD) is calculated as follows:

$$RSD = \frac{SD}{\overline{\overline{CF}}} x100\% \qquad \textit{Equation 5}$$

Where SD is the standard deviation of the average CF, which is calculated as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(CF_i - \overline{CF}\right)^2}{n-1}} \qquad \textit{Equation 6}$$

11.3.2.5 To calculate the concentration in an unknown sample extract, the equation is solved for concentration, resulting in the following equation:

$$C_{ex} = \frac{R_x}{\overline{\overline{CF}}} \qquad \text{Equation 7}$$

Where:
C_{ex} = Extract analyte concentration, µg/mL
R_x = Response for analyte
$\overline{CF}$ = Average Calibration Factor

11.3.3 Average Calibration Factor Evaluation

Examine the residuals, i.e., the difference between the actual calibration points and the plotted line. Particular attention should be paid to the residuals for the highest points, and if the residual values are relatively large, a linear regression should be considered.

Acceptance Criteria: The RSD of the average response factor must be <20%. (15% for Method 8330B for DOD/DOE QSM 5.0 and 5.1). Also examine the residuals, especially for the high points versus the fitted function. If the residual values are large, a linear regression should be considered.

Corrective Action: If the RSD is > 20% (or >15% for Method 8330B for DOD/DOE QSM 5.0 and 5.1), average response factor cannot be used and least-squares linear regression should be attempted.

11.3.4 Linear Calibration Using Least-Squares Regression

Calibration using least-squares linear regression produces a straight line that does not pass through the origin. The calibration relationship is constructed by performing a linear regression of the instrument response (peak area or peak height) versus the concentration of the standards. The instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x).

The weighting used is the reciprocal of the concentration or the reciprocal of the square of the concentration. The regression produces the slope and intercept terms for a linear equation in the following:

$$R_x = m_1(C_s) + b \qquad \text{Equation 8}$$

Where:
C_s = Concentration in calibration standard, µg/mL
R_x = Response for analyte
b = y - Intercept
m_1 = Slope

To calculate the concentration in an unknown sample extract, the regression equation is solved for concentration, resulting in the following equations, where C_{ex} is the concentration of the target analyte in the unknown sample:

$$C_{ex} = \frac{[R_x - b]}{m_1} \qquad \textit{Equation 9}$$

Where:
C_{ex} = Extract analyte concentration, µg/mL
R_x = Response for analyte
b = y - Intercept
m_1 = Slope

11.3.5 Evaluation of the Linear Least-Squares Regression Calibration Function:

With an unweighted linear regression, points at the lower end of the calibration curve have less weight in determining the curve than points at the high concentration end of the curve. For this reason, inverse weighting of the linear function is recommended to optimize the accuracy at low concentrations.

Note that the August 7, 1998 EPA memorandum “Clarification Regarding Use of SW-846 Methods”, Attachment 2, Page 9, includes the statement “The Agency further recommends the use of this for weighted regression over the use of an unweighted regression.”

Acceptance Criteria:

11.3.5.1 Examine the residuals, but with particular attention to the residuals at the bottom of the curve. If the intercept or the residuals are large, a second-order regression should be considered.

11.3.5.2 The linear regression must have a correlation coefficient (r) ≥ 0.995 ($r^2 \geq 0.990$).

11.3.6 Non-linear Calibration Using a Second-Order Equation

When the instrument response does not follow a linear model over a sufficiently wide working range, or when the previously described calibration approaches fail acceptance criteria, a non-linear, second-order calibration model may be employed. The second-order calibration uses the following equation:

$$R_x = m_2(C_s)^2 + m_1(C_s) + b \qquad \textit{Equation 10}$$

Where:
C_s = Analyte concentration in calibration standard, µg/mL

R_x = Response for analyte
m_2 = Curvature
m_1 = Slope
b = y - Intercept

To calculate the concentration in an unknown sample extract, the roots of the quadratic equation are solved for:

$$C_{ex} = \frac{-m_1 \pm \sqrt{(m_1)^2 - 4(m_2)(b - R_x)}}{2m_2} \qquad \textit{Equation 11}$$

Where:
C_{ex} = Extract analyte concentration, µg/mL
R_x = Response for analyte
m_2 = Curvature
m_1 = Slope
b = y – Intercept

11.3.7 Evaluation of Second-Order Regression Calibration:

A minimum of six points must be used for a second-order regression fit.

Acceptance Criteria:

11.3.7.1 Second-order regressions should be the last option, and note that some programs (e.g., South Carolina) do not allow the use of second-order regressions.

11.3.7.2 The coefficient of determination (COD, r^2) must be ≥ 0.99.

11.3.7.3 The response increases significantly with increasing standard concentration (i.e., the instrument response does not plateau at high concentrations).

11.3.7.4 The distribution of concentrations is adequate to characterize the curvature.

11.4 Calibration Verification

11.4.1 Initial Calibration Verification (ICV)

A second-source verification standard must be analyzed with each initial calibration. The calculated concentration of the analytes in this standard may not be greater than 20% different from the calibration standard (15% for DoD/DOE QSM 5.0 and 5.1 for Method 8330A).

11.4.2 Continuing Calibration Verification (CCV)

The working calibration curve or RF must be verified by the analysis of a mid-point continuing calibration standard at the beginning of the analysis sequence, after every 10 samples, and at the end of the analysis sequence.

Acceptance Criteria:

Results are acceptable for any individual compound if the %D (percent difference between the standard and measured values of the CCV standard) is ≤ 20%. (≤ 15% for DoD/DOE QSM 5.0 and 5.1 for Method 8330A). TestAmerica discourages the use of grand mean for method 8000B. The use of grand mean is not acceptable for Method 8000C (required by Arizona) or 8000D (required by North Carolina, South Carolina and West Virginia).

NOTE: In order to comply with DoD/DOE QSM 5.0 or 5.1 requirements, the use of the grand mean is not acceptable (refer to policy DV-QA-024P). Results are acceptable for individual compounds if the %D is:

8330A		**8330B**	
QSM 4.2	%D ≤ 15%	QSM 4.2	%D ≤ 20%
QSM 5.0	%D ≤ 15%	QSM 5.0	%D ≤ 20%
QSM 5.1	%D ≤ 15%	QSM 5.1	%D ≤ 20%

Corrective Action:

If the percent difference for any analyte falls outside of ± 20% (or program specific limit such as DoD or DOE), corrective action must be taken. This may include back flushing the column, changing the guard cartridge, changing the frit on the front end of the column, or other minor instrument adjustments, followed by reanalyzing the standard. If the response for any analyte still varies by more than 20% (or program specific limit such as DoD or DOE), a new calibration curve must be prepared and analyzed. The column may also need to be replaced based on the chromatography.

Reported sample results must be bracketed by successful CCVs. When a CCV fails, all samples run since the last successful calibration verification must be reanalyzed. If the CCV recovery is >20% D (or program specific limit such as DoD or DOE) and the associated samples are ND, the samples may be reported without reanalysis. Flag the data and document the decision in an NCM. For DoD or DOE, this must be accepted by the client and documented in the project records.

12.0 Calculations / Data Reduction

12.1 Detailed calibration equations can be found in the corporate SOP CA-Q-P-003, *Calibration Curves and the Selection of Calibration Points* and under the public folder, Arizona Calibration Training.

12.2 Qualitative Identification

12.2.1 Tentative identification occurs when a peak is found within the retention time window for an analyte, at a concentration above the method detection limit. The required quantitation level is defined as the LIMS test code reporting limit for standard reports, adjusted for initial weight and volume and any dilutions. A UV detector wavelength of 254 nm is used to quantify and report all analytes except PETN and Nitroglycerin that are quantified and reported using a UV detector wavelength of 215 nm.

12.2.2 Identification is confirmed if a peak is also detected within the retention time window on a dissimilar column (Section 12.3).

12.2.3 Sample Evaluation:

12.2.3.1 Analyst judgment weighs heavily in the evaluation of retention time shifts for client samples. The evaluation may be based on RT shifts of the surrogate standard. The chromatograms must be examined closely to ensure that false positive / negative results are not reported. In the absence of significant shifts of the surrogate, peaks within a ± 0.035 minutes (C18 column) or ± 0.07 minutes (phenyl hexyl column) window must be considered positive results.

12.2.3.2 If the sample required significant dilution due to high levels of target peaks or interfering compounds, the surrogate peak may not be obvious. In this case, an adjustment of RTs due to matrix for target compounds cannot be done reliably, and ± 0.035 minutes (C18 column) or ± 0.07 minutes (phenyl hexyl column) (or the established RT window described in Section 10.5.7) from the most recent CCV will be used for all compounds.

12.2.3.3 The expected retention time for target analytes is updated with the retention times of each CCV. If sample matrix is causing significant retention time shifts between CCVs, samples may require dilution and reanalysis to minimize the matrix effects.

12.2.3.4 Method Blank Detections:

When a detection is observed in the method blank on either column, the result must be confirmed on the other dissimilar column to be considered a true hit. See Section 9.3 and

Appendix 4 for additional information for evaluation of method blanks.

12.2.3.5 Interferences:

2,4,6-Trinitrotoluene elutes closely with 4-amino-2,6-dinitrotoluene on the primary (C18) column. Because of this close elution, high levels of 2,4,6-trinitrotoluene can overlap the retention time window for, and thus mask the presence of, low levels of 4-amino-2,6-dinitrotoluene. Therefore, 4-amino-2,6-dinitrotoluene may be reported as a detection from the confirmation (phenyl-hexyl) column, even though no peak could be detected on the primary column. In this event, an NCM is necessary.

Other target compound interferences may be observed in samples. Analyst judgment will be necessary to evaluate sample chromatograms and potentially report additional detections without confirmation due to interferences and/or analyze samples at dilutions. In this event, an NCM is required, documenting the decision.

12.3 Second-Column Confirmation

Detection of compounds on the primary column is confirmed using a second, dissimilar column. This column is calibrated using the same calibration levels as the primary column. The analysis on the second column must meet all of the instrument QC described in Section 9.0 and 11.0. Identification is confirmed if a peak is also present in the retention time window for that analyte on the confirmatory column.

The RPD between two results is calculated using the following equation:

$$\%RPD = \frac{|R_1 - R_2|}{\frac{1}{2}(R_1 + R_2)} \times 100\% \qquad \textit{Equation 12}$$

Where R_1 is the result for the first column and R_2 is the result for the second column.

Acceptance Criteria:

The RPD between confirmed results should agree within 40%; results will then be reported from the primary column.

Corrective Action:

If the RPD is >40% and there is visible positive interference, e.g., co-eluting peaks, elevated baseline, etc., for one column and not the other, then report the results from the column without the interference with the appropriate data qualifier flag, footnote, and/or narrative comment in the final report.

If the RPD is >40% and there is visible positive interference for both columns, then report the lower of the two results with the appropriate flag, footnote, and/or narrative comment in the final report.

Special project reporting requirements may supersede these reporting schemes. Verify in the method comments or project Quality Assurance Summaries.

12.4 Manual Integrations

Raw instrument data is automatically transferred to Chrom at the completion of each run for further processing. Review the chromatograms to ensure correct assigning of peaks and correct integration of each peak. If manual data manipulations are necessary, they must be justified and documented. See DV-QA-011P for requirements for manual integration.

12.5 % Difference Calculation for ICV / CCV Evaluation

The percent difference for the analysis of a CCV standard is calculated as follows:

$$\%\,\text{Difference} = \left(\frac{\text{Expected Value} - \text{Measured Value}}{\text{Expected Value}}\right) \times 100\% \qquad \textit{Equation 13}$$

12.6 Concentration in Aqueous Samples

The concentration of analyte in the original aqueous sample is calculated as follows:

$$\text{Concentration, } \mu\text{g/L} = \frac{C_{ex} V_t}{V_o} x DF \qquad \textit{Equation 14}$$

Where: C_{ex} = Extract analyte concentration, µg/mL
V_t = Volume of total extract in mL (normally 5 mL)
V_o = Volume of water extracted in liters (normally 0.5 L)
DF = Dilution factor, as appropriate

12.7 Concentration in Soil Samples

The concentration of analyte in the original non-aqueous sample is calculated as follows:

$$\text{Concentration, } \mu\text{g/kg} = \frac{C_{ex} V_t}{WD} \times DF \qquad \textit{Equation 15}$$

Where:
C_{ex} = Concentration of analyte in the extract (µg/mL)
V_t = Total volume of original extract in mL (normally 20 mL for 8330A or 40 mL for 8330B); this volume includes the extracted volume in ACN and the 1:1 dilution with $CaCl_2$
W = Weight (mass) of sample extracted in kg (normally 0.002 kg for 8330A or 0.010 kg for 8330B)
D = (100-% moisture in sample)/100 for dry weight basis or 1 for wet-weight basis
DF = Dilution factor, as appropriate

12.8 Concentration of Ammonium Picrate

Ammonium picrate is requested by some clients as a target compound. This is the ammonium salt of picric acid. Chromatographically, there is no difference between these two compounds, therefore, upon request, the result for ammonium picrate (C_{AP}) is calculated based on the measured concentration of picric acid, as follows:

$$C_{AP} = Picric\,Acid\,Result \times \left(\frac{246.13 (Molar Mass\ of\ Ammonium Picrate)}{229.11 (Molar Mass\ of\ Picric\ Acid)} \right) \qquad \textit{Equation 16}$$

In TALS, this calculation is accomplished by opening the batch information in the analytical batch, and setting the calculation line to 1 (Yes).

12.9 LCS and CCV Percent Recovery

$$\text{Control Spike Recovery} = \frac{S_{SR}}{S_A} \times 100\% \qquad \textit{Equation 17}$$

Where S_{SR} = Calculated analyte concentration of spiked sample
S_A = Concentration of standard added

12.10 MS / MSD Percent Recovery Calculation

$$\text{Matrix Spike Recovery} = \frac{S_{SR} - S_R}{S_A} \times 100\% \qquad \textit{Equation 18}$$

Where S_{SR} = Calculated analyte concentration of spiked sample
S_R = Calculated analyte concentration of parent sample
S_A = Concentration of standard added

12.11 Relative Percent Difference Calculation for the MS/MSD

$$RPD = \frac{|MS_R - MSD_R|}{1/2(MS_R + MSD_R)} \times 100$$ *Equation 19*

Where
RPD = Relative percent difference
MS_R = Matrix spike result of analyte
MSD_R = Matrix spike duplicate result of analyte

12.12 Reporting limits are shown in Table 1. If samples require dilutions or smaller volumes than normally used, the MDLs and RLs will be correct based on the actual volume used and/or the dilution factor. Reporting limits for soil samples are adjusted for the actual weight of sample extracted. As samples are dried prior to subsampling for analysis percent moisture is not determined.

12.13 All results are subject to two levels of technical review. See SOP DV-QA-0020 for a more detailed description for data review and an example of this checklist.

13.0 Method Performance

13.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-006 MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

13.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

13.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

13.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest

13.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.2.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

13.2.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

13.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and local regulations. When reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Corporate Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

15.2 The following waste streams are produced when this method is carried out:

15.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

15.2.2 Flammable solvent waste – Waste Stream C

15.2.3 Flammable vial waste – Waste Stream A

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16.0 References / Cross-References

16.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

16.1.1 Method 3535A, Solid Phase Extraction (SPE), Revision 0, December 1996.

16.1.2 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

16.1.3 Method 8000C, Determinative Chromatographic Separations, Revision 3, March 2003.

16.1.4 Method 8000D, Determinative Chromatographic Separations, Revision 4, July 2014.

16.1.5 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

16.1.6 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

16.1.7 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

16.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/25/2010.

16.3 Department of Defense/Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories Version 5.0, July 2013.

16.4 Department of Defense/Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories Version 5.1, 2017.

17.0 Method Modifications:

17.1 Deviations from Method Source and Rationale

Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life per 8330A	Shelf Life per 8330B
Stock standards	1,000,000 µg/L (1,000 ppm)	Six Months	One year
Intermediate standards	2.5 to 10,000 µg/L	Thirty days	One year
Working standards	1 to 500 µg/L	Daily	Daily

This SOP describes the use of 100,000 µg/L high-level standards, which are assigned a six month shelf life based on TestAmerica's experience with these materials. Further, a 25-1,000 µg/L standard mix is characterized as an intermediate-level, and assigned a 30 day shelf life.

17.2 Acidic water (pH < 3) is added to the concentrated extract, dilutions, and all calibration and check standards in place of reagent water. This is to preserve any Tetryl present in the extract.

17.3 Method 8330B suggests that the %RSD for triplicate analysis for soil should be ≤10%. The laboratory uses a criterion of ≤ 20% consistent with DoD/DOE QSM requirements.

18.0 Attachments

Appendix 1.	Analyte List
Appendix 2.	Suggested Calibration Levels (µg/mL)
Appendix 3.	Spike Levels
Appendix 4.	Assessment of Method Blank Results
Appendix 5.	Suggested Instrument Conditions
Appendix 6.	Example Chromatogram from Primary Column – Ultracarb ODS (20)
Appendix 7.	Example Chromatogram from Confirmation Column – Luna Phenyl-Hexyl

19.0 Revision History

- Revision 20, dated 31 July 2018

    - Annual Review

- Revision 19, dated 30 June 2017
    - Updated text and references to DOD QSM to DOD/DOE QSM 5.0 and/or 5.1 as appropriate throughout SOP.
    - Revised low point of curve in Sections 1.5.2 and 7.5.2 and Appendix 2.
    - Added statement to Section 4.3 that both DOD/DOE QSM 5.0 and 5.1 exclude vegetation.
    - Updated reference from 2003 NELAP Standard to 2009 TNI Standard in Section 9.4.
    - Removed language in Section 9.5 regarding dilution of MS/MSD and parent sample as how to handle over-range MS/MSD is discussed later in the paragraph.
    - Added DOD/DOE QSM 5.1 requirements for grinding blank to Section 9.9.
    - Added notes regarding states requiring 8000D (North Carolina, South Carolina, West Virginia).
    - Added reference to 8000D in Section 16.
    - Updated Section 17.1 to reflect current shelf life for standards
    - Added 3,5-Dinitroaniline (Method 8330B only) to Appendix 2.

- Revision 18, dated 6 July 2016
    - Added clarification to Section 1.3 to comply with document control policy
    - Revised Section 7.8.10 to require no changes to eluent composition between initial calibrations.
    - Removed reference to DoD QSM 3 in Section 8.2.1. The laboratory no longer performs work in compliance with this outdated version of the QSM.
    - Added reference to grinding blank in Method Blank description in Section 9.3
    - Clarified corrective action for failed method blank in Section 9.3
    - Added statement to Section 9.4 to analyze LCS on confirmation column if samples

analyzed on confirmation column (positive control).

  - Revised corrective action for Section 9.5 to include requirements for dilution of MS/MSD when required
  - Added clarification to replicate analyses in Section 9.8
  - Removed section 9.11, redundant with Section 9 subsections.
  - Added clarification for confirmation analyses in Section 10.5.3
  - Added clarification in Sections 10.5.6.2 and 10.5.7.3 for updating RT windows only at start of each 12-hour sequence.
  - Removed statement in Section 10.5.7.4 that RT can be adjusted based on each calibration verification standard.
  - Added “at least annually” to section 10.5.7.5 for consistency with requirements in the QA Manual.
  - Removed statements regarding changes to eluent between initial calibrations.
  - Revised corrective action in Section 10.5.8.
  - Added method reference to DoD QSM criteria stated in Section 11.3.3
  - Removed paragraph referencing the grand mean; TestAmerica discourages the use of the grand mean.
  - Clarified Section 12.2.3.4 on Method Blank Detections referencing Section 9.3 and new Appendix 4.
  - Clarified sentence in Section 12.2.3.5 regarding interferences.
  - Removed references in Section 12.2.3.5 to using MS confirmation as the laboratory uses HPLC analysis on a second distinct column for confirmation rather than MS analysis.
  - Added sentence to Section 12.3 corrective action regarding potential for project specific reporting requirements pending results for dual column RPDs.
  - Added section 15.2.3 for proper disposal of vial waste.
  - Added Section 17.3 to the Method Modifications section.
  - Added new Appendix 4 to provide MB interpretation guidance and renumbered remaining appendices.

- Revision 17, dated 31 March 2016
  - Revised Section 4.6 to clarify procedural steps to minimize decomposition of tetryl.
  - Added 12.0 mL vial size to section 6.2.1.1
  - Added TALS reagent IDs in Section 7
  - Revised preparation frequency of working eluent for primary column in Section 7.8.10.1
  - Revised amount of glacial acetic acid to add for working eluent for confirmation column, section 7.8.10.2
  - Added new section 9.6 to describe surrogate, acceptance criteria and corrective actions; renumbered remainder of section 9
  - Revised new sections 9.7 and 9.8 to clarify when duplicate and triplicate are required
  - Updated reference to corporate SOP for calibration curves from CA-Q-S-005 to current version CA-Q-P-003.
  - Revised Section 11.4.2 to clarify use of grand mean cannot be used in conjunction with Method 8000C such as required by Arizona and South Carolina
  - Revised equation 15 to include dry weight correction
  - Updated Section 13 to reflect current practice
  - Clarified DoD specific criteria throughout
  - Removed all references to AFCEE
  - Formatting and grammatical changes throughout.

- Revision 16, dated 31 March 2015
    - Annual Review
    - Updated section 1.4.4 to reflect current analyte exceptions
    - Expanded and clarified section 7.1
    - Made minor corrections to sections 7.3 and 7.4.
    - Moved Instrument Maintenance and Troubleshooting section 13.5 to section 10.7
    - Expanded the Instrument Maintenance and Troubleshooting section 10.7

- Revision 15, dated 31 March 2014
    - Updated Sections 2.2, 6.1.2, 7.8.10, Appendix 4 and Appendix 5 with a new primary column (Agilent Poroshell 120, EC-C18)
    - Added Section 13.5 as a DoD QSM 5.0 requirement
    - Added QSM reference information
    - Annual Review

- Revision 14, dated 30 April 2013
    - Updated Sections 9.1, 10.1 and 10.2
    - Annual Review

- Revision 13, dated 04 April 2012
    - Updated calibration section.
    - Updated standards section.
    - Replaced chromatograms in Appendices 5 and 6 with current chromatograms from Chrom.
    - Source method review.

- Revision 12.2, dated 15 February 2011
    - Added a comment to section 10.3 regarding saturation concentrations for the solid phase extraction cartridges.
    - Added section 11.1 referencing corporate SOP CA-Q-S005, “Calibration Curves”.

Earlier revision histories have been archived and are available upon request.

Appendix 1. Analyte List

Compound	Peak#		CAS #	Symbol	Standard Reporting Limits		
	Col A	Col B			Water (µg/L)	Soil, 2 g (mg/Kg)	Soil, 10 g (mg/Kg)
2,6-Diamino-4-nitrotoluene**	1	2	59229-75-3	2,6-DA-4-NT	1.0	2.0	1.0
Octahydro-1,3,5,7-tetranitro-1,3,5,7,-tetrazocine	2	5	2691-41-0	HMX	0.40	0.25	0.10
2,4-Diamino-6-nitrotoluene**	3	3	6629-29-4	2,4-DA-6-NT	1.0	2.0	1.0
Hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine	4	6	5755-27-1	MNX	2.0	0.25	0.10
Hexahydro-1,3,5-trinitro-1,3,5-triazine	5	7	121-82-4	RDX	0.20	0.26	0.20
Picric Acid (2,4,6-Trinitrophenol)	6	4	88-89-1	PA	2.0	0.25	0.10
1,3,5-Trinitrobenzene	7	18	99-35-4	1,3,5-TNB	1.0	0.25	0.10
1,2-Dinitrobenzene (surrogate)	8	9	528-29-0	1,2-DNB	NA	NA	NA
1,3-Dinitrobenzene	9	11	99-65-0	1,3-DNB	0.40	0.25	0.10
Methyl-2,4,6-trinitrophenyl nitramine	10	21	479-45-8	Tetryl	0.24	0.50	0.20
3,5-Dinitroaniline** (8330B only)	11	10	618-87-1	3,5-DNA	0.40	NA	0.10
Nitrobenzene	12	8	98-95-3	NB	0.40	0.25	0.30
Nitroglycerin	13	12	55-63-0	NG	3.0	5.1	2.0
2,4,6-Trinitrotoluene	14	22	118-96-7	2,4,6-TNT	0.40	0.25	0.10
4-Amino-2,6-dinitrotoluene	15	15	19406-51-0	4-Am-DNT	0.20	0.25	0.10
2-Amino-4,6-dinitrotoluene	16	17	35572-78-2	2-Am-DNT	0.20	0.25	0.10
2,6-Dinitrotoluene	17	19	606-20-2	2,6-DNT	0.20	0.25	0.10
2,4-Dinitrotoluene	18	20	121-14-2	2,4-DNT	0.40	0.25	0.10
2-Nitrotoluene (o-Nitrotoluene)	19	13	88-72-2	2-NT	0.40	0.25	0.20
4-Nitrotoluene (p-Nitrotoluene)	20	14	99-99-0	4-NT	1.0	0.40	0.20
PETN	21	23	78-11-5	PETN	2.0	4.0	2.0
3-Nitrotoluene (m-Nitrotoluene)	22	16	99-08-1	3-NT	0.40	0.50	0.20

**Non-standard spike analytes, only spiked when specifically requested.
A: - UltraCarb5uDODS
B: - Lina-Phenyl Hexyl

Appendix 2. Suggested Calibration Levels (μg/mL)

Compound	Level 1	Level 2	Level 3	Level 4*	Level 5	Level 6	Level 7	Level 8
HMX	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
RDX	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,3,5-Trinitrobenzene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,3-Dinitrobenzene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Tetryl	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Nitrobenzene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,4,6-Trinitrobenzene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
4-Amino-2,6-dinitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2-Amino-4,6-dinitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,4-Dinitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,6-Dinitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2-Nitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
3,5-Dinitroaniline (8330B only)	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
3-Nitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
4-Nitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Nitroglycerin	0.2	0.5	1.0	2.5	4	7	10.	25
PETN	0.2	0.5	1.0	2.5	4	7	10.	25
2,4-Diamino-6-ditrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,6-Diamino-4-nitrotoluene	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Picric Acid	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,2-Dinitrobenzene (surrogate)	0.02	0.05	0.10	0.25	0.4	0.7	1.0	2.5

* This level is used for the daily and continuing calibration standards.

Appendix 3. Spike Levels

LCS / MS / MSD Spike Levels					
Method and Matrix	Working Solution		Spike Amount	Final Concentrations	
	Standard Analytes	Nitroglycerin & PETN		Standard Analytes	Nitroglycerin & PETN
Water, Methods 8330A and 8330B	10 µg/mL	100 µg/mL	0.1 mL	2 µg/L	20 µg/L
Soil Method 8330A (2 g prep)	10 µg/mL	100 µg/mL	0.5 mL	2.5 mg/Kg	25 mg/Kg
Soil Method 8330B (10 g prep)	10 µg/mL	100 µg/mL	1.0 mL	1.0 mg/Kg	10 mg/Kg

Surrogate Spike Levels			
Method and Matrix	Working Solution 1,2-DNB	Spike Amount	Final Concentration
Water, Methods 8330A and 8330B	10 µg/mL	0.1 mL	2 µg/L
Soil Method 8330A (2 g prep)	10 µg/mL	0.5 mL	2.5 mg/Kg
Soil Method 8330B (10 g prep)	10 µg/mL	1.0 mL	1.0 mg/Kg

Appendix 4. Assessment of Method Blank Results

Primary Column	Confirmation Column	Corrective Action
NO	NO	Proceed with analysis; MB is ND
YES	NO	Proceed with analysis; MB is ND
NO	YES	Proceed with analysis; MB is ND
J FLAG	NO	Proceed with analysis; MB is ND
NO	J FLAG	Proceed with analysis; MB is ND
J FLAG	J FLAG	Detection confirms; however, no reworks needed if primary result < ½ RL If primary result > ½ RL, re-extract if possible unless the sample-samples are ND or >10x the MB for the analyte detected in the MB. Report with NCM
YES	YES	Samples must be ND or >10x the MB; otherwise re-extract. Report with NCM
J FLAG	YES	If primary result > ½ RL, re-extract if possible unless the sample analytes are ND or >10x the MB for the analyte detected in the MB. The relative percent difference between the primary and confirmation result determines which result to report. See Section 12.3. Flags applied by formatter. Report with NCM.
YES	J FLAG	

YES = Analyte was detected at a concentration above the RL
NO = Analyte was not detected above the MDL
J FLAG = Analyte was detected at a concentration less than the RL but at or above the MDL

NOTE: The formatter assigned in TALS will apply B flags according to program rules. Do NOT remove B flags. If a client requests such removal, QA staff and PM must be involved in the decision making process and all such removals must be documented. (See Policy P15-001.)

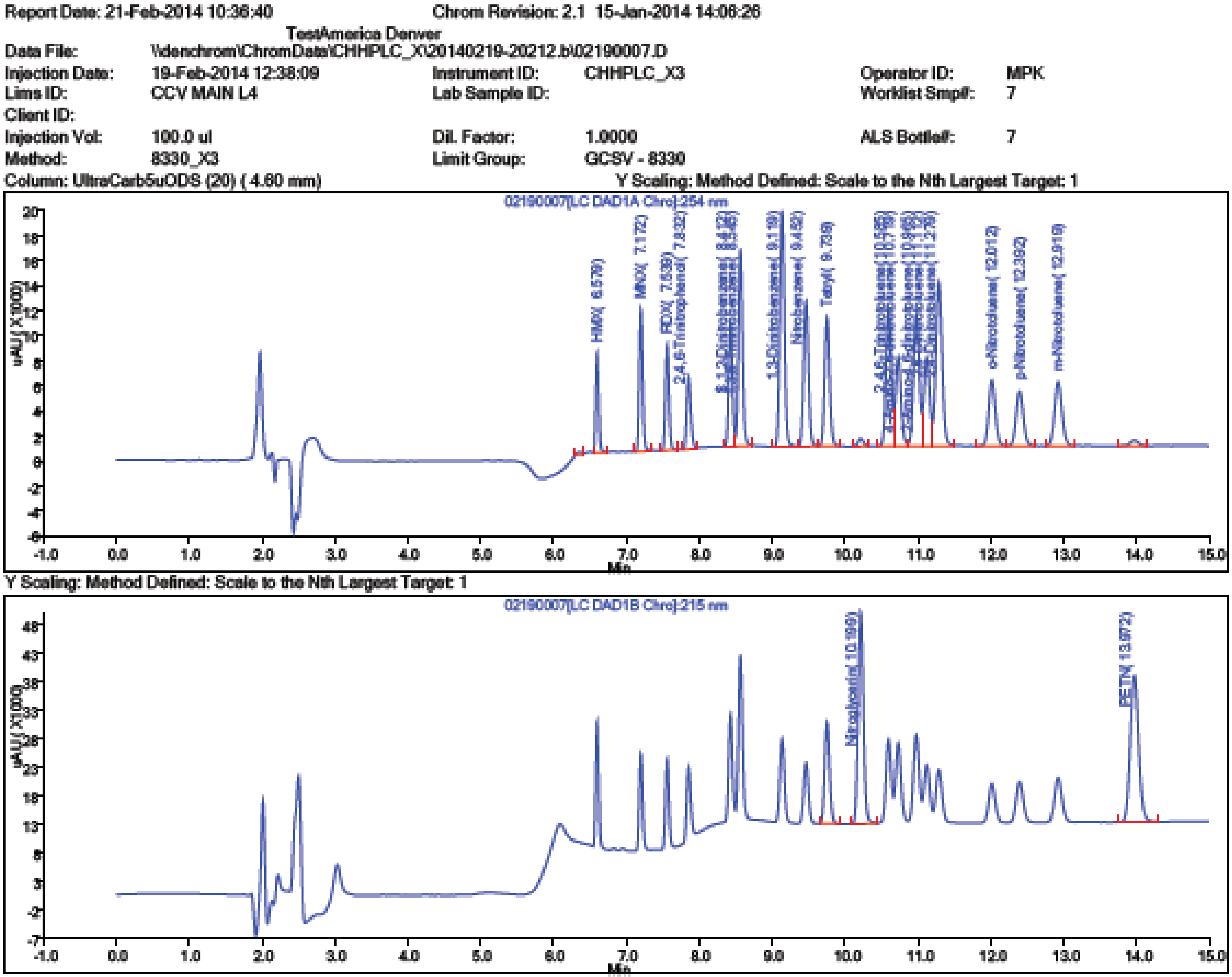
Appendix 5. Suggested Instrument Conditions

<table>
<tr><th colspan="4">Instrument Conditions</th></tr>
<tr><td rowspan="2">Column Types</td><td colspan="3">Primary Column: Agilent Poroshell 120, EC-C18,
4.6 mm x 150 mm (2.7 μm)</td></tr>
<tr><td colspan="3">Confirmation Column: Phenomenex Luna Phenyl-Hexyl,
4.6mm x 150mm (3.0 μm)</td></tr>
<tr><td>Detector - 1st Channel</td><td colspan="3">UV 254 nm, 40 R 550 nm</td></tr>
<tr><td>Detector - 2nd Channel</td><td colspan="3">UV 215 nm, 40 R 450 nm</td></tr>
<tr><td rowspan="3">General Parameters</td><td></td><td>Primary Column</td><td>Confirmation Column</td></tr>
<tr><td>Injection Volume:</td><td>50 μL</td><td>100 μL</td></tr>
<tr><td>Column Temperature:</td><td>26.9°C</td><td>24.3°C</td></tr>
</table>

<table>
<tr><th colspan="7">Suggested Column Parameters</th></tr>
<tr><th></th><th>Stop Time (min.)</th><th>Post Time (min.)</th><th>Flow Rate (mL/min.)</th><th>Time (minutes)</th><th>% H_2O</th><th>% Methanol</th></tr>
<tr><td>Gradient: Primary (C18) Column</td><td>15.5</td><td>5.0</td><td>0.75</td><td>0.0, 2.0, 2.98, 13.0, 13.5, 15.0, 15.5</td><td>90, 90, 41, 40,10, 10, 90</td><td>10, 10, 59, 60, 90, 90, 10</td></tr>
<tr><td>Gradient: Confirmation (Phenyl-Hexyl) Column</td><td>26.0</td><td>4.0</td><td>0.8</td><td>0.0, 26.0, 30.0</td><td>50, 25, 50</td><td>50, 75, 50</td></tr>
</table>

Appendix 6. Example Chromatograms from Primary (C18) Column

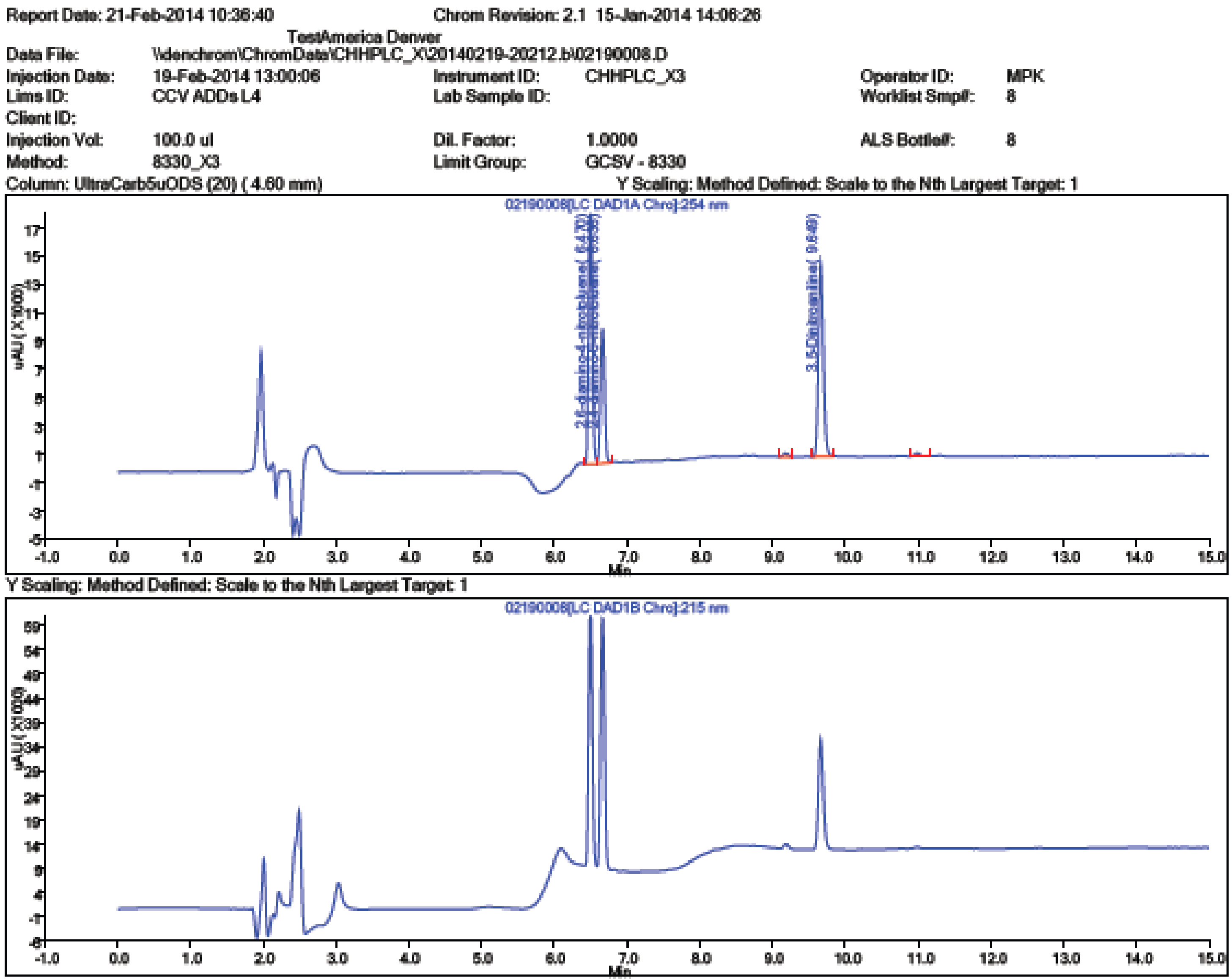
8330IntermStk:



Report Date: 21-Feb-2014 10:36:40 Chrom Revision: 2.1 15-Jan-2014 14:06:26
TestAmerica Denver
Data File: \\denchrom\ChromData\CHHPLC_X\20140219-20212.b\02190007.D
Injection Date: 19-Feb-2014 12:38:09 Instrument ID: CHHPLC_X3 Operator ID: MPK
Lims ID: CCV MAIN L4 Lab Sample ID: Worklist Smpl#: 7
Client ID:
Injection Vol: 100.0 ul Dil. Factor: 1.0000 ALS Bottle#: 7
Method: 8330_X3 Limit Group: GCSV - 8330
Column: UltraCarb5uODS (20) (4.60 mm) Y Scaling: Method Defined: Scale to the Nth Largest Target: 1

Y Scaling: Method Defined: Scale to the Nth Largest Target: 1

Additional Compounds (8330_ADDs):



Report Date: 21-Feb-2014 10:36:40 Chrom Revision: 2.1 15-Jan-2014 14:06:26

TestAmerica Denver

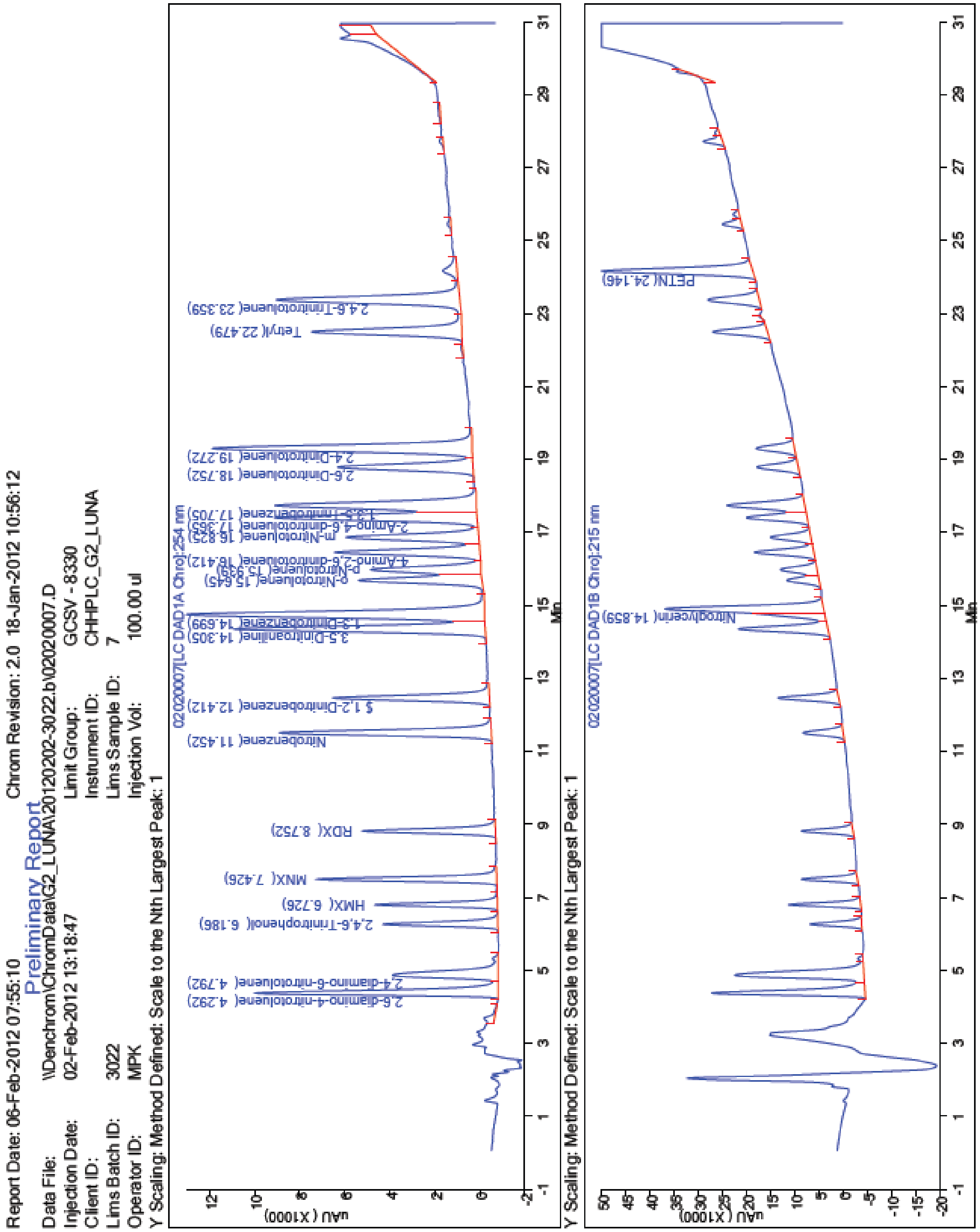
Data File:	\\denchrom\ChromData\CHHPLC_X\20140219-20212.b\02190008.D				
Injection Date:	19-Feb-2014 13:00:06	Instrument ID:	CHHPLC_X3	Operator ID:	MPK
Lims ID:	CCV ADDs L4	Lab Sample ID:		Worklist Smp#:	8
Client ID:					
Injection Vol:	100.0 ul	Dil. Factor:	1.0000	ALS Bottle#:	8
Method:	8330_X3	Limit Group:	GCSV - 8330		

Column: UltraCarb5uODS (20) (4.60 mm)

Y Scaling: Method Defined: Scale to the Nth Largest Target: 1

Y Scaling: Method Defined: Scale to the Nth Largest Target: 1

Appendix 7. Example Chromatogram from Confirmation (Phenyl-Hexyl) Column



Report Date: 06-Feb-2012 07:55:10 Chrom Revision: 2.0 18-Jan-2012 10:56:12

Preliminary Report

Data File: \\Denchrom\ChromData\G2_LUNA\20120202-3022.b\02020007.D

Injection Date: 02-Feb-2012 13:18:47 Limit Group: GCSV - 8330

Client ID: Instrument ID: CHHPLC_G2_LUNA

Lims Batch ID: 3022 Lims Sample ID: 7

Operator ID: MPK Injection Vol: 100.00 ul

Y Scaling: Method Defined: Scale to the Nth Largest Peak: 1

TestAmerica Denver

Electronic Document Cover

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TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Electronic Copy Only

Title: Polynuclear Aromatic Hydrocarbons by GC/MS Selected Ion Monitoring (SIM) [SW 846 Method 8270C and 8270D]

Approvals (Signature/Date):

	5/2/18	Doug Gomer	5/1/18
Tegan Moore Technical Specialist	Date	Doug Gomer Health & Safety Manager / Coordinator	Date
	5/1/18		5/2/18
Roxanne Sullivan Quality Assurance Manager Thomas Lill, signing for Roxanne Sullivan.	Date	Richard Clinkscales Laboratory Director	Date

Facility Distribution No. ____________	**Distributed To:**__________________________

1.0 Scope and Application

1.1 This procedure is a Gas Chromatography/Mass Spectrometry (GC/MS) technique for the analysis of polynuclear aromatic hydrocarbons (PAH) and heterocyclic compounds at the part per trillion (ng/L or ng/kg) level in waters or solids. This procedure follows the general guidelines of EPA Methods 8270C and 8270D for Selected Ion Monitoring (SIM) analysis.

1.2 The SIM technique optimizes quantitative information at the expense of qualitative information gained from other methods of analysis. It is important to note that this procedure is intended for the analysis of samples previously characterized by another method such as open-scan 8270C/D. The initial characterization is necessary to avoid misidentification of the parent compounds producing the ions used for this analysis.

1.3 In addition, this procedure is appropriate only for sample analytes of interest at less than 10,000 ng/L or 330,000 ng/kg. Samples containing semivolatile organics at concentrations greater than 10,000 ng/L and 330,000 ng/kg should be analyzed by a method designed to detect at higher (part per billion) levels. Samples at these levels may still be analyzed by this procedure, however, extra measurement uncertainty would be introduced because of the sample dilutions that would be required.

1.4 This procedure is applicable to water and soil samples. For water samples, 1 liter of water is extracted. It is also possible to extract 250 mL of water and analyze by an LVI (large volume injection) method designed to maintain reporting limits while reducing the initial volume of sample required for extraction. For soil samples, a sample aliquot of 30 g is extracted.

1.5 Analytes, Matrix(s), and Reporting Limits

The standard list of compounds that can be analyzed by this procedure is shown in Table IV. Typical reporting limits are 100 ng/L for aqueous samples and 5.0 μg/kg for soil samples for the PAH compounds.

2.0 Summary of Method

2.1 Sample Preparation

2.1.1 Aqueous Samples

Analytes of interest are extracted from water samples using separatory funnel extraction (EPA 3510C or 3510C_LVI) described in SOP DV-OP-0006. The PAH compounds are extracted from the sample without any adjustment to pH. The concentration of organic extracts is covered in SOP DV-OP-0007.

2.1.2 Solid Samples

Solid samples are extracted by sonication (EPA 3550C), which is covered in SOP DV-OP-0016 or by microwave extraction (EPA 3546) described in SOP DV-OP-0015. The extraction solvent is a 1:1 mixture of methylene chloride and acetone. The concentration of organic extracts is covered in SOP DV-OP-0007.

2.2 Instrumental Analysis

2.2.1 Quantitation of the extracted compounds is performed by gas chromatography - mass spectrometry (GC/MS) in the selected ion monitoring mode (SIM). Routine instrument conditions and the ions used for analysis are shown in Tables I and IV, respectively.

2.2.2 Development of a successful SIM method requires identifying the ions to be monitored, the ion dwell times, the ions in each group, and the timing for switching between groups. A quantitation ion is selected with a confirmation ion being monitored for identification purposes (see Table IV). Switching times are set where there is adequate resolution (a gap of 1-2 minutes) between peaks. If there is inadequate time between eluting peaks, small retention time shifts may cause peaks to partially or completely disappear as there are changes in the ions monitored. Dwell times will be set by default once the ions per group and the switching times are identified in the data acquisition method. These can be adjusted manually in order to optimize sensitivity as needed.

3.0 Definitions

3.1 Refer to TestAmerica Denver's Quality Assurance Manual (QAM) and SOP DV-QA-003P for definitions of the quality control terms used in this document.

3.2 Selected Ion Monitoring - A mass spectrometry technique that provides lower detection level capability by monitoring fewer mass scans for longer periods of time than is done in open-scan methods.

3.3 Primary Ion Area - The signal chosen for quantitation purposes.

3.4 Secondary Ion Area - The signal chosen for identification and confirmation purposes.

3.5 LVI – Large Volume Injection – An analysis method designed to maintain reporting limits while reducing the initial volume of sample required for extraction by increasing the volume of sample extract introduced onto the GC column.

4.0 Interferences

4.1 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the ion current profiles. All of these materials must be routinely demonstrated to be free from interferences under the conditions of the analysis by running laboratory reagent blanks. The use of high purity reagents and solvents helps to minimize interference problems.

4.2 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the environment being sampled.

4.3 An interference that is unique to selected ion monitoring techniques can arise from the presence of an interfering compound which produces the same ion used for quantitation of one of the PAHs. This event results in a positive interference to the reported value for the compound of interest. This interference is controlled to some degree by acquiring data for a confirmation ion. If the ion ratios between the quantitation ion and the confirmation ion are not within the specified limits, then interferences may be present. Open scan analysis to identify compounds throughout the mass range is the most reliable assurance against reporting false positives.

4.4 Contamination by carryover can occur whenever high–level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe must be rinsed with solvent between samples. Whenever an unusually concentrated sample is encountered, typically with compound concentrations well in excess of the high calibration standard, the sample analysis that immediately follows the high level sample should be evaluated for carryover. If detections are observed for the compounds that were over the calibration range in the prior sample this sample should be reanalyzed to rule out carryover unless some other objective evidence indicates that carryover is not an issue.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately. Latex and vinyl gloves provide no protection against the organic solvents used in this method. Nitrile or similar gloves must be used.

5.3.2 The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

5.3.3 The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.

5.3.4 There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect the instrument from its source of power.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Materials with Serious or Significant Hazard Rating

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm - TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm - TWA 125 ppm - STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
PAH standards can contain all or some of the following:			Standards contain low concentrations of compounds known to be or suspected to be carcinogens. All PAH compounds are considered to be hazardous, toxic, and irritants. Some or all are reported human carcinogens, mutagens, and/or teratogens.
benzo(a)anthracene	Carcinogen		
benzo(b)fluoranthene	Carcinogen		
benzo(k)fluoranthene	Carcinogen		
benzo(a)pyrene	Carcinogen		
chrysene	Carcinogen	0.2 mg/m^3 - PEL	
dibenz(a,h)anthracene	Carcinogen		
indeno(1,2,3-cd)pyrene	Carcinogen		
naphthalene		10 ppm - PEL	

(1) Always add acid to water to prevent violent reactions.
(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Gas Chromatograph (See Table I for operating conditions)

The analytical system includes a temperature programmable gas chromatograph and all required accessories including syringes, analytical columns, and gases. The injection port is designed for on-column injection when using packed columns and for split or splitless injection when using capillary columns. Instruments F (Agilent 6890 with a 5973 MSD), G5 (Agilent 6890 with a 5975 MSD), and X4 (Agilent 6890 with a 5973 MSD) may be used for this analysis. Equivalent instruments may be used.

6.1.2 Mass Spectrometer (See Table I for operating conditions)

A mass spectrometer operating at 70 eV (nominal) electron energy in the electron impact ionization mode and tuned to maximize the sensitivity of the instrument to the compounds being analyzed. The GC capillary column is fed directly into the ion source of the mass spectrometer.

6.1.3 A computer system interfaced to the mass spectrometer that allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer has software that allows searching any GC/MS data file for ions of a specific mass and plotting such ion abundances versus time or scan number. The computer allows acquisition at pre-selected mass windows for selected ion monitoring.

6.1.4 Please refer to the Master List of Documents, Software, and Hardware (or current revision) located on R:\QA\Read\Master List of Documents for the current software and hardware to be used for data processing.

6.2 Supplies

6.2.1 All glassware used, both within the scope of this SOP and for the initial sample extraction (see SOPs DV-OP-0006, DV-OP-0008, DV-OP-0007, DV-OP-0015, and DV-OP-0016) must be scrupulously cleaned. Clean all glassware as soon as possible after use by rinsing with the last solvent used in it. This should be followed by detergent washing with hot water, and rinses with tap water, reagent water, and finally with acetone.

6.2.2 Glassware should not be oven dried or heated in a muffle furnace. Successive solvent rinses of the CLLE, separatory funnel, sonication, and Kuderna-Danish glassware are required to minimize low level contamination of samples.

6.2.3 Store glassware inverted or in sealed containers capped with aluminum foil.

6.2.4 Gas-tight syringes, various sizes, and SMI pipettors.

6.2.5 Serological pipettes are used for final extract volume measurement.

6.2.6 Micro reaction vessels, 1.8 mL vials with Teflon caps, for storing concentrated extracts.

6.2.7 Column – A Varian VF-5MS 30-meter fused silica capillary column, 0.5 μm film thickness, 0.25 mm ID, plus 10-meter EZguard, or equivalent.

6.2.8 Agilent Ultra Inert splitless single taper liners.

6.2.9 Amber crimp cap vials with Sil/PTFE aluminum seals.

6.2.10 Hamilton 10 μL autosampler syringes.

7.0 Reagents and Standards

7.1 Reagents

All solvents are reagent grade or higher unless specified otherwise. See SOPs CA-Q-S-001 and CA-Q-S-001 DV-1 for a description of the program for testing solvents prior to use. The manufacturer expiration applies to all solvents and when not specified by the manufacturer the expiration will be recorded as one year after opening the solvent for use.

7.1.1 Methanol, reagent grade.

7.1.2 Methylene chloride, reagent grade.

7.1.3 Helium gas, 99% + purity.

7.2 Standards

Commercial standards are received in flame-sealed ampoules or as neat, 100% concentration solutions. Standards are verified before use. Details concerning verification of standards are given in SOP DV-QA-0015. Stock standards are stored refrigerated at ≤ 6 °C. All stock standards must be protected from light. Stock standards are monitored for signs of degradation or evaporation. The standards must be replaced annually from the date of opening or earlier, if the vendor indicates an earlier date. Dilutions or working level standards that are prepared from stock standards are assigned an expiration date according to the earliest expiring stock or one year from the date of preparation, whichever date is earlier.

For the PAH compounds and the additional compounds that are mentioned in this SOP the following stock standards are currently used. **MS-48925** Supelco cat. # 48925 at 1000 μg/mL (surrogates). **MS-31009** Restek cat. # 31009 SV Calibration Mix #3 at 2000 μg/mL. **MS-31010** Restek cat. # 31010 SV Calibration Mix #4 at 2000 μg/mL (has 2-methyl naphthalene). **MS-31853** Restek cat. # 31853 1,4-Dioxane at 2000 μg/mL. **MS-31995** Restek cat. #31995 8270 CalibrationMix #5 at 2000 μg/mL (has all PAH compounds including 2 methyl naphthalene). **MS-APP914820X** Accustandard cat. #APP-9-148-20x at 2000 μg/mL (n-nitrosodiethylamine). **MS-47643-U** Supelco cat. # CRM47643 8270 Ether/Phthalate mix at 2000 μg/mL. Other vendors and mixes may be substituted for these stocks but an NCM must be written for the SOP deviation.

7.2.1 GC/MS Tuning Standard

A methylene chloride solution containing decafluorotriphenylphosphine (DFTPP) at a concentration of 50 μg/mL (25 μg/mL for LVI) is prepared by diluting 0.5 mL of the stock to a final volume of 10ml. The current vendor for the tuning standard is Supelco cat. # 47548-U at a concentration of 1000 μg/mL.

7.2.2 Calibration Standards

Calibration standards for the initial calibration (ICAL) are prepared at 7 concentrations to cover the calibration range by diluting vendor stock standard solutions using methylene chloride. The standards are prepared directly in autosampler vials by using syringes to deliver the appropriate volumes of stock standard solution, internal standard solution, and methylene chloride. The following tables summarize a typical set of calibration standards:

MS-SIM SL_Stk is a 200 μg/mL calibration substock that is prepared by diluting 0.5 mL of **MS-31009, MS-31010, MS-31853, MS-31995, (and MS-APP914820X)** to a final volume of 5 mL.

Standard Method: Prepared using a PAH SIM stock standard **MS-SIMSL** with a concentration of 20 μg/mL for levels 4 through 7.The **MS-SIMSL** standard is prepared by diluting 0.2 mL of **MS-48925** (surrogates) and 1 mL of **MS-SIM SL_Stk** and 0.1 mL of **MS-47643-U** to a final volume of 10 mL. A secondary PAH SIM stock standard **MS-SIMSL Int** prepared by diluting 1 mL of the **MS-SIMSL** to a final volume of 10 mL with a concentration of 2 μg/mL is used to prepare levels 1 through 3:

Vol Stock (μL)	Methylene Chloride (μL)	Internal Standard (μL)	Final Volume (μL)	Conc PAH (μg/mL)
5	495	50	500	0.02
25	475	50	500	0.1
75	425	50	500	0.3
15	485	50	500	0.6
30	470	50	500	1.2
62.5	437.5	50	500	2.5
125	375	50	500	5.0

LVI Method: Prepared using a PAH SIM stock standard with a concentration of 20 µg/mL for levels 6 and 7. A secondary PAH SIM stock standard with a concentration of 2 µg/mL is used to prepare levels 1 through 5:

Vol Stock (µL)	Methylene Chloride (µL)	Internal Standard (µL)	Final Volume (µL)	Conc PAH (µg/mL)
1	499	50	500	0.004
5	495	50	500	0.02
15	485	50	500	0.06
30	470	50	500	0.12
60	440	50	500	0.24
12.5	487.5	50	500	0.5
25	475	50	500	1.0

7.2.3 Initial Calibration Verification (ICV) Standard (MS-SIM SSV)

A second source initial calibration verification (ICV) standard is prepared using a standard solution that is obtained from a source independent from the source that supplies the standard used for the initial calibration. It is prepared by diluting 30 µL of a substock that is at a concentration of 20 µg/mL to a final volume of 0.5 mL. The final PAH SIM concentration for this ICV standard is 1.2 µg/mL (0.24 µg/mL for LVI).

The substock for **MS-SIMSSV** (above) is prepared by diluting 1 mL of another substock, **MS-HSLB1_STK,** to 10 mL final volume.

MS_HSLB1_STK is prepared by diluting 2 mL of **MS-570666.SEC** (Restek cat. # 570666.sec 8270 List 1/Std#1 Mega Mix at 500, 1000, 2000 µg/mL) and 2 mL of **MS-569731SEC** (Restek cat. #769731.sec 8270 List 1/Std #10 at 2000 ug/ml) to a final volume of 10 ml. The final concentration of this stock varies as either 200 µg/mL or 400 µg/mL depending upon the compound.

The final PAH SIM concentration for this ICV standard is 1.2 µg/mL (0.24 µg/mL for LVI).

7.2.4 Continuing Calibration Verification (CCV) Standard

A standard with the same analytes and concentrations as the 600 ng/mL (120 ng/mL for LVI) calibration standard. The standard may be from the same preparation as the initial calibration or prepared at a later date.

7.2.5 Surrogate Spiking Solutions (8270SIM Surr)

The surrogate spike solution contains neutral surrogates at concentrations of 500 ng/mL in methanol. It is prepared by diluting 0.1 ml of **8270SurrStkHL** (Restek cat. #567685 at 5000 µg/mL) to a final volume of 1000 ml with acetone. Table II lists the surrogate compounds for the standard list of PAHs.

- 1.0-liter water extractions, add 1.0 mL of the surrogate spike solution
- 250-mL LVI water extractions, add 0.250 mL of the surrogate spike solution
- 30-gram soil sample extractions, add 1.0 mL of the surrogate spike solution

7.2.6 Internal Standard (IS) Solutions (MS-SIM IS)

A 6000 ng/mL solution of the internal standards is prepared in methylene chloride from vendor stock **MS-57604** (Restek cat. #567684 8270 Internal Standard at 2000 µg/mL) by diluting 60ml of this stock to 300 mL final volume. Then 1.5 mL of this stock, **MS-IS**, is diluted to 100 mL to yield the **MS-SIMIS** spiking solution. Table III lists the IS compounds.

To each sample extract, 20 µL of the respective IS solution is added to a 200 µL aliquot of the sample extract for both standard (1 L sample) and LVI extracts.

7.2.7 LCS, MS, and MSD Spike Solution (8270BO-SIMLCS)

A methanol solution containing the requested spike compounds at a concentration of 900 ng/mL each is prepared from vendor stock solution by diluting 0.225 mL of **MS-570666** (Restek cat. #570666 HSL Mega Mix at 1000 µg/mL) to a final volume of 250 mL with P&T methanol. Following are the final sample concentrations of the spiked compounds for the water and solid extractions:

- 1.0-liter water extractions, add 1.0 mL of the spike solution, [PAH] = 900 ng/L
- 250-mL LVI water extractions, add 0.250 mL of the spike solution, [PAH] = 900 ng/L
- 30-gram soil sample extractions, add 1.0 mL of the spike solution, [PAH] = 30 µg/kg

7.3 All stock and working standards are stored according to the manufacturer's instructions. Dilutions from stocks may not be assigned expiration dates that exceed the stock standard expiration date set by the manufacturer.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Sample Amounts

8.1.1 Water samples are collected in pre-cleaned amber glass bottles fitted with a Teflon-lined cap. To guarantee the ability to meet routine reporting limits, two full bottles of sample should be provided. Additional bottles are needed to satisfy the requirements for matrix spikes and duplicate matrix spikes. For the standard method, each bottle should be 1.0 L; for the LVI method, each bottle should be 250 mL.

8.1.2 Soil samples are collected in an 8-ounce, pre-cleaned, wide-mouth jar with a Teflon-lined lid.

8.2 Samples are chilled to a temperature between 0 and 6 °C immediately after collection and shipped via overnight carrier to the laboratory.

8.3 Samples and excess sample volume must be stored refrigerated at ≤ 6 °C from when the log-in process is completed (see SOP DV-QA-0003) to storage after analysis.

8.4 Water samples must be extracted within 7 days of the time of sample collection, while solid samples must be extracted within 14 days of sampling. Extracts must be analyzed within 40 days from the start of the sample extraction.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), and Department of Energy (DOE), are described in TestAmerica Denver policy SOP DV-QA-024P, Requirements for Federal Programs. Table 8 details the components of the DoD QSM 5.0 and DoE QSAS 3.0 that are different from TestAmerica Denver's standard procedures, for further details, see SOP DV-QA-024P. Also listed are the variances that TestAmerica is requesting for this analysis; these alternate criteria are only used with project-specific approval.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Method Blank (MB)

A method blank is processed and analyzed with each analytical batch, not to exceed 20 samples. For aqueous samples, the method blank consists of reagent water spiked with surrogates. For soil samples, the method blank is Ottawa sand spiked with surrogates. This sand is mixed with sodium sulfate for extraction by ultrasonication. Method blanks are used to assess whether the laboratory has contributed contamination to the sample analysis process that adversely affects the accuracy of the determination of target analytes. The goal is to have no detectable contaminants in the method blank. However, due to the sensitivity of this analysis, it is not uncommon to detect target analytes at levels above the method detection limit (MDL).

Acceptance Criteria: MB results must be less than ½ the reporting limit.

Corrective Action: If the MB exceeds ½ the RL for any target analyte, then one of the following must apply for acceptance of the batch:

The blank contamination is less than $^1/_{10}$ of the measured concentration of any sample in the associated preparation batch, or

The blank contamination is less than the concentration present in the samples and is less than $^1/_{10}$ of the regulatory limit, or

The same contaminants are <u>not</u> found in the associated samples.

NOTE: Positive method blank results below the reporting limit should be evaluated by the analyst for potential impact on sample results at or near the reporting limit.

9.3 Laboratory Control Samples (LCS)

A Laboratory Control Sample (LCS) is processed and analyzed with each analytical batch not to exceed 20 samples. For aqueous samples, the LCS consists of reagent water spiked with the analytes of interest and surrogates. For soil samples, the LCS is Ottawa sand spiked with analytes of interest and surrogates. For ultrasonic extraction, sodium sulfate is added to the reagent sand. The LCS spiking solution is described in Section 7.2.7. LCS results are used to determine whether the analytical system is in control. Depending on project requirements, a duplicate LCS (LCSD) may be required to assess the precision of the analytical system.

Acceptance Criteria: The percent recovery for each requested target analyte in the LCS must fall within the established control limits (found in the LIMS system).

Corrective Action: If the percent recovery for any requested analyte in the LCS exceeds the upper control limit and the analyte is not detected in any of the associated samples, then no further action is required, and data are reported with an NCM.

If the percent recovery for any analyte in the LCS exceeds the upper control limit and the analyte is detected in any of the associated samples, then reanalyze the LCS. If similar results are obtained on the second attempt, then investigate and correct any problems. Re-extract and reanalyze the preparation batch.

If the percent recovery for any analyte in the LCS is below the lower control limit, reanalyze the LCS. If similar results are obtained on the second attempt, then investigate and correct any problems. Re-extract and reanalyze the preparation batch.

If re-extraction of samples is not possible or the client requests the samples not be re-extracted, qualify data and explain in a NCM.

9.4 Matrix Spike and Spike Duplicate (MS/MSD)

One matrix spike (MS) sample and one matrix spike duplicate (MSD) sample are prepared and analyzed for each preparation batch. An MS sample is a field sample to which known amounts of the target analytes, as well as the surrogates, have been added. An MSD is a second aliquot of the same sample that is spiked the same as the MS. The MS/MSD spiking solution is described in Section 7.2.7. MS results are used to assess the effects of the sample matrix on the accuracy of the analytical system. The MSD results are used to assess the effects of the sample matrix on the precision of the analytical system. Given the expected variability in sample matrix, the MS/MSD results are applicable to only the sample used to prepare the MS and MSD. MS/MSD results should not be extrapolated to other samples without extensive investigation and characterization to demonstrate similarity between samples. The DoD QSM 5 requires that the MS/MSD be prepared from samples from the same site.

Acceptance Criteria: The MS and MSD recoveries and the relative percent difference (RPD) between the MS and MSD results must be within the established control limits. Percent recovery control limits are set at ± 3 standard deviations around the historical mean of the LCS recovery data, unless otherwise dictated by the client or project. The RPD control limit is set at 3 standard deviations above the mean of the historical data.

NOTE: DOD QSM 5 limits apply to projects performed under this program.

Corrective Actions: The information obtained from MS data are sample/matrix specific and are not normally used to determine the validity of the entire batch. If the MS and/or MSD recovery falls outside of the established control limits, the bracketing CCV and batch LCS recoveries must be within control limits in order to accept results for the associated samples. The following corrective actions are required for MS/MSD recovery failures to rule out lab error:

- Check calculation and instrument performance;
- Verify, if possible, that the MS and MSD were spiked correctly (e.g., very low or very high recoveries);
- Consider objective evidence of matrix interference (e.g., heterogeneous sample, interfering peaks seen on chromatograms, or interference demonstrated by prior analyses);
- Flag the data for any results outside of acceptance limits.
- For any single RPD failure, check calculations; verify, if possible, that the MS and MSD were spiked correctly; check instrument performance; consider objective evidence of matrix interference or sample inhomogeneity; and flag the data.
- If both the parent sample and associated matrix spike results are over range the parent and the spikes shall be diluted by the same amount and the results from the reanalysis reported for both. If the analyte concentration in the parent sample is greater than four times the concentration of spike added, then spike recovery results are not compared to control limits, and the recovery is either reported as “NC” (not calculated) or with a qualifier flag to indicate that the spike was less than four times the analyte concentration in the sample. If the dilution will cause the spike to be less than two times the reporting limit, the MS/MSD do not need to be diluted and the recovery reported as “NC” (not calculated).
- For MS/MSD that serve as batch QC, if the parent sample result is within the calibration range and the MS/MSD results are above the calibration range, the results are reported with the MS/MSD result being

flagged as an over-range measurement (e.g., the E-flag qualifier).

- If the MS/MSD are client requested, the parent sample result is within calibration range and the MS/MSD results are above the calibration range, the sample and spike should be diluted, keeping in mind that we need to assess whether or not the dilution will best serve the client's needs. Consult with the PM as needed. Both the parent sample and MS/MSD samples must have the same dilution factor. Some EDDs do not accept data that are at different dilution factors.
- If the native analyte concentration in the MS/MSD sample exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated) and the appropriate qualifier flags are added.

NOTE: See Denver Policy Memorandum P16-001 and Corporate Policy Memorandum CA-Q-QM-013 for more detail.

NOTE: Some client programs require reanalysis to confirm matrix interferences. Check special project requirements for this corrective action.

9.5 Internal Standards

The internal standards listed in Table III and described in Section 7.2.6 are spiked at the same level in all field sample extracts, QC sample extracts, instrument blanks, and calibration standards.

Acceptance Criteria: The peak area for each internal standard in each field sample and QC sample extract should be between 50% and 200% of the peak area for the same internal standard in the midlevel standard of the initial calibration.

Corrective Action: If the internal standard fails acceptance criteria, then perform the following corrective actions:

- Inspect system for malfunction and correct as needed.
- Reanalyze the affected samples.
- If the interference cannot be corrected for field samples, the earlier analysis is reported with discussion in an NCM.
- If QC samples have internal standard failures that are confirmed by re-analysis, the cause of the failures

must be investigated.

9.6 Surrogate Compound Analysis

Surrogate compounds listed in Table II and described in Section 7.2.4 are added to all field and QC samples prior to extraction. Surrogate recoveries are used to assess individual sample matrix effects on sample preparation and analysis.

Acceptance Criteria: Surrogate recoveries must fall within established control limits. QC sample results are not acceptable unless the surrogate recoveries for those samples are in control.

Corrective Action: Corrective action must be considered for any surrogate failure and may depend on project-specific instructions. Lacking instructions to the contrary the following actions shall be taken:

- Evaluate sample chromatogram and other QC.
- If the surrogate(s) fail in the LCS and/or method blank, then re-prepare and reanalyze all associated samples. Samples may be excepted where the surrogate recovers high in the MB and the MB does not have detection above ½ of the RL. Likewise, if the surrogate is out of control in the LCS but the LCS compounds recover in control then the samples may be reportable but the program requirements must be checked to see if this is acceptable. In any case an NCM must be written to describe the situation.
- For surrogate failures in field samples, re-prepare and reanalyze the samples, unless matrix interference is evident from earlier analysis or from chromatograms in which case the samples are reported with an NCM.

9.7 Instrument QC

9.7.1 Instrument Optimization

9.7.1.1 The GC/MS system must be tuned to meet manufacturer's specifications, using a suitable calibration such as perfluorotri-n-butylamine (FC-43). This is performed through the auto-tune feature in the software. The mass calibration and resolution of the GCMS system is then verified by the analysis of DFTPP prior to the analysis of any standards or samples. In some instances the laboratory will opt to omit the DFTPP. The DFTPP tune check is less useful for SIM analysis than it is for full scan analysis because the DFTPP analysis must necessarily be done in full scan mode. When this check is omitted, the FC-43 check will be performed daily.

9.7.1.2 The instrument is tuned for DFTPP (decafluorotriphenylphosphine), calibrated initially with a seven-point calibration curve, and verified each 12-hour shift that samples are to be run with one or more continuing calibration verification (CCV) standard(s).

9.7.2 Instrument Tuning

At the beginning of every 12-hour shift when analyses are to be performed, the GC/MS system must be checked to see if acceptable performance criteria (Table VI) are achieved for DFTPP.

9.7.2.1 Inject 1 μL of the 50 μg/mL GC/MS tuning standard (see Section 7.2.1) into the GC/MS system.

9.7.2.2 The mass spectrum of the DFTPP must be obtained in the following manner: three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is also required, and must be accomplished using a single scan acquired no more than 20 scans prior to the elution of the DFTPP. Do not subtract part of the DFTPP peak. A procedure compliant with these requirements is programmed into a Macro used to evaluate the DFTPP spectrum. Confirm that all the key m/z criteria in Table VI are achieved.

9.7.2.3 If all the criteria are not achieved, the analyst must adjust or retune the mass spectrometer and repeat the test until all criteria are achieved. The performance criteria must be achieved before any samples, blanks, or standards are analyzed.

9.7.3 Initial Calibration (ICAL)

9.7.3.1 A new calibration curve must be generated initially, after major changes to the system, or when continuing calibration criteria cannot be met. Major changes include installation of new columns and source maintenance.

9.7.3.2 A minimum five-point initial calibration curve must be established for linear fit calibrations (weighted or unweighted). Six points or more are required for second order curve fits. See Section 9.7.4 for Calibration Acceptance Criteria.

- The concentrations of standards commonly used to construct the PAH calibration curve are 20,100, 300, 600 (often analyzed before the rest of the standards and called the ICIS), 1200, 2500, and 5000 ng/mL.

- For the LVI method, the concentrations of standards commonly used to construct the PAH calibration curve are 4, 20, 60, 120 (often analyzed before the rest of the standards and called the ICIS), 240, 500, and 1000 ng/mL.

9.7.3.3 If the concentration of any target compound in a sample exceeds the calibration range, the extract must be diluted with methylene chloride so that the concentrations of all target compounds fall within the range of the calibration curve, and be reanalyzed. Any samples analyzed immediately following the sample that exceeded the linear range may require reanalysis due to possible carryover from the high-level sample.

9.7.3.4 Generally, it is NOT acceptable to remove points from a calibration for the purposes of meeting calibration criteria, unless the points are the highest or lowest on the curve AND the reporting limit and/or the linear range is supported or adjusted accordingly. The only exception is that a level may be removed from the calibration if the reason can be clearly documented, for example a broken vial. A minimum of five levels must remain in the calibration. The documentation must be retained with the initial calibration. Alternatively, if the analyst believes that a point on the curve is inaccurate, the point may be reanalyzed and the reanalysis used for the calibration. All initial calibration points must be analyzed without any changes to instrument conditions, and all points must be analyzed within 12 hours.

9.7.3.5 Calculate the response factor (RF) for each analyte for each calibration standard level as described in Section 11.3. Calculate the mean RF and relative standard deviation (RSD) for each analyte.

9.7.4 Calibration Acceptance Criteria and Corrective Action:

Acceptance Criteria 8270C:

The RSD of the initial calibration for each analyte of interest must be ≤ 35%.

Acceptance Criteria 8270D:

Refer to Table VII for the acceptance criteria for minimum response factor and RSD. Two target compounds and surrogates may fail to meet the minimum RRF criteria listed in Table VII but must still meet the minimum RRF criteria of 0.010 (excluding compounds with a minimum RRF requirement of 0.010). In addition, two target compounds and surrogates may fail to meet the RSD criteria listed in Table VII but must still meet the maximum RSD requirement of 40%. (excluding compounds with a maximum RSD requirement of 40%). Refer to SOP DV-QA-024P for requirements for federal programs.

Acceptance Criteria for DoD5:

The RSD of the initial calibration for each analyte of interest must be < 15%. See SOP DV-QA-024P for further details for QSM 4.2 requirements.

Corrective Actions:

If these criteria cannot be met, least-squares weighted or unweighted linear regression may be used to establish a calibration function as described in Section 11.4. In this case, the correlation coefficient (r) must be greater than 0.995 (equivalent to $r^2 \geq 0.99$) or a second-order regression fit with coefficient of determination (COD, r^2) greater than 0.99 may be used. If these linearity criteria are not achieved, verify the standard preparation and instrument conditions, and then recalibrate the instrument. If technical acceptance criteria are not met, it may be necessary to clean the ion source, perform injector maintenance, change the column, or take other corrective actions.

9.7.5 In the event that a least-squares regression is used, the analyst should evaluate the bias at the lower portion of the curve. This can be accomplished by re-fitting the low point standard back into the curve. The recalculated concentration should be within ±50% of the standard's true concentration. If these criteria are not met, the analyst may have to evaluate the concentration range of the standards, or the lower limit of quantitation.

9.8 Initial Calibration Verification (ICV)

The Initial Calibration Verification (ICV) is a second-source, mid-level standard that is analyzed immediately following the initial calibration standards.

Acceptance Criteria: The absolute value of the difference between the measured PAH analyte concentration and the true value must be ≤ 30 % or be ≤ 20 % for DoD QSM 4.2 or 5.0.

Corrective Action: If the ICV recovery fails, then take the following actions:

- Verify standard preparation, and if incorrect, re-prepare the ICV standard solution.
- If preparation of the ICV standard was correct, then re-prepare the initial calibration standards and recalibrate.

9.9 Continuing Calibration Verification (CCV)

Every 12 hours, the mass spectrometer response for each PAH relative to the internal standard is determined by analyzing a 600 ng/mL calibration standard

(120 ng/mL for the LVI method). The RF for each compound in the continuing calibration verification (CCV) analysis is compared to the RF for that compound in the ICAL.

9.9.1 Acceptance Criteria 8270C

The absolute value of the difference between the CCV RF for each PAH analyte and the corresponding ICAL value must be ≤ 35 %.

9.9.2 Acceptance Criteria 8270D

The absolute value of the difference between the CCV RF for each PAH analyte and the corresponding ICAL value must meet the criteria in Table VII. The compounds must also meet the minimum response factor criteria listed in Table VII. Two target compounds and surrogates may fail to meet the minimum RRF criteria in Table VII (excluding compounds with a minimum RRF requirement of 0.010) but must still meet the minimum RRF criteria of 0.010. In addition, two target compounds and surrogates may fail to meet the difference criteria in Table VII (excluding compounds with a maximum percent difference requirement of ±40%) but must still meet the maximum difference requirement of ±40%. (Refer to SOP DV-QA-024P for requirements for federal programs).

9.9.3 Acceptance Criteria for DoD QSM 4.2 or 5.0

The absolute value of the difference between the CCV RF for each PAH analyte and the corresponding ICAL value must be ≤ 20 % for DoD QSM 4.2 or 5.0.

9.9.4 Acceptance Criteria 8270C & 8270D

9.9.4.1 The internal standard response of the CCV must be within 50-200% of the internal standard response in the mid-level (ICIS) of the most recent ICAL sequence.

9.9.4.2 The internal standard retention time must be within ± 30 seconds of the internal standard retention time in the corresponding level of the most recent ICAL sequence.

9.9.5 Corrective Action:

9.9.5.1 If, for any analyte, the CCV RF does not meet the stipulated acceptance criteria, a five-point calibration curve must be repeated for that analyte prior to the analysis of samples.

9.9.5.2 If any internal standard retention time in the CCV changes by more than 30 seconds from that of the corresponding level of the most recent ICAL sequence, the chromatographic system must be inspected for malfunctions and corrections made, as required.

9.10 Closing CCV (DoD QSM 5.0 only)

DoD QSM 5.0 requires a closing CCV, injected within 12 hours of the DFTPP injection.

9.10.1 Acceptance Criteria

All reported analytes and surrogates must be within ±50%.

9.10.2 Corrective Action

Recalibrate and reanalyze all affected samples since the last acceptable CCV

Or

Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails perform column maintenance and recalibrate; then reanalyze all affected samples sine the last acceptable CCV.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preparation

10.3.1 Aqueous Sample Extraction and Concentration

10.3.1.1 Instructions for the extraction of aqueous samples may be found in SOP DV-OP-0006.

10.3.1.2 Instructions for the concentration of extracts may be found in SOP DV-OP-0007.

10.3.2 Soil Sample Extraction and Concentration

10.3.2.1 Instructions for the ultrasonic extraction of soil samples may be found in SOP DV-OP-0016.

10.3.2.2 Instructions for the microwave extraction of soil samples may be found in SOP DV-OP-0015.

10.3.2.3 Instructions for the concentration of extracts may be found in SOP DV-OP-0007.

10.4 Sample Analysis

10.4.1 All aliquotting, extract dilutions, and spike additions must be performed in the trace fume hood using equipment dedicated to PAH-SIM analysis. An aliquot of 200ul of each sample extract is placed into a two-milliliter GC/MS autosampler vial. Sufficient volume of extract remains should reanalysis be necessary.

10.4.2 Prior to analysis, 20 uL of internal standard is added to the sample vial giving a final internal standard concentration of 600 ng/mL (150 ng/mL for LVI) in the extract.

10.4.3 Representative aliquots are injected into the gas chromatograph/mass spectrometer using similar conditions to those summarized in Table I. The injection volume is 1 μL (5 μL for LVI).

10.4.4 Whenever an unusually concentrated sample is encountered, it may be necessary to reanalyze the subsequent sample extracts after analyzing an instrument blank to demonstrate that there is no cross contamination.

10.4.5 The following is a typical analytical sequence:

- Solvent rinses, as needed
- MS tune
- ICAL plus ICV or CCV
- Instrument blank
- MB, LCS
- LCSD (if requested by client)
- Sample extracts
- MS and MSD are interspersed with sample extracts, and usually run after the sample from which they are produced.
- The last sample extract must be injected within 12 hours of the tune.

10.4.6 The sequence may be altered to accommodate reanalysis or additional instrument blank and calibration evaluations. At a minimum, an instrument blank or a method blank shall be included in the sequence. Refer to QC policy DV-QA-003P for additional details.

10.4.7 The effluent from the GC capillary column is fed directly into the ion source of the mass spectrometer. The MS is operated in the selected ion monitoring (SIM) mode using appropriate windows to include the quantitation and confirmation masses for each analyte as shown in Table IV.

10.4.8 All compounds detected at concentrations above the method MDL are checked to ensure that the confirmation ion is present at the appropriate ratio.

10.4.9 All compounds detected at concentrations above the highest calibration standard require dilution and reanalysis. In addition, any samples that were analyzed immediately following a high-level sample should be reanalyzed to rule out carryover from the high-level sample, unless they are preceded by an acceptable instrument blank or the high compound(s) were not detected in the subsequent samples.

10.4.10 Manual Integrations

10.4.10.1 Upon completion of the analytical sequence, transfer the raw instrument data to Chrom for further processing. Review the chromatograms to ensure correct assigning of peaks and correct integration of each peak.

10.4.10.2 Note that certain compounds (e.g., benzo(b)fluoranthene and benzo(k)fluoranthene) may require frequent manual integrations. Special attention must be exercised by the analyst and secondary reviewer for compounds that are commonly mis-integrated in automated software or are manually integrated. If manual data manipulations are necessary, they must be justified and documented. See DV-QA-011P requirements for manual integration.

10.5 Troubleshooting and Maintenance

10.5.1 Daily Instrument Maintenance

In addition to the checks listed in Appendix B, the following daily maintenance should be performed.

- Clip column as necessary.
- Install new or cleaned injection port liner as necessary.
- Install new septum as necessary.
- Install new or cleaned gold seal and washer as necessary.
- Perform mass calibration as necessary.

10.5.2 Major Maintenance

A new initial calibration is necessary following certain maintenance procedures. These maintenance procedures include changing the column, cleaning the repeller, cleaning the source, replacing the multiplier, and replacing the “topboard” or RF-related electronics. Refer to the manufacturer's manual for specific guidance.

11.0 Calculations / Data Reduction

11.1 Qualitative Identification

Obtain electronic ion current profiles (EICP) for the primary mass ion and the confirmatory ion for detected compounds. The following criteria must be met to make a qualitative identification:

11.1.1 The characteristic masses of each parameter of interest must maximize in the same or within one scan of each other.

11.1.2 The retention time (RT) of unknown peaks must fall within ± 0.2 minute of the RT for the compound in the daily calibration standard (mid-point ICAL or daily CCV).

11.1.3 The relative peak areas of the primary ion compared to the confirmation or secondary ion masses in the EICPs must fall within ± 20% of the relative intensities of these masses in a reference mass spectrum. The reference mass spectrum can be obtained from a standard analyzed in the GC/MS system or from a reference library. A compound that does not meet secondary ion confirmation criteria may still be determined to be present in a sample after close inspection of the data by the mass spectroscopist. Supportive information includes correct relative retention time (RRT) and the presence of the secondary ion, but the ratio falls outside of ± 20% of the primary ion, which may be caused by an interference of the secondary ion.

11.1.4 Structural isomers that have very similar mass spectra and less than a 30-second difference in retention time, can be explicitly identified only if the resolution between authentic isomers in a standard mix is acceptable. Acceptable resolution is achieved if there is a definitive inflection between the two peaks, according to the analyst’s judgment. Otherwise, structural isomers are identified as isomeric pairs.

11.2 Detailed information regarding calibration models and calculations can be found in Corporate SOP CA-Q-P-003, *Calibration Curves and the Selection of Calibration Points* and the public folder *Arizona Calibration Training*.

11.3 Average Response Factor Calibration

The following formula is used to calculate the response factor for each analyte of interest relative to the applicable internal standard for each of the calibration standards:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

Where:

A_s = Area of the characteristic ion for the target analyte in the calibration standard

A_{is} = Area of the characteristic ion for the internal standard
C_{is} = Concentration of the internal standard, (ng/mL)
C_s = Concentration of the target analyte in the calibration standard (ng/mL)

The calibration uses the average response factor for each target analyte, which is calculated as follows:

$$\text{average(mean) RF} = \overline{RF} = \frac{\sum_{i=1}^{n} RF_i}{n}$$

Where:

RF_i = Response factor for the i^{th} calibration level
n = Number of calibration levels

The standard deviation for the mean RF for each target analyte is calculated as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(RF_i - \overline{RF}\right)^2}{n-1}}$$

The relative standard deviation (RSD) for the average response factor for each target analyte is calculated as follows:

$$RSD = \frac{SD}{\overline{\overline{RF}}} \times 100\%$$

The concentration of each target analyte in the sample extract is calculated using the average response factor that was calculated in the equation above as follows:

$$C_e = \frac{A_e \times C_{is}}{A_{is} \times \overline{\overline{RF}}}$$

Where:

C_e = Concentration of target analyte in the sample extract, ng/mL
A_e = Area of the characteristic ion for the target analyte in the sample extract.
A_{is} = Area of the characteristic ion for the internal standard
C_{is} = Concentration of the internal standard, (ng/mL)
$\overline{RF}$ = Average response factor for the target analyte as determined by calibration

11.4 Linear Least-Squares Regression Calibration (Unweighted)

A linear least-squares regression is performed using the concentration of the target analyte in the calibration standard as the independent variable (x) and the instrument response as the dependent variable (y). The regression produces the slope and intercept terms for a linear equation in the following form:

$$y = mx + b$$

Where:

y = instrument response (e.g., peak area)
x = concentration of target analyte in calibration standard
m = slope of the line
b = intercept of the line

For the internal standard calibration, the regression equation is rewritten as follows:

$$\frac{A_s C_{is}}{A_{is}} = mC_s + b$$

Where:

A_s = Area of the characteristic ion for the target analyte in the calibration standard
A_{is} = Area of the characteristic ion for the internal standard
C_s = Concentration of the target analyte in the calibration standard, (ng/mL)
C_{is} = Concentration of the internal standard, (ng/mL)
m = slope of the line
b = intercept of the line

The concentration in an unknown extract is then calculated by rearranging the calibration equation as follows:

$$C_e = \frac{\left[\frac{A_s C_{is}}{A_{is}} - b\right]}{m}$$

Where C_e is the concentration of the target analyte in the sample extract, and A_e is the area of the characteristic ion for the target analyte in the sample extract.

The actual sample concentration (C) for each compound is calculated as follows:

$$C = C_e \times \left(\frac{V_e}{V_o}\right) \times DF$$

Where:

C = Concentration of the target analyte in the original sample, ng/L (water sample) or ng/kg (solid sample)
C_e = Concentration of the target analyte in the sample extract, ng/mL
V_e = Final extract volume, mL.
V_o = The original volume or weight of the sample that was extracted, L (aqueous sample) or kg (solid sample).
DF = Dilution factor, if appropriate.

11.5 Additional Regression Calibration Models

As needed, weighted linear least-squares or second order regressions may be utilized for this analysis. See Corporate SOP CA-Q-P-003, *Calibration Curves and the Selection of Calibration Points* (Attachment 1) and the public folder *Arizona Calibration Training* for calculations and further explanations.

11.6 A second-level technical review of the organic data is performed prior to data reporting. This review is performed by a peer or supervisor using the guidelines and checklists detailed in SOP DV-QA-0020.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in DV-QA-005P. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

12.2.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

12.4 Retention Time Study

12.4.1 Expected absolute retention times (RTs) are initially determined by analyzing all target analytes in the open-scan mode. Example RTs are listed in Table V.

12.4.2 Relative retention times (RRTs) are then calculated for samples in each analytical run based on the RTs found in the continuing calibration verification standard (CCV).

12.4.3 RTs are re-established after any significant instrument maintenance, including source cleaning and changing columns, or whenever compounds are not adequately detected in CCVs or LCSs.

13.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, "Waste Management and Pollution Prevention", of the Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

14.2.2 Methylene chloride solvent rinse waste – Waste Stream B

14.2.3 Expired extract vial waste – Waste Stream A

14.2.4 Radioactive and potentially radioactive waste must be segregated from non-radioactive and mixed waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Soil Waste Physical/Chemical Methods (SW-846), Third Edition, September 1986, Final update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final update IIB, January 1995; Final Update III, December 1996, Final Update IV January 2008.

15.1.1 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

15.1.2 Method 8270C, Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 3, December 1996.

15.1.3 Method 8000C, Determinative Chromatographic Separations, Revision 2, February 2007.

15.1.4 Method 8270D, Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 4, February 2007.

15.1.5 Method 3510C, Separatory funnel Liquid-Liquid Extraction, Revision 3, December 1996.

15.1.6 Method 3520C, Continuous Liquid-Liquid Extraction, Revision 3, December 1996.

15.1.7 Method 3550B, Ultrasonic Extraction, Revision 2, December 1996.

15.1.8 Method 3546, Microwave Extraction, Revision 0, February 2006.

15.2 CLP Statement of work for Multi-Media, Multi-Concentration Organics Analysis, SOM01.2. June 2007.

16.0 Method Modifications

16.1 The CLP SOW referenced in 8270D does not require the analysis of DFTPP prior to the analysis of samples. The method relies on the successful analysis of calibration standards to verify acceptable function of the mass spectrometer. TestAmerica Denver utilizes the DFTPP check to identify any operational issues with the mass spectrometer prior to the analysis of the calibration standards. This allows the analyst to identify possible problems independent of the GC. As a result, the laboratory will start the 12 hour clock with the injection of the DFTPP, not the calibration standard as required in the method.

16.2 Method 8270C serves as the basis for this SOP, but the method has been modified extensively for low-level analysis using selected ion monitoring (SIM) and optimizing instrument conditions for the low-level analysis. Consequently the sensitivity of the method has been enhanced and it is not uncommon to detect low-level contamination in the method blank at levels well below the limits of detection for the less sensitive GC/MS method. For example, Method 8270C states that the

RSD of the initial and continuing calibration must be less than or equal to 15% and 20% respectively. Due to the low-level nature of the analysis, this SIM procedure allows both of these criteria to be less than or equal to 35%.

16.3 Method 8270C stipulates qualitative identification based on relative retention time (RRT), which is calculated by dividing the retention time (RT) of the target analyte by the RT of the internal standard. The RRT of the suspected target analyte in the sample extract must be within ± 0.06 RRT units of the RRT for that analyte in the calibration standard. This SOP stipulates qualitative identification based on an absolute RT. Namely the RT of the suspected target analyte in the sample extract must be within ± 0.2 minute of the RT for that analyte in the calibration standard. Additionally, the RT for the internal standard in the sample extract must also be within ± 0.2 minute of the RT for the internal standard in the calibration standard. The criteria used in this SOP are more restrictive than those imposed by the referenced method. For the earliest eluting compounds, the RT for the internal standard is typically 8 minutes. The earliest eluting target analyte must be at a RRT of at least 0.8, which translates to a RT of 6.4 minutes. Assuming a worst-case scenario where the RT of the internal standard is 0.2 minute higher (i.e., 8.2 minutes) and the RT of the target analyte is 0.2 minute lower (i.e., 6.2 minutes), the calculated RRT is 0.76. The total deviation from the expected RRT is 0.04 RRT units, which is smaller than what is allowed by Method 8270C.

17.0 Attachments

Table I:	Routine Instrument Operating Conditions
Table II:	Surrogates for Standard List Analysis
Table III:	Internal Standards for Standard List Analysis
Table IV:	PAH Compounds and Ions Used for Analysis
Table V:	Example Retention Times, IS and Surrogate Associations
Table VI:	DFTPP Key Ions and Ion Abundance Criteria for 8270C and 8270D
Table VII:	8270D Relative Response Factor Criteria for Initial and Continuing Calibration
Table VIII:	Specific DoD QSM 5.0 and DoE QSAS 3.0 Requirements for 8270D
Appendix I:	Extended List PAHs
Appendix II:	Suggested Instrument Maintenance Schedule – Mass Spectrometer & Gas Chromatograph
Appendix III:	Mass Spectrometer Settings for Single Ion Monitoring

18.0 Revision History

- Revision 12: 2 May 2018
  - Annual Review
- Revision 11: 28 February 2017
  - Added Section 4.4 to address contamination by carryover.
  - Added details on instruments currently used in Section 6.1.1.
  - Added supplies as Sections 6.2.8-6.2.10.
  - Revised standards information in Section 7.0 to reflect current TALS names in the reagent module and to reflect current practice regarding makeup of solutions.
  - Added clarification for when NCM is written in lieu of reprep/reanalysis for failed LCS.
  - Revised Section 9.4 on MS/MSD to reflect current policy.

  - Added detail to surrogate corrective actions in Section 9.6.
  - Revised volume of IS added in Section 10.4.2 to reflect current practice.
  - Revised Section 12 to reflect current practice.
  - Added list of injection volumes by method chain in Table I.
  - Editorial and formatting changes throughout.

- Revision 10: 2 September 2015
  - Formatting and editorial changes throughout
  - Updated Section 9.4 on corrective action for MS/MSD to reflect current practice
  - Added requirement for Initial Calibration to be %RSD = ±15%, or Linear regression or 2nd order to be $r^2 \geq 0.99$; CCV and ICV to be ± 20% to meet DOD 5 criteria in appropriate sections per DOD requirement that these must be explicitly stated in the SOP.
  - Added new Section 9.10 to address closing CCV required by DoD QSM 5.0.
  - Updated references to corporate SOP on Calibration Curves in Section 11.2 and 11.5.
  - Updated Sections 12.1-12.3 to reflect current practice.
  - Updated Table IV analytes and ions used for analysis
  - Added Appendix III to identify MS Settings for SIM for each compound
- Revision 9: 31 August 2014
  - Added Table 8, Specific DoD QSM 5.0 and DoE QSAS 3.0 Requirements for 8270 C or D
  - Added reference to DoD QSM 5.0
  - Modified the large volume injection (LVI) internal standard concentration to 600ng/mL
  - Added Appendix II, Suggested Instrument Maintenance Schedules
- Revision 8: 31 August 2013
  - Annual Technical Review
  - Added references to analysis by LVI
  - Updated Appendix I to reflect current practice
- Revision 7: 31 July 2012
  - Annual Technical Review
  - Grammatical and formatting changes throughout
  - Updated the quant ion for surrogate terphenyl-d14 to IS#2 in Table V
  - Updated Table 1 to match current GC conditions
- Revision 6.2: 31 August 2011
  - Inserted Section 7.2.4.
  - Revised QC section (Section 9)
  - Inserted paragraph 10.2.10. regarding manual integration
  - Added Section 11.5
  - Revised Section 16.2 regarding calibration criteria
  - Updated prep methods used and inserted prep methods in reference section
  - Annual Technical Review
  - Grammatical and formatting changes throughout

Earlier revision histories have been archived and are available upon request.

Table I: Routine Instrument Operating Conditions

GC Conditions[1]	
Inlet	Split or Pulsed Split at 275 °C Split ratio - 3.1 : 1 Split Flow – 10.4 mL / min
Capillary Column	Varian Vf-5MS, 30 m length, 0.25 mm diam ID, 0.5 µm thickness
Column Mode	Constant flow, 3.4 mL/min
Temperature Program	Initial temp = 55 °C 30 °C/min ramp to 256 °C 4 °C/min ramp to 296 °C 30 °C/min ramp to 340 °C and hold for at least 1 minute past the elution time of the last compound.
Run Time	About 20 minutes with a new column.
Carrier Gas	Helium Purge flow = 25.0 mL/min, 3.00 min Total flow ≈ 31 mL/min
Injection Volume	Injection volume will be 1.0 µL or 5.0 µL depending on the logged method chain. 1. 8270C_SIM/3510C = 1.0 µL 2. 8270C_SIM/3510C_LVI = 5.0 µL 3. 8270D_SIM/3510C = 1.0 µL 4. 8270D_SIM/3510C_LVI = 1.0 µL 5. 8270D_SIM_DOD5/3510C = 1.0 µL 6. 8270D_SIM_DOD5/3510C_LVI = 1.0 µL 1.0 µL injection uses Standard Method Calibration standards (Section 7.2.2) 5.0 µL injections uses LVI Method Calibration standards (Section 7.2.2)
Transfer Line	290 °C or 300 °C
Mass Spectrometer Conditions[1,2]	
MS Source	230 °C or 240 °C
MS Quadrupole	200 °C
Dwell Time per Ion	Ranges from 30 to 100 milliseconds
Ions	See following tables

[1] The conditions listed above are subject to final fine adjustments to maximize instrument sensitivity. Changes to the above conditions are acceptable as long as method criteria are met.

[2] Details on the mass assignments in each window along with start and dwell times are given in Appendix III.

Table II: Surrogates for Standard List Analysis

PAH Surrogates	Mass Ion	Confirmation Ion
Nitrobenzene-d_5	82	128
2-Fluorobiphenyl	172	171
Terphenyl-d_{14}	244	122

Table III: Internal Standards for Standard List Analysis

Compound	Mass Ion	Confirmation Ion
Acenaphthene-d_{10}	164	162
Phenanthrene-d_{10}	188	94
Chrysene-d_{12}	240	120

Table IV: PAH Compounds and Ions Used for Analysis

Compound	Mass Ion	Confirmation Ion
Acenaphthene	153	152
Acenaphthylene	152	151
Anthracene	178	179
Benzo(a)anthracene	228	226
Benzo(a)pyrene	252	253
Benzo(b)fluoranthene	252	253
Benzo(g,h,i)perylene	276	138
Benzo(k)fluoranthene	252	253
Chrysene	228	226
Dibenzo(a,h)anthracene	278	139
Dibenzofuran	168	139
Fluoranthene	202	101
Fluorene	166	165
Indeno(1,2,3,cd)pyrene	276	138
1-Methylnaphthalene	142	141
2-Methylnaphthalene	142	141
Naphthalene	128	129
Phenanthrene	178	179
Pyrene	202	101
Morpholine	57	87

Table V: Example Retention Times, IS and Surrogate Associations

Compound	RT[1] (min.)	IS #	Surrogate #
Morpholine	4.001	1	1
Naphthalene	5.921	1	1
2-Methylnaphthalene	6.595	1	1
1-Methylnaphthalene	6.700	1	1
Acenaphthylene	7.512	1	2
Acenaphthene	7.686	1	2
Dibenzofuran	7.861	1	2
Fluorene	8.210	1	2
Phenanthrene	9.194	2	2
Anthracene	9.255	2	2
Fluoranthene	10.768	2	2
Pyrene	11.166	2	2
Benzo(a)anthracene	13.827	3	3
Chrysene	13.924	3	3
Benzo(b)fluoranthene	17.004	3	3
Benzo(k)fluoranthene	17.089	3	3
Benzo(a)pyrene	18.034	3	3
Indeno(1,2,3,cd)pyrene	21.509	3	3
Dibenz(a,h)anthracene	21.583	3	3
Benzo(g,h,i)perylene	22.306	3	3
Acenaphthene-d_{10} (IS)	7.657	1	-
Phenanthrene-d_{10} (IS)	9.177	2	-
Chrysene-d_{12} (IS)	13.856	3	-
Nitrobenzene-d_5 (Surr)	5.201	1	1
2-Fluorobiphenyl (Surr)	6.945	1	2
Terphenyl-d_{14} (Surr)	11.38	2	3

[1] Retention times may vary depending upon chromatographic conditions.

Table VI: DFTPP Key Ions and Ion Abundance Criteria
8270C

Mass	Ion Abundance Criteria
51	30-60 % of mass 198
68	< 2 % of mass 69
69	Mass 69 relative abundance
70	< 2 % of mass 69
127	40-60 % of mass 198
197	< 1 % of mass 198
198	Base peak, 100 % relative abundance
199	5-9 % of mass ion 198
275	10-30 % of mass 198
365	> 1 % of mass 198
441	Present, but less than mass 443
442	40-100 % of mass 198
443	17-23 % of mass 442

With the exception of mass 442, the tune criteria for SW846 method 8270D are less stringent for the criteria required in SW846 method 8270C. For 8270D, the 442 mass must be greater than 50% of mass 198 to meet the tune criteria. By using the 8270C criteria, the rest of the data will be within the 8270D criteria.

Table VII: 8270D Relative Response Factor Criteria for Initial and Continuing Calibration

Compound	Minimum RRF	Maximum %RSD	Maximum %Diff
Acenaphthene	0.900	20	25
Acenaphthylene	0.900	20	25
Anthracene	0.700	20	25
Benzo(a)anthracene	0.800	20	25
Benzo(a)pyrene	0.700	20	25
Benzo(b)fluoranthene	0.700	20	25
Benzo(g,h,i)perylene	0.500	20	25
Benzo(k)fluoranthene	0.700	20	25
Chrysene	0.700	20	25
Dibenzo(a,h)anthracene	0.400	20	25
Dibenzofuran	0.800	20	25
Fluoranthene	0.600	20	25
Fluorene	0.900	20	25
Indeno(1,2,3,cd)pyrene	0.500	20	25
1-Methylnaphthalene	0.400	20	25
2-Methylnaphthalene	0.400	20	25
Naphthalene	0.700	20	25
Phenanthrene	0.700	20	25
Pyrene	0.600	20	25

Table VIII

Specific DoD QSM 5.0 and DOE QSAS 3.0 Requirements for 8270D

This table includes components of the DoD QSM 5.0 and DoE QSAS 3.0 that are different from TestAmerica's standard procedures. For a complete description of the requirements, see DV-QA-024P. Also listed are the variances that TestAmerica is requesting for this analysis; these alternate criteria are only used with project-specific approval

Requirement	Variance (if allowed)	DoD QSM 5.0 and DoE QSAS 3.0
Initial Calibration Verification (ICV)	-- 4PP	All analytes must be within ± 20% of the true value. Allow ± 30% of true value for known poor performers only if these compounds are not identified as critical compounds of concern by the client for the project under consideration.
Continuing calibration Verification (CCV)	-- 4PP 3HR 7MS	Run before sample and at the end of the analytical batch (end of 12 hours). Acceptance limits for all analytes is ± 20% of true value for CCV at start of 12 hours. Allow ±30% of true value for known poor performers only if these compounds are not identified as critical compounds of concern by the client If the CCV is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project Allow ± 50% for end of analytical batch excluding poor performing compounds. Reanalysis performed due to failed closing CCV only for the analytes identified by the client as critical compounds of concern for the project, and to report qualified results for other analytes. If any analytes fail in a CCV, recalibrate and re-analyze all affected samples or immediately (within one hour) analyze two consecutive CCVs and if both pass for the analytes that failed, the CCV is acceptable.
Internal Standards (IS)	-- 8ISRT	RT must be ± 10 seconds from RT of the midpoint standard in the ICAL RT must be ± 30 seconds from RT of the midpoint standard in the ICAL. Daily routine column maintenance often results in larger RT changes than 10 sec. within a short time.
LCS	-- 4PP 3HR 1SME	Include all analyte(s) in LCS that are required to be reported, including surrogates, except those compounds listed as "Additional Analytes" by TestAmerica. These compounds are rarely requested and historical limits may not accurately reflect current performance. If the LCS recovery is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project Otherwise, correct any problems then re-prep and reanalyze the LCS and all associated samples for failed analytes. If insufficient sample, then apply Q-flag to specific analyte(s) in all samples in the associated prep batch. Flagging is only appropriate when samples cannot be reanalyzed unless 3HR is accepted by the client. Marginal exceedances are not allowed for critical chemicals of concern (risk drivers). Client must notify TestAmerica of these targets or if marginal exceedances will not be allowed.
Surrogates	-- 4PP	For QC and field samples, correct any problems, then re-prep and reanalyze all failed samples for failed surrogates in the associated prep batch. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary. If surrogate recoveries are above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project.

Appendix I: Extended List PAH Analysis by GC/MS

Summary of Method

This is the extended list for the SIM analysis that some clients require. All of the compounds listed in this appendix are analyzed for in addition to the standard compounds discussed throughout this SOP.

Modifications from the SIM analysis are as follows:

- The DFTPP tune has tailing factors that are calculated for Pentachlorophenol and Benzidine and a DDT breakdown check is performed.
- The instrument is calibrated at eight concentration levels. The calibration levels are made by diluting two stock standards with concentrations of 20 µg/mL [PAHXSIM stock (#1)] and 2µg/mL [PAHXSIM 2º stock (#2)] down to the concentrations listed below, in methylene chloride. All phthalate compounds and 2-methylnaphthalane are at a ratio of 2:1 in the stock standards. Therefore, if the concentration is 0.02 µg/mL for the target analytes, the phthalates are at 0.04 µg/mL.

Level (µg/mL)	Stock ID	Stock Amt (µL)	Solvent amount (µL)	IS amount (µL)	Final Volume (µL)
0.02 µg/mL	#2	5	495	50	500
0.1 µg/mL	#2	25	475	50	500
0.3 µg/mL	#2	75	425	50	500
0.6 µg/mL	#1	15	485	50	500
1.2 µg/mL	#1	30	470	50	500
2.5 µg/mL	#1	62.5	437.5	50	500
5.0 µg/mL	#1	125	375	50	500
10.0 µg/mL	#1	250	250	50	500

Response factors for each compound must be ≤ 20% RSD. If any compound is > 20% RSD, must use the best curve fit.

Initial Calibration Verification

- The second source calibration stock is also at 20 µg/mL (PAHSIM SSV stock).
- The second source verification (SSV or ICV) is analyzed at 1.2 µg/mL.

- The acceptance criterion for the ICV is ± 25%D.

Continuing Calibration Verification

- The CCV is run at 0.6 µg/mL
- The criterion: The Average %D for all compounds must be <20%D, with no single compound exceeding 30%D.

Sample extraction: See DV-OP-0008 (aqueous) and DV-OP-0009 (soil).

Sample concentration: See DV-OP-0007.

Sample analysis:

- Internal Standard final concentration is 6 µg/mL in standards and extracts. The stock is at 400 µg/mL
- For the MS/MSD, the recovery for the spike pair must be within the control limits stored in the LIMS system. The MS/MSD pair is generally aliquotted and run two times on the instrument, to confirm the results. If the results to be reported are from the first analysis, it is not required that the second analysis be within the 12 hour tune clock.

Instrument Configuration:

The GCMS instrumentation is configured the same as in the SIM analysis.

Extended List Compounds, Reporting Limits and Ions Used for Analysis:

Compound	Water Reporting Limit (ng/L)	Soil Reporting Limit (µg/kg)	Mass Ion	Confirmation Ion
1,4-Dioxane	NA	20	88	58
N-Nitrosodiphenylamine	1000	20	169	168
N-Nitrosodimethylamine	400	18	74	42
N-Nitrosodiethylamine (LVI)	100	--	102	44
N-Nitrosodi-n-propylamine (LVI)	100	--	70	42
Butyl Benzyl Phthalate	1000	20	149	91
Dimethyl Phthalate	1000	20	163	164
Diethyl Phthalate	1000	20	149	177
Bis(2-Ethylhexyl) Phthalate	1000	20	149	167
Di-n-octyl Phthalate	1000	20	149	150
Di-n-butyl Phthalate	1000	20	149	150

Extended List Compounds Example Retention Times, IS and Surrogate Associations:

Compound	RT[1] (min.)	IS #	Surrogate #
1,4-Dioxane	1.60	1	2
N-Nitrosodiphenylamine	6.75	2	2
N-Nitrosodimethylamine	2.16	1	2
N-Nitrosodiethylamine (LVI)	2.72	1	1
N-Nitrosodi-n-propylamine (LVI)	3.69	1	1
Butyl Benzyl Phthalate	10.33	2	2
Dimethyl Phthalate	5.92	1	2
Diethyl Phthalate	6.51	1	2
Bis(2-Ethylhexyl) Phthalate	11.67	2	2
Di-n-octyl Phthalate	13.69	3	2
Di-n-butyl Phthalate	7.95	2	2
Acenaphthene-d_{10} (IS)	7.657	1	-
Phenanthrene-d_{10} (IS)	9.177	2	-
Chrysene-d_{12} (IS)	13.856	3	-
Nitrobenzene-d_5 (Surr)	5.201	1	1
2-Fluorobiphenyl (Surr)	6.945	1	2
Terphenyl-d_{14} (Surr)	11.38	2	3

[1] Retention times may vary depending upon chromatographic conditions.

APPENDIX II

Instrument Maintenance Schedules
Mass Spectrometer & Gas Chromatograph

MASS SPECTROMETER Instrument Maintenance Schedule				
Daily	**Weekly**	**As Needed**	**Quarterly**	**Annually**
Check for sufficient gas supply. Check for correct column flow and/or inlet pressure.	Check mass calibration (PFTBA or FC-43).	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between service contract maintenance.	Check vacuum, relays, gas pressures, and flows.	Replace the exhaust filters on the mechanical rough pump every 1 to 2 years.
Check temperatures of injector, detector. Verify temperature programs.		Replace electron multiplier when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.		Change the oil in the mechanical rough pump.
Check inlets, septa.		Clean source, including all ceramics and lenses. Source cleaning is indicated by a variety of symptoms, including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.		Relubricate the turbomolecular pump-bearing wick.
Check baseline level.		Repair/replace jet separator.		
Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds.		Replace filaments when both filaments burn out or performance indicates the need for replacement.		

APPENDIX II (continued)

Instrument Maintenance Schedules
Mass Spectrometer & Gas Chromatograph

GAS CHROMATOGRAPH Instrument Maintenance Schedule (For GC/MS only.)	
Daily	***As Needed***
Check for sufficient supply of carrier and detector gases. Check for correct column flow and/or inlet pressures.	Replace front portion of column packing or guard column or break off front portion of capillary columns. Replace column if this fails to restore column performance or when column performance indicates it is required (e.g., peak tailing, poor resolution, high backgrounds, etc.).
Check temperatures of injectors and detectors. Verify temperature programs.	Change glass wool plug in injection port and/or replace injection port liner when front portion of column packing is changed or front portion of capillary column is removed.
Check inlets, septa. Clean injector port.	Replace septa.
Check baseline level.	Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).
Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks.	Repair or replace flow controller if constant gas flow cannot be maintained.
	Reactivate flow controller filter dryers when the presence of moisture is suspected.
	Autosampler: Replace syringe, fill wash bottle, dispose of waste bottle contents.

APPENDIX III
Mass Spectrometer Settings for Single Ion Monitoring

Group ID	Group Start Time[1] (min)	Analyte	Masses	Dwell Times
1	1.45	N-Nitrosodimethylamine	74, 42	50, 50
		1,4-Dioxane	88, 58	50, 50
		Morpholine[2]	57, 87	50, 50
		N-Nitrosodiethylamine (LVI)[3]	102, 44	50, 50
2	2.60	Nitrobenzene-d_5	82, 128	50, 50
		Naphthalene	128, 129	50, 50
		N-Nitrosodiethylamine (LVI)[3]	102, 44	50, 50
		N-Nitrosodi-n-propylamine (LVI)	70, 42	50, 50
3	4.79	2-Fluorobiphenyl	172, 171	50, 50
		2-Methylnaphthalene	142, 141	50, 50
		1-Methylnaphthalene	142, 141	50, 50
4	5.46	Dimethyl Phthalate	163, 164	50, 50
		Acenaphthene- d_5	164, 162	50, 50
		Acenaphthene	153, 152	50, 50
		Acenaphthylene	152, 151	50, 50
		Dibenzofuran[4]	168, 139	50, 50
5	6.06	Diethyl Phthalate	149, 177	50, 50
		N-Nitrosodiphenylamine	169, 168	50, 50
		Fluorene	166, 165	50, 50
		Dibenzofuran[4]	168, 139	50, 50
6	6.78	Phenanthrene-d_{10}	188, 94	50, 50
		Phenanthrene	178, 179	50, 50
		Di-n-butyl Phthalate	149, 150	50, 50
		Anthracene	178, 179	50, 50
7	8.05	Butyl Benzyl Phthalate	149, 91	50, 50
		Terphenyl-d_{14}	244, 122	50, 50
		Fluoranthene	202, 101	50, 50
		Pyrene	202, 101	50, 50
8	10.48	Chrysene- d_{12}	240, 120	50, 100
		Bis(2-Ethylhexyl) Phthalate	149, 167	100, 100
		Chrysene	228, 226	50, 50
		Benzo(a)anthracene	228, 226	50, 50
9	12.33	Di-n-octyl Phthalate	149, 150	50, 50
		Benzo(a)pyrene	252, 253	50, 50
		Benzo(b)fluoranthene	252, 253	50, 50
		Benzo(k)fluoranthene	252, 253	50, 50
10	16.48	Dibenzo(a,h)anthracene	278, 139	50, 50
		Indeno(1,2,3-cd)pyrene	276, 138	50, 50
		Benzo(g,h,i)perylene	276, 138	50, 50

[1] Group start times may vary due to chromatographic conditions.
[2] Morpholine method detection limit verifications not kept current. Laboratory does not stock standards.
[3] N-Nitrosodiethylamine (LVI) elutes between windows 1 and 2 and was therefore included in both.
[4] Dibenzofuran elutes between windows 4 and 5 and was therefore included in both.

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Title: Determination of Volatile Organics by GC/MS [8260B/C and 624]

Approvals (Signature/Date):

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Roxanne Sullivan Quality Assurance Manager	Date	Richard Clinkscales Laboratory Director	Date

Facility Distribution No. ____________ **Distributed To:**__________________________

1.0 Scope and Application

1.1 This method is applicable to the determination of volatile organic compounds (VOCs) in water, wastewater, soils, sludges, and other solid matrices. Standard analytes are listed in Table 1. Additional analytes that can be determined by this SOP are listed in Tables 2, 3 and 4.

1.2 This SOP is applicable to Method 8260B, which is appropriate for compliance testing under RCRA regulations and Method 624 (CWA compliance testing). It is important that the procedural differences described in this document for these methods are carefully observed.

1.3 This method can be used to quantify most volatile organic compounds that have boiling points below 200 °C and are insoluble or slightly soluble in water. Volatile water-soluble compounds can be included in this analytical technique; however, for more soluble compounds, quantitation limits are approximately ten times higher because of poor purging efficiency.

1.4 The method is based upon a purge-and-trap, gas chromatograph/mass spectrometric (GC/MS) procedure. The approximate working range is 0.5 to 60 μg/L for 8260B waters, 1.0 to 200 μg/kg for low-level soils, and 200 to 30,000 μg/kg for medium-level soils. The working range for Method 624 (5 mL purge) is 1.0-200 μg/L.

1.5 Reporting limits for Method 8260B are listed in Tables 1, 2, and 3. Reporting limits for Method 624 are given in Table A1. Reporting limits for soil samples prepared by the AK methanol technique are listed in Table Bp-1.

1.6 Method performance is monitored through the use of surrogate compounds, matrix spike/matrix spike duplicates (MS/MSD), and laboratory control spike samples (LCS).

2.0 Summary of Method

2.1 Volatile compounds are introduced into the gas chromatograph by the purge and trap method. The components are separated via the gas chromatograph and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information.

2.2 Aqueous samples are purged directly. Generally, soils are preserved by extracting the volatile analytes into methanol. If especially low detection limits are required, soil samples may be preserved in water (with or without sodium bisulfate) and purged directly.

2.3 In the purge-and-trap process, an inert gas is bubbled through the solution at ambient temperature or at 40 °C (40 °C is required for low-level soils), and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are trapped. After purging is completed, the sorbent column (trap) is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column. The gas chromatographic column is then heated to elute the components, which are detected with a mass spectrometer.

2.4 Qualitative identifications are confirmed by analyzing standards under the same conditions used for samples and comparing the resultant mass spectra and GC retention times. Each identified component is quantified by relating the MS response for an appropriate selected ion produced by that compound to the MS response for another ion produced by an internal standard.

2.5 Unless otherwise noted all requirements are for both 8260B, 8260C and 624.1

3.0 Definitions

3.1 **Contaminated glassware:** Glassware that may have come into contact with samples and/or chemical standard and that have not been cleaned using this procedure.

3.2 **Uncontaminated glassware:** Glassware that has not come into contact with samples, chemical standards, or is otherwise believed to be uncontaminated.

NOTE: Newly purchased glassware is not necessarily clean. The manufacturing process can contaminate glassware with high molecular weight organic constituents that can be extracted by organic solvents. New glassware should be thoroughly Methanol rinsed prior to use for analytical applications.

3.3 Calibration Check Compound (CCC)

CCCs are a representative group of compounds that are used to evaluate initial calibrations and continuing calibrations. Relative percent difference for the initial calibration and percent drift for the continuing calibration response factors are calculated and compared to the specified method criteria.

3.4 System Performance Check Compounds (SPCC)

SPCCs are compounds that are sensitive to system performance problems and are used to evaluate system performance and sensitivity. A response factor from the continuing calibration is calculated for the SPCC compounds and compared to the specified method criteria.

3.5 Initial Calibration Verification (ICV)

The ICV is a second-source calibration verification standard. In this SOP, the LCS and the MS/MSD spikes are second-source standards.

3.6 Continuing Calibration Verification (CCV)

A solution of method analytes, surrogate compounds, and internal standards used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

3.7 Lower Limit of Quantitation (LLOQ)

The lowest concentration at which the laboratory has demonstrated target analytes can be reliably measured and reported with a certain degree of confidence, which must be $\geq$ the lowest point in the calibration curve. The LLOQ is equivalent to the standard reporting limit. The required LLOQ verification is performed at a concentration of 1-2 times the LLOQ (or RL).

3.8 Other Quality Terms

The quality control terms used in this procedure are consistent with SW-846 terminology. Definitions are provided in the glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and in SOP DV-QA-003P, Quality Assurance Program.

4.0 Interferences

4.1 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All of these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. The use of ultra high purity gases, pre-purged purified reagent water, and approved lots of purge-and-trap-grade methanol will greatly reduce introduction of contaminants. In extreme cases, the purging vessels may be pre-purged to isolate the instrument from laboratory air contaminated by solvents used in other parts of the laboratory.

4.2 It is imperative that all glassware used in the laboratory be free of contaminants and potential interferences before starting and analysis or extraction process. Many problems encountered in the laboratory can be traced to improperly cleaned glassware and can be avoided by following the proper cleaning procedures.

4.3 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) into the sample through the septum seal during shipment and storage. A field blank prepared from reagent water and carried through the sampling and handling protocol can serve as a check on such contamination.

4.4 Matrix interferences may be caused by non-target contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source depending upon the nature and diversity of the site being sampled.

4.5 Cross-contamination can occur whenever high-level and low-level samples are analyzed sequentially or in the same purge position on an autosampler. Whenever an unusually concentrated sample is analyzed, it should be followed by one or more blanks to check for cross-contamination. The purge and trap system may require extensive bake-out and cleaning after a high-level sample.

4.6 Some samples may foam when purged due to surfactants present in the sample. When this kind of sample is encountered, an antifoaming agent (e.g., J.T. Baker's Antifoam B silicone emulsion) can be used. A blank spiked with this agent must be analyzed with the sample. (See Section 10.7.4.12.)

4.7 Interferences are observed with the surrogate Toluene-d_8 when the samples appear to be treated with potassium permanganate.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

5.3.2 The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.

5.3.3 There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.

5.3.4 Inspect all glassware before use and remove from service any glassware that is chipped or broken.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm (TWA)	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.

(1) Always add acid to water to prevent violent reactions.
(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Purge and Trap Device: The purge and trap device consists of the sample purger, the trap, and the desorber.

6.1.2 Sample Purger: The recommended purging chamber is designed to accept between 5 mL and 25 mL samples with a water column at least 3 cm deep. The purge gas must pass through the water column as finely divided bubbles, each with a diameter of less than 3 mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. Alternative sample purge devices may be used provided equivalent performance is demonstrated. Low level soils are purged directly from a VOA vial.

6.1.3 Trap: A variety of traps may be used, depending on the target analytes required. The O.I. #10 (Tenax / Silica gel / Carbon Molecular Sieve) is recommended. Other traps such as the Vocarb 3000 or Vocarb 4000 may be used if the Quality Control criteria are met.

6.1.4 Desorber: The desorber should be capable of rapidly heating the trap up to 270 °C depending on the trap packing material. Many such devices are commercially available.

6.1.5 Sample Heater: A heater capable of maintaining the purge device at 40 °C is necessary for low level soil analysis.

6.1.6 Purge-and-trap Autosampler: An autosampler capable of sampling from a sealed vial, Varian Archon, or equivalent.

6.1.7 Gas Chromatograph: The gas chromatograph (GC) system must be capable of temperature programming.

6.1.8 Gas Chromatographic Columns: Capillary columns are used. Some typical columns are listed below:

6.1.8.1 Column 1: 60 m X 0.25 ID DB-624 with 1.4 µm film thickness.

6.1.8.2 Column 2: 75 m X 0.53 ID DB-624 wide bore with 3 µm film thickness.

6.1.9 Mass Spectrometer: The mass spectrometer must be capable of scanning 35-300 amu every two seconds or less, using 70 volts electron energy in the electron impact mode and capable of producing a mass spectrum that meets the required criteria when 50 ng of 4-bromofluorobenzene (BFB) are injected onto the gas chromatograph column inlet.

6.1.10 GC/MS interface: In general, glass jet separators are used but any interface (including direct introduction to the mass spectrometer) that achieves all acceptance criteria may be used.

6.1.11 Data System: A computer system that allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that allows searching any GC/MS data file for ions of a specified mass and plotting such ion abundances versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile (EICP). Software must also be available that allows integrating the abundances in any EICP between the specified time or scan-number limits. In addition, for the non-target compounds, software must be available that allows for the comparison of sample spectra against reference library spectra. The most recent release of the NIST/EPA mass spectral library should be used as the reference library. The computer system must also be capable of backing up data for long-term off-line storage.

6.2 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls (or current revision) for the current software and hardware to be used for data processing.

6.3 Supplies

6.3.1 Microsyringes: 10 μL and larger, 0.006-inch ID needle.

6.3.2 Syringe: 5 or 25 mL glass with Luerlok tip, if applicable to the purging device.

6.3.3 Balance: Analytical balance capable of accurately weighing 0.0001 g, and a top-loading balance capable of weighing 0.1 g

6.3.4 Vials: 2 mL, 20 mL, and 40 mL with screw caps and Teflon liners

6.3.5 Disposable magnetic stirrers for low-level soil analyses

6.3.6 Volumetric flasks: 10 mL and 100 mL, class A with ground-glass stoppers.

6.3.7 Spatula: Disposable wooden tongue depressors.

6.3.8 Disposable pipettes: Pasteur.

6.3.9 pH paper: Wide range.

6.3.10 Gases:

6.3.10.1 Helium: Ultra high purity, grade 5, 99.999% (carrier gas).

6.3.10.2 Compressed nitrogen: Used for instrument pneumatics and sample purge.

7.0 Reagents and Standards

7.1 Methanol: Purge and Trap Grade, High Purity

7.2 Reagent Water: High purity water that meets the requirements for a method blank when analyzed. (See Section 9.4.) Reagent water may be purchased as commercial distilled water and prepared by purging with an inert gas overnight. Other methods of preparing reagent water are acceptable.

7.3 Sand: Reagent grade Ottawa sand or equivalent.

7.4 Antifoam B, Silicon Emulsion, J. T. Baker, 100% purity.

7.5 Sodium bisulfate ($NaHSO_4$), reagent grade

7.6 If stock or secondary dilution standards are purchased in sealed ampoules they may be used up to the manufacturers' expiration date.

7.7 Calibration Stock Standard Solutions

Stock solutions may be purchased as certified solutions from commercial sources or prepared from pure standard materials as appropriate. These standards are prepared in methanol and stored in Teflon-sealed screw-cap bottles with minimal headspace at -10 to -20 °C. Stock standards and aliquots for gases must be replaced at least every week. The Gas Standards Tracking Log is used to verify and track open dates to assist in weekly replacement of the gas standards. See Attachment 1. Other stock standards must be replaced at least every 6 months.

7.8 Calibration Working standards

A working solution containing the compounds of interest prepared from the stock solution(s) in methanol. These standards are stored in the freezer or as recommended by the manufacturer. Working standards are monitored by comparison to the initial calibration curve. If any of the calibration check compounds drift in response from the initial calibration by more than 20%, then corrective action is necessary. This may include steps such as instrument maintenance, preparing a new calibration verification standard or tuning the instrument. If the corrective actions do not correct the problem then a new initial calibration must be performed.

7.9 Aqueous calibration standards are prepared in reagent water using the secondary dilution standards. These aqueous standards must be prepared daily.

7.10 Internal standards (IS) are added to all samples, standards, and blank analyses. Refer to Tables 8 and 8A for internal standard components.

7.11 Surrogate Standards: Refer to Tables 9 and 9A for surrogate standard components and spiking levels.

7.12 Laboratory Control Sample Spiking Solutions: A second source set of standards is used and contains the Main_B, Gas/Ket_B, and SS-2-Cleve. Compounds not included in these standards can be spiked with lab pre-approval. See TALS Reagent Module for these standards for complete list of target analytes.

7.13 Matrix Spiking Solutions: The matrix spike contains the same components as the LCS.

7.14 Tuning Standard: A standard is made up that will deliver 50 ng on column upon injection. A recommended concentration of 50 ng/µL of BFB in methanol is prepared from stock standards as described in Sections 7.7 and 7.8.

8.0 <u>Sample Collection, Preservation, Shipment and Storage</u>

8.1 Water samples

8.1.1 Water samples are collected in triplicate in 40 mL glass VOA vials with PTFE-lined septum caps with minimal headspace. There should be no bubbles present in the container larger than ~6 mm.

8.1.1.1 Analysts will select the VOA vial without a red sticker for analysis if possible. If all vials contain red stickers then the VOA vials with the smallest headspace/bubbles will be chosen for analysis. Any VOA vials analyzed with a red sticker(headspace >6mm) will be documented in an NCM.

8.1.2 Preservation depends upon the target analytes and the sampling location. At a minimum, aqueous samples are stored refrigerated at ≤ 6 °C and not frozen. Specific preservation requirements are given in the following table. If multiple analytes are requested, it may be necessary to provide aliquots with different preservations. For each preservation technique, the samples should be collected in triplicate.

8.1.3 SW-846 states that if carbonaceous materials are present, or if MTBE and other fuel oxygenate ethers are present and a high temperature sample preparative method is to be used, do not acid preserve the samples. The holding time for these unpreserved samples is 7 days. SW-846 does not otherwise provide guidance for processing unpreserved samples. EPA MICE has interpreted the holding time on an unpreserved sample as 7 days.

Preservation and Holding Time for Volatiles in Water

Analyte(s)	Reference	Preservation	Holding time	Dechlorination Required[1]
Routine target analytes[2]	SW-846, Ch. 4	Cool, <6ºC, pH < 2 with 1:1 HCl	14 days	Y
	SW-846, Ch. 4	Cool, <6ºC	7 days	Y
	624	Cool, <6ºC, pH < 2 with 1:1 HCl	14 days	Y
	624	Cool, <6ºC	7 days	Y
Acrolein[3]	SW-846, Ch. 4	Cool, <6ºC, pH 4-5	7 days	N
	40 CFR Part 136 (624)	Cool, <6ºC (no HCl)	3 days	Y
	40 CFR Part 136 (624)	Cool, <6ºC, pH 4-5	14 days	Y
Acrylonitrile[3]	SW-846, Ch. 4	Cool, <6ºC, pH 4-5	7 days	N
	40 CFR Part 136 (624)	Cool, <6ºC (no HCl)	14 days	Y
	40 CFR Part 136 (624)	Cool, <6ºC, pH 4-5	14 days	Y
2-Chloroethylvinyl ether (2-CLEVE)[4]	SW-846, Ch. 4	Cool, <6ºC (no HCl)	7 days	Y
	624	Cool, <6ºC (no HCl)	14 days	Y

[1] If residual chlorine is present, 2 drops of 10% sodium thiosulfate are added. *Never add acid preservative directly to a dechlorinating agent prior to sample collection.*

[2] Separate aliquots must be collected and preserved as indicated if acrolein, acrylonitrile, 2-CLEVE (by Methods 8260B or 624), vinyl chloride (by Method 8260B) or styrene (by Method 8260B) are also to be analyzed. If aromatic and biologically active compounds are analytes of interest, acid preservation is necessary.

[3] SW-846 only recommends a 7 day holding time for acrolein and acrylonitrile preserved to pH 4-5. As this preservation is difficult to achieve with HCl, the laboratory recommends unpreserved aliquots with a three day holding time.

According to 40 CFR Part 136, the preferred method for acrolein and acrylonitrile is Method 603. In the Method Update Rule published in the Federal Register on May 18, 2012 (40 CFR Parts 136) EPA approved Method 624 for the determination of acrolein and acrylonitrile in wastewater. The current sample preservation and holding time requirements for acrolein and acrylonitrile apply to these compounds when analyzed by Method 624. Implementation of this rule is subject to individual state program decisions and timetables.

[4] SW-846 includes vinyl chloride and styrene in the list of compounds which require unpreserved sample for analysis. Method 624 does not include these two analytes on the standard analyte list. The laboratory recommends that if these analytes are requested by Method 624 that unpreserved aliquots be submitted.

8.2 Soil Samples

8.2.1 Sampling Techniques and Containers

8.2.1.1 Soil samples can be taken using the EnCore™ sampler. Typically three Encores are collected per sampling location. At specific client request, unpreserved soil samples may be accepted for preservation at the lab.

8.2.1.2 The more common way to collect soils is with Terra Core kits. Typically three aliquots are collected. Terra Core kits consist of the Terra Core sampling device and three 40 mL tared VOA vials. Samples are extruded into empty tared vials and preserved at the laboratory or are extruded into pre-preserved, tared vials in the field and transported to the laboratory for analysis.

8.2.2 An additional bottle of unpreserved soil for each sampling location must be shipped for percent moisture determination.

8.2.3 A second bottle of unpreserved soil is sent for screening.

8.2.4 Unpreserved Soils

8.2.4.1 At specific client request unpreserved soils packed into glass jars or brass tubes may be accepted and sub sampled in the laboratory. This is the old procedure based on Method 5030A. It is no longer included in subsequent revisions of Method 5030 and is likely to generate results that are biased low, possibly by more than an order of magnitude.

8.2.4.2 The maximum holding time is 14 days from sampling until the sample is analyzed. Unpreserved samples should be analyzed as soon as possible. The lack of preservation should be addressed in the case narrative.

8.3 Trip blanks, consisting of laboratory prepared water samples with acid preservative, are also provided when bottles are supplied by the laboratory to the field. Trip blanks are used for both water and soil samples to monitor potential contamination from volatile compounds in transit and in the field.

8.4 A holding blank is stored in each refrigerator with the samples. This is analyzed every 14 days (see SOP DV-QA-0013).

8.5 Preservation and holding times for volatiles in soils are summarized in the following table, based on SW-846 Method 5035A.

Preservation and Holding Time for Volatiles in Soil
Method 5035A

Sample Handling in Field	**Preservation**[1,2, 3]	**Holding Time**
Sample Extruded into Empty Vial in Field, sealed and shipped to Lab	Cool to $\leq 6^{o}$C or freeze on site to -7^{o}C in field (do not freeze below -20^{o}C), maintained cold in transit	48 hours from sampling to other preservation
	Upon receipt the laboratory must: a) Maintain the sample frozen or b) Add 5 mL water and freeze (-20^{o}C to -7^{o}C), or c) Add 5 mL water and 1 g $NaHSO_4$, store at $\leq 6^{o}$C or d) Add methanol, store at $\leq 6^{o}$C	14 days from sampling
Encore sampler used for transport	Cool to $\leq 6^{o}$C or freeze on site to -7^{o}C in field (do not freeze below -20^{o}C), maintained cold in transit	48 hours from sampling to other preservation
	Upon receipt at laboratory sample is extruded to a sealed vial and either frozen to $<-7^{o}$C or chemically preserved (see above).	14 days from sampling
Field Preserved	Sample is extruded into a vial containing reagent water and frozen on –site to $<-7^{o}$C	14 days
Field Preserved	Sample is extruded into a vial containing reagent water and cooled on –site to $\leq 6^{o}$C for 48 hours or less then frozen to $<-7^{o}$C upon receipt at laboratory	14 days if samples frozen within 48 hours
Field Preserved	Sample is extruded into a vial containing reagent water and 1 g NaHSO4 and cooled to $\leq 6^{o}$C. Maintained $\leq 6^{o}$C upon receipt at laboratory.	14 days
Field Preserved	Sample is extruded into a vial containing methanol and cooled to $\leq 6^{o}$C. Maintained $\leq 6^{o}$C upon receipt at laboratory.	14 days

[1] If multiple aliquots of sample are provided a combination of preservation techniques may be used

[2] Reactive compounds such as 2-chloroethylvinyl ether readily break down under acidic conditions. If these types of compounds are analytes of interest, collect a second set of samples without acid preservatives and analyze as soon as possible.

[3] For biologically active soils, immediate chemical or freezing preservation is necessary due to the rapid loss of BTEX compounds within the first 48 hours of sample collection.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Proper cleaning of laboratory glassware is an essential element of contamination control and therefore an important element of the laboratory's quality control program. Proper cleaning of glassware is reflected in acceptable method blanks results.

9.2.1 Gastight syringes must be triple rinsed with Methanol and air dried.

9.2.2 Class A volumetric flasks must be triples rinsed before and after each use and air dried. **Note:** Do not bake or use wire brushes to clean Class A glassware.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples (method blank, lab control sample, and matrix spike/matrix spike duplicate), processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. A method blank must be run on each instrument. See Policy DV-QA-003P for further details.

9.4 Method Blanks

For each batch of samples, analyze a method blank. The method blank is analyzed after the calibration standards, normally before any samples. For low-level volatiles in water, the method blank consists of reagent water. For low-level volatiles in soil, the blank medium is Ottawa sand preserved with DI water or Sodium Bisulfate depending on how the samples are preserved. For medium-level volatiles, the method blank consists of Ottawa sand to which surrogates are added and extracted with methanol. The method blank is carried through the entire preparation and analytical procedure.

NOTE: If both DI and sodium bisulfate preserved samples are analyzed the QC samples should be prepared with sodium bisulfate.

Acceptance Criteria: The method blank must not contain any analyte of interest at or above one-half the reporting limit (except common laboratory contaminants, see below) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher.

For DOD QSM 4.2 or 5.0, common lab contaminants must not exceed the reporting limit.

The method blank must have acceptable surrogate recoveries. (See Section 9.5)

Note: Only use data associated with acceptable Calibration and QC data for 624 compliance samples.

Corrective Actions: If the analyte is a common laboratory contaminant (i.e., methylene chloride, acetone, 2-butanone, and carbon disulfide), the data may be reported with qualifiers if the concentration of the analyte is less than five times the reporting limit. Such action must be taken in consultation with the client.

Reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the associated samples.

If there is no target analyte greater than one-half the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be taken in consultation with the client.

If surrogate recoveries in the blank are not acceptable, the data must be evaluated to determine if the method blank has served the purpose of demonstrating that the analysis is free of contamination. If surrogate recoveries are low and there are reportable analytes in the associated samples, re-extraction of the blank and affected samples will normally be required. Consultation with the client should take place.

If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all associated samples are flagged with a "B”, and appropriate comments may be made in the narrative to provide further documentation.

9.5 Surrogates

Every sample, blank, and QC sample is spiked with surrogates. Surrogate recoveries in samples, blanks, and QC samples must be assessed to ensure that recoveries are within established limits. The compounds included in the surrogate spiking solutions are listed in Tables 8 and 8A.

For DoD QSM 4.2 or 5.0, special method codes in TALS include program specific QC limits for surrogates. If limits are not available in the appropriate QSM, in-house historical limits are to be used.

Acceptance Criteria: Acceptance limits for surrogate recoveries are set at ± 3 standard deviations around the historical mean. Surrogate recovery limits are updated annually and stored in the LIMS.

Note: Only use data associated with acceptable Calibration and QC data for 624 compliance samples.

Corrective Actions: If any surrogates are outside limits, the following corrective actions must take place (except for dilutions):

- Check all calculations for error.
- Ensure that instrument performance is acceptable.
- Recalculate the data and/or reanalyze if either of the above checks reveal a problem.
- Re-prepare and reanalyze the sample or flag the data as “Estimated Concentration” if neither of the above resolves the problem.

The decision to reanalyze or flag the data should be made in consultation with the client. It is necessary to re-prepare/reanalyze a sample only once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out of control results are not due to matrix effect.

If the surrogates are out of control for the sample, matrix spike, and matrix spike duplicate, then matrix effect has been demonstrated for that sample and re-preparation/reanalysis is not necessary. If the sample is out of control and the MS and/or MSD is in control, then reanalysis or flagging of the data is required.

9.6 Laboratory Control Samples (LCS)

An LCS is analyzed for each batch. The LCS is analyzed after the calibration standard, and normally before any samples. The LCS spiking solution is prepared from a different source than are the calibration standards. See Section 7.12 for description of spiking solution. For low-level volatiles in soil, the LCS medium is Ottawa sand preserved with DI water or sodium bisulfate depending on how the samples are preserved. For medium-level volatiles, the LCS consists of Ottawa sand to which surrogate and LCS spiking solutions are added and extracted with methanol. The LCS is carried through the entire preparation and analytical procedure. If antifoam agent is added to samples it must also be added to the LCS.

NOTE: If both DI and sodium bisulfate preserved samples are analyzed the QC samples should be prepared with sodium bisulfate.

NOTE: DoD and South Carolina require that all target compounds are spiked and reported. Specific reporting requirements for spiked compounds must be in the method comments for the job. Each project must be set up to include all spiked compounds to be reported. (NELAP requires that all targeted compounds be spiked across a two year period in the MS/MSD.)

Acceptance Criteria: The LCS recovery for the control analytes must be within established control limits. Unless otherwise specified in a reference method or project requirements, the control limits are set at ± 3 standard deviations around the mean of the historical data. An LCS that is determined to be within acceptance criteria effectively demonstrates that the analytical system is in control and validates system performance for the samples in the associated batch. Recovery limits are updated annually and stored in the LIMS. For DoD QSM 4.2 or 5.0, special method codes in TALS include program specific QC limits. If limits are not available in the appropriate QSM, in-house historical limits are to be used.

If there are a large number of analytes in the LCS, then a specified number of results may fall beyond the LCS control limit (3 standard deviations), but within the marginal exceedance (ME) limits, which are set at ± 4 standard deviations around the mean of historical data. Marginal exceedances are recognized and allowed by NELAP. DoD QSM 5.0 allows marginal exceedances but excludes them from being applied to specified critical compounds of concern. Marginal exceedances must not be applied to an analyte specified by the project team as a compound of concern.

The number of marginal exceedances is based on the number of analytes in the LCS, as shown in the following table:

# of Analytes in LCS	# of Allowed Marginal Exceedances
> 90	5
71 – 90	4
51 – 70	3

# of Analytes in LCS	# of Allowed Marginal Exceedances
31 – 50	2
11 – 30	1
< 11	0

If more analytes exceed the LCS control limits than is allowed, or if any analyte exceeds the ME limits, the LCS fails and corrective action is necessary. Marginal exceedances must be random. If the same analyte repeatedly fails the LCS control limits, it is an indication of a systematic problem. The source of the error must be identified and corrective action taken.

Note: Additional criteria are stated in the North Carolina QAS.

Note: Only use data associated with acceptable Calibration and QC data for 624 compliance samples.

Note: Some programs (e.g., South Carolina) do not allow marginal exceedances. Please see the QAS's in the public folders for the current requirements.

Note: DoD allows marginal exceedances except for critical compounds of concern. These must be specified in the communication of project requirements to the lab.

Corrective Actions: If any analyte or surrogate is outside established control limits as described above, the system is out of control and corrective action must occur. Corrective action will normally be re-preparation and reanalysis of the batch.

If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. Examples of acceptable reasons for not reanalyzing might be that the matrix spike and matrix spike duplicate are acceptable, and sample surrogate recoveries are good, demonstrating that the problem was confined to the LCS. This type of justification should be reviewed and documented with the client before reporting.

If samples are ND and LCS recovery for an analyte is out high, the sample may be reported with a qualifier, if acceptable to the client.

If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.

9.7 Matrix Spike and Matrix Spike Duplicate (MS/MSD)

For each QC batch, analyze a matrix spike and matrix spike duplicate. See Section 7.13 for description of spiking solution. The matrix spike/duplicate must be analyzed at the same dilution as the unspiked sample, even if the matrix spike compounds will be diluted out.

NOTE: DoD and South Carolina require that all target compounds are spiked and reported. Specific reporting requirements for spiked compounds must be in the method comments for the job. Each project must be set up to include all spiked compounds to be reported. (NELAP requires that all targeted compounds be spiked across a two year period in the MS/MSD.)

Acceptance Criteria: The MS/MSD recovery for the control analytes must be within established control limits. Unless otherwise specified in a reference method or project requirements, the control limits are set at ± 3 standard deviations around the mean of the historical data. The relative percent difference (RPD) between the MS and the MSD must be less than the established RPD limit, which is based on statistical analysis of historical data. MS/MSD recovery and RPD limits are updated annually and stored in the LIMS.

DoD QSM 5.0 requires the RPD limit to be ≤ 20%. DoD MS/MSD recovery limits are the same as LCS limits. See Section 9.6.

Note: Only use data associated with acceptable Calibration and QC data for 624 compliance samples.

Corrective Action: The information obtained from MS data are sample/matrix specific and are not normally used to determine the validity of the entire batch. If the MS and/or MSD recovery falls outside of the established control limits, the bracketing CCV and batch LCS recoveries must be within control limits in order to accept results for the associated samples. The following corrective actions are required for MS/MSD recovery failures to rule out lab error:

- When the parent sample and MS/MSD concentration are above the linear range; the MS/MSD and parent sample **MUST** be re-analyzed at a dilution.

- Check calculation and instrument performance;

- Verify, if possible, that the MS and MSD were spiked correctly (e.g., very low or very high recoveries);

- Consider objective evidence of matrix interference (e.g., heterogeneous sample, interfering peaks seen on chromatograms, or interference demonstrated by prior analyses);

- Flag the data for any results outside of acceptance limits and note it on the final report.

- For any single RPD failure, check calculations; verify, if possible, that the MS and MSD were spiked correctly; check instrument performance; consider objective evidence of matrix interference or sample inhomogeneity; and flag the data.

NOTE: Some client programs require reanalysis to confirm matrix interferences. Check special project requirements for this request.

NOTE: A sample duplicate is not performed as precision is obtained from either the MS/MSD or LCS/LCSD pair. Use of the MS/MSD precision is preferred as not all samples will contain measurable concentrations of target analytes. Any samples that have target analytes at such low levels do not provide useful precision data.

9.8 Acid Preservation or pH adjustment

The stability of 2-chloroethylvinyl ether, acrolein, and according to the regulations, acrylonitrile is reduced when subjected to low pH. It is therefore not recommended that these compounds be analyzed routinely from preserved VOA vials and since there is no reasonable way to achieve pH between 4 and 5, it is recommended that unpreserved vials be used for the analysis of these compounds.

Acceptance Criteria: To ensure detection of these compounds, samples must be processed correctly. Where Method 624 is being used for compliance purposes, the regulatory hold times take precedence.

Corrective Actions: If 624 data are not being generated for compliance purposes, the technical stability of the compounds may be considered. Where method 8260 is the base method, it is allowable to qualify the results as estimated. To deviate from the regulatory hold times, the following documentation must be maintained:

- A NCM must be generated by the lab that the samples are for non-compliance.
- A NCM must be generated that results are not method compliant.
- A NCM must be generated if the samples are not analyzed from an upreserved container.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preservation using EnCore^{TM} Samplers.

10.3.1 Preservation in Methanol (Medium-Level Analysis)

10.3.1.1 Extrude the (nominal) 5 g sample from one of the Encore^{TM} samplers into a tared 20 mL VOA vial. Obtain the weight of the soil added to the vial and record it in the prep batch. Select the correct cell in prep batch worksheet and once the balance is stable hit the print key. The weight will automatically be recorded in the batch record. Quickly add 5 mL of methanol and cap the vial.

10.3.1.2 If sufficient samplers are provided (or for the sample(s) designated by the client), prepare MS and MSD samples as above.

10.3.1.3 Prepare a method blank and LCS sample by weighing approximately 5 g of baked Ottawa sand for each into separate, tared 20 mL VOA vials. Add 5 mL of methanol to the blank. For the LCS, the volume of methanol added is dependent upon the spike list. Add 4.95 mL methanol if the Short List is to be spiked and 4.85 mL methanol if the full list is to be spiked. Cap tightly. Store with the samples.

10.3.1.4 Store the samples and QC samples in the freezer until screening is performed. Surrogates and LCS/MS/MSD spikes are only added if it is determined the samples will be analyzed at the medium level.

10.3.2 Preservation in Water (Low-Level Analysis)

10.3.2.1 Extrude the (nominal) 5 g sample from one of the Encore^{TM} samplers into a tared 20 mL VOA vial. Obtain the weight of the soil added to the vial and record it in the prep batch. Select the correct cell in prep batch worksheet and once the balance is stable hit the print key. The weight will automatically be recorded in the batch record. Quickly add 5 mL of water and a magnetic stirrer. Cap the vial. Repeat for the remaining aliquot.

10.3.2.2 If requested by the client, 1 g of sodium bisulfate is added to the second sample preserved with water.

10.3.2.3 If sufficient samplers are provided for a sample in the batch, or for any samples identified by the client, prepare MS and MSD samples as above.

10.3.2.4 Prepare a method blank and LCS sample by weighing approximately 5 g of baked Ottawa sand for each into separate, tared 20 mL VOA vials. Add 5 mL of water to the MB and LCS. Add a magnetic stirrer. Cap tightly. Store with the samples.

10.3.2.5 After all of the samples in the prep batch have been weighed and preserved in water the status of the samples and QC in the prep batch will remain at “batched” status for backlog tracking purposes.

10.3.2.6 When the samples are loaded on the instrument for analyses then the analyst can change the status of the samples and QC to “2nd level” so that the prep method’s status will change from “Ready” to “2nd level” therefore changing the status of the analytical method from “wait” to “Ready”

10.3.2.7 Store the samples and QC samples in the freezer until screening is performed.

10.3.3 Screen the samples. (See Section 10.5.) If the screen indicates any samples will be analyzed as medium level, go to Section 10.5.1. If the screen indicates any samples will be analyzed as low level, go to Section 10.7.7.

10.4 Sample Storage for Field Preserved Samples

10.4.1 Obtain the weight of the soil added to each vial and record it in TALS. The samples will arrive with a tare weight (weight of vial, preservative and stir bar) and no other labels attached to it. The unlabeled vial is weighed and the difference between this weight and the tare weight is the weight of the sample used for analyses.

NOTE: Do not affix label to unprepared/unweighed sample vial.

10.4.1.1 Prepare a method blank and LCS sample by weighing approximately 5 g of baked Ottawa sand for each into tared VOA vials for each analysis method. The low level preparation is done in a 40mL VOA vial and the medium level preparation is done in a 20mL VOA vial.

10.4.1.1.1 For the medium level method, in a 20mL VOA vial add 5 mL of methanol to the blank. For the LCS, the volume of methanol added is dependent upon the spike list. Add 4.95 mL methanol if the Short List is to be spiked and 4.85 mL methanol if the full list is to be spiked. Cap tightly. Store with the samples.

10.4.1.1.2 For the low level method in a 40ml VOA vial add water instead of methanol using the same volumes as in Section 10.4.1.1.1.

10.4.1.2 Store the samples and QC samples in the freezer until screening is performed. Surrogates and LCS/MS/MSD spikes are only added if it is determined the samples will be analyzed at the medium level.

10.4.2 Screen the samples. (See Section 10.5) If the screen indicates any samples will be analyzed as medium level, go to Section 10.7.5. If the screen indicates any samples will be analyzed as low level, go to Section 10.7.7.

10.5 Sample Screening

10.5.1 Where possible, samples are screened by headspace or GC/MS off-tune analysis to determine the correct aliquot for analysis. See SOP DV-MS-0009. Alternatively, an appropriate aliquot can be determined from sample histories.

10.6 Sample Preparation for Medium-Level Analysis – Field or Lab Preserved

10.6.1 For each of the samples that are determined to be Medium-Level samples by the screening procedure, add the correct amount of surrogate spiking mixture for a final concentration of 2 μg/mL. Example: 4 μL of 2500 μg/mL for a nominal 5 g sample or 20 μg/mL for a nominal 25 g sample. Cap the sample vial. Surrogates are added to all QC samples as well as field samples.

10.6.2 Add the correct amount of matrix spiking solution to the matrix spike and matrix spike duplicate samples for a final concentration of 2 μg/mL.

10.6.3 Add the correct amount of matrix spiking solution to the LCS sample for a final concentration of 2 μg/mL. If 25 g samples are being used, adjust the proportions for the LCS accordingly.

10.6.4 Shake the samples for two minutes to distribute the methanol throughout the soil.

10.6.5 Centrifuge the samples to clarify the extract.

10.6.6 Remove a portion of methanol and store in a clean Teflon-capped vial with no headspace refrigerated at $\leq$ 6 ^{o}C until analysis. Duplicate aliquots of the methanol extract should be taken and stored.

10.7 Sample Analysis Procedure

10.7.1 All analysis conditions for samples must be the same as for the initial and continuing calibration standards (including purge volume, time and flow, desorb time and temperature, column temperatures, multiplier setting etc.).

10.7.2 All samples must be analyzed as part of a batch. The batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same time period. The batch also must contain a method blank, an LCS, and a MS/MSD.

10.7.2.1 If there is insufficient time in the 12-hour tune period to analyze 20 samples, the batch may be continued into the next tune period. The 12-hour tuning requirements in Section 10.7.12.3 and 12-hour continuing calibration requirements in 10.7.14 must still be met. However, if any re-tuning or recalibration of the instrument is necessary, or if a period of greater than 24 hours from the preceding BFB tune has passed, a new QC batch must be started. For high-level soils the batch is defined at the sample preparation stage. Laboratory generated QC samples (Blank, LCS, MS/MSD) do not count towards the maximum 20 samples in a batch. Field QC samples are included in the batch count.

10.7.2.2 Any reruns must be part of a valid analytical batch. If dilutions of sample are analyzed in the same 12-hour tune they do not count towards the maximum batch count. (See DV-QA-003P.)

10.7.3 Water Samples

10.7.3.1 Purge-and-trap units that sample from a VOA vial should be equipped with a module that automatically adds surrogate and internal standard solution to the sample prior to purging the sample.

10.7.3.2 All samples and standard solutions must be at ambient temperature before analysis.

NOTE: Aqueous samples with high amounts of sediment present in the vial may not be suitable for analysis on this instrumentation, or they may need to be analyzed as soils.

10.7.3.3 To transfer a sample from its original container, fill a gas-tight syringe with the sample and adjust the sample volume based on the requested method. Place the measured sample into a clean VOA vial.

10.7.3.3.1 For Method 8260B, 20 mL sample aliquots are used unless dilutions are performed. (See Section 10.7.4.) Sample aliquots are measured in 25 mL gas tight syringes. Separate syringes are used for each sample.

10.7.3.3.2 For Method 8260C, 5mL sample aliquots are used unless dilutions are performed. (See Section 10.7.4) Sample aliquots are measured in 10 mL gas tight syringes. Separate syringes are used for each sample.

10.7.3.3.3 For Method 624, 5 or 20 mL sample aliquots are used unless dilutions are performed. (See Section 10.7.4.). Sample aliquots are measured in 5 or 25 mL gas-tight syringes. Separate syringes are used for each sample.

10.7.4 Dilutions should be done just prior to the GC/MS analysis of the sample. Dilutions are made in volumetric flasks or in a Luerlok syringe.

10.7.4.1 For dilutions of aqueous samples which require less than 1 mL of sample the sample volume is added to 20 mL of reagent water in a VOA vial or in a gas-tight syringe.

10.7.4.2 For dilutions of aqueous samples which require more than 1 mL of sample, the volume of reagent water is adjusted so that the total volume of sample and reagent water is 20 mL. The dilution is made in the VOA vial by adding the appropriate amount of reagent water to the vial. The sample aliquot is then added to the closed vial by injecting below the surface of the water.

10.7.4.3 If the dilution required would use less than 5 µL of sample, then serial dilutions must be made in volumetric flasks.

10.7.4.4 Check the pH of the sample by dipping the pH paper into the sample that is remaining in the VOA vial after the aliquot for analysis has been taken (the remaining sample is not used in analysis.) Document the pH value on the run log. If the pH is not as expected, based on the sample type and preservation, document in an NCM in the LIMS.

10.7.4.5 Sample remaining in the vial after sampling is no longer valid for further analysis. A fresh VOA vial must be used for further sample analysis.

10.7.4.6 For TCLP samples, use 2.0 mL of TCLP leachate and spike it with 2.5 µL of the 40 µg/mL TCLP spiking solution. Bring to a volume of 20 mL with reagent water.

10.7.4.7 Surrogates and internal standards are added to each sample at the instrument at the time of purging.

10.7.4.8 Calibration standards and spiking solutions are added to the CCVs, LCS and MS/MSD samples by the analyst prior to purging by inserting the syringe needle through the septum into the water. Surrogates and internal standards are added to these samples by the instrument.

10.7.4.9 Purge the sample for eleven minutes (the trap should be below 50 ºC).

10.7.4.10 After purging is complete, desorb the sample, start the GC temperature program, and begin data acquisition. After desorption, bake the trap for 2-5 minutes to condition it for the next analysis. When the trap is cool, it is ready for the next sample.

10.7.4.11 Desorb time, bake time, and temperature are optimized for the type of trap in use.

NOTE: The same conditions must be used for samples and standards.

10.7.4.12 If foaming of the sample occurs, reanalyze the sample with the addition of 1 µL of an antifoaming agent such as Antifoam B (J. T. Baker). A method blank spiked with 1 µL of the Antifoam B must also be analyzed with the sample. Make notation of “AF” on runlog for each sample to which antifoam is added.

10.7.5 Methanol Extracts of Soils

10.7.5.1 Rinse a gas-tight syringe with organic-free water. Fill the syringe with the same volume of organic-free water as used in the calibrations (typically 20 mL).

10.7.5.2 Add no more than 200 µL of methanolic extract (from Section 10.3.1 or 10.5.1) to the syringe for each sample and QC sample.

10.7.5.3 Calibration standards and spiking solutions are added to the CCVs, LCS and MS/MSD samples by the analyst prior to purging by inserting the syringe through the septum of the vial.

10.7.5.4 If less than 5 µL of methanolic extract is to be added to the water, dilute the methanolic extract such that a volume greater than 5 µL will be added to the water in the syringe.

10.7.5.5 Only internal standards are added at the instrument for methanol extracts.

10.7.5.6 Load the sample onto the purge and trap device and analyze as for aqueous samples. (See Section 10.7.3.)

10.7.6 Liquid Wastes that are Soluble in Methanol and Insoluble in Water

10.7.6.1 Pipette 2 mL of the sample into a tared vial. Use a top-loading balance. Record the weight to the nearest 0.1 gram.

10.7.6.2 Quickly add 7 mL of methanol, then add 1 mL of surrogate spiking solution to bring the final volume to 10 mL. Cap the vial and shake for 2 minutes to mix thoroughly.

10.7.6.3 For an MS/MSD pair, add 6 mL of methanol to 2 mL of the sample in a tared vial. Add 1 mL of surrogate solution and 1 mL of matrix spike solution.

10.7.6.4 Prepare an LCS by adding 1 mL of surrogate solution and 1 mL of matrix spike solution to 8 mL of methanol.

10.7.6.5 Rinse a gas-tight syringe with organic-free water. Fill the syringe with the same volume of organic-free water as used in the calibrations.

10.7.6.6 Add no more than 200 µL of methanolic extract (Section 10.7.6.2) to the syringe. Add internal standard (if used).

10.7.6.7 Load the sample onto the purge and trap device and analyze as for aqueous samples using 5 mL reagent water.

10.7.6.8 If less than 5 µL of methanolic extract is to be added to the water, dilute the methanolic extract such that a volume greater than 5 µL will be added to the water in the syringe. (See Section 10.7.4.)

10.7.7 Low-Level Soil Sample Analysis following SW846 Method 5035A

10.7.7.1 This technique is to be used when samples are collected utilizing SW-846 Method 5035A. Pre-weighed vials are used to collect approximately a 5 gram aliquot of soil (see section 8.2).

10.7.7.2 The sample vial should not have any labels applied to it until after the sample weight has been taken. Any labels applied prior to weighing will affect the initial weight calculation of the sample, because it was not accounted for in the tare weight.

10.7.7.3 Purge-and-trap units that sample from the VOA vial should be equipped with a module that automatically adds surrogate and internal standard solution to the sample prior to purging the sample.

10.7.7.4 If the autosampler uses automatic IS/SS injection, no further preparation of the VOA vial is needed. Otherwise, the internal and surrogate standards must be added to the vial.

10.7.7.5 The autosampler will heat and stir each sample as it is purged.

10.7.7.6 If any target analytes exceed the calibration range, analysis of the methanol preserved sample must be performed.

10.7.8 Low-Level Solids Analysis When Field Samples are Provided in a Jar

NOTE: This technique may seriously underestimate analyte concentration and must not be used except at specific client request for the purpose of comparability with previous data. It is no longer part of SW-846.

10.7.8.1 This method is based on purging a heated sediment/soil sample mixed with water and, if applicable, internal and matrix spiking standards. Analyze all reagent blanks and standards under the same conditions as the samples (e.g., heated). The calibration curve is also heated during analysis. Purge temperature is 40 ºC.

10.7.8.2 Do not discard any supernatant liquids. Mix the contents of the container with a disposable tongue depressor as spatula.

10.7.8.3 Weigh out 5 g (or other appropriate aliquot) of sample into a clean VOA vial. Record the weight to the nearest 0.1 g. If method sensitivity is demonstrated, a smaller aliquot may be used. Do not use aliquots less than 1.0 g. If the sample is contaminated with analytes such that a purge amount less than 1.0 g is appropriate, use the medium-level method described in Section 10.7.5 with preparation described in Section 10.5.1.

10.7.8.4 Rinse a 5 mL gas-tight syringe with organic-free water, and fill. Compress to 5 mL. Inject the spiked water into the VOA vial that contains the soil sample and add a stirring bar.

10.7.8.5 The above steps should be performed rapidly and without interruption to avoid loss of volatile organics.

10.7.8.6 Prepare a Method Blank and LCS using 5 g of Ottawa sand and 5 mL of water. Add a stirring bar to each. Prepare the MS/MSD (based on the sample requested by the client. The LCS spiking solution is added via a syringe inserted through the septum of the vial to the LCS and MS/MSD samples.

10.7.8.7 Low level soil samples may be analyzed with a 1 g aliquot in place of the 5 g aliquot, mixed with water. If higher dilutions are required, the methanol extract (medium level) will be analyzed.

10.7.8.8 Surrogate and internal standards are added automatically to all samples at the instrument.

10.7.8.9 The autosampler will heat and stir each sample as it is purged.

10.7.8.10 Soil samples that have low internal standard recovery when analyzed (< 50%) should be reanalyzed once to confirm matrix effect.

10.7.9 Initial Review and Corrective Actions

10.7.9.1 If the retention time for any internal standard in the continuing calibration changes by more than 0.5 minute from the mid-level initial calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required. DoD QSM 5.0 requires that the retention time for any internal standard be within 10 sec of the midpoint of the ICAL. If accepted by the client, this window can be expanded to 30 sec of the midpoint of the ICAL.

10.7.9.2 If the internal standard response in the continuing calibration is more than 200% or less than 50% of the response in the mid-level of the initial calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required.

Sample internal standard areas are compared to the mid-point of the supplemental initial calibration internal standard areas. Responses from 50% to 200% are acceptable. If a sample fails to meet these internal standard criteria, further investigation is necessary. If the change in sensitivity is a matrix effect confined to an individual sample, reanalysis is not necessary. If the change in sensitivity is due to instrumental problems, all affected samples must be reanalyzed after the problem is corrected.

10.7.9.3 The surrogate standard recoveries are evaluated to ensure that they are within limits. Corrective action for surrogates out of control will normally be to reanalyze the affected samples. However, if the surrogate standard response is out high and there are no target analytes or tentatively identified compounds, reanalysis may not be necessary. Out of control surrogate standard response may be a matrix effect. It is only necessary to reanalyze a sample once to demonstrate matrix effect, but reanalysis at a dilution should be considered.

10.7.10 Dilutions

10.7.10.1 If the response for any compound exceeds the working range of the GC/MS system, a dilution of the sample or extract is prepared and analyzed. An appropriate dilution should be in the upper half of the calibration range. Samples may be screened to determine the appropriate dilution for the initial run. If the initial diluted run has no hits or hits below 20% of the calibration range and the matrix allows for analysis at a lesser dilution, then the sample must be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.

10.7.10.2 Guidance for Dilutions Due to Matrix

If the sample is initially run at a dilution and the baseline rise is less than half the height of the internal standards, or if individual non target peaks are less than twice the height of the internal standards, then the sample should be reanalyzed at a more concentrated dilution. This requirement is approximate and subject to analyst judgment.

10.7.10.3 Reporting Dilutions

The most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions will be reported only at client request.

10.7.11 Instrument Set-up

Prior to the analysis of samples and blanks, the GC/MS system must be tuned and calibrated. Tuning is accomplished by analyzing 4-bromofluorobenzene (BFB) to establish that the GC/MS system meets the standard mass spectral abundance criteria. The GC/MS system must be calibrated initially at a minimum of five concentrations to determine the linearity of the response utilizing target calibration standards. The calibration must be verified each twelve-hour time period for each GC/MS system. The use of separate calibrations is required for water and low soil matrices.

10.7.12 Recommended Instrument Conditions

10.7.12.1 General

Parameter	Setting
Electron Energy:	70 volts (nominal)
Mass Range:	35–300 amu
Scan Time:	to give at least 5 scans/peak, ≤ 2 second/scan
Injector Temperature:	200 – 250 ˚C
Source Temperature:	According to manufacturer's specifications
Transfer Line:	Temperature: 250 – 300 ˚C
Purge Flow:	40 mL/minute
Carrier Gas Flow:	1-15 mL/minute, dependent upon column specifications

10.7.12.2 Gas Chromatograph Suggested Temperature Program

The following temperature programs vary with the column type used.

BFB Analysis

Initial Temperature:	150 ˚C
Initial Hold Time:	0.00 minutes
1st Temperature Program:	50.00 ˚C/minute
Final Temperature:	220 ˚C
Final Time:	4.00 minutes
2nd Temperature Program:	OFF
Post Temperature:	0 ˚C
Post Time:	0.00 minutes
Run Time:	5.40 minutes

Sample Analysis

Initial Temperature:	40 ˚C
Initial Hold Time:	4 minutes
1st Temperature Program:	8 ˚C/minute
Final Temperature:	184 ˚C
2nd Temperature Program:	40 ˚C/minute
Final Temperature:	240 ˚C
Final Hold Time:	2.6 minutes

10.7.12.3 Instrument Tuning

Each GC/MS system must be hardware-tuned to meet the abundance criteria listed in Table 10 for a maximum of a 50 ng injection or purging of BFB. Analysis must not begin until these criteria are met. These criteria must be met for each twelve-hour time period. The twelve-hour time period begins at the moment of injection of BFB.

10.7.13 Initial Calibration

10.7.13.1 Detailed information regarding calibration models and calculations can be found in Corporate SOP CA-Q-S-005, *Calibration Curves (General)* and in the public folder *Arizona Calibration Training.*

10.7.13.2 A series of five or more initial calibration standards is prepared and analyzed for the target compounds and each surrogate compound. Certain analytes are prepared at higher concentrations due to poor purge performance. The following calibration curves are maintained. Calibration levels for each analyte are given in the stated tables. Other calibration levels and purge volumes may be used depending on the capabilities of the specific instrument or program requirements.

Initial Calibration by Matrix and Method

Method	Matrix	Purge Volume	Calibration Levels
624	Water	5 mL	Table 5A
8260	Water	20 mL	Tables 5 and 5A
8260	Soil (low level)	5 mL	Tables 4 and 4A
8260	Soil (Methanol Extract)	20 mL reagent water + 100 µL Methanol	Tables 6 and 6A
Alaska	Soil	See Appendix B	See Appendix B

10.7.13.3 Calibration levels below the reporting limit may be removed provided that there is a minimum of five calibration points for linear regression and six calibration points for second order calibration. The lowest standard used in the calibration must be at or below the TestAmerica reporting limit.

10.7.13.4 The same purge volume must be used for calibration and sample analysis, and the low level standard must be at or below the reporting limit.

10.7.13.5 It may be necessary to analyze more than one set of calibration standards to encompass all of the analytes required for some tests.

10.7.13.6 Internal standard calibration is used. The internal standards are listed in Tables 8 and 8A. Target compounds should reference the nearest internal standard. Each calibration standard is analyzed and the response factor (RF) for each compound is calculated using the area response of the characteristic ions against the concentration for each compound and internal standard. See Equation 1, Section 11.5.1.1, for calculation of response factor.

10.7.13.7 Evaluation of retention times

The retention time of each target analyte in each calibration standard should agree within 0.5 min.

10.7.13.8 The % RSD of each of the calibration check compounds (CCC) must be less than or equal to 30%. Refer to Table 12. See Table A-2 for Method 624 criteria.

10.7.13.9 The average RF must be calculated for each compound. A system performance check is made prior to using the calibration curve. The five system performance check compounds (SPCC) are checked for a minimum average response factor. Refer to Table 11 for the SPCC compounds and required minimum response factors.

10.7.13.10 If the software in use is capable of routinely reporting curve coefficients for data validation purposes and the necessary calibration reports can be generated, then the analyst should evaluate analytes with %RSD > 15% for calibration on a curve. If it appears that substantially better accuracy would be obtained using quantitation from a curve then the appropriate curve should be used for quantitation. The correlation coefficient (coefficient of determination for non-linear curves) must be ≥ 0.990.

NOTE: Additional criteria are stated in the North Carolina QAS. South Carolina does not allow the use of second order curves.

10.7.13.11 If the software in use is capable of routinely reporting curve coefficients for data, and if the average of all the %RSDs in the calibration is > 15%, then calibration on a curve must be used for all analytes with %RSD > 15%. The analyst should consider instrument maintenance to improve the linearity of response. Otherwise, the correlation coefficient, r (coefficient of determination, r^2 for non-linear curves) must be ≥ 0.990. DoD QSM 5.0 requires that the correlation coefficient for linear fits be ≥ 0.995 (i.e., $r^2 \geq 0.99$).

NOTE: Some states (like Arizona) and federal programs do not allow the use of grand mean. Refer to the Arizona QAS and SOP DV-QA-024P.

10.7.13.12 Once the initial calibration has been evaluated and determined to be valid, the calibration must be verified with an Initial Calibration Verification (ICV) using a standard prepared from an alternate source. All compounds in the ICV must be <35% drift when compared to the initial calibration, except poor performers (see Table 15) which must be <55% drift. The laboratory's GC/MS group identified this list of compounds based on current and historical performance. The recovery performance was reviewed against spike recovery data and method performance data, where available, to validate each compound as a "poor performer." The ICV is generally run at the same concentration as the level 5 standard. See Table A-2 for method 624 criteria.

DoD QSM 5.0 requires the ICV analytes must be within ± 20% of the true value. Poor performers listed in the TestAmerica Technical Specifications may be ± 30% if approved by the client.

South Carolina requires that all analytes of interest in the ICV must recover at ≤ 30% (≤ 40%) for poor purgers prior to sample analysis.

10.7.13.13 If time remains in the 12-hour period initiated by the BFB injection before the initial calibration, samples may be analyzed. Otherwise, proceed to continuing calibration, Section 10.7.14.

10.7.13.14 A separate five point calibration must be prepared for analysis of low-level soils. Low-level soils analysis requires the use of a closed vial autosampler. Each standard is prepared by spiking the methanol standard solution through the septum of a VOA vial containing 5 mL of water. The standards are heated to 40°C for purging. All low-level soil samples, standards, and blanks must also be heated to 40°C for purging. Methanol soil extracts should be analyzed using the methanol calibration curve.

10.7.13.15 Non-standard analytes are sometimes requested. For these analytes, it is acceptable to analyze a single standard at the reporting limit with each continuing calibration rather than a five point initial calibration. The primary ion for the single standard must generate a peak clearly visible over background noise (greater than three standard deviations at a minimum) and be free of spectral interferences. If the analyte is detected in any of the samples, a five point initial calibration must be generated and the sample(s) reanalyzed for quantitation. However, if the analyte is not detected, the non-detect may be reported and no further action is necessary. A footnote or narrative comment should describe the basis of the reported result.

10.7.14 Continuing Calibration

10.7.14.1 The initial calibration must be verified every twelve hours.

10.7.14.2 Continuing calibration begins with analysis of BFB as described in Section 10.7.12.3. If the system tune is acceptable, the continuing calibration standard(s) are analyzed. The level 5 calibration standard is used as the continuing calibration standard. See Table A-2 for method 624 criteria.

10.7.14.3 The RF data from the standards are compared with the initial five-point calibration to determine the percent drift of the CCC compounds.

10.7.14.4 The % drift of the CCCs must be ≤ 20% for the continuing calibration to be valid. The SPCCs are also monitored. The SPCCs must meet the criteria described in Table 11. In addition, the % drift for most non-CCC analytes must be ≤ 35 %, and for poor performers ≤ 50 % (See Table 15), with allowance for up to six target analytes to have a % drift greater than the applicable limit. For agencies that require specific control limits for non-CCC compounds (i.e., State of Arizona) see Table 14. See Table A-2 for method 624 criteria.

For South Carolina, the percent drift for non-CCC analytes must be ≤ 30 % (≤ 40%) for poor purgers.,

Note: Additional criteria are stated in the North Carolina QAS.

10.7.14.4.1 If none of the CCCs are required analytes, project specific calibration specifications (which may include the use of the CCCs listed in Table 12) must be agreed to with the client.

10.7.14.4.2 Cyclohexanone is unstable in the calibration solution forming 1,1-dimethoxycyclohexane. No calibration criteria are applied to cyclohexanone and quantitation is tentative. Cyclohexanone is included on the Universal Treatment Standard and FO-39 regulatory lists.

10.7.14.5 The retention time of the internal standards in the continuing calibration standard cannot change by more than 30 seconds when compared to the most recent five-point calibration. The internal standard areas must not change by more than a factor of 2 (50 - 200 %) from the mid point standard of the most recent five-point calibration.

10.7.14.6 If the CCCs and/or the SPCCs do not meet the criteria in Sections 10.7.14.3 and 10.7.14.4, the system must be evaluated and corrective action must be taken. The BFB tune and continuing calibration must be acceptable before analysis begins. Extensive corrective action, such as a different type of column, will require a new initial calibration.

10.7.14.7 Once the above criteria have been met, sample analysis may begin. Initial calibration average RFs (or the calibration curve) will be used for sample quantitation, not the continuing calibration RFs. Analysis may proceed until 12 hours from the injection of the BFB have passed. (A sample desorbed less than or equal to 12 hours after the BFB is acceptable.)

10.7.14.8 Sodium Bisulfate must be added to the CCV when analyzing samples preserved with it.

10.7.14.9 Example analytical sequence for GC/MS volatile analysis:

1. BFB
2. CCV Main
3. CCV Supp
4. LCS
5. LCSD (if required)
6. MB

20 client samples

The above example sequence is the only way that client samples can be analyzed. If any part of lines 1 through 3 does not meet method criteria for running client samples it must be re-analyzed before continuing on to the next step. For example, the CCV(s) can not be run without first passing the BFB tune and LCS/LCSD/MB must follow passing CCV(s).

DoD QSM 5.0 requires a closing CCV be run. The injection time must be within the 12-hour tune time. Acceptance criteria are ± 50%. See Section 10.10 for alternate acceptance criteria if approved for the project.

10.8 Maintenance

See section 20 of the Denver QAM

10.9 Troubleshooting

10.9.8 For RT shifts check purge flow for possible leaks or blockage depending on which way the RT is shifted.

10.9.9 If no peaks appear in chromatogram

10.9.9.1 Check water and standard reservoirs and helium switch is to on position.

10.9.9.2 Check that purge needle is not broken/leaking.

10.9.9.3 Check tune to make sure filaments are still functional.

10.9.9.4 Check GC column for breaks

10.9.9.5 If maintenance was recently performed, re-check that area to make sure all connections are tight.

10.9.10 Samples with high concentrations of hydrocarbons may cause internal standards to fail high in samples analyzed afterwards. Depending on severity either running Methanol blanks or replacing contaminated parts may be needed.

10.9.11 Samples with a basic pH (>10) will cause the surrogate Dibromofluoromethane to fail low.

10.9.12 Samples that contain organic matter may cause internal standard failures.

10.9.13 Temperature variations in the laboratory will cause shifts in the recoveries of water soluble compounds (i.e., Ketones and Alcohols).

10.9.14 If instrument has difficulty passing BFB tune, front end maintenance can solve the problem.

10.9.15 Samples with extreme foaminess can cause issues ranging from failing QC to contamination of instrumentation which may require replacement of contaminated parts.

10.10 Method specific requirements for QSM 5.0

Method Comment Codes and definitions for possible method variances. Method Comment indicates that client has accepted the variance. Requirement if variance NOT accepted is provided in the table below. DoD QSM 5.0 requirements are listed throughout this SOP in the appropriate sections.

Code	If Variance accepted	If Variance not accepted
1SME	Laboratory must be informed of critical compounds of concern to ensure ME not applied to these compounds.	SME is allowed (see table in section 9.5 for number of analytes) except for critical compounds of concern.
2CLC	Common lab contaminants allowed up to RL – Variance identifies those compounds identified as common lab contaminants	Common lab contaminants allowed up to RL. See section 9.4
3HR	Allowed to report biased high failures in CCV/LCS/surrogate when samples ND. Report with NCM and flags.	All QC failures not matrix related must be re-analyzed
4PP	30%D CCV/ICV criteria allowed for poor performers as long as not listed as constituent of concern (COC) by client	Does not recognize poor performers. All targets must pass 20% criteria.
6CCVOrg	If closing CCV fails due to the matrix of samples run prior to it and failure is confirmed once, consult client before reporting	All samples must be bracketed by passing CCV
7MS	Poor performers excluded from 50%D in closing CCV. Re-analyze closing CCV for non-COC's and report others with NCM and flags.	Closing CCV must pass 50%D criteria for all target compounds.
8ISRT	Internal standard window +/- 30 seconds from ICIS	Internal standard window +/- 10 seconds from ICIS

11.0 Calculations / Data Reduction

11.1 Detailed calibration equations can be found in the corporate SOP CA-Q-P-003 “Calibration Curves and Selection of Calibration Points” and in the public folder, *Arizona Calibration Training*.

11.2 Qualitative Identification

11.2.1 An analyte is identified by retention time and by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound (standard reference spectrum). Mass spectra for standard reference may be obtained on the user's GC/MS by analysis of the calibration standards or from the NIST Library (same library as used for routine sample analysis). Two criteria must be satisfied to verify identification: (1) elution of sample component at the same GC retention time as the standard component; and (2) correspondence of the sample component and the standard component characteristic ions.

NOTE: Care must be taken to ensure that spectral distortion due to co-elution is evaluated.

11.2.1.1 The sample component retention time must compare to within ± 0.5 min. of the retention time of the standard component. For reference, the standard must be run within the same twelve hours as the sample.

11.2.1.2 All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) should be present in the sample spectrum.

11.2.1.3 The relative intensities of ions should agree to within ±30% between the standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80%.)

11.2.2 If a compound cannot be verified by all the above criteria, but in the technical judgment of the analyst, the identification is correct, then the analyst shall report that identification and proceed with quantitation.

11.2.3 All data are subject to two levels of technical review, as described in SOP DV-QA-0020.

11.3 Tentatively Identified Compounds (TICs)

11.3.1 If the client requests components not associated with the calibration standards, a search of the NIST library may be made for the purpose of tentative identification. The following guidelines apply:

11.3.1.1 Relative intensities of major ions in the reference spectrum (ions > 10% of the most abundant ion) should be present in the sample spectrum.

11.3.1.2 The relative intensities of the major ions should agree to within 20%. (Example: If an ion shows an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30% and 70%).

11.3.1.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

11.3.1.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.

11.3.1.5 Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the spectrum because of background contamination or co-eluting peaks. (Data system reduction programs can sometimes create these discrepancies.)

11.3.1.6 Computer-generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Only after visual inspection of the sample with the nearest library searches should the analyst *assign a tentative identification.*

11.3.2 Chrom setup

Set up for identification of TICs in Chrom is done by using the following settings in the Chrom Method Editor.

Item	**Setting**
Enable TIC quantitation	Checkmark on
Quant from	Nearest ISTD
Min % for ID	10%
Start and end time	Set both to 0.000
Match Threshold	85%
Disable calibrated TICs	Checkmark on
Enable TIC search	Checkmark on
Path to Library	Must be set to correct path
Subtraction method	Generally best set to no subtraction
Chrom match RT window	Set to 0.1 min

11.4 Data Review

Common Oversights and Possible Fixes

Finding	**Fix**
Level 4 QC summary report error	8260B: Set 1,4-Dioxane-d_8 set to “not needed” status in samples and ICAL 624: Set 1,4-Dioxane-d_8 and TBA-d_9 to “not needed” status in samples and ICAL

Finding	Fix
Missing MS/MSD % recoveries and/or RPD	MS/MSD linked to incorrect parent (all three must be run at same concentration); relink. Missing reagent value – verify and correct on reagent tab. Parent and MS/MSD not processed with "all compounds" list; verify worklist is correct; re-upload if error found in worklist.
Dilution factor/initial volume incorrect	Double check that what is being reported reflects what was performed; correct as needed
Proper sample preservative	8260B: Create NCM when 2–CLEVE is a target and sample has pH<2. 624: Create NCM when 2-CLEVE and/or Acrolein is a target and sample pH<2. All: Create NCM when pH does not match preservative type.
QC not in deliverables	All associated QC must be at 2nd level review status to appear in deliverables. This includes any ICIS, ICV, CCVC, LCS/LCSD, MB, LB, and MS/MSD. Use Job Data Review or QC checker to verify and correct as needed.
Incorrect flagging	Re-calculate sample, do not manually remove flag without permission.
False hit for 1,2,3-Trichloropropane	When anti-foam is used take extra care in evaluating any hit for 1,2,3-Trichloropropane. Ensure correct identification.
TIC with large ion 44 early in run	This is usually Carbon Dioxide labeled as an unknown. Verify identification. If reporting TICs it should be marked as undetected in order to not report.

11.4.4 Linear Fit

Calibration using least-squares linear regression produces a straight line that does not pass through the origin. The calibration relationship is constructed by performing a linear regression of the instrument response (peak area or peak height) versus the concentration of the standards. The instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x). The weighting used is the reciprocal of the concentration or the reciprocal of the square of the concentration. The regression produces the slope and intercept terms for a linear equation in the following:

$$R_x = m_1(C_s) + b \qquad \textit{Equation 6}$$

Where:

C_s = Analyte concentration in calibration standard, µg/L
R_x = Response for analyte
b = y - Intercept
m_1 = Slope

To calculate the concentration in an unknown sample extract, the regression equation is solved for concentration, resulting in the following equations, where C_{ex} is the concentration of the target analyte in the unknown sample:

$$C_{ex} = \frac{[R_x - b]}{m_1} \quad \textit{Equation 7}$$

Where:

C_{ex} = Extract analyte concentration, µg/L
R_x = Response for analyte
b = y - Intercept
m_1 = Slope

11.4.5 Evaluation of the Linear Least-Squares Regression Calibration Function:

11.4.5.1 With an unweighted linear regression, points at the lower end of the calibration curve have less weight in determining the curve than points at the high concentration end of the curve. For this reason, inverse weighting of the linear function is recommended to optimize the accuracy at low concentrations.

11.4.5.2 Note that the August 7, 1998 EPA memorandum “Clarification Regarding Use of SW-846 Methods”, Attachment 2, Page 9, includes the statement “The Agency further recommends the use of this for weighted regression over the use of an unweighted regression.”

Acceptance Criteria:

11.4.5.3 To avoid bias in low level results, the absolute value of the y-intercept must be significantly less than the reporting limit (RL), and preferably less than the MDL.

11.4.5.4 Also examine the residuals, but with particular attention to the residuals at the bottom of the curve. If the intercept or the residuals are large, a second-order regression should be considered.

11.4.5.5 The linear regression must have a correlation coefficient (r) ≥ 0.99 ($r^2 \geq 0.98$). Some programs (e.g., DoD) require a correlation coefficient (r) ≥ 0.995 ($r^2 \geq 0.99$).

11.4.6 Quadratic Fit

When the instrument response does not follow a linear model over a sufficiently wide working range, or when the previously described calibration approaches fail acceptance criteria, a non-linear, second-order calibration model may be employed. The second-order calibration uses the following equation:

$$R_x = m_2(C_s)^2 + m_1(C_s) + b \quad \textit{Equation 8}$$

Where:

C_s = Analyte concentration in calibration

standard, µg/L
R_x = Response for analyte
m_2 = Curvature
m_1 = Slope
b = y - Intercept

To calculate the concentration in an unknown sample extract, the roots of the quadratic equation are solved for:

$$C_{ex} = \frac{-m_1 \pm \sqrt{(m_1)^2 - 4(m_2)(b - R_x)}}{2m_2}$$ *Equation 9*

Where:

C_{ex} = Extract analyte concentration, µg/L
R_x = Response for analyte
m_2 = Curvature
m_1 = Slope
b = y - Intercept

11.4.7 Evaluation of Second-Order Regression Calibration:

A minimum of six points must be used for a second-order regression fit.

Acceptance Criteria:

11.4.7.1 Second-order regressions should be the last option, and note that some programs (e.g., South Carolina) do not allow the use of second-order regressions.

11.4.7.2 The coefficient of determination (COD, r^2) must be ≥ 0.99.

11.4.7.3 The absolute value of the intercept is not large relative to the lowest concentrations being reported.

11.4.7.4 The response increases significantly with increasing standard concentration (i.e., the instrument response does not plateau at high concentrations).

11.4.7.5 The distribution of concentrations is adequate to characterize the curvature.

11.5 Calculations.

11.5.1 Linear Calibration Using Average Response Factors

11.5.1.1 Relative Response Factor Calculation

$$RF = \frac{A_x C_{is}}{A_{is} C_x}$$ *Equation 1*

Where:

A_x = Area of the characteristic ion for the compound being measured
A_{is} = Area of the characteristic ion for the specific internal standard
C_x = Concentration of the compound being measured (µg/L)
C_{is} = Concentration of the specific internal standard (µg/L)

11.5.1.2 For each target analyte, calculate the average response factor as follows:

$$\text{Average Response Factor} = \overline{RF} = \frac{\sum_{i=1}^{n} RF_i}{n} \qquad \textit{Equation 2}$$

Where: n = Number of calibration levels
RF_i = Response factor for the ith level

11.5.1.3 The relative standard deviation (RSD) is calculated as follows:

$$\%RSD = \frac{SD}{\overline{RF}} \times 100\% \qquad \textit{Equation 3}$$

Where:

$\overline{RF}$ = Mean of RFs from the initial calibration for a compound
SD = Standard deviation for the mean RF from the initial calibration for a compound

$$\mathrm{SD} = \sqrt{\frac{\sum_{i=1}^{N}\left(RF_i - \overline{RF}\right)^2}{N-1}} \qquad \textit{Equation 4}$$

RF_i = RF for each of the calibration levels
n = Number of RF values

11.5.1.4 Average Calibration Fit Evaluation

The calibration relationship can be graphically represented as a line through the origin with a slope equal to the average response factor.

Acceptance Criteria: The RSD of the average response factor must be ≤15%. Also examine the residuals, especially for the high points versus the fitted function. If the residual values are large, a linear regression should be considered.

Corrective Action: If the RSD is > 15%, average response factor cannot be used and least-squares linear regression should be attempted.

11.5.1.5 Calculating the Concentration in the Extract

$$C_{ex} = \frac{R_x C_{is}}{R_{is}\overline{RF}} \qquad \textit{Equation 5}$$

Where:

C_{ex} = Concentration in the extract, µg/mL
R_x = Response for the analyte
R_{is} = Response for the internal standard
C_{is} = Concentration of the internal standard
$\overline{RF}$ = Average response factor

11.6 Acceptance Criteria Independent of Calibration Model – Method 8000D

11.6.1 Method 8000D in SW-846 recommends the use of either the Percent Error or Relative Standard Error to evaluate the calibration model as described below.

NOTE: For South Carolina work, one of these methods of evaluation must be used.

11.6.2 Percent Error

11.6.2.1 The percent error assesses the refitting of the calibration data back to the model. The percent error between the calculated and expected amounts of an analyte should be $\leq$ 30% for all standards except for the lowest data point which should be $\leq$ 50%.

11.6.2.2 Calculation of the Percent Error

$$\%Error = \frac{x_i - x_i'}{x_i} \times 100$$

Equation 10

Where:

x'_I = Measured amount of analyte at calibration level *i*, in mass or concentration units

x'_I = True amount of analyte at calibration level i, in mass or concentration units

11.6.3 Relative Standard Error (RSE)

11.6.3.1 Relative standard error provides a measure of the fit of the calibration that is independent of the calibration model. RSE is calculated using the following equation:

$$\mathrm{RSE} = 100 \times \sqrt{\frac{\sum_{i=1}^{N}\left(\frac{x'_i - x_i}{x_i}\right)^2}{(n-p)}}$$

Equation 11

Where:

x'_I = Measured amount of analyte at calibration level *i*, in mass or concentration units

x_i = True amount of analyte at calibration level *i*, in mass or concentration units

p = Number of terms in the fitting equation *(average = 1, linear = 2, quadratic = 3, cubic = 4)*

n = Number of calibration terms

11.6.3.2 The RSE acceptance limit criterion is the same as the RSD limit.

11.7 Calculations for reporting original samples

11.7.1 Calculating concentration in aqueous samples:

$$\text{Concentration, } \mu\text{g/L} = \mathrm{C_{ex}}\,D \qquad \textit{Equation 12}$$

Where:

C_{ex} = Analyte concentration, µg/L

D = Dilution factor

11.7.2 Calculating concentration in low level soil samples:

$$\text{Concentration, } \mu\text{g/Kg} = \mathrm{C_{ex}} \times \frac{Vp}{Ws} \times \frac{1}{(100 - M)} \times D \qquad \textit{Equation 13}$$

Where:

C_{ex} = Analyte concentration, µg/L

Vp = Purge volume (5 mL)

Ws = sample weight (in grams)

M = Percent Moisture

D = Dilution factor

Note: Units conversions for purge volume and sample weight yield conversion factor of 1 and are not shown in the equation for simplicity.

11.7.3 Calculating concentration in medium level soil samples

$$Concentration, \mu g / Kg = C_{ex} \times \frac{V_p}{V_a} \times \frac{V_e}{W_s} \times \frac{1}{(100 - M)} \times DF \qquad \textit{Equation 14}$$

C_{ex} = Uncorrected concentration of sample from instrument quantitation report (µg/L)

V_p = Final purge volume (mL)

V_a = Volume of methanol extract added to the purge volume (mL)

V_e = Volume of methanol used for extraction (mL)

W_s = Weight of sample extracted (g)

DF = Dilution Factor

Note: Units conversions for purge volume and sample weight yield conversion factor of 1 and are not shown in the equation for simplicity.

11.7.4 LCS and CCV Percent Recovery

$$\text{ControlSpike Recovery} = \frac{S_{SR}}{S_A} \times 100\% \qquad \textit{Equation 15}$$

Where (in µg/L):

S_{SR} = Calculated analyte concentration of spiked sample
S_A = Concentration of standard added

11.7.5 MS/MSD Recovery

$$\%\,\text{Recovery} = \frac{SSR - SR}{SA} \times 100\% \qquad \textit{Equation 16}$$

Where:

SSR = Spike sample result.
SR = Sample result.
SA = Spike added.

11.7.6 RPD calculation for the MS/MSD:

$$RPD = \frac{|MSR - MSDR|}{\frac{1}{2}(MSR + MSDR)} \times 100\% \qquad \textit{Equation 17}$$

Where:

RPD = Relative percent difference.
MSR = Matrix spike result.
MSDR = Matrix spike duplicate result.

11.7.7 See SOP CA-Q-S-005 for more detailed calibration equations. All data are subject to two levels of technical review, documented on a checklist, as described in SOP DV-QA-0020.

12.0 <u>Method Performance</u>

12.1 Method Detection Limit Study (MDL)

12.1.1 The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL procedure in TestAmerica Denver's Policy No. CA-Q-S-006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements (e.g., DoD) indicate a greater frequency.

12.1.2 MDLV and LOQV

12.1.2.1 MDLVs and LOQVs must be performed on blank matrix as defined for the method blank (Section 9.3), spiked with the appropriate analytes at the programmatically required spike amounts.

12.1.2.2 MDLVs are analyzed for compounds on the DOD certificate and those required for Texas TRPP on each instrument each quarter. For DOD the spike requirement is 2-4X the MDL and for Texas it is 1-4X the MDL. There are no recovery requirements for MDLV. The MDLs for all other compounds are verified at least annually

12.1.2.3 LOQVs (aka LLOQV) are analyzed for compounds on the DOD certificate on each instrument each quarter. The spiking requirement is 1-2X the RL and must pass percent recovery limits. For all compounds analyzed by Method 8260, LOQVs must be performed annually for compliance with Method 8000D, SW-846 Update V.

12.2 Demonstration of Capabilities

12.2.1 All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.1.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to the LCS.

12.2.1.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.1.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.1.4 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst’s IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

It is TestAmerica’s policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability).

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, “Waste Management and Pollution Prevention”, of the Environmental Health and Safety Manual, and DV-HS-001P, “Waste Management Program.”

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Methanol Waste - Vial Waste and Flammable – Waste Streams A and C

14.2.2 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

14.2.3 Acidified Water – Waste Stream W

NOTE: Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of these materials.

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

15.1.1 Method 8260B, Volatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 2, December, 1996.

15.1.2 Method 5030B, Purge-and-Trap for Aqueous Samples, Revision 2, December, 1996.

15.1.3 Method 5035, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples, Revision 0, December, 1996.

15.1.4 Method 5035A (R1-MIR), Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples, Draft Revision 1, July 2002.

15.1.5 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

15.1.6 Method 8000C, Determinative Chromatographic Separations, Revision 3, March 2003.

15.1.7 Method 8000D, Determinative Chromatographic Separations, Revision 4, July 2014.

15.2 40 CFR Part 136, Appendix A (Method 624, Method 603) and update on August 28, 2018.

15.3 Method AK101 For the Determination of Gasoline Range Organics, Alaska DEC, Version 04/08/02.

16.0 Method Modifications:

Item	Method	Modification
1	SW-846 8260B	Ion 119 is used as the quantitation ion for chlorobenzene-d_5.
2	SW-846 8260B	The quantitation and qualifier ions for some compounds have been changed from those recommended in SW-846 in order to improve the reliability of qualitative identification.
3	SW-846 8260B	This SOP has been written to allow for a 20 mL purge volume for waters. An additional 5 mL of DI water is added to all samples, QC and calibration standards. The final purge volume is 25 mL.
4	SW-846 8260B	Method 8260B recommends that the purge vessel is run through an additional purge cycle after 25 mL sample analysis to remove carryover. Instead, purge vessels are oven baked between analyses or disposable vessels are used one time only.
5	EPA 624	Method 624 is required for demonstration of compliance with CWA permits, e.g., NPDES wastewater discharge permits. This method can be applied only to aqueous matrices. The standard analyte list and reporting limits are listed in Table A-1. If compounds are added to the analysis, all of the method criteria must be satisfied for the additional compounds.
6	EPA 624	The tune period for this method is defined as 12 hours, which is the maximum elapsed time before the tune check is performed. Calibration verifications are done at the same 12 hour frequency.
7	EPA 624	The initial calibration curve for this method requires at least five points, as shown in Table 5A.
8	EPA 624	Sample concentrations are calculated using the average RRF from the initial calibration curve.
9	EPA 624	Each target analyte is assigned to the closest eluting internal standard.
10	EPA 624	Initial demonstration of Proficiency • The spiking level for the four replicate initial demonstration of proficiency is 20 µg/L. The acceptance criteria are listed in Table A-2
11	EPA 624	Initial calibration curve requirements: • Target compounds must have RSD ≤ 35%. • If this requirement can not be met, a regression curve must be constructed for the non-compliant compounds. Then the r^2 was be greater than 0.920.
12	EPA 624	Continuing calibration verification requirements: • The continuing calibration standard is from a different source than the initial calibration standard. The daily CCAL concentration is 20 µg/L. The acceptance criteria are listed in Table A-2.

Item	Method	Modification
		Matrix Spike and LCS Requirements • The matrix spike and LCS are spiked at 20 μg/L, prepared from the same source containing all analytes of interest. A matrix spike duplicate is not necessary for this method. The recovery limits for matrix spike and LCS recovery are listed in Table A-2.
13	EPA 624	Consistent with the other volatile methods, corrections for recovery are not allowed.
14	EPA 624	Qualitative Identification – The source method states that the relative intensities of ions should agree to within ±20% between the standard and sample spectra. This SOP uses $\underline{+}$30%. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80 percent.)
15	EPA 624	Section 5.2.2 of the source method describes the trap packing materials as Tenax GC, Methyl silicone, silica gel and coconut charcoal. TestAmerica routinely employs the OI #10 trap which consists of Tenax/Silica Gel/ Carbon Molecular Sieve or the Supelco Vocarb 3000 which consists of Carbopack B, Carbonxen1000 and 1001.
16	EPA 624	Section 5.3.2 of the source method describes a packed analytical column. TestAmerica routinely employs capillary columns when performing this method.
17	EPA 624	The source method provides a suggested list of compounds for internal and surrogate standards. Others are permitted by the method. TestAmerica uses three internal standards, including chlorobenzene-d_5 and 1,4-dichlorobenzene-d_4, which are not listed in Table 3 of the source method. Toluene-d_8 is used as a surrogate compound, which is also not listed in the source method.
18	EPA 624	The lab is preparing internal standards at 10 µg/L and applying the same criteria designed for 30 µg/L in the Method. The lower concentration is consistent with the greater sensitivity provided by capillary columns as compared to the older packed columns described in the method. It could only be more challenging for the lab to meet the acceptance criteria at 10 µg/L; it provides a higher level of data quality.
19	EPA 624	Method 624 describes a mass scan range of 25 to 260 amu. Table 13 lists all of the ions used for analysis. None of the ions are below 35 amu. Therefore, the laboratory scans from 35 to 300 and includes all ions needed for analysis.
20	EPA 624	Method 624 describes dilutions “if response of any m/z” exceeds the response for the highest m/z in the ICAL. As the m/z ratio is always directly proportional to the concentration, evaluation based on dilution (per 11.10) is equivalent.
21	EPA 624	Method 624 has criteria for unresolved isomers. The problems of isomeric resolution for the routine analytes listed in this SOP were worked through when the laboratory developed its implementation of the method. For example, we know through experience that meta- and para-xylenes will not be resolved and it was not necessary to include an evaluation for the xylenes in each analysis. meta- and para-xylenes are reported as an

Item	Method	Modification
		isomeric pair. Any development work to add compounds would take this into account.
22	624	The source method recommends Method 603 as the preferred method for Acrolein and Acrylonitrile. Method 624 is recommended as a screening method (see section 1.2 of Methods 603 and 624). Calibration and quality control samples indicate that the conditions described in this SOP are suitable for the analysis of Acrolein and Acrylonitrile. EPA's Method Update Rule (MUR), May 18, 2012, allows the addition of acrolein and acrylonitrile to Method 624, using the preservation, holding time and QC acceptance criteria from Method 603. As states implement the MUR Method 624 becomes a determinative method for these two analytes. Until such time, Method 624 remains a screening method for regulatory compliance.
23	SW846 5035	The source method recommends adding approximately the same amount of the sodium bisulfate preservative as the sample (e.g., ~ 1 g), as the presence of the preservative will affect the purging efficiencies of the analytes. TestAmerica Denver does not recommend the use of sodium bisulfate to preserve soil samples, but encourages clients to collect samples using other available methods. The use of this preservative has been shown to cause difficulties recovering more reactive analytes on the purge and trap system (e.g. 2-Chloroethyl vinyl ether, acrylamide).

17.0 Attachments

Table 1.	TestAmerica Primary List Reporting Limits for 8260B
Table 2.	TestAmerica 8260 Secondary List Reporting Limits
Table 3.	TestAmerica Appendix IX List Reporting Limits
Table 4.	TestAmerica Non-Standard Compound List Reporting Limits
Table 5.	Soil Calibration Levels, 5-gram Purge (μg/Kg) (Standard Mixes: MV-Main A, MV-GasKet A, and MV-2 Cleve)
Table 5A.	Soil Calibration Levels, 5 gram Purge (μg/Kg) (Standards: MV-Supp A and Freon_A)
Table 6.	Water 8260 List Calibration Levels (μg/L) (Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve)
Table 6A	Water 8260 List Calibration Levels (μg/L) (Standards: MV-Supp A and Freon_A)
Table 7.	Medium Level Soil 8260 List Calibration Levels (μg/Kg) (Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve)
Table 7A.	Medium Level Soil 8260 List Calibration Levels (μg/Kg) (Standards: MV-Supp A and Freon_A)
Table8.	Manually added Internal Standards
Table 8A.	Automatically Added Internal Standards
Table 9.	Manually Added Surrogate Standards
Table 9A.	Automatically Added Surrogate Standards
Table 10.	BFB Key Ion Abundance Criteria
Table 11.	SPCC Compounds and Minimum Response Factors
Table 12.	CCC Compounds
Table 13.	Characteristic Ions

Table 14.	State of Arizona ICV/CCV Quality Control Limits
Table 15.	List 1 Poorly Performing Compounds
Table A-1.	Method 624 Analytes and Reporting Limits, 5-mL Purge
Table A-2.	Method 624 QC Acceptance Criteria
Table 5A.	Calibration Levels for 624, 5 mL Purge
Table 17.	Associated Surrogates and Internal Standards for 8260B
Appendix A	Modifications for Analysis of Soils Collected for the State of Alaska
Table Ap-1:	TestAmerica 8260 Reporting Limits – AK Soils
Table Ap-2:	Calibration Levels for 8260, 5035FM_AK
Table Ap-3:	5035FM_AK Calibration Levels (µg/Kg) (Standards: MV-Supp Std and MV-2 Cleve)
Attachment 1.	Gas Standards Tracking Log

18.0 Changes from Previous Revision

- Revision 22, dated 05 November 2018
  - Updated section 8.1.1.1 concerning headspace/bubbles.
- Revision 21, dated 30 September 2018
  - Added section 8.1.1.1 regarding headspace/bubble check requirements by Sample Receiving and Analysts.
- Revision 20, dated 31 August 2018
  - Updated for 8260C.
- Revision 19, dated 31 March 2018
  - Updated for 624.1 MUR update.
- Revision 18, dated 15 August 2017
  - Changed concentration of Ethanol in calibration tables to reflect new standard concentration.
  - Fixed spelling of Tetrachloroethene in IS/Surr association table.
  - Added instructions on handling status change of soil prep batches.
- Revision 17, dated 20 October 2016
  - Added definition for LLOQ as new Section 3.7 per 8000D
  - Removed comment about Colorado allowing 14 day holding time for unpreserved samples in existing section 8.1.3
  - Revised Holding time table for water to reflect Update V and clarify HT for method 624 based on 40 CFR Part 136; revised footnotes to the table.
  - Revised section 10.3 regarding how soil sample weights are documented to reflect current practice
  - Added note in Section 10.4.1 to NOT affix labels on terracore vials before sample is analyzed or prepped.
  - Added information on Chrom setup for TICs in new section 11.3.2
  - Added new Section 11.5 for Accetpance Criteria Independent of Calibration Model for 8000D (Percent Error and Relative Standard Error)
  - Added equations for calculation of soil concentrations in new Sections 11.6.5 and 11.6.6
  - Added MDLV and LOQV information in Section 12.1.2
  - Added reference to Method 8000D in Section 15

- Revision 16, dated 21 April 2016
  - Added requirements for glassware cleaning in appropriate sections throughout.
  - Added requirements for LCS and MS spikes to Sections 7.12, 7.13, 9.6 and 9.7,

clarifying requirements for DoD, South Carolina and NELAP (TNI).

  - Added requirement to Section 9.6 to add antifoam to LCS when added to samples.
  - Clarified Section 10.7.4.4.
  - Removed requirement to document use of antifoam in NCM in Section 10.7.4.12. Record made on run log.
  - Revised Section 10.7.13.12 to include South Carolina criteria for ICV.
  - Revised Section 10.7.14.4 to include South Carolina criteria for CCV (non-CCC compounds).
  - Added new section 11.4 to list common data review findings and appropriate fixes.
  - Revised Section 11.5.1.4 (old section 11.4.1.4) to correctly refer to average response factor rather than calibration factor as this is an internal standard calibration technique.
  - Removed Table 10 (LCS short list) and made reference to spikes actually used throughout. Renumbered remaining tables.
  - Removed references to AFCEE throughout; laboratory follows requirements of DoD QSM for all DoD work.
  - Corrected terminology for evaluation of calibration using %RSD from calibration factor (external standard) to response factor (internal standard)
  - Reviewed SOP to ensure that all DoD QSM 5.0 requirements were appropriately stated in addition to Section 10.10. Added specifications as needed throughout document for clarity.
  - Deleted Item 5 from previous Method Modifications table. No longer applicable. Renumbered remaining items.

- Revision 15, dated 30 September 2015
  - Revised section 6.3.7 for use of disposable wooden spatulas
  - Revised Sections 9.3 and 9.5 to describe matrix used for QC samples

- Revision 14, dated 08 September 2015
  - Revised description of method blank with respect to blank matrix used for each type of analysis (Section 9.3)
  - Added description of LCS for medium level soil.
  - Revised corrective actions for matrix spike/matrix spike duplicate in Section 9.6.
  - Added notes to Section 10.7.2.1 and Appendix A requiring 12-hour tune for Method 624 for South Carolina samples.
  - Revised Section 10.10 to clarify QSM requirements and lab requested variances.
  - Updated SOP reference in Section 11.1 to current corporate SOP.
  - Added statement to Section 12.1 that MDLV be performed using matrix for method blank.
  - Added note to Method Modification #7 limiting Method 624 tune time to 12 hours for South Carolina samples.

- Revision 13, dated 30 April 2015
  - Revised discussion and preservation/HT table for soil samples in Section 8
  - Corrected retention time window in 11.2.1.1 for qualitative identification
  - Added clarification to ICAL tables in Attachments regarding use of calibration points below standard reporting limits
  - Corrected RL in water for 2-chloroethylvinyl ether
  - Corrected Table 13 entry for methyl-*tert*-butyl ether characteristic ions
  - Corrected footnotes on Table A-2, Method 624 QC Acceptance Criteria to reflect current practice

- Revision 12, dated 31 December 2014
  - Added Section 10.7.14.9 to describe run sequence.

- Revision 11, dated 31 January 2014
  - Changed calibration tables to reflect changes due to standard standards
  - Added internal standard reference table (Table 17)
  - Added TBA-d_9 and 1,4-Dioxane-d_8 as internal standards
  - Removed SIM (see SOP DV-MS-0016)
  - Removed section 9.8

- Revision 10, dated 19 August 2013
  - Formatting changes

- Revision 9, dated 04 January 2013
  - Added section 9.8 to address the 2012 MUR QC requirements

- Revision 8, dated 28 September 2012
  - Added to compounds to the reporting limit, characteristic ion and calibration tables to match TALS.

- Revision 7, dated 27 July 2012
  - Added sodium bisulfate to Section 7.
  - Revised Section 8 to include Terra Core samplers and moved instructions on sample preparation and handling in the lab to Section 10. Reorganized sampling and preservation information into tables. Updated information including footnote on Holding Time and preservation table for water regarding Method Update Rule that approves use of Method 624 for analysis of acrolein and acrylonitrile.
  - Removed flowcharts from Section 8.
  - Revised Section 9.1
  - Revised Section 10.
  - Updated reference section to include Method 603, Method 5035A, and Method 8000B and 8000C.
  - Revised Method Modifications #23
  - Updated tables to reflect current practice.
  - Added Appendix A for the analysis of soils using the AK methanol extraction procedure.
  - Formatting and editorial changes throughout

- Revision 6.4, dated 28 December 2011
  - Changed the column ID and film thickness in section 6.1.8.1

- Revision 6.3, dated 26 October 2011
  - Added Section 4.6 regarding interferences with toluene-d_8 surrogate when potassium permanganate may have been added to sample
  - Updated path to QAS folders in the public folders, section 9.7
  - Added J. T. Baker Antifoam B and reagent sand, sections 7.3, 7.4
  - Added description of procedure for use of antifoaming agent B, section 10.1.3.8
  - Formatting

- Revision 6.2, dated 25 August, 2011

  - Added requirements to section 9.4 for the use of Ottawa sand in soil LCS's.

- Revision 6.1, dated 31 January, 2011
  - Added Attachment 1, Gas Standards Tracking Log
  - Added section 11.1 referencing corporate SOP CA-Q-S-005 "Calibration Curves"

Earlier revision histories have been archived and are available upon request.

Table 1. TestAmerica Primary List Reporting Limits for 8260B

Compound	CAS Number	Reporting Limits[1]		
		20 mL Water(µg/L)	Low Soil (µg/kg)	Med Soil (µg/kg)
Dichlorodifluoromethane	75-71-8	2	10	500
Chloromethane	74-87-3	2	10	500
Bromomethane	74-83-9	2	10	500
Vinyl chloride	75-01-4	1	5	500
Chloroethane	75-00-3	2	10	500
Trichlorofluoromethane	75-69-4	2	10	500
Acrolein	107-02-8	20	50	5,000
Acetone	67-64-1	10	20	1,000
Trichlorotrifluoroethane	76-13-1	3	20	1,000
Ethanol	64-17-5	300	600	10,000
Iodomethane	74-88-4	1	5	250
Carbon disulfide	75-15-0	2	5	250
Methylene chloride	75-09-2	2	5	250
tert-Butyl alcohol	75-65-0	50	200	10,000
1,1-Dichloroethene	75-35-4	1	5	250
1,1-Dichloroethane	75-34-3	1	5	250
trans-1,2-Dichloroethene	156-60-5	1	2.5	125
Acrylonitrile	107-13-1	20	50	5,000
Methyl *tert*-butyl ether (MTBE)	1634-04-4	5	20	250
Hexane	110-54-3	2	5	250
cis-1,2-Dichloroethene	156-59-2	1	2.5	125
1,2-Dichloroethene (Total)	540-59-0	1	5	250
Tetrahydrofuran	109-99-9	7	20	1,000
Chloroform	67-66-3	1	10	250
1,2-Dichloroethane	107-06-2	1	5	250
Dibromomethane	74-95-3	1	5	250
2-Butanone	78-93-3	6	20	1,000
1,4-Dioxane	123-91-1	200	500	25,000
1,1,1-Trichloroethane	71-55-6	1	5	250
Carbon tetrachloride	56-23-5	1	5	250
Bromodichloromethane	75-27-4	1	5	250
1,2-Dichloropropane	78-87-5	1	5	250

Table 1. TestAmerica Primary List Reporting Limits for 8260B (continued)

Compound	CAS Number	Reporting Limits[1]		
		20 mL Water(µg/L)	Low Soil (µg/kg)	Med Soil (µg/kg)
cis-1,3-Dichloropropene	10061-01-5	1	5	250
Trichloroethene	79-01-6	1	5	250
Dibromochloromethane	124-48-1	1	5	250
1,2-Dibromoethane	106-93-4	1	5	250
1,2,3-Trichloropropane	96-18-4	2.5	5	250
1,1,2-Trichloroethane	79-00-5	1	5	250
Benzene	71-43-2	1	5	250
Ethylmethacrylate	97-63-2	3	5	250
trans-1,3-Dichloropropene	10061-02-6	3	5	250
Bromoform	75-25-2	1	5	250
4-Methyl-2-pentanone	108-10-1	5	20	1,000
2-Hexanone	591-78-6	5	20	1,000
Tetrachloroethene	127-18-4	1	5	250
Toluene	108-88-3	1	5	250
1,1,2,2-Tetrachloroethane	79-34-5	1	5	250
2-Chloroethyl vinyl ether[2]	110-75-8	3[2]	50	2,500
Vinyl acetate	108-05-4	3	10	500
Chlorobenzene	108-90-7	1	5	250
Ethylbenzene	100-41-4	1	5	250
Styrene	100-42-5	1	5	250
trans-1,4-Dichloro-2-butene	110-57-6	3	5	250
m- and p-Xylenes	179601-23-1	2	3.5	250
o-xylene	95-47-6	1	2.5	125
Total xylenes	1330-20-7	2	10	250
1,3-Dichlorobenzene	541-73-1	1	5	250
1,4-Dichlorobenzene	106-46-7	1	5	250
1,2-Dichlorobenzene	95-50-1	1	5	250

[1] Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

[2] 2-Chloroethylvinyl ether cannot be reliably recovered from acid preserved samples

Table 2. TestAmerica 8260 Secondary List Reporting Limits

Compound	CAS Number	Reporting Limits[1]		
		20 mL Water µg/L	Low Soil µg/kg	Medium Soil µg/kg
2,2-Dichloropropane	590-20-7	1	5	250
Bromochloromethane	74-97-5	1	5	250
1,1-Dichloropropene	563-58-6	1	5	250
1,3-Dichloropropane	142-28-9	1	5	250
1-Chlorohexane	544-10-5	1	5	500
1,1,1,2-Tetrachloroethane	630-20-6	1	5	250
Isopropylbenzene	98-82-8	1	5	250
Bromobenzene	108-86-1	1	5	250
n-Propylbenzene	103-65-1	1	5	250
2-Chlorotoluene	95-49-8	1	5	250
4-Chlorotoluene	106-43-4	1	5	250
1,3,5-Trimethylbenzene	108-67-8	1	5	250
tert-Butylbenzene	98-06-6	1	5	250
1,2,4-Trimethylbenzene	95-63-6	1	5	250
sec-Butylbenzene	135-98-8	1	5	250
4-Isopropyltoluene	99-87-6	1	5	250
n-Butylbenzene	104-51-8	1	5	250
1,2-Dibromo-3-chloropropane	96-12-8	5	5	250
1,2,4-Trichlorobenzene	120-82-1	1	5	250
Naphthalene	91-20-3	1	5	500
Hexachlorobutadiene	87-68-3	1	5	250
1,2,3-Trichlorobenzene	87-61-6	1	5	250
2-Pentanone	107-87-9	5	10	500
cis-1,4-Dichloro-2-butene	1476-11-5	3	5	250
Ethylene oxide	75-21-8	600	3,000	150,000

Table 3. TestAmerica Appendix IX List Reporting Limits

Compound	CAS Number	Reporting Limits[1] 20 mL Water µg/L	Low Soil µg/kg	Medium Soil µg/kg
Allyl Chloride	107-05-1	2	10	500
Acetonitrile	75-05-8	30	100	5,000
Dichlorofluoromethane	75-43-4	2	10	25,000
Isopropyl ether	108-20-3	10	50	2,500
Chloroprene	126-99-8	1	5	500
n-Butanol	71-36-3	60	200	10,000
Propionitrile	107-12-0	20	50	1,000
Methacrylonitrile	126-98-7	10	50	2,500
Isobutanol	78-83-1	110	200	10,000
Methyl methacrylate	80-62-6	4	5	250
1,1,1,2-Tetrachloroethane	630-20-6	1	5	250
1,2-Dibromo-3-chloropropane	96-12-8	5	10	500
Ethyl ether	60-29-7	2	10	500
Ethyl Acetate	141-78-6	5	10	500
2-Nitropropane	79-46-9	5	10	500
Cyclohexanone[2]	108-94-1	N/A[2]	N/A[2]	N/A[2]
Isopropylbenzene	98-82-8	1	5	250

[1] Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

[2] Cyclohexanone decomposes to 1,1-dimethoxycyclohexane in methanolic solution. Reporting limits cannot be accurately determined.

Table 4. TestAmerica Non-Standard List Reporting Limits for 8260B

Compound	CAS Number	Reporting Limits[1]		
		20 mL Water(µg/L)	Low Soil (µg/kg)	Med Soil (µg/kg)
1,1,1-Trifluoro-2,2-Dichloroethane	306.83-2	2.0	5.0	1000
1,2,3-Trimethylbenzene	526-73-8	2.0	5.0	250
1,2-Dichloro-1,1,2,2-Tetrafluoroethane	76-14-2	2.0	5.0	250
1,2-Dichloro-1,1,2-Trifluoroethane	354-23-4	2.0	5.0	250
1,3,5-Trichlorobenzene	108-70-3	5.00	***	***
2,2,3-Trimethylbutane	464-06-2	5.00	***	***
2,2-Dimethylpentane	590-35-2	5.00	***	***
2,3-Dimethylpentane	565-59-3	5.00	***	***
2,4-Dimethylpentane	108-08-7	5.00	***	***
2-Chloro-1,1,1-Trifluoroetane	75-88-7	5.00	5.0	250
2-Methylhexane	591-76-4	5.00	***	***
3,3-Dimethylpentane	562-49-2	5.00	***	***
3-Ethylpentane	617-78-7	5.00	***	***
3-Methylhexane	589-34-4	5.00	***	***
Chlorotrifluoroethene	79-38-9	5.00	5.0	250
Cyclohexane	110-82-7	2.0	5.0	250
Dimethyl Disulfide	624-92-0	5.00	***	***
Isopropyl Alcohol	67-63-0	40	200	10,000
Methyl Acetate	79-20-9	5.0	10	1000
Methylcyclohexane	108-87-2	1.0	5.0	250
n-Heptane	142-82-5	5.00	***	***
n-Nonyl Aldehyde	124-19-6	10.00	***	***
Pentachloroethane[2]	76-01-7	0.5	***	***
Propene Oxide	75-56-9	50	3000	250
Sec-Butyl Alcohol	78-92-2	***	200	***
Tert-amyl methyl ether	994-05-8	5	5.0	1000
Tert-butyl ethyl ether	637-92-3	5	5.0	1000
Tetrahydrothiophene	110-01-0	2.0	5.0	***

[1] Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

[2] Due to breakdown, QC and samples being analyzed for Pentachlroethane must be preserved with acid (pH<2).

Calibration levels:
Table 5. 8260B Soil-5mL Purge, Aqueous-5mL purge 624[1] and 8260C water and soil-5mL purge
(Standard Mixes: MV-Main A, MV-GasKet A, and MV-2 Cleve)

Compound	Calibration Level, µg/Kg							
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
1,1,1,2-Tetrachloroethane	1	2	5	10	20	50	100	200
1,1,1-Trichloroethane	1	2	5	10	20	50	100	200
1,1,2,2-Tetrachloroethane	1	2	5	10	20	50	100	200
1,1,2-Trichloro-1,2,2-Trifluoroethane	1	2	5	10	20	50	100	200
1,1,2-Trichloroethane	1	2	5	10	20	50	100	200
1,1-Dichloroethane	1	2	5	10	20	50	100	200
1,1-Dichloroethene	1	2	5	10	20	50	100	200
1,1-Dichloropropene	1	2	5	10	20	50	100	200
1,2,3-Trichlorobenzene	1	2	5	10	20	50	100	200
1,2,3-Trichloropropane	1	2	5	10	20	50	100	200
1,2,4-Trichlorobenzene	1	2	5	10	20	50	100	200
1,2,4-Trimethylbenzene	1	2	5	10	20	50	100	200
1,2-Dibromo-3-chloropropane	1	2	5	10	20	50	100	200
1,2-Dichlorobenzene	1	2	5	10	20	50	100	200
1,2-Dichloroethane	1	2	5	10	20	50	100	200
1,2-Dichloropropane	1	2	5	10	20	50	100	200
1,3,5-Trimethylbenzene	1	2	5	10	20	50	100	200
1,3-Dichlorobenzene	1	2	5	10	20	50	100	200
1,3-Dichloropropane	1	2	5	10	20	50	100	200
1,4-Dichlorobenzene	1	2	5	10	20	50	100	200
1,4-Dioxane	20	40	100	200	400	1,000	2,000	4,000
1-Chlorohexane	1	2	5	10	20	50	100	200
2-Chloroethyl vinyl ether	1	2	5	10	20	50	100	200
2,2-Dichloropropane	1	2	5	10	20	50	100	200
2-Butanone	4	8	20	40	80	200	400	800
2-Chlorotoluene	1	2	5	10	20	50	100	200
2-Hexanone	4	8	20	40	80	200	400	800
2-Pentanone	4	8	20	40	80	200	400	800
3-Chloro-1-propene (Allyl Chloride	1	2	5	10	20	50	100	200
4-Chlorotoluene	1	2	5	10	20	50	100	200
4-Isopropyltoluene	1	2	5	10	20	50	100	200

Calibration levels:
Table 5. 8260B Soil-5mL Purge, Aqueous-5mL purge 624[1] and 8260C water and soil-5mL purge
(Standard Mixes: MV-Main A, MV-GasKet A, and MV-2 Cleve)

Compound	Calibration Level, µg/Kg							
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
4-Methyl-2-pentanone	4	8	20	40	80	200	400	800
Acetone	4	8	20	40	80	200	400	800
Acrolein	10	20	50	100	200	500	1,000	2,000
Acrylonitrile	10	20	50	100	200	500	1,000	2,000
Benzene	1	2	5	10	20	50	100	200
Bromobenzene	1	2	5	10	20	50	100	200
Bromoform	1	2	5	10	20	50	100	200
Bromomethane	1	2	5	10	20	50	100	200
Carbon Disulfide	1	2	5	10	20	50	100	200
Carbon tetrachloride	1	2	5	10	20	50	100	200
Chlorobenzene	1	2	5	10	20	50	100	200
Chlorobromomethane	1	2	5	10	20	50	100	200
Chloroethane	1	2	5	10	20	50	100	200
Chloroform	1	2	5	10	20	50	100	200
Chloromethane	1	2	5	10	20	50	100	200
cis-1,2-Dichloroethene	1	2	5	10	20	50	100	200
cis-1,3-Dichloropropene	1	2	5	10	20	50	100	200
Cyclohexane	1	2	5	10	20	50	100	200
Cyclohexanone	40	80	200	400	800	2,000	4,000	8,000
Chlorodibromomethane	1	2	5	10	20	50	100	200
Dibromomethane	1	2	5	10	20	50	100	200
Dichlorobromomethane	1	2	5	10	20	50	100	200
Dichlorofluoromethane	1	2	5	10	20	50	100	200
Dichlorodifluoromethane	1	2	5	10	20	50	100	200
Ethylbenzene	1	2	5	10	20	50	100	200
Ethyl Ether	1	2	5	10	20	50	100	200
Ethyl methacrylate	1	2	5	10	20	50	100	200
Ethylene dibromide	1	2	5	10	20	50	100	200
Hexachlorobutadiene	1	2	5	10	20	50	100	200
Hexane	1	2	5	10	20	50	100	200
Iodomethane	1	2	5	10	20	50	100	200
Isobutyl alcohol	25	50	125	250	500	1,250	2,500	5,000
Isopropylbenzene	1	2	5	10	20	50	100	200

Calibration levels: Table 5. 8260B Soil-5mL Purge, Aqueous-5mL purge 624[1] and 8260C water and soil-5mL purge (Standard Mixes: MV-Main A, MV-GasKet A, and MV-2 Cleve)

Compound	Calibration Level, µg/Kg							
	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
m- and p-Xylenes	1	2	5	10	20	50	100	200
Methyl Acetate	5	10	25	50	100	250	500	1,000
Methylcyclohexane	1	2	5	10	20	50	100	200
Methylene chloride	1	2	5	10	20	50	100	200
Methyl tert-butyl ether (MTBE)	1	2	5	10	20	50	100	200
Naphthalene	1	2	5	10	20	50	100	200
n-Butylbenzene	1	2	5	10	20	50	100	200
n-Propylbenzene	1	2	5	10	20	50	100	200
o-Xylene	1	2	5	10	20	50	100	200
sec-Butylbenzene	1	2	5	10	20	50	100	200
sec- Butyl Alcohol	30	60	150	300	600	1,500	3,000	6,000
Styrene	1	2	5	10	20	50	100	200
2-Methyl-2-propanol (tert-Butyl alcohol)	10	20	50	100	200	500	1,000	2,000
tert-Butylbenzene	1	2	5	10	20	50	100	200
Tetrachloroethene	1	2	5	10	20	50	100	200
Tetrahydrofuran	2	4	10	20	40	100	200	400
Toluene	1	2	5	10	20	50	100	200
trans-1,2-Dichloroethene	1	2	5	10	20	50	100	200
trans-1,3-Dichloropropene	1	2	5	10	20	50	100	200
trans-1,4-Dichloro-2-butene	1	2	5	10	20	50	100	200
Trichloroethene	1	2	5	10	20	50	100	200
Trichlorofluoroethane	1	2	5	10	20	50	100	200
Vinyl Acetate	2	4	10	20	40	100	200	400
Vinyl chloride	1	2	5	10	20	50	100	200

[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

Calibration levels:
Table 5A: 8260B Soil-5mL Purge, Aqueous-5mL purge 624[1] and 8260C water and soil-5mL purge
(Standards: MV-Supp A and Freon_A)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
1,1,1-Trifluoro-2,2-dichloro-ethane	2	5	10	20	50	100	200
1,2,3-Trimethylbenzene	2	5	10	20	50	100	200
1,2-Dichloro-1,1,2,2-tetrafluroethane	2	5	10	20	50	100	200
1,2-Dichloro-1,1,2-trifluoroethane	2	5	10	20	50	100	200
2-Chloro-1,1,1-Trifluoroethane	2	5	10	20	50	100	200
2-Chloro-1,3-butadiene (Chloroprene)	2	5	10	20	50	100	200
2-Nitropropane	4	10	20	40	100	200	400
Acetonitrile	20	50	100	200	500	1,000	2,000
cis-1,4-Dichloro-2-butene	2	5	10	20	50	100	200
Chlorotrifluoroethene	2	5	10	20	50	100	200
Ethanol	120	300	600	1200	3000	6,000	12,000
Ethyl Acetate	4	10	20	40	100	200	400
Ethylene Oxide	400	1,000	2,000	4,000	10,000	20,000	40,000
Isopropyl alcohol	20	50	100	200	500	1,000	2,000
Isopropyl ether	2	5	10	20	50	100	200
Methylacrylonitrile	20	50	100	200	500	1,000	2,000
Methyl methacrylate	4	10	20	40	100	200	400
n-Butanol	50	125	250	500	1,250	2,500	5,000
Propene Oxide	100	250	500	1,000	2,500	5,000	10,000
Propionitrile	20	50	100	200	500	1,000	2,000
tert-Amyl methyl ether	2	5	10	20	50	100	200
tert-Butyl ethyl ether	2	5	10	20	50	100	200
Tetrahydrothiophene	2	5	10	20	50	100	200

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[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

Table 6: Water 8260B-20mL purge List Calibration Levels (μg/L)[1]
(Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
1,1,1,2-Tetrachloroethane	0.3	1.0	2.0	5.0	10	30	60
1,1,1-Trichloroethane	0.3*	1.0	2.0	5.0	10	30	60
1,1,2,2-Tetrachloroethane	0.3	1.0	2.0	5.0	10	30	60
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.3*	1.0	2.0	5.0	10	30	60
1,1,2-Trichloroethane	0.3*	1.0	2.0	5.0	10	30	60
1,1-Dichloroethane	0.3*	1.0	2.0	5.0	10	30	60
1,1-Dichloroethene	0.3*	1.0	2.0	5.0	10	30	60
1,1-Dichloropropene	0.3*	1.0	2.0	5.0	10	30	60
1,2,3-Trichlorobenzene	0.3*	1.0	2.0	5.0	10	30	60
1,2,3-Trichloropropane	0.3*	1.0	2.0	5.0	10	30	60
1,2,4-Trichlorobenzene	0.3*	1.0	2.0	5.0	10	30	60
1,2,4-Trimethylbenzene	0.3*	1.0	2.0	5.0	10	30	60
1,2-Dibromo-3-chloropropane	0.3*	1.0	2.0	5.0	10	30	60
1,2-Dichlorobenzene	0.3*	1.0	2.0	5.0	10	30	60
1,2-Dichloroethane	0.3	1.0	2.0	5.0	10	30	60
1,2-Dichloropropane	0.3*	1.0	2.0	5.0	10	30	60
1,3,5-Trimethylbenzene	0.3*	1.0	2.0	5.0	10	30	60
1,3-Dichlorobenzene	0.3*	1.0	2.0	5.0	10	30	60
1,3-Dichloropropane	0.3	1.0	2.0	5.0	10	30	60
1,4-Dichlorobenzene	0.3	1.0	2.0	5.0	10	30	60
1,4-Dioxane	6*	20	40	100	200	600	1,200
1-Chlorohexane	0.3*	1.0	2.0	5.0	10	30	60
2-Chloroethyl vinyl ether	0.3*	1.0*	2.0	5.0	10	30	60
2,2-Dichloropropane	0.3*	1.0	2.0	5.0	10	30	60
2-Butanone (MEK)	1.2*	4.0	8.0	20	40	120	240
2-Chlorotoluene	0.3*	1.0	2.0	5.0	10	30	60
2-Hexanone	1.2*	4.0	8.0	20	40	120	240
2-Pentanone	1.2*	4.0	8.0	20	40	120	240
3-Chloro-1-propene (Allyl Chloride)	0.3*	1.0	2.0	5.0	10	30	60
2-Methyl-2-propanol (tert-Butyl alcohol)	3.0*	10	20	50	100	300	600
4-Chlorotoluene	0.3*	1.0	2.0	5.0	10	30	60
4-Isopropyltoluene	0.3*	1.0	2.0	5.0	10	30	60
4-Methyl-2-pentanone	1.2*	4.0	8.0	20	40	120	240
Acetone	1.2*	4.0*	8.0	20	40	120	240

Table 6: Water 8260B-20mL purge List Calibration Levels (μg/L)[1]
(Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Acrolein	3*	10	20	50	100	300	600
Acrylonitrile	3*	10	20	50	100	300	600
Benzene	0.3	1.0	2.0	5.0	10	30	60
Bromobenzene	0.3*	1.0	2.0	5.0	10	30	60
Bromoform	0.3*	1.0	2.0	5.0	10	30	60
Bromomethane	0.3*	1.0	2.0	5.0	10	30	60
Carbon Disulfide	0.3*	1.0*	2.0	5.0	10	30	60
Carbon tetrachloride	0.3	1.0	2.0	5.0	10	30	60
Chlorobenzene	0.3	1.0	2.0	5.0	10	30	60
Chlorobromomethane	0.3*	1.0	2.0	5.0	10	30	60
Chlorodibromomethane	0.3	1.0	2.0	5.0	10	30	60
Chloroethane	0.3*	1.0*	2.0	5.0	10	30	60
Chloroform	0.3	1.0	2.0	5.0	10	30	60
Chloromethane	0.3*	1.0*	2.0	5.0	10	30	60
cis-1,2-Dichloroethene	0.3*	1.0	2.0	5.0	10	30	60
cis-1,3-Dichloropropene	0.3	1.0	2.0	5.0	10	30	60
Cyclohexane	0.3*	1.0	2.0	5.0	10	30	60
Cyclohexanone	12*	40	80	200	400	1,200	2,400
Dibromomethane	0.3*	1.0	2.0	5.0	10	30	60
Dichlorobromomethane	0.3	1.0	2.0	5.0	10	30	60
Dichlorofluoromethane	0.3*	1.0	2.0	5.0	10	30	60
Dichlorodifluoromethane	0.3*	1.0*	2.0	5.0	10	30	60
Ethylbenzene	0.3*	1.0	2.0	5.0	10	30	60
Ethyl Ether	0.3*	1.0	2.0	5.0	10	30	60
Ethyl methacrylate	0.3*	1.0	2.0	5.0	10	30	60
Ethylene dibromide (EDB)	0.3*	1.0	2.0	5.0	10	30	60
Hexachlorobutadiene	0.3	1.0	2.0	5.0	10	30	60
Hexane	0.3*	1.0	2.0	5.0	10	30	60
Iodomethane	0.3*	1.0	2.0	5.0	10	30	60
Isobutyl alcohol	7.5*	25	50	125	250	750	1,500
Isopropylbenzene	0.3*	1.0	2.0	5.0	10	30	60
m and p Xylenes	0.3*	1.0	2.0	5.0	10	30	60
Methyl Acetate	1.5*	5.0	10	25	50	150	300
Methylcyclohexane	0.3*	1.0	2.0	5.0	10	30	60
Methylene chloride	0.3*	1.0	2.0	5.0	10	30	60

Table 6: Water 8260B-20mL purge List Calibration Levels (µg/L)[1]
(Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Methyl tert-butyl ether (MTBE)	0.3*	1.0	2.0	5.0	10	30	60
Naphthalene	0.3*	1.0	2.0	5.0	10	30	60
n-Butylbenzene	0.3*	1.0	2.0	5.0	10	30	60
n-Propylbenzene	0.3*	1.0	2.0	5.0	10	30	60
o-Xylene	0.3*	1.0	2.0	5.0	10	30	60
sec-Butylbenzene	0.3*	1.0	2.0	5.0	10	30	60
sec-Butyl Alcohol	9.0*	30	60	150	300	900	1,800
Styrene	0.3*	1.0	2.0	5.0	10	30	60
tert-Butylbenzene	0.3*	1.0	2.0	5.0	10	30	60
Tetrachloroethene	0.3*	1.0	2.0	5.0	10	30	60
Tetrahydrofuran	0.6*	2.0	4.0	10	20	60	120
Toluene	0.3*	1.0	2.0	5.0	10	30	60
trans-1,2-Dichloroethene	0.3*	1.0	2.0	5.0	10	30	60
trans-1,3-Dichloropropene	0.3*	1.0	2.0	5.0	10	30	60
trans-1,4-Dichloro-2-butene	0.3*	1.0	2.0	5.0	10	30	60
Trichloroethene	0.3*	1.0	2.0	5.0	10	30	60
Trichlorofluoromethane	0.3*	1.0*	2.0	5.0	10	30	60
Vinyl Acetate	0.6*	2.0	4.0	10	20	60	120
Vinyl chloride	0.3	1.0	2.0	5.0	10	30	60

[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

* These compounds are not routinely used at this concentration of the calibration.

Table 6A: Water 8260B-20mL purge List Calibration Levels (µg/L)[1]
(Standards: MV-Supp A and Freon_A)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1,1,1-Trifluoro-2,2-dichloroethane	1.0	2.0	5.0	10	30	60
1,2,3-Trimethylbenzene	1.0	2.0	5.0	10	30	60
1,2-Dichloro-1,1,2,2-tetrafluoroethane	1.0	2.0	5.0	10	30	60
1,2-Dichloro-1,1,2-trifluoroethane	1.0	2.0	5.0	10	30	60
2-Chloro-1,1,1-Trifluoroethane	1.0	2.0	5.0	10	30	60
2-Chloro-1,3-butadiene (Chloroprene)	1.0	2.0	5.0	10	30	60
2-Nitropropane	1.0	2.0	5.0	10	30	60
Acetonitrile	10	20	50	100	300	600
cis-1,4-dichloro-2-butene	1.0	2.0	5.0	10	30	60
Chlorotrifluoroethene	1.0	2.0	5.0	10	30	60
Ethanol	60	120	300	600	1,800	3,600
Ethyl acetate	2.0	4.0	10	20	60	120
Ethylene oxide	200	400	1,000	2,000	6,000	12,000
Isopropyl Alcohol	10	20	50	100	300	600
Isopropyl Ether	1.0	2.0	5.0	10	30	60
Methylacrylonitrile	10	20	50	100	300	600
Methyl methacrylate	2.0	4.0	8.0	20	60	120
n-Butanol	25	50	125	250	750	1,000
Propene oxide	50	100	250	500	1,500	3,000
Propionitrile	10	20	50	100	300	600
tert-Amyl methyl ether	1.0	2.0	5.0	10	30	60
tert-Butyl ethyl ether	1.0	2.0	5.0	10	30	60
Tetrahydrothiophene	1.0	2.0	5.0	10	30	60
1,2-Dichloroethane-d4 (surr)	1.0*	2.0	5.0	10	30	60
Toluene-d8 (surr)	1.0*	2.0	5.0	10	30	60
4-Bromofluorobenzene (surr)	1.0*	2.0	5.0	10	30	60
Dibromofluoromethane (surr)	1.0*	2.0	5.0	10	30	60

[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

* These compounds are not routinely used at this concentration of the calibration.

Table 7: Medium Level Soil 8260B List Calibration Levels (µg/Kg)[1]
(Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
1,1,1,2-Tetrachloroethane	0.5	1.0	2.0	5.0	10	30	60
1,1,1-Trichloroethane	0.5	1.0	2.0	5.0	10	30	60
1,1,2,2-Tetrachloroethane	0.5	1.0	2.0	5.0	10	30	60
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.5	1.0	2.0	5.0	10	30	60
1,1,2-Trichloroethane	0.5	1.0	2.0	5.0	10	30	60
1,1-Dichloroethane	0.5	1.0	2.0	5.0	10	30	60
1,1-Dichloroethene	0.5	1.0	2.0	5.0	10	30	60
1,1-Dichloropropene	0.5	1.0	2.0	5.0	10	30	60
1,2,3-Trichlorobenzene	0.5	1.0	2.0	5.0	10	30	60
1,2,3-Trichloropropane	0.5	1.0	2.0	5.0	10	30	60
1,2,4-Trichlorobenzene	0.5	1.0	2.0	5.0	10	30	60
1,2,4-Trimethylbenzene	0.5	1.0	2.0	5.0	10	30	60
1,2-Dibromo-3-chloropropane	0.5	1.0	2.0	5.0	10	30	60
1,2-Dichlorobenzene	0.5	1.0	2.0	5.0	10	30	60
1,2-Dichloroethane	0.5	1.0	2.0	5.0	10	30	60
1,2-Dichloropropane	0.5	1.0	2.0	5.0	10	30	60
1,3,5-Trimethylbenzene	0.5	1.0	2.0	5.0	10	30	60
1,3-Dichlorobenzene	0.5	1.0	2.0	5.0	10	30	60
1,3-Dichloropropane	0.5	1.0	2.0	5.0	10	30	60
1,4-Dichlorobenzene	0.5	1.0	2.0	5.0	10	30	60
1,4-Dioxane	10	20	40	100	200	600	1,200
1-Chlorohexane	0.5	1.0	2.0	5.0	10	30	60
2-Chloroethyl vinyl ether	0.5	1.0	2.0	5.0	10	30	60
2,2-Dichloropropane	0.5	1.0	2.0	5.0	10	30	60
2-Butanone (MEK)	2.0	4.0	8.0	20	40	120	240
2-Chlorotoluene	0.5	1.0	2.0	5.0	10	30	60
2-Hexanone	2.0	4.0	8.0	20	40	120	240
2-Pentanone	2.0	4.0	8.0	20	40	120	240
3-Chloro-1-propene (Allyl Chloride)	0.5	1.0	2.0	5.0	10	30	60
2-Methyl-2-propanol (tert-Butyl alcohol)	10	20	40	100	200	600	1,200
4-Chlorotoluene	0.5	1.0	2.0	5.0	10	30	60
4-Isopropyltoluene	0.5	1.0	2.0	5.0	10	30	60
4-Methyl-2-pentanone	2.0	4.0	8.0	20	40	120	240
Acetone	2.0	4.0	8.0	20	40	120	240
Acrolein	5	10	20	50	100	300	600

Table 7: Medium Level Soil 8260B List Calibration Levels (µg/Kg)[1] (Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve) (cont.)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Acrylonitrile	5	10	20	50	100	300	600
Benzene	0.5	1.0	2.0	5.0	10	30	60
Bromobenzene	0.5	1.0	2.0	5.0	10	30	60
Bromoform	0.5	1.0	2.0	5.0	10	30	60
Bromomethane	0.5	1.0	2.0	5.0	10	30	60
Carbon Disulfide	0.5	1.0	2.0	5.0	10	30	60
Carbon tetrachloride	0.5	1.0	2.0	5.0	10	30	60
Chlorobenzene	0.5	1.0	2.0	5.0	10	30	60
Chlorobromomethane	0.5	1.0	2.0	5.0	10	30	60
Chlorodibromomethane	0.5	1.0	2.0	5.0	10	30	60
Chloroethane	0.5	1.0	2.0	5.0	10	30	60
Chloroform	0.5	1.0	2.0	5.0	10	30	60
Chloromethane	0.5	1.0	2.0	5.0	10	30	60
cis-1,2-Dichloroethene	0.5	1.0	2.0	5.0	10	30	60
cis-1,3-Dichloropropene	0.5	1.0	2.0	5.0	10	30	60
Cyclohexane	0.5	1.0	2.0	5.0	10	30	60
Cyclohexanone	20	40	80	200	400	1,200	2,400
Dibromomethane	0.5	1.0	2.0	5.0	10	30	60
Dichlorobromomethane	0.5	1.0	2.0	5.0	10	30	60
Dichlorofluoromethane	0.5	1.0	2.0	5.0	10	30	60
Dichlorodifluoromethane	0.5	1.0	2.0	5.0	10	30	60
Ethylbenzene	0.5	1.0	2.0	5.0	10	30	60
Ethyl Ether	0.5	1.0	2.0	5.0	10	30	60
Ethyl Methacrylate	0.5	1.0	2.0	5.0	10	30	60
Ethylene dibromide (EDB)	0.5	1.0	2.0	5.0	10	30	60
Hexachlorobutadiene	0.5	1.0	2.0	5.0	10	30	60
Hexane	0.5	1.0	2.0	5.0	10	30	60
Iodomethane	0.5	1.0	2.0	5.0	10	30	60
Isobutyl Alcohol	12.5	25	50	125	250	750	1,500
Isopropylbenzene	0.5	1.0	2.0	5.0	10	30	60
m and p Xylenes	0.5	1.0	2.0	5.0	10	30	60
Methyl Acetate	2.5	5.0	10	25	50	150	300
Methylcyclohexane	0.5	1.0	2.0	5.0	10	30	60
Methylene chloride	0.5	1.0	2.0	5.0	10	30	60
Methy tert-butyl ether	0.5	1.0	2.0	5.0	10	30	60

Table 7: Medium Level Soil 8260B List Calibration Levels (µg/Kg)[1] (Standards: MV-Main A, MV-GasKet A, and MV-2 Cleve) (cont.)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
Naphthalene	0.5	1.0	2.0	5.0	10	30	60
n-Butylbenzene	0.5	1.0	2.0	5.0	10	30	60
n-Propylbenzene	0.5	1.0	2.0	5.0	10	30	60
o-Xylene	0.5	1.0	2.0	5.0	10	30	60
sec-Butylbenzene	0.5	1.0	2.0	5.0	10	30	60
sec-Butyl Alcohol	15	30	60	150	300	900	1,800
Styrene	0.5	1.0	2.0	5.0	10	30	60
tert-Butylbenzene	0.5	1.0	2.0	5.0	10	30	60
Tetrachloroethene	0.5	1.0	2.0	5.0	10	30	60
Tetrahydrofuran	1.0	2.0	4.0	10	20	60	120
Toluene	0.5	1.0	2.0	5.0	10	30	60
trans-1,2-Dichloroethene	0.5	1.0	2.0	5.0	10	30	60
trans-1,3-Dichloropropene	0.5	1.0	2.0	5.0	10	30	60
trans-1,4-Dichloro-2-butene	0.5	1.0	2.0	5.0	10	30	60
Trichloroethene	0.5	1.0	2.0	5.0	10	30	60
Trichlorofluoromethane	0.5	1.0	2.0	5.0	10	30	60
Vinyl Acetate	1.0	2.0	4.0	10	20	60	120
Vinyl chloride	0.5	1.0	2.0	5.0	10	30	60

[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

Table 7A: Medium Level Soil 8260B List Calibration Levels (µg/Kg)[1]
(Standards: MV-Supp A and Freon_A)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
1,1,1-Trifluoro-2,2-dichloroethane	0.5	1.0	2.0	5.0	10	30	60
1,2,3-Trimethylbenzene	0.5	1.0	2.0	5.0	10	30	60
1,2-Dichloro-1,1,2,2-tetrafluoroethane	0.5	1.0	2.0	5.0	10	30	60
1,2-Dichloro-1,1,2-trifluoroethane	0.5	1.0	2.0	5.0	10	30	60
2-Chloro-1,1,1-Trifluoroethane	0.5	1.0	2.0	5.0	10	30	60
2-Chloro-1,3-butadiene (Chloroprene)	0.5	1.0	2.0	5.0	10	30	60
2-Nitropropane	0.5	1.0	2.0	5.0	10	30	60
Acetonitrile	5.0	10	20	50	100	300	600
cis-1,4-dichloro-2-butene	0.5	1.0	2.0	5.0	10	30	60
Chlorotrifluoroethene	0.5	1.0	2.0	5.0	10	30	60
Ethanol	30	60	120	300	600	1,800	3,600
Ethyl acetate	1.0	2.0	4.0	10	20	60	120
Ethylene oxide	100	200	400	1,000	2,000	6,000	12,000
Isopropyl Alcohol	5	10	20	50	100	300	600
Isopropyl Ether	0.5	1.0	2.0	5.0	10	30	60
Methylacrylonitrile	5	10	20	50	100	300	600
Methyl methacrylate	1.0	2.0	4.0	8.0	20	60	120
n-Butanol	12.5	25	50	125	250	750	1,000
Propene oxide	25	50	100	250	500	1,500	3,000
Propionitrile	5	10	20	50	100	300	600
tert-Amyl methyl ether	0.5	1.0	2.0	5.0	10	30	60
tert-Butyl ethyl ether	0.5	1.0	2.0	5.0	10	30	60
Tetrahydrothiophene	0.5	1.0	2.0	5.0	10	30	60

[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

Table 8. Manually Added Internal Standards

Internal Standard	Standard Concentration (µg/mL)	Quantitation Ion
Fluorobenzene	20	96
Chlorobenzene-d_5	20	119
1,4-Dichlorobenzene-d_4	20	152
TBA-d9	400	65
1,4-Dioxane-d8*	400	96

NOTES:

1) 10 µL of the internal standard is added to the sample. This results in a concentration of each internal standard in the sample at 10 µg/L for a 20 mL purge.

2) Except for high-level soils, the surrogate and internal standards may be combined in one solution.

Table 8A. Automatically Added Internal Standards

Internal Standard	Standard Concentration (µg/mL)	Quantitation Ion
Fluorobenzene	250	96
Chlorobenzene-d_5	250	119
1,4-Dichlorobenzene-d_4	250	152
TBA-d9	5000	65
1,4-Dioxane-d8*	5000	96

NOTES:

1) 1 µL of the internal standard is added to the sample. This results in a concentration of each internal standard in the sample at 10 µg/L for a 20 mL purge.

2) There may be some variability in the size of the internal standard loop from one instrument to the next. This is compensated for on the day of initial calibration by comparing the manually added and automatically added internal standard concentrations.

* 1,4-Dioxane-d8 is in the Internal Standard spiked into every sample but is not associated to any analytes due to poor stability. 1,4-Dioxane must be set to “rejected” or “not needed” status in TALs.

Table 9. Manually Added Surrogate Standards

Surrogate Compounds	Standard Concentration (µg/mL)
1,2-Dichloroethane-d_4	20
Dibromofluoromethane	20
Toluene-d_8	20
4-Bromofluorobenzene	20

NOTES:

1) 10 µL of the surrogate standard is added to the sample. This results in a concentration of each surrogate in the sample at 10 µg/L for a 20 mL purge.
2) Except for high-level soils, the surrogate and internal standards may be combined in one solution.
3) Recovery limits for surrogates are generated from historical data and are maintained by the QA department.

Table 9A. Automatically Added Surrogate Standards

Surrogate Compounds	Standard Concentration (µg/mL)
1,2-Dichloroethane-d_4	250
Dibromofluoromethane	250
Toluene-d_8	250
4-Bromofluorobenzene	250

NOTES:

1) 1 µL of the surrogate standard is added to the sample. This results in a concentration of each surrogate in the sample at 10 µg/L for a 20 mL purge.
2) There may be some variability in the size of the surrogate standard loop from one instrument to the next. This is compensated for on the day of initial calibration by comparing the manually added and automatically added surrogate standard concentrations.
3) Recovery limits for surrogates are generated from historical data and are maintained by the QA department.

Table 10. BFB Key Ion Abundance Criteria

Mass	Ion Abundance Criteria
50	15 to 40 % of Mass 95
75	30 to 60 % of Mass 95
95	Base Peak, 100 % Relative Abundance
96	5 to 9 % of Mass 95
173	Less than 2 % of Mass 174
174	Greater than 50 % of Mass 95
175	5 to 9 % of Mass 174
176	Greater than 95 %, but less than 101 % of Mass 174
177	5 to 9 % of Mass 176

Table 11. SPCC Compounds and Minimum Response Factors

Compound	8260B Min. RF
Chloromethane	0.100
1,1-Dichloroethane	0.100
Bromoform	> 0.100
1,1,2,2-Tetrachloroethane	0.300
Chlorobenzene	0.300

Table 12. CCC Compounds

Compound	Max. %RSD from Initial Calibration	Max. %D for continuing calibration
Vinyl Chloride	≤ 30.0	≤ 20.0
1,1-Dichloroethene	≤ 30.0	≤ 20.0
Chloroform	≤ 30.0	≤ 20.0
1,2-Dichloropropane	≤ 30.0	≤ 20.0
Toluene	≤ 30.0	≤ 20.0
Ethylbenzene	≤ 30.0	≤ 20.0

Table 13. Characteristic Ions

Compound	Primary*	Secondary	Tertiary
1,2-Dichloroethane-d_4 (Surrogate)	65	102	--
Dichlorodifluoromethane	85	87	50, 101,103
Dibromofluoromethane	111	113	--
Chloromethane	50	52	49
Vinyl chloride	62	64	61
Bromomethane	94	96	79
Chloroethane	64	66	49
Trichlorofluoromethane	101	103	66
1,1-Dichloroethene	96	61	98
Acrolein	56	55	58
Iodomethane	142	127	141
Carbon disulfide	76	78	--
Trichlorotrifluoroethane	151	101	153
Ethanol	45	46	--
Acetone	43	58	--
Methylene chloride	84	49	51, 86
Tert-Butyl alcohol	59	74	--
Trans-1,2-Dichloroethene	96	61	98
Acrylonitrile	53	52	51
Methyl-*tert*-butyl ether	73	41	57
Hexane	57	43	--
1,1-Dichloroethane	63	65	83
cis-1,2-Dichloroethene	96	61	98
2-Butanone	43	72**	--
Tetrahydrofuran	42	71	--
Chloroform	83	85	47
1,2-Dichloroethane	62	64	98
Dibromomethane	93	174	95, 172, 176
1,4-Dioxane	88	58	--
Vinyl acetate	43	86	--
1,1,1-Trichloroethane	97	99	117
Carbon tetrachloride	117	119	121

Table 13. Characteristic Ions (cont.)

Compound	Primary*	Secondary	Tertiary
Benzene	78	52	77
Trichloroethene	95	130***	97, 132
1,2-Dichloropropane	63	65	41
Bromodichloromethane	83	85	129
2-Chloroethyl vinyl ether	63	65	106
cis-1,3-Dichloropropene	75	77	39
trans-1,3-Dichloropropene	75	77	39
1,1,2-Trichloroethane	97	83	85, 99
Chlorodibromomethane	129	127	131
Bromoform	173	171	175, 252
1,2,3-Trichloropropane	75	110	77, 112, 97
Toluene-d_8 (Surrogate)	98	70	100
4-Bromofluorobenzene (Surrogate)	95	174	176
Toluene	91	92	65
4-Methyl-2-pentanone	43	58	57, 100
Tetrachloroethene	164	166	131
Ethyl methacrylate	69	41	99, 86, 114
2-Hexanone	43	58	57, 100
Chlorobenzene	112	114	77
Ethylbenzene	106	91	--
Xylenes	106	91	--
Styrene	104	103	78, 51, 77
Dichlorobenzene (all isomers)	146	148	111
Trans 1,4-Dichloro-2-butene	53	75	89, 77, 124
1,1,2,2-Tetrachloroethane	83	85	131, 133
Allyl Chloride	41	76	78
Acetonitrile	41	40	--
Dichlorofluoromethane	67	69	--
Isopropyl ether	87	59	45
Chloroprene	53	88	90
n-Butanol	56	41	42
Propionitrile	54	52	55
Methacrylonitrile	41	67	52
Isobutanol	41	43	74

Table 13. Characteristic Ions (cont.)

Compound	Primary*	Secondary	Tertiary
Methyl methacrylate	41	69	100
1,1,1,2-Tetrachloroethane	131	133	119
1,2-Dibromo-3-chloropropane	157	155	75
Ethyl ether	59	74	--
Ethyl Acetate	43	88	61
2-Nitropropane	41	43	46
Cyclohexanone	55	42	98
Isopropylbenzene	105	120	--
2,2-Dichloropropane	77	97	--
Bromochloromethane	128	49	130
1,1-Dichloropropene	75	39	110
1,3-Dichloropropane	76	41	78
1-Chlorohexane	91	55	41
1,1,1,2-Tetrachloroethane	131	133	--
Bromobenzene	156	158	77
n-Propylbenzene	120	91	65
2-Chlorotoluene	126	91	65
1,3,5-Trimethylbenzene	105	120	77
4-Chlorobenzene	126	91	89
t-Butylbenzene	119	134	91
sec-Butylbenzene	134	105	--
4-Isopropyltoluene	119	134	91
n-Butylbenzene	91	92	134
1,2,4-Trichlorobenzene	180	182	--
Hexachlorobutadiene	225	227	223
Naphthalene	128	127	--
1,2,3-Trichlorobenzene	180	182	--
1,1,1-Trifluoro-2,2-Dichloroethane	83	133	--
1,2,3-Trimethylbenzene	105	120	91
1,2,4-Trimethylbenzene	105	120	119
1,2-Dichloro-1,1,2,2-Tetrafluoroethane	85	87	--
1,2-Dichloro-1,1,2-Trifluoroethane	117	67	85
1,3,5-Trichlorobenzene	180	182	184
2,2,3-Trimethylbutane	57	43	85
2,2-Dimethylpentane	57	43	85
2,3-Dimethylpentane	56	71	73

Table 13. Characteristic Ions (cont.)

Compound	Primary*	Secondary	Tertiary
2,4-Dimethylpentane	43	57	85
2-Chloro-1,1,1-Trifluoroetane	118	83	69
2-Methylhexane	43	85	57
3,3-Dimethylpentane	43	71	--
3-Ethylpentane	43	70	71
3-Methylhexane	43	57	71
4-Chlorotoluene	126	91	89
2-Pentanone	43	86	--
Chlorotrifluoroethene	116	66	97
Cis-1,4-Dichloro-2-butene	53	75	89
Cyclohexane	56	84	55
Dimethyl Disulfide	94	79	45
Ethylene Dibromide	107	109	--
Ethylene Oxide	43	44	--
Isopropyl Alcohol	45	43	--
Methyl Acetate	43	74	59
Methylcyclohexane	55	83	41
m-Xylene & p-Xylene	91	106	77
n-Heptane	43	100	71
n-Nonyl Aldehyde	46	44	207
O-Xylene	106	91	--
Propene Oxide	58	43	57
Sec-Butyl Alcohol	45	59	--
Tert-amyl methyl ether	73	55	87
Tert-butyl ethyl ether	59	87	57
Tetrahydrothiophene	60	88	45

* The primary ion should be used for quantitation unless interferences are present, in which case a secondary ion may be used.

** m/z 43 may be used for quantitation of 2-butanone, but m/z 72 must be present for positive identification.

*** Used as quantitation ion for method 624.

Table 14. State of Arizona ICV/CCV Quality Control Limits

QC Limits not specified in method	Default QC (method specified or laboratory historical if not specified)
CCV Non-CCC compounds	CCC limits (≤30%)
ICV	Same as CCV (≤30%)
Reporting Limit	Must be supported by low level initial calibration standard
LCS/LCSD	Lab historical
MS/MSD	Lab historical

NOTES:

1) Based on ADHS Rule A.A.C.R9-14-615.C.8. Director approved on June 29, 2005 for the labs to use default limits as an alternative to developing statistically derived limits.

Table 15. List 1 Poorly Performing Compounds

The laboratory's GC/MS group identified this list of compounds based on current and historical performance. The recovery performance was reviewed against full spike recovery data and method performance data, where available, to validate each compound as a "poor performer."

Acetone	1,2-Dichloro-1,1,2,2-tetrafluoroethane
Acetonitrile	Ethanol
Acrolein	Ethyl acetate
Acrylonitrile	Ethylene oxide
n-Butanol	2-Hexanone
2-Butanone (MEK)	Isobutyl alcohol
tert-Butyl alcohol	Isopropanol
Carbon disulfide	Methacrylonitrile
2-Chloroethyl vinyl ether	Methyl acetate
2-Chloro-1,1,1-trifluoroethane	4-Methyl-2-pentanone
Chlorotrifluoroethene	2-Nitropropane
cis-1,4-Dichloro-2-butene	2-Pentanone
trans-1,4-Dichloro-2-butene	2-Propanol
Dichlorodifluoromethane	Propionitrile
Dichlorofluoromethane	Tetrahydrofuran
1,2-Dibromo-3-chloropropane (DBCP)	Tetrahydrothiophene
1,2-Dichlorotetrafluoroethane	1,1,2-Trichloro-1,2,2-trifluoroethane
1,2-Dichloro-1,1,2-trifluoroethane (Freon 123a)	Trichlorofluoromethane
2,2-Dichloro-1,1,1-trifluoroethane	Vinyl acetate
1,4-Dioxane	

Table A-1. Method 624 Analytes and Reporting Limits, 5-mL Purge

Analytes	µg/L
Acrolein[1]	100
Acrylonitrile[1]	100
Benzene	5
Bromodichloromethane	5
Bromoform	5
Bromomethane	10
Carbon tetrachloride	5
Chlorobenzene	5
Chloroethane	10
2-Chloroethyl vinyl ether	5
Chloroform	5
Chloromethane	10
Dibromochloromethane	5
1,2-Dichlorobenzene	5
1,3-Dichlorobenzene	5
1,4-Dichlorobenzene	5
1,1-Dichloroethane	5
1,2-Dichloroethane	5
1,1-Dichloroethene	5
trans-1,2-Dichloroethene	5
1,2-Dichloropropane	5
cis-1,3-Dichloropropene	10
trans-1,3-Dichloropropene	5
Ethylbenzene	5
Methylene chloride	5
1,1,2,2-Tetrachloroethane	5
Tetrachloroethene	5
Toluene	5
1,1,1-Trichloroethane	5
1,1,2-Trichloroethane	5
Trichloroethene	5
Trichlorofluoromethane	15
Vinyl chloride	10

[1] Acrolein and Acrylonitrile have been added to the 624 analyte list in the EPA Method Update Rule, May 18, 2012. Analysis of these analytes by Method 624 as being regulatory compliant is dependent upon individual state approval of the MUR. Verify state status before analysis.

Table A-2. Method 624 QC Acceptance Criteria

Analytes[1]	Daily QC Check (CCV) Acceptance Criteria (20 µg/L spike)	Mean Recovery, Initial Demonstration Acceptance Criteria (IDOC) (20 µg/L spike)	Std Dev, Initial Demonstration Acceptance Criteria (IDOC) (20 µg/L spike)	Matrix Spike and LCS Acceptance Criteria (% Recovery)
Acrolein[2]	45.9-54.1	42.9-60.1	4.6	88-118
Acrylonitrile[2]	41.2-58.8	33.1-66.9	9.9	71-135
Benzene	12.8 - 27.2	15.2 - 26.0	6.9	37 - 151
Bromodichloromethane	13.1 - 26.9	10.1 - 28.0	6.4	35 - 155
Bromoform	14.2 - 25.8	11.4 - 31.1	5.4	45 - 169
Bromomethane	2.8 - 37.2	D - 41.2	17.9	D - 242
Carbon tetrachloride	14.6 - 25.4	17.2 - 23.5	5.2	70 - 140
Chlorobenzene	13.2 - 26.8	16.4 - 27.4	6.3	37 - 160
Chloroethane	7.6 - 32.4	8.4 - 40.4	11.4	14 - 230
2-Chloroethyl vinyl ether	D - 44.8	D - 50.4	25.9	D - 305
Chloroform	13.5 - 26.5	13.7 - 24.2	6.1	51 - 138
Chloromethane	D - 40.8	D - 45.9	19.8	D - 273
Dibromochloromethane	13.5 - 26.5	13.8 - 26.6	6.1	53 - 149
1,2-Dichlorobenzene	12.6 - 27.4	11.8 - 34.7	7.1	18 - 190
1,3-Dichlorobenzene	14.6 - 25.4	17.0 - 28.8	5.5	59 - 156
1,4-Dichlorobenzene	12.6 - 27.4	11.8 - 34.7	7.1	18 - 190
1,1-Dichloroethane	14.5 - 25.5	14.2 - 28.5	5.1	59 - 155
1,2-Dichloroethane	13.6 - 26.4	14.3 - 27.4	6.0	49 - 155
1,1-Dichloroethene	10.1 - 29.9	3.7 - 42.3	9.1	D - 234
trans-1,2-Dichloroethene	13.9 - 26.1	13.6 - 28.5	5.7	54 - 156
1,2-Dichloropropane	6.8 - 33.2	3.8 - 36.2	13.8	D - 210
cis-1,3-Dichloropropene	4.8 - 35.2	1.0 - 39.0	15.8	D- 227
trans-1,3-Dichloropropene	10.0 - 30.0	7.6 - 32.4	10.4	17- 183
Ethylbenzene	11.8 - 28.2	17.4 - 26.7	7.5	37 - 162
Methylene chloride	12.1 - 27.9	D - 41.0	7.4	D - 221
1,1,2,2-Tetrachloroethane	12.1 - 27.9	13.5 - 27.2	7.4	46 - 157
Tetrachloroethene	14.7 - 25.3	17.0 - 26.6	5.0	64 - 148
Toluene	14.9 - 25.1	16.6 - 26.7	4.8	47 - 150
1,1,1-Trichloroethane	15.0 - 25.0	13.7 - 30.1	4.6	52 - 162
1,1,2-Trichloroethane	14.2 - 25.8	14.3 - 27.1	5.5	52 - 150
Trichloroethene	13.3 - 26.7	18.6 - 27.6	6.6	71 - 157
Trichlorofluoromethane	9.6 – 30.4	8.9- 31.5	10.0	17 - 181
Vinyl chloride	0.8 – 39.2	D - 43.5	20.0	D - 251

[1] Analytes not listed on the table must meet a CCV drift criteria of ± 35%. Method 624 does not specify second source (ICV) criteria. The laboratory has adopted criteria of ± 30% difference for the ICV. The LIMS requires a minimum value of 10% for the limit when D is noted in the reference table, therefore if this table lists a limit greater than ±90% difference LIMS will list a limit of ±90%.

[2] Acrolein and Acrylonitrile have been added to the 624 analyte list in the EPA Method Update Rule, May 18, 2012. Analysis of these analytes by Method 624 as being regulatory compliant is dependent upon individual state approval of the MUR. Verify state status before analysis. Per the MUR, QC criteria from Method 603 are to be applied and are presented here.

Table 17

Associated Surrogates and Internal Standards for 8260B/C

Analyte	Associated IS	Associated Surrogate
1,1,1,2-Tetrachloroethane	2	2
1,1,1-TCA	1	1
1,1,2,2-Tetrachloroethane	3	3
1,1,2-TCA	1	4
1,1-DCA	1	1
1,1-DCE	1	1
1,1-Dichloropropene	1	4
1,2,3-Trichlorobenzene	3	3
1,2,3-Trichloropropane	3	3
1,2,4-Trichlorobenzene	3	3
1,2,4-Trimethylbenzene	3	3
1,2-DCA	1	4
1,2-DCB	3	3
1,2-Dibromo-3-chloropropane	3	3
1,2-Dichloropropane	1	4
1,2-EDB	2	2
1,3,5-Trimethylbenzene	3	3
1,3-DCB	3	3
1,3-Dichloropropane	2	2
1,4-DCB	3	3
1-Chlorohexane	2	2
2,2-Dichloropropane	1	1
2-Chlorotoluene	3	3
4-Chlorotoluene	3	3
Acetone	1	1
Benzene	1	4
Bromobenzene	3	3
Bromochloromethane	1	1
Bromodichloromethane	1	4
Bromoform	2	2
Bromomethane	1	1
Carbon Tetrachloride	1	4
Chlorobenzene	2	2
Chloroethane	1	1
Chloroform	1	1
Chloromethane	1	1
Cis-1,2-DCE	1	1
Cis-1,3-Dichloropropene	1	4
Dibromochloromethane	2	2
Dibromomethane	1	4
Dichlorodifluoromethane	1	1
Ethylbenzene	2	2
Hexachlorobutadiene	3	3
Isopropylbenzene	3	3
M,P-Xylene	2	2
Methylene Chloride	1	1
Methyl tert-butyl ether (MTBE)	1	1

Table 17
Associated Surrogates and Internal Standards for 8260B/C (cont.)

Analyte	Associated IS	Associated Surrogate
MEK (2-Butanone)	1	1
MIBK (4-Methyl-2-Pentanone)	1	4
n-Butylbenzene	3	3
n-Propylbenzene	3	3
Napthalene	3	3
o-Xylene	2	2
p-Isopropyltoluene	3	3
sec-Butylbenzene	3	3
Styrene	2	2
TCE	1	4
tert-butylbenzene	3	3
Tetrachloroethene	2	2
Toluene	1	4
trans-1,2-DCE	1	1
trans-1,3-Dichloropropene	1	4
Trichlorofluoromethane	1	1
Vinyl Chloride	1	1
Chlorotrifluoroethene	1	1
1,2-Dichloro-1,1,2,2-Tetrafluoroethane	1	1
2-Chloro-1,1,1-Trifluoroethane	1	1
Ethylene Oxide	1	1
Ethanol	4	1
Ethyl Ether	1	1
1,2-Dichloro-1,1,2-Trifluoroethane	1	1
Propene Oxide	1	1
1,1,1-Trifluoro-2,2-dichloroethane	1	1
Acrolein	1	1
Iodomethane	1	1
Carbon Disulfide	1	1
3-Chloro-1-propene	1	1
Acetonitrile	1	1
Methyl Acetate	1	1
2-Methyl-2-propanol (TBA)	4	1
Acrylonitrile	1	1
Hexane	1	1
Vinyl Acetate	1	1
Isopropyl Alcohol	4	1
Isopropyl Ether	1	1
2-Chloro-1,3-butadiene	1	1
Tert-butyl ethyl ether (ETBE)	1	1
Propionitrile	1	1
Ethyl Acetate	1	1
sec-Butyl Alcohol	4	1
Methacrylonitrile	1	1
Tetrahydrofuran	1	1
Cyclohexane	1	1
Tert-amyl methyl ether (TAME)	1	1
Isobutyl Alcohol	4	1
n-Butanol	4	1

Table 17

Associated Surrogates and Internal Standards for 8260B/C (cont.)

2-Pentanone	1	4
Methycyclohexane	1	4
Methy Methacrylate	1	4
1,4-Dioxane	1	4
2-Nitropropane	1	4
2-Chloroethyl vinyl ether (2-Cleve)	1	4
Ethyl Methacrylate	1	4
2-Hexanone	2	2
Tetrahydrothiophene	2	2
1-Chlorohexane	2	2
cis-1,4-Dichloro-2-butene	3	3
Cyclohexanone	2	2
Trans-1,4-Dichloro-2-butene	3	3
Surrogates	Associated IS	Associated Surrogate
Dibromofluoromethane	1	1
Toluene-d8	2	2
4-Bromofluorobenzene	3	3
1,2-DCA-d4	1	4
Internal Standards	Associated IS	Associated Surrogate
Fluorobenzene	1	-
Chlorobenzene-d_5	2	-
1,4-Dichlorobenzene	3	-
TBA-d_9	4	-
1,4-Dioxane-d_8*	5	-

* 1,4-Dioxane-d_8 is in the Internal Standard spiked into every sample but is not associated to any analytes due to poor stability. 1,4-Dioxane-d_8 must be set to “rejected” or “not needed” status in TALS.

In the event that a compound is not covered by this table is requested the associated internal standard/surrogate will be used as required by the method.

Table 18: 8260C minimum response factors

Compound	Minimum response factor
1,1,1,2-Tetrachloroethane	0.010
1,1,1-Trichloroethane	0.100
1,1,2,2-Tetrachloroethane	0.300
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.100
1,1,2-Trichloroethane	0.100
1,1-Dichloroethane	0.200
1,1-Dichloroethene	0.100
1,1-Dichloropropene	0.010
1,2,3-Trichlorobenzene	0.010
1,2,3-Trichloropropane	0.010
1,2,4-Trichlorobenzene	0.200
1,2,4-Trimethylbenzene	0.010
1,2-Dibromo-3-chloropropane	0.050
1,2-Dichlorobenzene	0.400
1,2-Dichloroethane	0.100
1,2-Dichloropropane	0.100
1,3,5-Trimethylbenzene	0.010
1,3-Dichlorobenzene	0.600
1,3-Dichloropropane	0.010
1,4-Dichlorobenzene	0.500
1,4-Dioxane	0.001
1-Chlorohexane	0.010
2-Chloroethyl vinyl ether	0.010
2,2-Dichloropropane	0.010
2-Butanone (MEK)	0.100
2-Chlorotoluene	0.010
2-Hexanone	0.100
2-Pentanone	0.001
3-Chloro-1-propene (Allyl Chloride)	0.010
2-Methyl-2-propanol (tert-Butyl alcohol)	0.001
4-Chlorotoluene	0.010
4-Isopropyltoluene	0.010
4-Methyl-2-pentanone	0.100
Acetone	0.050
Acrolein	0.001
Acrylonitrile	0.010

Compound	Minimum response factor
Benzene	0.500
Bromobenzene	0.010
Bromoform	0.100
Bromomethane	0.100
Carbon Disulfide	0.100
Carbon tetrachloride	0.100
Chlorobenzene	0.500
Chlorobromomethane	0.010
Chlorodibromomethane	0.100
Chloroethane	0.100
Chloroform	0.200
Chloromethane	0.100
cis-1,2-Dichloroethene	0.100
cis-1,3-Dichloropropene	0.200
Cyclohexane	0.100
Cyclohexanone	0.001
Dibromomethane	0.010
Dichlorobromomethane	0.200
Dichlorofluoromethane	0.010
Dichlorodifluoromethane	0.100
Ethylbenzene	0.100
Ethyl Ether	0.010
Ethyl methacrylate	0.010
Ethylene dibromide (EDB)	0.100
Hexachlorobutadiene	0.010
Hexane	0.010
Iodomethane	0.010
Isobutyl alcohol	0.001
Isopropylbenzene	0.100
m and p Xylenes	0.100
Methyl Acetate	0.100
Methylcyclohexane	0.100
Methylene chloride	0.100
Methyl tert-butyl ether (MTBE)	0.100
Naphthalene	0.010
n-Butylbenzene	0.010
n-Propylbenzene	0.010
o-Xylene	0.300

Compound	Minimum response factor
sec-Butylbenzene	0.010
Styrene	0.300
tert-Butylbenzene	0.010
Tetrachloroethene	0.200
Tetrahydrofuran	0.001
Toluene	0.400
trans-1,2-Dichloroethene	0.100
trans-1,3-Dichloropropene	0.100
trans-1,4-Dichloro-2-butene	0.010
Trichloroethene	0.200
Trichlorofluoromethane	0.100
Vinyl Acetate	0.010
Vinyl chloride	0.100
1,2-Dichloroethane-d4 (surr)	0.010
Toluene-d8 (surr)	0.010
4-Bromofluorobenzene (surr)	0.010
Dibromofluoromethane (surr)	0.010

8260B versus 8260C

Method 8260C does not have CCC or SPCC. In the ICV and CCV all target compounds must meet the listed minimum response factor and 20% drift. In the initial calibration for 8260C compliant work each compound must meet 20% RSD to be a valid calibration for that compound. 8260B and 8260C have different control limits for spikes and surrogates. See TALs for limits.

APPENDIX A

Modifications for Analysis of Soils Collected for the State of Alaska

1. Collection and Preservation Requirements

Preservation and Holding Time for Volatiles in Soil
Method 5035A for Alaska

Container/Contents[1]	Preservation	Holding time	Analysis
Vial containing methanol and TFT surrogate	Sample is extruded into pre-tared 4 oz jar, containing 25 mL of methanol spiked with 2.5 ppm (ug/mL) of α, α, α-trifluorotoluene, cooled to $\leq 6^{o}$C and frozen upon receipt at laboratory.	14 days	Medium Level

Sample weights are calculated in the laboratory by adding the received weight of the sample into the AK Methanol Volume Correction spreadsheet stored on G:\QA\Edit\FORMS\GCMS.

2. Sample Preparation for Medium-Level Analysis – Field Preserved, AK method

a. Fill a 40 mL VOA vial with reagent water ~ 42 mL (no head space), and remove 1000 µL of water using a volumetric pipette or syringe.

b. Add 1050 µL of methanol extract to the vial and immediately cap. Invert the vial to ensure that there is no air bubble larger than 4 mm present. If a > 4 mm air bubble is present, re-prepare the sample.

c. Load the sample in the auto sampler and proceed to analyze against the methanol calibration curve.

d. As with water samples, surrogate and internal standard solutions are added by the autosampler (see Tables 7 and 7A in the main body of this SOP). The surrogate α, α, α-trifluorotoluene is added to the samples at the time of sampling. Recoveries for this surrogate will be reported in addition to recoveries for the surrogate compounds added at the time of analysis.

e. Prepare laboratory control samples by filling a 40 mL VOA vial with reagent water, and remove 1000 µL of water using a volumetric pipette or syringe. Add reagents as needed plus sufficient methanol for a total methanol volume of 1050 µL. The recommended concentration for the LCS is the same as the Level 5 of the initial calibration curve.

f. Remove a portion of the methanol extract for each sample and store in a clean Teflon-capped vial with no headspace at $\leq 6\ ^{o}$C until analysis. Duplicate aliquots of the methanol extract should be taken and stored.

3. Percent Moisture Correction for Soils from the State of Alaska

A percent moisture correction is required for soil samples submitted from the state of AK to adjust the extraction final volume in order to allow for the miscible solvent effects. The following formula is used to determine the corrected final volume. This calculation is performed in the AK Methanol Volume Correction spreadsheet stored on G:\QA\Edit\FORMS\GCMS.

$$V_t = [V_m + (M * W_s/100)]$$

Where:

V_t = final extract volume, corrected for moisture (mL)
V_m = volume methanol used for extraction (mL)
M = moisture content of the sample (%)
W_s = aliquot of sample extracted (g)

Table Ap-1. TestAmerica 8260 Reporting Limits – AK Soils

Compound	**CAS Number**	**Medium Soil µg/Kg**
Dichlorodifluoromethane	75-71-8	80
Chloromethane	74-87-3	40
Bromomethane	74-83-9	40
Vinyl chloride	75-01-4	40
Chloroethane	75-00-3	40
n-Butanol	71-36-3	800
Trichlorofluoromethane	75-69-4	40
Acrolein	107-02-8	200
Acetone	67-64-1	400
Trichlorotrifluoroethane	76-13-1	400
Iodomethane	74-88-4	500
Carbon disulfide	75-15-0	40
Methylene chloride	75-09-2	40
tert-Butyl alcohol	75-65-0	800
1,1-Dichloroethene	75-35-4	40
1,1-Dichloroethane	75-34-3	40
trans-1,2-Dichloroethene	156-60-5	40
Acrylonitrile	107-13-1	400
Methyl *tert*-butyl ether (MTBE)	1634-04-4	200
Hexane	110-54-3	400
cis-1,2-Dichloroethene	156-59-2	40
1,2-Dichloroethene (Total)	540-59-0	40
Tetrahydrofuran	109-99-9	80
Chloroform	67-66-3	40
1,2-Dichloroethane	107-06-2	40
Dibromomethane	74-95-3	40
2-Butanone	78-93-3	160
1,4-Dioxane	123-91-1	2,000
1,1,1-Trichloroethane	71-55-6	40
Carbon tetrachloride	56-23-5	40
Bromodichloromethane	75-27-4	40
1,2-Dichloropropane	78-87-5	40
Isopropyl Alcohol	67-63-0	1,000
Isopropyl ether	108-20-3	200

Table Ap-1. TestAmerica 8260 Reporting Limits – AK Soils

Compound	**CAS Number**	**Medium Soil µg/Kg**
cis-1,3-Dichloropropene	10061-01-5	40
Trichloroethene	79-01-6	40
Dibromochloromethane	124-48-1	40
1,2-Dibromoethane	106-93-4	40
1,2,3-Trichloropropane	96-18-4	40
1,1,2-Trichloroethane	79-00-5	40
Benzene	71-43-2	16
Ethylmethacrylate	97-63-2	80
trans-1,3-Dichloropropene	10061-02-6	40
Bromoform	75-25-2	40
4-Methyl-2-pentanone	108-10-1	160
2-Hexanone	591-78-6	160
Tetrachloroethene	127-18-4	40
Toluene	108-88-3	40
1,1,2,2-Tetrachloroethane	79-34-5	40
2-Chloroethyl vinyl ether	110-75-8	80
Vinyl acetate	108-05-4	80
Chlorobenzene	108-90-7	40
Ethylbenzene	100-41-4	40
Styrene	100-42-5	40
trans-1,4-Dichloro-2-butene	110-57-6	400
m- and p-Xylenes	179601-23-1	80
o-Xylene	95-47-6	40
Total xylenes	1330-20-7	80
1,3-Dichlorobenzene	541-73-1	40
1,4-Dichlorobenzene	106-46-7	40
1,2-Dichlorobenzene	95-50-1	40
2,2-Dichloropropane	590-20-7	40
Bromochloromethane	74-97-5	40
1,1-Dichloropropene	563-58-6	40
1,3-Dichloropropane	142-28-9	40
1-Chlorohexane	544-10-5	80
1,1,1,2-Tetrachloroethane	630-20-6	40

Table Ap-1. TestAmerica 8260 Reporting Limits – AK Soils

Compound	CAS Number	Medium Soil µg/Kg
Isopropylbenzene	98-82-8	40
Bromobenzene	108-86-1	40
n-Propylbenzene	103-65-1	40
2-Chlorotoluene	95-49-8	40
4-Chlorotoluene	106-43-4	40
1,3,5-Trimethylbenzene	108-67-8	40
tert-Butylbenzene	98-06-6	40
1,2,4-Trimethylbenzene	95-63-6	40
sec-Butylbenzene	135-98-8	40
4-Isopropyltoluene	99-87-6	40
n-Butylbenzene	104-51-8	40
1,2-Dibromo-3-chloropropane	96-12-8	200
1,2,4-Trichlorobenzene	120-82-1	40
Naphthalene	91-20-3	40
Hexachlorobutadiene	87-68-3	40
1,2,3-Trichlorobenzene	87-61-6	40
Propionitrile	107-12-0	400
Cylcohexanone	108-94-1	1,600
Methyl methacrylate	80-62-6	80
Acetonitrile	75-05-8	400
Methacrylonitrile	126-98-7	400
1,2-Dichloro-1,1,2,2-Tetrafluoroethane	76-14-2	160
1,2-Dichloro-1,1,2-trifluoroethane	354-23-4	160
2-Pentanone	107-87-9	600
cis-1,4-Dichloro-2-butene	1476-11-5	400
Cyclohexane	110-82-7	40
Methyl acetate	79-20-9	200
Methylcyclohexane	108-87-2	160
2-Chloro-1,3-butadiene	126-99-8	80
2-Methyl-2-propanol	75-65-0	800

Table Ap-1. TestAmerica 8260 Reporting Limits – AK Soils

Compound	CAS Number	Medium Soil µg/Kg
tert-Butyl ethyl ether	637-92-3	80
1,2,3-Trimethylbenzene	526-73-8	40
Ethyl acetate	141-78-6	80
Ethyl ether	60-29-7	200
Isobutyl alcohol	78-83-1	800
Dichlorofluoromethane	75-43-4	120
Tetrahydrothiophene	110-01-0	40

[1] Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

Table Ap-2

Calibration Levels for 8260, 5035FM_AK (ug/Kg)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
1,1,1,2-Tetrachloroethane	20	40	80	200	600	2000	4000	8000
1,1,1-Trichloroethane	20	40	80	200	600	2000	4000	8000
1,1,2,2-Tetrachloroethane	20	40	80	200	600	2000	4000	8000
1,1,2-Trichloroethane	20	40	80	200	600	2000	4000	8000
1,1-Dichloroethane	20	40	80	200	600	2000	4000	8000
1,1-Dichloroethene	20	40	80	200	600	2000	4000	8000
1,1-Dichloropropene	20	40	80	200	600	2000	4000	8000
1,2,3-Trichlorobenzene	20	40	80	200	600	2000	4000	8000
1,2,3-Trichloropropane	20	40	80	200	600	2000	4000	8000
1,2,4-Trichlorobenzene	20	40	80	200	600	2000	4000	8000
1,2,4-Trimethylbenzene	20	40	80	200	600	2000	4000	8000
1,2-Dibromo-3-chloropropane	20	40	80	200	600	2000	4000	8000
1,2-Dichlorobenzene	20	40	80	200	600	2000	4000	8000
1,2-Dichloroethane	20	40	80	200	600	2000	4000	8000
1,2-Dichloropropane	20	40	80	200	600	2000	4000	8000
1,3,5-Trimethylbenzene	20	40	80	200	600	2000	4000	8000
1,3-Dichlorobenzene	20	40	80	200	600	2000	4000	8000
1,3-Dichloropropane	20	40	80	200	600	2000	4000	8000
1,4-Dichlorobenzene	20	40	80	200	600	2000	4000	8000
1,4-Dioxane	1000	2000	4000	10000	30000	100000	200000	400000
1-Chlorohexane	20	40	80	200	600	2000	4000	8000
2,2-Dichloropropane	20	40	80	200	600	2000	4000	8000
2-Butanone (MEK)	80	160	320	800	2400	8000	16000	32000
2-Chloro-1,3-butadiene (chloroprene)	20	40	80	200	600	2000	4000	8000
2-Chlorotoluene	20	40	80	200	600	2000	4000	8000
2-Hexanone	80	160	320	800	2400	8000	16000	32000
2-Methyl-2-propanol (tert-Butyl alcohol)	400	800	1600	4000	12000	40000	80000	160000
4-Chlorotoluene	20	40	80	200	600	2000	4000	8000
4-Isopropyltoluene	20	40	80	200	600	2000	4000	8000
4-Methyl-2-pentanone	80	160	320	800	2400	8000	16000	32000
Acetone	80	160	320	800	2400	8000	16000	32000
Acetonitrile	200	400	800	2000	6000	20000	40000	80000
Acrolein	200	400	800	2000	6000	20000	40000	80000
Acrylonitrile	200	400	800	2000	6000	20000	40000	80000

Table Ap-2

Calibration Levels for 8260, 5035FM_AK (ug/Kg)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Benzene	20	40	80	200	600	2000	4000	8000
Bromobenzene	20	40	80	200	600	2000	4000	8000
Bromoform	20	40	80	200	600	2000	4000	8000
Bromomethane	20	40	80	200	600	2000	4000	8000
Carbon tetrachloride	20	40	80	200	600	2000	4000	8000
Chlorobenzene	20	40	80	200	600	2000	4000	8000
Chlorobromomethane	20	40	80	200	600	2000	4000	8000
Chlorodibromomethane	20	40	80	200	600	2000	4000	8000
Chloroethane	20	40	80	200	600	2000	4000	8000
Chloroform	20	40	80	200	600	2000	4000	8000
Chloromethane	20	40	80	200	600	2000	4000	8000
cis-1,2-Dichloroethene	20	40	80	200	600	2000	4000	8000
cis-1,3-Dichloropropene	20	40	80	200	600	2000	4000	8000
Cyclohexanone	20	40	80	200	300	1000	2000	4000
Dibromomethane	20	40	80	200	600	2000	4000	8000
Dichlorobromomethane	20	40	80	200	600	2000	4000	8000
Dichlorodifluoromethane	20	40	80	200	600	2000	4000	8000
Ethylbenzene	20	40	80	200	600	2000	4000	8000
Ethylene dibromide (EDB)	20	40	80	200	600	2000	4000	8000
Hexachlorobutadiene	20	40	80	200	600	2000	4000	8000
Iodomethane	20	40	80	200	600	2000	4000	8000
Isopropyl alcohol	400	800	1600	4000	12000	40000	80000	160000
Isopropyl ether	100	200	400	1000	3000	10000	20000	40000
Isopropylbenzene	20	40	80	200	600	2000	4000	8000
m- and p-Xylenes	40	80	160	400	1200	4000	8000	16000
Methacrylonitrile	200	400	800	2000	6000	20000	40000	80000
Methylene chloride	20	40	80	200	600	2000	4000	8000
Naphthalene	20	40	80	200	600	2000	4000	8000
n-Butanol	600	1200	2400	6000	18000	60000	120000	240000
n-Butylbenzene	20	40	80	200	600	2000	4000	8000
n-Propylbenzene	20	40	80	200	600	2000	4000	8000
o-Xylene	20	40	80	200	600	2000	4000	8000
Propionitrile	200	400	800	2000	6000	20000	40000	80000
sec-Butylbenzene	20	40	80	200	600	2000	4000	8000
Styrene	20	40	80	200	600	2000	4000	8000
tert-Butylbenzene	20	40	80	200	600	2000	4000	8000

Table Ap-2

Calibration Levels for 8260, 5035FM_AK (ug/Kg)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Tetrachloroethene	20	40	80	200	600	2000	4000	8000
Tetrahydrothiophene	20	40	80	200	600	2000	4000	8000
Toluene	20	40	80	200	600	2000	4000	8000
trans-1,2-Dichloroethene	20	40	80	200	600	2000	4000	8000
trans-1,3-Dichloropropene	20	40	80	200	600	2000	4000	8000
Trichloroethene	20	40	80	200	600	2000	4000	8000
Trichlorofluoromethane	20	40	80	200	600	2000	4000	8000
Vinyl chloride	20	40	80	200	600	2000	4000	8000

[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

Table Ap-3: 5035FM_AK Calibration Levels (µg/Kg)[1]
(Standards: MV-Supp Std and MV-2 Cleve)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
1,1,1-Trifluoro-2,2-dichloroethane	20	40	80	200	600	2000	4000	8000
1,1,2-Trichloro-1,2,2-trifluoroethane	20	40	80	200	600	2000	4000	8000
1,2,3-Trimethylbenzene	20	40	80	200	600	2000	4000	8000
1,2-Dichloro-1,1,2,2-tetrafluoroethane	20	40	80	200	600	2000	4000	8000
1,2-Dichloro-1,1,2-trifluoroethane	20	40	80	200	600	2000	4000	8000
2-Chloroethy vinyl ether	20	40	80	200	600	2000	4000	8000
2-Nitropropane	20	40	80	200	600	2000	4000	8000
2-Pentanone	80	160	320	800	2400	8000	16000	32000
3-Chloro-1-propene (Allyl chloride)	20	40	80	200	600	2000	4000	8000
Carbon disulfide	20	40	80	200	600	2000	4000	8000
cis-1,4-dichloro-2-butene	20	40	80	200	600	2000	4000	8000
Cyclohexane	20	40	80	200	600	2000	4000	8000
Dichlorofluoromethane	20	40	80	200	600	2000	4000	8000
Ethyl acetate	40	80	160	400	1200	4000	8000	16000
Ethyl ether	20	40	80	200	600	2000	4000	8000
Ethyl methacrylate	40	80	160	400	1200	4000	8000	16000
Ethylene oxide	2500	5000	10000	25000	75000	250000	500000	1000000

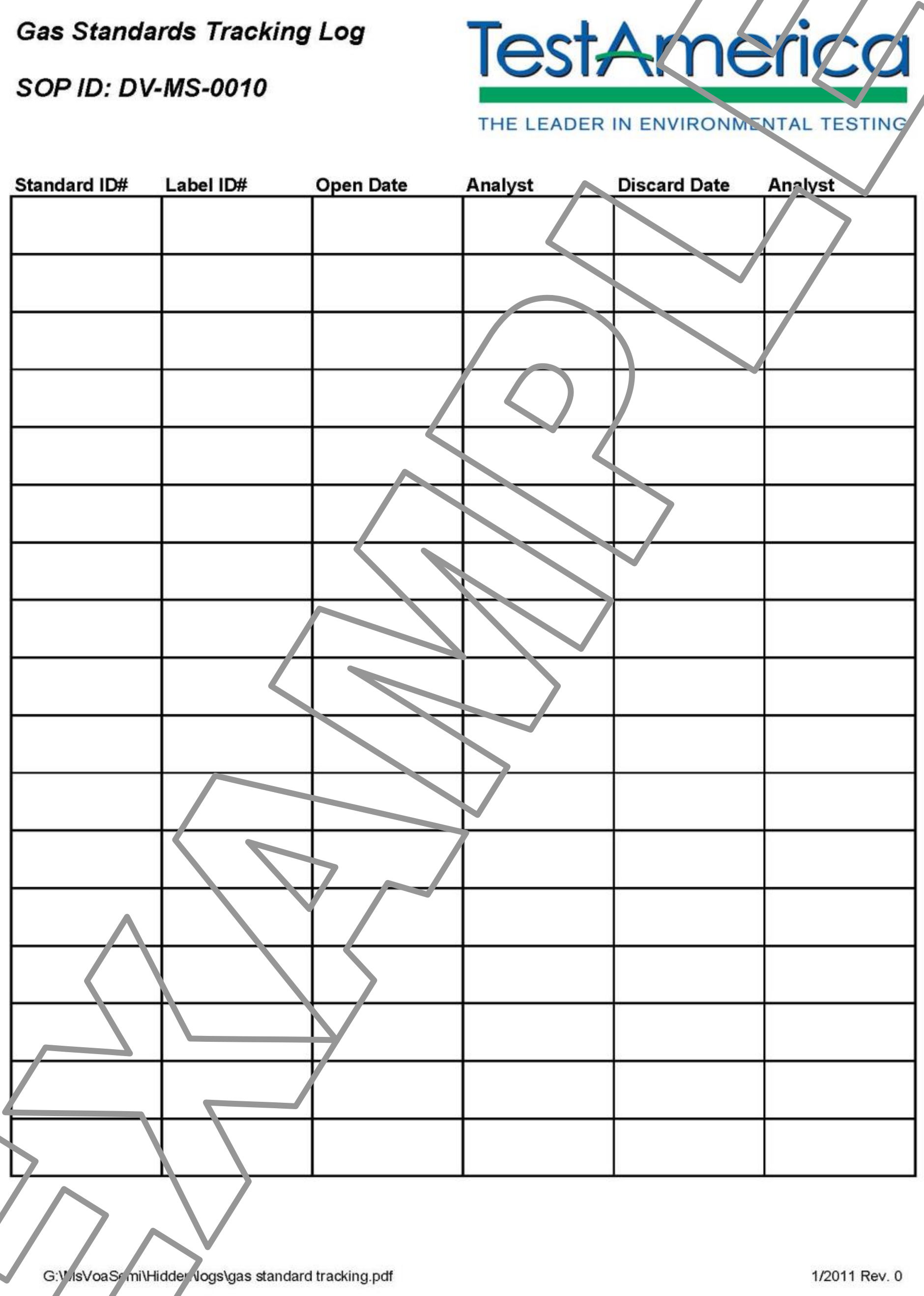
Table Ap-3: 5035FM_AK Calibration Levels (µg/Kg)[1]
(Standards: MV-Supp Std and MV-2 Cleve)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Hexane	20	40	80	200	600	2000	4000	8000
Isobutyl alcohol	400	800	1600	4000	12000	40000	80000	160000
Methyl acetate	100	200	400	1000	3000	10000	20000	40000
Methylcylcohexane	20	40	80	200	600	2000	4000	8000
Methyl methacrylate	40	80	160	400	1200	4000	8000	16000
Methyl *tert*-butyl ether (MTBE)	20	40	80	200	600	2000	4000	8000
Propene oxide	400	800	1600	4000	12000	40000	80000	160000
sec-Butyl alcohol	600	1200	2400	6000	18000	60000	120000	240000
tert-Amyl methyl ether	100	200	400	1000	3000	10000	20000	40000
tert-Butyl ethyl ether	100	200	400	1000	3000	10000	20000	40000
Tetrahydrofuran	40	80	160	400	1200	4000	8000	16000
trans-1,4-dichloro-2-butene	20	40	80	200	600	2000	4000	8000
Vinyl acetate	40	80	160	400	1200	4000	8000	16000

[1] Standards are spiked at all levels. A minimum of 5 points are used for each calibration model. Low points below the RL are routinely dropped and the high point might also be dropped for some analytes.

Attachment 1

Gas Standards Tracking Log



Gas Standards Tracking Log

SOP ID: DV-MS-0010

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Standard ID#	Label ID#	Open Date	Analyst	Discard Date	Analyst

G:\MsVoaSemi\Hidden\logs\gas standard tracking.pdf 1/2011 Rev. 0

TestAmerica Denver

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Title: GC/MS Analysis Based On Method 8270D

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10/31/18
Richard Clinkscales — Date
Laboratory Director

Facility Distribution No. ____________ **Distributed To:** ______________________

1.0 Scope and Application

1.1 This method is based upon standard method SW846 8270D, and is applicable to the determination of the concentration of semivolatile organic compounds in extracts prepared from solid and aqueous matrices.

1.1.1 The modifications presented in Appendix A may be followed for analysis of samples following method 8270D_LL (best practices).

1.1.2 Direct injection of a sample may be used in limited applications.

1.1.3 Refer to Tables 1 and 2 for the list of compounds applicable for this method. Note that the compounds are listed in approximate retention time order. This method may be amenable to additional compounds. If non-standard analytes are required, they must be validated by the procedures described in Section 13 before sample analysis.

1.2 The following compounds may require special treatment when being determined by this method:

1.2.1 Benzidine can be subject to oxidative losses during solvent concentration and exhibits poor chromatography. Neutral extraction should be performed if this compound is expected.

1.2.2 Hexachlorocyclopentadiene is subject to thermal decomposition in the inlet of the gas chromatograph, chemical reaction in acetone solution, and photochemical decomposition.

1.2.3 N-Nitrosodiphenylamine decomposes in the gas chromatographic inlet and cannot be distinguished from diphenylamine.

1.2.4 Pentachlorophenol, 2,4-dinitrophenol, 4-nitrophenol, 4,6-dinitro-2-methylphenol, 4-chloro-3-methylphenol, benzoic acid, 2-nitroaniline, 3-nitroaniline, 4-chloroaniline, and benzyl alcohol are subject to erratic chromatographic behavior, especially if the GC system is contaminated with high boiling material.

1.2.5 3-Methylphenol cannot be separated from 4-methylphenol by the conditions specified in this method. They are reported as 3&4-methylphenol.

1.2.6 Hexachlorophene analysis is not quantitatively reliable by this method, as it is calibrated using a single-point calibration on the day of sample analysis.

1.2.7 Kepone should be analyzed by GC/ECD.

1.2.8 Azobenzene is formed by decomposition of 1,2-diphenlyhydrazine. If 1,2-diphenylhydrazine is requested, it will be analyzed as azobenzene.

1.3 The standard reporting limit (SRL) of this method for determining an individual compound is approximately 0.33 – 3.3 mg/kg (wet weight) for soil/sediment samples, 1 - 200 mg/kg for wastes (dependent on matrix and method of preparation), and 1-100 µg/L for groundwater samples. Some compounds have higher reporting limits. Refer to Tables 1 and 2 for specific SRLs. Reporting limits will be proportionately higher for sample extracts that require dilution. Reporting limits are adjusted for dry weight for soil samples.

2.0 Summary of Method

2.1 Aqueous samples are extracted with methylene chloride using a continuous extractor or a separatory funnel.

2.1.1 TestAmerica Denver performs extractions using either a one liter sample aliquot or a 250 mL aliquot. The extract is dried, concentrated to 1 mL and analyzed by GC/MS. Samples extracted using 250 mL are analyzed following the Large Volume Injection (LVI) procedures described in this SOP.

2.1.2 LVI is used only for aqueous samples. It is utilized to maintain reporting limits while reducing the initial volume of the sample required for extraction. The extraction procedure is the same, proportionately adjusting only sample size, spike concentrations and volume of extraction solvent. South Carolina requires a separate certification for LVI.

2.2 Solid samples are extracted with methylene chloride / acetone using sonication. The extract is dried, concentrated to a volume of 1 mL, and analyzed by GC/MS.

2.3 Waste dilution is used for samples that are miscible with the solvent.

2.4 Extraction procedures are detailed in the following SOPs:

DV-OP-0006	Extraction of Aqueous Samples by Separatory Funnel, SW846 3510C and EPA 600 Series
DV-OP-0007	Concentration of Organic Extracts, SW846 3510C, 3520C, 3540C, 3550B, 3550C, 3660B, 3665A and EPA 600 Series
DV-OP-0008	Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C and Method 625
DV-OP-0012	Waste Dilution Preparation for Non-Aqueous Waste Samples, SW-846 3540C
DV-OP-0016	Ultrasonic Extraction of Solid Samples, SW846 3550C

2.5 Qualitative identification of the analytes in the extract is performed using the retention time and the relative abundance of characteristic ions. Quantitative analysis is performed using the internal standard technique with a single characteristic ion and a minimum of a five-point calibration curve.

2.6 For LVI, the GC/MS analysis is the same with the exception of the injection liner, injection volume and standard concentrations.

3.0 Definitions

3.1 Batch - The batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same time period. The Quality Control batch must contain a matrix spike / matrix spike duplicate (MS/MSD), a Laboratory Control Sample (LCS), and a method blank (MB). If it is not possible to prepare both an MS and MSD due to limitations of sample amount, then a duplicate LCS should be prepared and analyzed. The RPD between the LCS and LCSD must be less than or equal to the RPD limit established for the MS/MSD.

3.2 Batches are defined at the sample preparation stage. Batches should be kept together through the whole analytical process to the extent possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. Refer to the TAL QC Program document (DV-QA-003P) for further details of the batch definition.

3.3 Method Blank (MB) - An analytical control consisting of all reagents, internal standards and surrogate standards that is carried through the entire analytical procedure. The method blank is used to define the level of laboratory background and reagent contamination.

3.4 Laboratory Control Sample (LCS) - A blank matrix (reagent water or Ottawa Sand) spiked with the analytes of interest that is carried through the entire analytical procedure. Analysis of this sample with acceptable recoveries of the spiked analytes demonstrates that the laboratory techniques for this method are acceptable.

3.5 Matrix Spike (MS) – An aliquot of a matrix (water or soil) fortified (spiked) with known amounts of specific analytes and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

3.6 Matrix Spike Duplicate (MSD) - A second aliquot of the same sample as the matrix spike (above) that is spiked in order to determine the precision of the method by measuring the relative percent difference (RPD) between the MS and MSD results.

3.7 Surrogates - Organic compounds which are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples. Each sample, blank, LCS, MS, and MSD is spiked with surrogate standards. Surrogate spike recoveries must be evaluated by determining whether the concentration (measured as percent recovery) falls within the required recovery limits.

4.0 Interferences

4.1 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the sample. Cleanup procedures may help to eliminate select interferences, as follows:

- Method 3640A, Gel-Permeation Chromatography (GPC) - Removes higher molecular weight hydrocarbons by size exclusion chromatography, which is most frequently used for biological samples (TestAmerica Denver does not have a GPC unit).

- Method 3660B, Sulfur Cleanup – If a sulfur peak is detected, copper or mercury can be used to treat the extract and remove the sulfur.

- Other, more aggressive cleanup procedures listed in SW-846 may be used for select compounds listed in this procedure, but may cause degradation of some of the more reactive compounds. Consult with a technical expert in the laboratory for more difficult interference problems.

Details concerning cleanup steps are described in the organic extraction SOP DV-OP-0007.

4.2 Contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts may cause method interferences. All of these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section (Section 9.3). Raw GC/MS data from all blanks, samples, and spikes must be evaluated for interferences. If an interference is detected, it is necessary to determine if the source of interference is in the preparation and/or cleanup of the samples; then take corrective action to eliminate the problem.

4.3 The use of high purity reagents, solvents, and gases helps to minimize interference problems.

4.4 Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe must be rinsed with solvent between samples. Whenever an unusually concentrated sample is encountered, it should be followed by the analysis of solvent to check for cross contamination.

4.5 Phthalate contamination is commonly observed in this analysis and its occurrence should be carefully evaluated as an indicator of a contamination problem in the sample preparation step of the analysis.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

NOTE: Latex and vinyl gloves provide no protection against the organic solvents used in this method. Nitrile or similar gloves must be used.

5.3.2 The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.

5.3.3 The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.

5.3.4 There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power before performing any maintenance.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Materials with Significant or Serious Hazard Rating

Material	Hazards	Exposure Limit (1)	Signs and Symptoms of Exposure
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
(1) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Gas chromatograph/mass spectrometer system: an analytical system complete with a temperature-programmable gas chromatograph suitable for split/splitless injection and all required accessories, including syringes, analytical columns, and gases. The capillary column should be directly coupled to the source.

6.2 Column: 30 m x 0.25 mm I.D., 0.5-µm film thickness fused-silica capillary column coated with 5% diphenyl/95% dimethyl polysiloxane (Agilent VF 5MS). Alternate columns are acceptable if they provide acceptable performance.

6.3 Mass Spectrometer: Capable of scanning from 35 to 500 u (previously "amu") every one second or less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The mass spectrometer must be capable of producing a mass spectrum for decafluorotriphenylphosphine (DFTPP) that meets all of the criteria in Table 4 when 25 ng of the GC/MS tuning standard is injected through the GC.

6.4 Autosampler: HP7683 Autosampler or equivalent.

6.5 GC/MS Interface: Any GC-to-MS interface that gives acceptable calibration points and achieves acceptable tuning performance criteria may be used.

6.6 Data System: A computer system must be interfaced to the mass spectrometer. The system must allow the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that can search any GC/MS data file for ions of a specific mass and that can plot such ion abundances versus time or scan number. This type of plot is defined as the Extracted Ion Current Profile (EICP). Software must also be available that allows integrating the abundances in any EICP between specified time or scan-number limits. The most recent version of the EPA/NIH Mass Spectral Library is recommended.

6.7 Syringe: 5 µL or 10 µL Hamilton Laboratory grade syringes or equivalent. The 5 µL syringe is used for the Agilent ALS to be able to inject 0.5 µL and either the 5 µL or 10 µL syringe is commonly used for the Large Volume Injection

6.8 Sample Aliquot Equipment: laboratory grade syringes and pipettes as appropriate to dilute and aliquot extracts. Also, amber glass aliquot vials with polytetrafluoroethylene (PTFE)-lined screw or crimp caps and suitable for use with autosampler.

6.9 Carrier gas: Ultra high-purity helium.

6.10 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\|Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Methylene Chloride, equivalent to pesticide quality or better, used to dilute samples as needed.

7.2 Stock standards are received from the vendor in multiple mixtures for each set of calibration standards, for both primary ICAL standards and second source verification standards. Other standards may be used to accommodate client-specific target lists or reporting limit requirements.

7.2.1 Surrogate Standards:

Restek 567685	Surrogates at 5000 ug/mL

7.2.2 Internal Standards:

Restek 567684	Internal Standards at 2000 ug/mL

7.2.3 HSL (Primary) Standards:

Restek 567672	Mega Mix at 1000 ug/mL
Restek 567673	Amine Mix at 2000 ug/mL
Restek 567674	Benzoic Acid at 2000 ug/mL
Restek 567675	Indene at 2000 ug/mL
Restek 568023	Famphur at 2000 ug/mL
Restek 568033	HSL Custom Mix at 4000 ug/mL
Restek 568038	N-Nitrosodiphenylamine at 2000 ug/mL

7.2.4 AP9 Standards:

Restek 567678	Supplemental Standard 1 at 1000 ug/mL
Restek 567679	List 2 Standard 2 at 1000 ug/mL
Restek 567680	List 2 Standard 3 at 2000 ug/mL
Restek 567681	List 2 Standard 4 at 1000 ug/mL
Restek 567682	List 2 Standard 5 at 2000 ug/mL
Accustandard H-173N	Dibenz[a,j]acridine, neat

7.2.5 Benzaldehyde Standards:

Restek 567677	Benzaldehyde at 2000 ug/mL

7.2.6 Hexachlorophene Standards:

Restek 31811	Hexachlorophene at 2000 ug/mL

7.3 A minimum of seven calibration standards are typically prepared. A minimum five-point calibration curve is prepared when average response factors or linear regression curve fitting is used. Six calibration points are required for second-order curve fits. The low point should be at or below the reporting limit. Refer to Tables 10 and 11 for typical calibration levels for all analytes by the standard volume method. Other calibration levels may be used, depending on instrument capability, but the low standard must support the reporting limit and the high standard defines the range of the calibration. Tables LVI-1, and LVI-2 provide calibration levels for the LVI procedure.

7.4 An internal standard (IS) solution is prepared. Compounds in the IS Mix are acenaphthene-d_{10}, chrysene-d_{12}, 1,4-dichlorobenzene-d_4, naphthalene-d_8, perylene-d_{12}, and phenanthrene-d_{10}.

7.4.1 Internal standards are added to all standards and extracts to result in a final concentration of 40 µg/mL. For example, if the volume of an extract aliquot used was 200 µL, 20 µL of a 400 µg/mL internal standard solution would be added to the aliquot.

7.4.2 See Appendix B for the levels used for the 8270 best practice method.

7.5 Surrogate Standard Spiking Solution: Prepare as indicated in the extraction SOPs (refer to Section 2.4 for extraction SOPs numbers). Surrogate compounds and levels are listed in Table 9.

Acid Surrogates	Base Surrogates
2-Fluorophenol	2-Fluorobiphenyl
2,4,6-tribromophenol	Terphenyl-d_4
Phenol-d_5	Nitrobenzene-d_5
2-chlorophenol-d_4[1]	1,2,-Dichlorobenzene-d_4[1]

[1] These two surrogates are in the mix but are not evaluated or reported.

7.6 GC/MS Tuning Standard: A methylene chloride solution containing 50 µg/mL of decafluorotriphenylphosphine (DFTPP) is prepared. Pentachlorophenol, benzidine, and DDT should also be included in the Tuning Standard at 50 µg/mL.

7.7 Laboratory Control Spiking Solution: Prepare as indicated in the extraction SOPs (refer to Section 2.4 for extraction SOPs). LCS compounds and levels are listed in Table 7.

7.8 Matrix Spike Solution: Prepare as indicated in the extraction SOPs (refer to Section 2.4 for extraction SOPs). The matrix spike compounds and levels are the same as the LCS compounds.

7.9 The standards listed in sections 7.1 to 7.8 must be stored at -10°C to -20°C if it can be demonstrated that analytes do not fall out of solution at these temperatures. If not stable, the standards should be stored between 0°C and 6°C. The standard stock solutions expire after one year from preparation date or at the earliest expiration date assigned by the vendor to any parent standard, whichever is earlier. The continuing calibration standard should be replaced when there are visible signs of degradation or when the standard fails to meet QC criteria. The continuing calibration standard is stored at -10°C to -20°C.

8.0 <u>Sample Collection, Preservation, Shipment and Storage</u>

Matrix	Sample Container	Min. Sample Size	Preservation	Extraction Holding Time	Analysis Holding Time	Reference
Water	1 liter amber	1 Liter	Cool, $\leq$ 6°C and not frozen	7 Days	40 Days from extraction	40 CFR Part 136.3 and SW846 Chapter 4
Water[1]	250 mL amber	250 mL	Cool, $\leq$ 6°C and not frozen	7 Days	40 Days from extraction	40 CFR Part 136.3 and SW846 Chapter 4
Soil	4 oz Jar	30 grams	Cool, $\leq$ 6°C and not frozen	14 Days	40 Days from extraction	SW846 Chapter 4

[1] Samples extracted using 250 mL are analyzed following the LVI procedure.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Table 16 details the components of the DoD QSM 5.0 and DoE QSAS 3.0 that are different from TestAmerica Denver's standard procedures, for further details, see DV-QA-024P. Also listed are the variances that TestAmerica is requesting for this analysis; these alternate criteria are only used with project-specific approval.

9.1.4 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.5 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

9.2.1 Before analyzing samples, the laboratory must establish a method detection limit (MDL). See Section 13 for a discussion of detection limit studies.

9.2.2 In addition, an initial demonstration of capability (IDOC) must be performed by each analyst. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 13 for more details.

9.3 Control Limits

9.3.1 In-house historical control limits must be determined for surrogates, matrix spikes, and laboratory control samples (LCS). These limits are determined periodically (See SOP DV-QA-003P). The recovery limits are the mean recovery ±3 standard deviations for surrogates, MS, and LCS. The Precision limit for the MS/MSD pair results is the absolute value of the mean relative percent difference (RPD) +3 standard deviations.

9.3.2 These limits do not apply to dilutions, but surrogate and matrix spike recoveries will be reported unless the dilution is 4x or more.

9.3.3 All surrogate, LCS, and MS recoveries (except for dilutions) must be entered into the LIMS or other database so that accurate historical control limits can be generated. For multiple dilutions reported from the same extract, surrogates will be reported for all dilutions of less than 4x. For tests without a separate extraction, surrogates and matrix spikes will be reported for all dilutions.

9.3.4 Refer to the QC program document, DV-QA-003P, for further details of control limits.

9.4 Method Blank (MB)

For aqueous sample batches, the method blank is reagent water; for solid sample batches, the method blank is clean sand. In either case, the method blank is free of the analytes of interest and is spiked with the surrogates. At least one method blank must be processed with each preparation batch.

Acceptance Criteria: The result for the method blank must be less than ½ of the reporting limit or less than 10% of the analyte concentration found in the associated samples, whichever is higher. When a compound is above ½ the reporting limit an NCM needs to be completed.

NOTE: All programs require that the maximum blank concentration must be less than one-half of the reporting limit or less than 10% of the lowest sample concentration.

Corrective Action: Re-preparation and reanalysis of all samples associated with an unacceptable method blank. If the analyte was not detected in the samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative.

9.5 Instrument Blank

Instruments must be evaluated for contamination during each 12-hour analytical run. This may be accomplished by analysis of a method blank. If a method blank is not available, an instrument blank must be analyzed. An instrument blank consists of methylene chloride with the internal standards added. It is evaluated in the same way as the method blank (see Section 9.4).

9.6 Laboratory Control Sample (LCS)

The LCS is prepared using reagent water for aqueous methods and Ottawa sand for solid sample methods. A laboratory control sample (LCS) is prepared and analyzed with every batch of samples. The LCS is spiked with the compounds listed in Tables 7 and 8 unless specified by a client or agency. The compounds must be spiked at a concentration equivalent to 80 µg/L, unless a special QAS states a specific level. The LVI method uses the same concentration of analytes for the LCS. Ongoing monitoring of the LCS provides evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision.

Acceptance Criteria: All analytes must be within established control limits. See QC Policy DV-QA-003P for details on establishing control limits.

Corrective Action: If any analyte in the LCS is outside the laboratory-established historical control limits or project-specific control limits, as applicable, corrective action must occur. Corrective action may include re-extraction and reanalysis of the batch.

- If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. An example of acceptable reasons for not reanalyzing might be that the matrix spike and matrix spike duplicate are acceptable, and sample surrogate recoveries are good, demonstrating that the problem was confined to the LCS. This type of justification should be reviewed and documented with the client before reporting.
- If re-extraction and reanalysis of the batch are not possible due to limited sample volume or other constraints, the failed LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.
- Use of Marginal Exceedance is not allowed for South Carolina Compliance samples

9.7 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The matrix spike is a second aliquot of one of the samples in the batch. The matrix spike duplicate is a third aliquot of the same sample. The MS and MSD are spiked with the same analytes as the LCS (See Tables 7 and 8). An MS/MSD pair is prepared and analyzed with every batch of samples.

Acceptance Criteria: The MS and MSD recoveries and the relative percent difference (RPD) between the MS and MSD results must be within the established control limits. Percent recovery control limits are set at ± 3 standard deviations around the historical mean of the LCS recovery data, unless otherwise dictated by the client or project. The RPD control limit is set at 3 standard deviations above the mean of the historical data.

NOTE: DOD QSM 5 limits apply to projects performed under this program.

Corrective Actions: The information obtained from MS data are sample/matrix specific and are not normally used to determine the validity of the entire batch. If the MS and/or MSD recovery falls outside of the established control limits, the bracketing CCV and batch LCS recoveries must be within control limits in order to accept results for the associated samples. The following corrective actions are required for MS/MSD recovery failures to rule out lab error:

- Check calculation and instrument performance;
- Verify, if possible, that the MS and MSD were spiked correctly (e.g., very low or very high recoveries);
- Consider objective evidence of matrix interference (e.g., heterogeneous sample, interfering peaks seen on chromatograms, or interference demonstrated by prior analyses);
- Flag the data for any results outside of acceptance limits.
- For any single RPD failure, check calculations; verify, if possible, that the MS and MSD were spiked correctly; check instrument performance; consider objective evidence of matrix interference or sample inhomogeneity; and flag the data.
- If both the parent sample and associated matrix spike results are over range the parent and the spikes shall be diluted by the same amount and the results from the reanalysis reported for both. If the analyte concentration in the parent sample is greater than four times the concentration of spike added, then spike recovery results are not compared to control limits, and the recovery is either reported as “NC” (not calculated) or with a qualifier flag to indicate that the spike was less than four times the analyte concentration in the sample. If the dilution will cause the spike to be less than two times the reporting limit, the MS/MSD do not need to be diluted and the recovery reported as “NC” (not calculated).
- For MS/MSD that serve as batch QC, if the parent sample result is within the calibration range and the MS/MSD results are above the calibration range, the results are reported with the MS/MSD result being flagged as an over-range measurement (e.g., the E-flag qualifier).
- If the MS/MSD are client requested, the parent sample result is within calibration range and the MS/MSD results are above the calibration range, the sample and spike should be diluted, keeping in mind that we need to assess whether or not the dilution will best serve the client’s needs. Consult with the PM as needed. Both the parent sample and MS/MSD samples must have the same dilution factor. Some EDDs do not accept data that are at different dilution factors.
- If the native analyte concentration in the MS/MSD sample exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated) and the appropriate qualifier flags are added.

NOTE: See Denver Policy Memorandum P16-001 and Corporate Policy Memorandum CA-Q-QM-013 for more detail.

NOTE: Some client programs require reanalysis to confirm matrix interferences. Check special project requirements for this corrective action.

9.8 Surrogates

9.8.1 Each sample, blank, and QC sample is spiked with the surrogate standards. Surrogate compounds must be spiked at 100 ug/L for standard injection or 25 ug/L for LVI. The compounds routinely included in the surrogate spiking solution, along with recommended standard concentrations, are listed in Table 9. For the Best Practice method, see Table A-4 in Appendix A.

Acceptance Criteria: Surrogate spike recoveries must be evaluated by determining whether the concentration (measured as percent recovery) falls within the required recovery limits.

Corrective Action: If any surrogates are outside of the limits, then the following corrective actions must take place (except for dilutions):

- Check all calculations for error.
- Ensure that instrument performance is acceptable.
- Recalculate the data and/or reanalyze the extract if either of the above checks reveals a problem.
- Re-extract and reanalyze the sample or flag the data as “Estimated Concentration” if neither of the above resolves the problem.

NOTE: The decision to reanalyze or flag the data for failed QC should be made in consultation with the client. It is only necessary to reprepare / reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out-of-control results are not due to matrix effect.

9.8.2 If the sample with failed surrogate recoveries was a sample used for an MS/MSD pair and the surrogate recoveries in the MS/MSD are also outside of the control limits, then the sample and the MS and the MSD do not require reanalysis. This phenomenon indicates a possible matrix problem.

9.8.3 If the sample is reanalyzed and the surrogate recoveries in the reanalysis are acceptable, then the problem was within the analyst's control and only the reanalyzed data should be reported. (If the re-analysis was outside holding times, both sets of results may be reported, with appropriate flags and discussion in the case narrative. Consult client and/or program specifications for reporting requirements.)

9.8.4 If the reanalysis does confirm the original results, the original analysis is reported and the data flagged as estimated due to matrix effects.

9.9 Internal Standards

9.9.1 The peak areas of the internal standards are monitored in all field and QC samples.

Acceptance Criteria: The peak area for each internal standard should be between 50% and 200% of the peak area for the designated midpoint calibration (“ICIS”) standard in the initial calibration. This is typically the 80 ppm standard for standard 8270D and the 20 ppm standard for LVI.

Corrective action: If recovery for any internal standard is outside of the control limits, check for calculation errors or instrument problems, and reanalyze the associated samples at a dilution for the compounds quantified against the internal standard that was outside of control limits.

9.9.2 The retention times of the internal standards are monitored in all field samples and QC samples.

Acceptance Criteria: The retention time for any internal standard must be within +/- 0.5 minutes of the last continuing calibration standard.

Corrective Action: If the retention time of any internal standard is greater than +/- 0.5 minutes the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed if the retention time is outside of limits is required. If the retention time of any internal standard is between +/-0.1 minutes and +/-0.5 minutes, from the preceding continuing calibration standard, the data must be carefully evaluated to ensure that no analytes have shifted outside their retention time windows.

10.0 <u>Procedure</u>

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preparation

Samples are prepared according to the following organic preparation SOPs, as applicable:

DV-OP-0006	Extraction of Aqueous Samples by Separatory Funnel, SW846 3510C and EPA 600 Series
DV-OP-0007	Concentration of Organic Extracts, SW846 3510C, 3520C, 3540C, 3550B, 3550C, 3660B, 3665A and EPA 600 Series
DV-OP-0008	Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C and Methods 625 and 607
DV-OP-0016	Ultrasonic Extraction of Solid Samples, SW846 3550C

10.4 Sample Analysis Procedure

10.4.1 Calibrate the instrument as described in Section 11. Depending on the target compounds required by the client, it may be necessary to use more than one set of calibration standards.

10.4.2 All samples must be analyzed using the same instrument conditions as the preceding continuing calibration verification (CCV) standard. Extracts are allowed to warm to room temperature before aliquotting. Excess extract is returned to the ≤6°C refrigerator for storage.

10.4.3 Internal Standard

Add internal standard to an aliquot of the extract to result in a 40-ng/µL concentration (for example, 20 µL of internal standard solution at 400 µg/mL in 200 µL of extract). Mix thoroughly before injection into the instrument.

10.4.4 Inject the aliquot into the GC/MS system using the same injection technique as used for the standards.

10.4.4.1 For standard volume extracts the injection volume is 0.5 µL using a 5 µL syringe.

10.4.4.2 For LVI, the injection volume is 2.5 µL using either a 5 µL or a 10 µL syringe.

10.4.5 The data system will determine the concentration of each analyte in the extract using calculations equivalent to those in Section 12. Quantitation is based on the initial calibration, not the continuing calibration verification.

10.4.6 Identified compounds are reviewed for proper integration. Manual integrations are performed if necessary and are documented by the analyst (see DV-QA-0033, Acceptable Manual Integration Practices) or automatically by the data system. The minimum documentation required includes a chromatogram of original data system peak integration and a similarly scaled chromatogram showing the manual integration with analyst initials, date and reason for manually integrating.

10.4.7 Target compounds identified by the data system are evaluated using the criteria listed in Section 12.1.

10.4.8 Library searches of peaks present in the chromatogram that are not target compounds, i.e., Tentatively Identified Compounds (TIC), may be performed if required by the client. They are evaluated using the criteria in Section 12.2.

10.4.9 The internal standard response in the sample must be within 50 - 200% of the response in the CCV.

10.4.10 Structural isomers that produce very similar mass spectra should be quantitated as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 50% of the average of the two peak heights.

10.5 Dilutions

If the response for any compound exceeds the working range of the GC/MS system, a dilution of the extract is prepared and analyzed. An appropriate dilution should be in the upper half of the calibration range. Samples may be screened to determine the appropriate dilution for the initial run. If the initial diluted run has no hits or hits below 20% of the calibration range and the matrix allows for analysis at a lesser dilution, the sample must be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.

10.5.1 Guidance for Dilutions Due to Matrix

If the sample is initially run at a dilution and the baseline rise is less than the height of the internal standards, or if individual non-target peaks are significantly less than two times the height of the internal standards, the sample should be reanalyzed at a more concentrated dilution. This requirement is approximate and subject to analyst judgment. For example, samples containing organic acids may need to be analyzed at a higher dilution to avoid destroying the column.

10.5.2 Reporting Dilutions

The most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions will be reported only at client request.

10.6 Perform all qualitative and quantitative measurements. When the extracts are not being used for analyses, refrigerate them at $\leq$ 6°C, protected from light in screw cap vials equipped with unpierced Teflon lined septa.

10.7 Retention Time Criteria for Samples

10.7.1 If the retention time for any internal standard changes by more than 0.5 minutes from the last continuing calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required.

10.7.2 If the retention time of any internal standard in any sample varies by more than 0.1 minute from the preceding continuing calibration standard, the data must be carefully evaluated to ensure that no analytes have shifted outside their retention time windows.

10.8 Percent Moisture

Analytical results may be reported as dry or wet weight, as required by the client. Percent moisture must be determined if results will be reported as dry weight. Refer to SOP DV-WC-0023 for determination of percent moisture.

10.9 Data Review

10.9.1 All data are reviewed by the analyst, Level 1 Data Review, and documented on a checklist, GCMS-BNA TALS Data Review. See SOP DV-QA-0020 and DV-WI-0025.

10.9.2 The data package and review checklist are submitted to a peer reviewer (or supervisor) for the level 2 review. All manual integrations must be evaluated by the peer reviewer. The level 2 review is documented on the review checklist initiated at the level 1 review. See SOP DV-QA-0020 and DV-WI-0025.

10.10 Troubleshooting Guide

10.10.1 Daily Instrument Maintenance

In addition to the checks listed in Appendix B, the following daily maintenance should be performed.

- Clip column as necessary.
- Install new or cleaned injection port liner as necessary.
- Install new septum as necessary.
- Install new or cleaned gold seal and washer as necessary.
- Perform mass calibration as necessary.

10.10.2 Major Maintenance

A new initial calibration is necessary following certain maintenance procedures. These maintenance procedures include changing the column, cleaning the repeller, cleaning the source, replacing the multiplier, and replacing the “top board” or RF-related electronics. Refer to the manufacturer's manual for specific guidance.

11.0 Calibration

11.1 Summary

The instrument is tuned for DFTPP, calibrated initially with a minimum of a five levels, and verified each 12-hour shift with one or more continuing calibration standard(s). Recommended instrument conditions for both the standard analysis and LVI are listed in Table 3.

11.2 All standards and extracts are allowed to warm to room temperature before injecting.

11.3 Instrument Tuning

11.3.1 At the beginning of every twelve-hour shift when analyses are to be performed, the GC/MS system must be checked to see if the acceptance criteria are achieved for DFTPP (decafluorotriphenylphosphine), see Table 4. The mass spectrum is acquired with three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is required, and must be accomplished using a single scan acquired within 20 scans of the elution of DFTPP. The background subtraction should be designated only to eliminate column bleed or instrument background ions. Do not subtract part of the DFTPP peak or any other discrete peak that does not co-elute with DFTPP.

11.3.2 Inject 25 ng of the GC/MS tuning standard (Section 7.6) into the GC/MS system. Obtain a background-corrected mass spectra of DFTPP and confirm that all the key m/z criteria in Table 4 are achieved. If all the criteria are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are achieved. The performance criteria must be achieved before any samples, blanks, or standards are analyzed.

11.3.3 The GC/MS tuning standard should also be used to evaluate the inertness of the chromatographic system. The acceptance criteria for the peak tailing factor for benzidine is < 2.0 and pentachlorophenol is < 2.0. DDT breakdown to DDD and DDE must be <20%. Refer to section 12 for the appropriate calculations.

11.4 Initial Calibration

11.4.1 Detailed information regarding calibration models and calculations can be found in Corporate SOP CA-Q-P-003 *Calibration Curves and the Selection of Calibration Points* and in the corporate memorandum CA-Q-QM-009*, Quality Control Requirements for SW-846 Method 8270D.*

11.4.2 Internal Standard (IS) Calibration Procedure: Internal standards are listed in Table 5. Use the base peak m/z as the primary m/z for quantitation of the standards. If interferences are noted, use one of the next two most intense masses for quantitation.

11.4.3 Compounds are typically assigned to the IS with the closest retention time. The laboratory tries to maintain consistent internal standard references across instruments. As a result, there may be a few cases where compounds are very close to two different internal standards that this is not true.

11.4.4 Evaluation of retention times – The retention time (RT) of each target analyte in each calibration standard should agree within 0.5 minutes.

11.4.5 A minimum of seven calibration standards are typically prepared, however, the number of calibration points may vary. A minimum of five concentration levels for each parameter of interest when average response factors or linear regression curve fits are used. Six standards must be used for a quadratic least-squares calibration. It may also be useful to analyze six or seven calibration levels and use the lower five or six for most analytes and the upper five or six for analytes that have poor response.

11.4.6 Rejection of Calibration Points

11.4.6.1 Generally, it is NOT acceptable to remove points from a calibration. If calibration acceptance criteria are not met, the normal corrective action is to examine conditions such as instrument maintenance and accuracy of calibration standards. Any problems must be fixed and documented in the run log or maintenance log. Then the calibration standard(s) must be reanalyzed.

11.4.6.2 If no problems are found or there is documented evidence of a problem with a calibration point (e.g., obvious misinjection explained in the run log), then one point might be rejected, but only if all of the following conditions are met:

- The rejected point is the highest or lowest on the curve, i.e., the remaining points used for calibration must be contiguous; and
- The lowest remaining calibration point is still at or below the project reporting limit; and
- The highest remaining calibration point defines the upper concentration of the working range, and all samples producing results above this concentration are diluted and reanalyzed; and
- The calibration must still have the minimum number of calibration levels required by the method, i.e. five levels for calibrations modeled with average response factors or linear regressions, or six levels for second-order curve fits.

11.4.7 Internal Standards

For analysis of standard volume extraction or soil add the internal standard mixture to result in a 40-ng/µL final concentration. (For example, if the volume of the calibration standard used is 0.5 mL, add 50 µL of the 400 µg/mL internal standard).

11.5 The concentrations of all analytes in the calibration standards are listed in Tables 10 and 11. For the Best Practice method, see Table A-1 in Appendix A. For LVI see Tables LVI-1 and LVI-2

11.6 Analyze each calibration standard and tabulate the area of the primary characteristic m/z against the concentration for each compound and internal standard. Calculate the response factors (RF), average response factors, and the percent RSD of the response factors for each compound using the equations in section 12. No sample analysis may be performed unless the following criteria are met. See Table 15 for DoD QSM 5.0 criteria. For DoD work, the criteria in Table 15 take precedence over the method criteria.

NOTE: Second order curves are not allowed for South Carolina work.

11.6.1 The RSD must be < 20% for each compound of interest.

11.6.1.1 If the RSD in the initial calibration is > 20%, then calibration using a curve fit must be used for those analytes with RSD > 20%. Linear or quadratic curve fits may be used. Use of a weighted regression is recommended to improve the accuracy of quantitation at the low end of the curve. The analyst should consider instrument maintenance to improve the linearity of response.

NOTE: For DoD QSM 5.0, the initial calibration requirement for RSD is 15%. If this criterion is not met, linear or quadratic curve fits must be used.

11.6.1.2 If a linear regression equation is used, the correlation coefficient r must be greater than 0.995 (equivalent to r^2 greater than 0.990). Use of second-order regression equations may be used on rare occasions. In these cases, the intercept and degree of curvature should be examined to be sure that results will be reliable throughout the working range, and the coefficient of determination r^2 must be greater than 0.990.

11.6.1.3 If more than 10% of the compounds included with the initial calibration exceed the 20% RSD limit and do not meet the minimum requirements for alternate curve fits, then the chromatographic system is considered too reactive for analysis to begin. Clean or replace the injector liner and/or column, then repeat the calibration procedure.

11.6.2 Any individual analyte that fails both 20% RSD and the alternate curve fit criteria must have any positive result flagged as estimated (or can be noted in the narrative). This flagging of positive results is undesirable – every effort should be made to reanalyze on an instrument with a passing calibration.

11.6.3 Non-detect results for any analyte that fails both 20% RSD and 0.990 correlation coefficient may be reported without flagging if (and only if) there has been a successful analysis of a LLCCV (CCV at the reporting limit) in the same analytical batch. The LLCCV must be detected for the analyte and qualitative identification criteria in the method must be met.

NOTE: No more than one or two of the poorest performing analytes should fail both 20% RSD and 0.990 correlation. If several analytes fail both criteria, corrective action should include instrument and column maintenance and recalibration.

11.6.4 The minimum response factor for the most common target analytes from Table 14 must be met.

11.6.5 Weighting of Calibration Data Points

In a linear or quadratic calibration fit, the points at the lower end of the calibration curve have less weight in determining the curve generated than points at the high concentration end of the curve. However, in environmental analysis, accuracy at the low end of the curve is very important. For this reason, it is preferable to increase the weighting of the lower concentration points. 1/Concentration or 1/Concentration^2 weighting (often called 1/x or 1/x^2 weighting) will improve accuracy at the low end of the curve and should be used if the data system has this capability.

11.6.6 Acceptance criteria independent of calibration model

Either of the procedures Percent Error or Relative Standard Error (RSE) may be used to determine calibration function acceptability for linear and non-linear curves. Both evaluate the difference between the measured and the true amounts or concentrations used to create the model.

$$\%\ Error = \frac{xi - x'i}{xi} x\ 100$$

Where: $x'i$ = measured amount of the analyte at calibration level *i* in mass or concentration units and xi = the true amount of the analyte at calibration level *i* in mass or concentration units.

% Error should be ≤ 30%. For some data uses ≤ 50% may be acceptable for the lowest calibration point.

Calculation of Relative Standard Error:

$$RSE = 100\,x \sqrt{\sum_{i=1}^{n} \left[\frac{x'_i - x_i}{x_i} \right]^2 \Big/ (n-p)}$$

Where: *Xi* = True amount of the calibration level I, in mass or concentration units

X'i = measured amount of analyte in calibration level I, in mass or concentration units

p = number of terms in the fitting equation (average = 1), linear – 2, quaratic – 3)

n = number of calibration points

RSE acceptance criteria for the calibration model is the same as the RSD limit for CF or RF in the determinative method. IF not defined in the method, use ± 20%.

11.7 Initial Calibration Verification (ICV)

An initial calibration verification containing all components from a second source (an alternate vendor or a unique lot from the same vendor) must be analyzed immediately following the initial calibration. Acceptance criteria for ICV percent recovery (%R) are 80-120% for DoD QSM 4.2 or 5.0 and 70-130% for commercial work (See Method 8270D.)

NOTE: Several states (Arizona) and/or federal programs have special requirements. Be sure to review state QAS summaries and SOP DV-QA-024P for these special requirements. Criteria for DoD QSM 5.0 is detailed in Table 15.

11.8 If time remains in the 12-hour period initiated by the DFTPP injection before the initial calibration, samples may be analyzed.

NOTE: Quantitation is performed using the calibration curve or average response factor from the initial curve, not the continuing calibration. For additional information on calibrations see SOP CA-Q-P-003.

11.9 Continuing Calibration Verification (CCV)

11.9.1 At the start of each 12-hour period, the GC/MS tuning standard must be analyzed. A 25-ng injection of DFTPP must result in a mass spectrum for DFTPP, which meets the criteria given in Table 4.

11.9.2 Following a successful DFTPP analysis, the continuing calibration verification (CCV) standard(s) are analyzed. The standard(s) must contain all semivolatile analytes, including all required surrogates. A mid-level calibration standard (80 µg/mL for standard volume extraction and 20 ug/mL for LVI) is used for the CCV.

11.9.3 The following criteria must be met for the CCV to be acceptable:

- The percent difference or drift (%D) of each compound must be ≤ 20%. (See Section 12 for calculations.)

  NOTE: Some states (Wisconsin) have special continuing calibration requirements when initial calibration is performed using a quadratic curve. Please refer to the state specific QAS.

- Due to the large numbers of compounds that may be analyzed by this method, it is expected that some compounds will fail to meet the criterion. At least 80% of analytes included in the calibration must have the %D less than or equal to 20%. In cases where compounds fail, they may still be reported as non-detects if it can be demonstrated that there was adequate sensitivity to detect the compound at the applicable quantitation limit. For situations when the failed compound is present, the concentrations must be reported as estimated values or the system must be recalibrated and the extracts reanalyzed.

- Any sample detections for an analyte that fails the SOP CCV criteria must be flagged as estimated, or described in the narrative. In all cases, every effort should be made to reanalyze on an instrument with a passing CCV.

- Any sample non-detects for an analyte that fails the criteria low, must have a low level CCV (LLCCV) in the batch as a sensitivity demonstration. The criterion for a passing LLCCV is detection only, and a passing LLCCV allows non-detects to be reported without flagging.

  NOTE: Use of a LLCCV is not applicable for DoD work.

- The internal standard response of the CCV must be within 50 - 200% of the response in the same level of the corresponding calibration.

- If any internal standard retention time in the CCV changes by more than 30 seconds from that of the same level of the corresponding initial calibration, the chromatographic system must be inspected for malfunctions and corrections made, as required.

11.9.4 Once the above criteria have been met, sample analysis may begin. Initial calibration average RFs (or the calibration curve) will be used for sample quantitation, not the continuing calibration RFs. Analysis may proceed until 12 hours from the injection of the DFTPP have passed. (A sample injected less than or equal to 12 hours after the DFTPP is acceptable.)

11.9.5 Each of the most common target analytes in the CCV must meet the minimum response factors listed in Table 14. If they are not met, the system is evaluated, and corrective action takes place before sample analysis begins. Possible problems include standard mixture degradation, injection port inlet contamination, contamination at the front end of the analytical column, and active sites in the column or chromatographic system.

11.10 Closing CCV for DoD 5.0

DoD QSM 5.0 requires a closing CCV (CCVC) injected within 12 hours of the DFTPP injection that initiated the sequence. The acceptance criteria for the CCVC is ± 50% for each compound. See Table 15 for additional details.

12.0 Calculations / Data Reduction

12.1 Qualitative Identification

An analyte is identified by retention time and by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound (standard reference spectrum). Mass spectra for standard reference may be obtained on the user's GC/MS by analysis of the calibration standards or from the NBS library. Two criteria must be satisfied to verify identification: (1) elution of sample component at the same GC retention time as the standard component; and (2) correspondence of the sample component and the standard component characteristic ions.

NOTE: Care must be taken to ensure that spectral distortion due to co-elution is evaluated.

12.1.1 The sample component retention time must compare to within ± 30 sec retention of the standard component. For reference, the standard must be run within the same twelve hours as the sample.

12.1.2 All ions present in the standard mass spectra at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) should be present in the sample spectrum.

12.1.3 The characteristic ions of a compound must maximize in the same scan or within one scan of each other.

12.1.4 The relative intensities of ions should agree to within ±30% between the standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20% and 80%.)

12.1.5 If a compound cannot be verified by all the above criteria, but in the technical judgment of the analyst the identification is correct, the analyst shall report that identification and proceed with quantitation.

12.2 Tentatively Identified Compounds

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the type of analyses being conducted. Computer generated library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Only after visual comparison of sample spectra with the nearest library searches shall the mass spectral interpretation specialist assign a tentative identification. Following are guidelines for making tentative identification:

12.2.1 Relative intensities of major ions in the reference spectrum (ions >10% of the most abundant ion) should be present in the sample spectrum.

12.2.2 The relative intensities of the major ions should agree to within ±30%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance should be between 20%and 80%.)

12.2.3 Molecular ions present in the reference spectrum should be present in the sample spectrum.

12.2.4 Ions present in the sample spectrum, but not in the reference spectrum, should be reviewed for possible background contamination or the presence of co-eluting compounds.

12.2.5 Ions present in the reference spectrum, but not in the sample spectrum, should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting peaks. Data system library reduction programs can sometimes create these discrepancies.

12.2.6 Automatic background subtraction can severely distort spectra from samples with unresolved hydrocarbons.

12.3 Isomers with identical mass spectra and close elution times pose problems for definitive identification. The following compounds, listed in elution order, fall into this category:

Aniline and bis(2-chloroethyl) ether
N-Nitrosodiphenylamine and diphenylamine
1,3-Dichlorobenzene, 1,4-dichlorobenzene, and 1,2-dichlorobenzene
Benzyl alcohol, 2-Methylphenol, 3-methylphenol, and 4-methylphenol

(Note: 3-methylphenol and 4-methylphenol co-elute)

2- methylnaphthalene and 1-methylnaphthalene
2,4-Dimethylphenol and 3,5-Dimethylphenol
2,4,6-Trichlorophenol and 2,4,5-trichlorophenol
Phenanthrene and anthracene
Fluoranthene and pyrene
Benzo(a)anthracene and chrysene
Benzo(e)pyrene and Benzo(a)pyrene
bis(2-Ethylhexyl)phthalate and di-n-octyl phthalate
Benzo(b) and (k)fluoranthene
Indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene
Safrole and 1-chloronaphthalene
1-naphthylamine and 2-naphthylamine
1-chloronaphthalene and 2-chloronaphthalene
2,4,6-tribromophenol and 2,4,5-tribromophenol

Identification of these compounds requires both experience and extra precautions on the part of the analyst. Specifically, the analyst must more closely scrutinize the comparison of retention times between the unknown and the calibration standard. The analyst must check that all isomers have distinct retention times and that peak resolution is sufficient (valley height of less than 25% of the sum of the two peak heights).

12.4 A second category of problem compounds consists of the poor responders or compounds that chromatograph poorly. The integrations for these types of compounds should be checked manually. The following compounds are included in this category:

Benzoic acid
Chloroanilines
Nitroanilines
2,4-Dinitrophenol
4-Nitrophenol
Pentachlorophenol
3,3'-Dichlorobenzidine
Benzyl alcohol
4,6-Dinitro-2-methylphenol
Atrazine
Famphur
Benzidine

12.5 Relative Response Factor Calculation

$$RF = \frac{A_x C_{is}}{A_{is} C_x}$$

Where:

A_x = Area of the characteristic ion for the compound being measured
A_{is} = Area of the characteristic ion for the specific internal standard
C_x = Concentration of the compound being measured (µg/L)
C_{is} = Concentration of the specific internal standard (µg/L)

12.6 Calculating the Percent Relative Standard Deviation for Initial Calibration

$$\%RSD = \frac{SD}{\overline{RF}} \times 100\%$$

Where:

$\overline{RF}$ = Mean of RFs from the initial calibration for a compound
SD = Standard deviation for the mean RF from the initial calibration for a compound

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(RF_i - \overline{RF}\right)^2}{n-1}}$$

RF_i = RF for each of the calibration levels
n = Number of RF values

12.7 Calculating the Continuing Calibration Percent Drift

$$\%Drift = \frac{C_{found} - C_{actual}}{C_{actual}} \times 100\%$$

Where:

C_{actual} = Known concentration in standard
C_{found} = Measured concentration using selected quantitation method

12.8 Calculating the Concentration in the Extract

The concentration of each identified analyte and surrogate in the extract is calculated from the average RF, or linear or quadratic curve fitted to the initial calibration points. Start with the simplest model, i.e., a straight line through the origin and progress through the other options until the calibration acceptance criteria are met.

12.8.1 Average Response Factor Calibration

If the RSD of the response factors for each compound of interest in the initial calibration is ≤15% for DoD or ≤20% for commercial applications of Method 8270D, the average response factor from the initial calibration may be used for quantitation. Average response factor is calculated as follows:

$$C_{ex} = \frac{R_x C_{is}}{R_{is}\overline{RF}}$$

Where:

C_{ex} = Concentration in the extract, µg/mL
R_x = Response for the analyte
R_{is} = Response for the internal standard
C_{is} = Concentration of the internal standard
$\overline{RF}$ = Average response factor

12.8.2 Linear Fit Calibration

If the RSD of the response factors for each compound of interest in the initial calibration is >15% for DoD or >20% for commercial applications of Method 8270D, the linear fit calibration may be used for quantitation. To calculate the concentration in an unknown sample extract, the regression equation is solved for:

$$C_{ex} = \frac{\left[\frac{R_x C_{is}}{R_{is}} - b\right]}{m_1}$$

Where:

C_{ex} = Extract analyte concentration, µg/L
R_x = Response for analyte
R_{is} = Response for internal standard
C_{is} = Concentration of internal standard
b = y – Intercept
m_1 = Slope

12.8.3 Quadratic Fit Calibration

When the instrument response does not follow a linear model over a sufficiently wide working range, or when the previously described calibration approaches fail acceptance criteria, a non-linear, second-order calibration model may be employed. To calculate the concentration in an unknown sample extract, the roots of the quadratic equation are solved for:

$$C_{ex} = \frac{-m_1 \pm \sqrt{(m_1)^2 - 4(m_2)\left(b - \frac{R_x C_{is}}{R_{is}}\right)}}{2m_2}$$

Where:

C_{ex} = Extract analyte concentration, µg/L
R_x = Response for analyte
R_{is} = Response for internal standard
C_{is} = Concentration of internal standard
m_2 = Curvature
m_1 = Slope
b = y - Intercept

12.9 Calculating the Concentration in the Sample

12.9.1 Calculation for Aqueous Samples

$$\text{Concentration, } \mu\text{g / L} = \frac{C_{ex} V_t}{V_o}$$

Where:

C_{ex} = Concentration in the extract

V_t = Volume of total extract in µL, taking into account dilutions (i.e., a 1-to-10 dilution of a 1-mL extract will mean that V_t = 10,000 µL. If half of the base/neutral extract and half of the acid extract are combined, then V_t = 2,000 µL.)
V_o = Volume of the sample that was extracted (mL)

12.9.2 Calculation for Sediment, Soil, Sludge, and Waste Samples

Results for sediments, sludges, and soils are usually calculated on a dry-weight basis, and for waste, on a wet-weight basis.

$$\text{Concentration, } \mu\text{g/kg} = \frac{C_{ex} V_t}{W_s D}$$

Where:

C_{ex} = Concentration in the extract
V_t = Volume of total extract in µL, taking into account dilutions (i.e., a 1-to-10 dilution of a 1-mL extract will mean that V_t = 10,000 µL. If half of the base/neutral extract and half of the acid extract are combined, then V_t = 2,000 µL.)
W_s = Weight of sample extracted or diluted in grams
D = (100 - % moisture in sample)/100, for a dry-weight basis or 1 for a wet-weight basis

12.10 MS/MSD Percent Recovery Calculation

$$\text{Matrix Spike Recovery} = \frac{S_{SR} - S_R}{S_A} \times 100\%$$

Where:

S_{SR} = Spike sample result
S_R = Sample result
S_A = Spike added

12.11 Calculating the Relative Percent Difference (RPD) MS/MSD Pair

$$RPD = \frac{\left| MS_R - MSD_R \right|}{1/2(MS_R + MSD_R)} \times 100$$

Where:

RPD = Relative percent difference
MS_R = Matrix spike result
MSD_R = Matrix spike duplicate result

12.12 Calculation of TICs

The calculation of TICs (tentatively identified compounds) is identical to the RF calculation (Section 12.5) with the following exceptions:

A_x = Area of the total ion chromatogram for the compound being measured

A_{is} = Area of the total ion chromatogram for the nearest internal standard without interference

RF = 1

12.13 Calculating Percent DDT Breakdown

$$\%\,\text{DDT breakdown} = \frac{\text{DDEarea} + \text{DDDarea}}{\text{DDTarea} + \text{DDEarea} + \text{DDDarea}}$$

The areas for the m/z 235 ion are used for this calculation.

12.14 Calculating the Peak Tailing Factor

$$\text{Tailing Factor} = \frac{BC}{AB}$$

Where:

Peak width (AC) is measured at 10% peak height, and divided into two line segments at the peak centroid, so that

AC = AB + BC, with
AB = left-hand segment
BC = right-hand segment

13.0 Method Performance

13.1 Method Detection Limit Study (MDL)

13.1.1 The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-0006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

13.1.2 Non-standard Analytes

For non-standard analytes, an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration should include the analysis of an extracted standard at the reporting limit and a single point calibration.

13.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

13.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

13.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

13.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.2.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

13.2.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

13.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst’s IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 Pollution Control

14.1 Standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.2 The LVI method utilizes smaller sample sizes and extraction volumes resulting in a decrease in the amount of waste generated for the analysis of water samples.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, “Waste Management and Pollution Prevention”, of the Corporate Safety Manual, and HS-001, “Waste Management Program.”

15.2 The following waste streams are produced when this method is carried out

15.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

15.2.2 Methylene Chloride- B

15.2.3 Flammable Solvent- Waste Stream C

15.2.4 Used vials- Waste Stream A

NOTE: Radioactive, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16.0 References / Cross-References

16.1 SW846, Test Methods for Evaluating Solid Waste, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

16.1.1 Method 8270D, Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Capillary Column Technique, Update IV, Revision 4, February 2007

16.1.2 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

16.1.3 Method 8000C, Determinative Chromatographic Separations, Revision 3, March 2003.

16.1.4 Method 8000D, Determinative Chromatographic Separations, Revision 5, March 2018

16.1.5 Method 3510C, Separatory Funnel Liquid-Liquid Extraction, Revision 3, December 1996.

16.1.6 Method 3520C, Continuous Liquid-Liquid Extraction, Revision 3, December 1996.

16.1.7 Method 3540C, Soxhlet Extraction, Revision 3, December 1996.

16.1.8 Method 3550B, Ultrasonic Extraction, Revision 2, December 1996.

16.1.9 Method 3550C, Ultrasonic Extraction, Revision 3, February 2007.

16.1.10 Method 3580, Waste Dilution, Revision 1, July 1992.

16.1.11 Method 3620C, Florisil Cleanup, Revision 3, February 2007.

16.1.12 Method 3660A, Sulfur Cleanup, Revision 1, July 1992.

16.1.13 Method 3660B, Sulfur Cleanup, Revision 2, December 1996.

16.1.14 Method 3665A, Sulfuric Acid/Permanganate Cleanup, Revision 1, December 1996.

16.1.15 Quality Systems Manual (QSM) for Environmental Laboratories, DoD Quality Systems Manual Version 5.0, July 2013.

17.0 Method Modifications:

17.1 Modifications from Reference Method

17.1.1 A retention time window of 0.5 minutes is used for all components, since some data systems do not have the capability of using the relative retention time units specified in the reference method.

Method 8270D stipulates qualitative identification based on relative retention time (RRT), which is calculated by dividing the retention time (RT) of the target analyte by the RT of the internal standard. The RRT of the suspected target analyte in the sample extract must be within ± 0.06 RRT units of the RRT for that analyte in the calibration standard. This SOP stipulates qualitative identification based on an absolute RT. Namely the RT of the suspected target analyte in the sample extract must be within ± 0.5 minute of the RT for that analyte in the calibration standard. Additionally, the RT for the internal standard in the sample extract must also be within ± 0.5 minute of the RT for the internal standard in the calibration standard.

17.1.2 The quantitation and qualifier ions for some compounds have been changed from those recommended in SW-846 in order to improve the reliability of qualitative identification.

17.1.3 This procedure includes the option for weighted linear regression curves using 1/concentration and 1/concentration^2 weighting factors. Section 7.5.2 of Method 8000B discusses the use of weighted least square regression based on 1/standard deviation^2 weighting factors, which would require multiple analyses of each standard to determine the standard deviation. IAETL has presented information to the EPA Office of Solid Waste demonstrating that the variance (standard deviation^2) is proportional to the standard concentration. EPA accepted this argument and issued a memorandum dated August 7, 1998 (Attachments dated July 1998), which authorizes the use of 1/concentration^2 weighting factors.

17.1.4 The Large Volume Injection technique utilizes modifications in the source methods regarding both sample size and injection volume. These modifications are explicitly allowed by EPA. SW-846, Chapter Two lists as acceptable variations adjustment to both the sizes of sample prepared and injection volumes. See TestAmerica White Paper No. CA-Q-W-010, “Large Volume Injection (LVI) Technique for Organic Preparation and Analysis Methods” for detailed discussions. Reporting limits remain the same as the standard volume procedure for this technique.

17.1.5 Method 8270D lists the primary ion for Benzoic acid as m/z 122 and the secondary ion as m/z 105. The laboratory analyzes for 3,5-Dimethylphenol which can co-elute with the Benzoic acid primary ion 122 on some instruments. In order to distinguish between the two peaks, Benzoic acid has been assigned 105 as the primary ion and 122 as the secondary ion. 3,5-Dimethylphenol has 107 as the primary ion and 122 as the secondary ion.

17.1.6 The laboratory uses DFTPP criteria of for Method 8270C. The source method states that alternate tuning criteria may be used, provided that method performance is not adversely affected. The laboratory considers that use of the 8270C criteria does not adversely affect data for Method 8270D. The majority of the criteria for Method 8270C are within the limits for individual peaks in Method 8270D.

18.0 Attachments

Table 1.	TAL Primary Standard and Standard Reporting Limits
Table 2.	TAL Appendix IX Standard Reporting Limits
Table 3.	Suggested Instrument Conditions
Table 4.	DFTPP Key Ions and Ion Abundance Criteria
Table 5.	Characteristic Ions, Primary Standard (in approximate retention time order)
Table 6.	Characteristic Ions, Appendix IX Standard (in approximate retention time order)
Table 7.	8270D LCS Compounds
Table 8.	TCLP LCS Compounds
Table 9.	8270D Surrogate Compounds
Table 10.	Calibration Levels, Primary Standard, µg/mL
Table 11.	Calibration Levels, Appendix IX Standard, µg/mL
Table 12.	List 1 Reliably Performing Compounds
Table 13.	List 2 Poorly Performing Compounds
Table 14	Minimum Response Factor Criteria for Initial and Continuing Calibration Verification
Table 15	Specific DoD QSM 5.0 and DoE QSAS 3.0 Requirements for 8270D
Table LVI-1	LVI Calibration Levels, Primary (HSL) Standard, µg/mL
Table LVI-2	LVI Calibration Levels, Appendix IX Standard, µg/mL

APPENDIX A. Modifications Required for Analysis of Wastewater Following Method 8270 Best Practice (8270D_LL)

Table A-1. TAL Method 8270D_LL Standard Reporting Limits
Table A-2. Method 8270D_LL Calibration Levels
Table A-3. Method 8270D_LL LCS Spike Concentrations
Table A-4. 8270D_LL Surrogate Compounds
Table A-5. Suggested Instrument Conditions for 8270D_LL
Table A-6. Internal Standard and Surrogate Association for 8270_LL Base-only Extraction

APPENDIX B. Suggested Instrument Maintenance Schedules - Mass Spectrometer & Gas Chromatograph

19.0 Revision History

- Revision 11, dated 31 October 2018
  - Corrected MDL SOP name.
  - Corrected last sentence in the Copyright Information section.
  - Added references to SW 846 Method 8000D
  - Added explanations and calculations for % Error and Relative Standard Error
  - Added references to South Carolina compliance.
- Revision 10, dated 30 Sept 30 2017
  - Annual Review
  - Minor wording changes
- Revision 9, dated 31 August 2016
  - Revised Section 9.7 on Matrix Spike corrective actions to reflect current policy.
  - Removed Section 11.6.1.3, readback requirement for lowest cal point. This is neither a method nor DoD QSM requirement.
  - Added Section 17.1.6 to discuss DFTPP acceptance criteria
  - Revised Table 4, ion abundance for mass 442, to reflect current practice
  - Revised Appendix A to reflect current practice. The only analytes for which 8270D_LL is used are 1,4-dioxane and N-Nitrosodimethylamine. References to additional analytes were removed. Added Table A-6.
  - Updated surrogate assignments in Tables 5 & 6 to reflect current practice.
- Revision 8, dated 30 September 2015
  - Removed all details pertaining to Method 3546. This method is not longer used to prep soil samples for analysis by Method 8270.
  - Removed all references to South Carolina requirements. Lab is no longer certified in South Carolina for this method.
  - Revised Section 9.7 to reflect current practice
  - Updated reference to corporate SOP to reflect current document and added reference to corporate memo on QC requirements for Method 8270D
  - Revised Section 11.6.1.2 to reflect both DoD and method criteria
  - Revised list of compounds in Section 12.3 to review for correct identification due to closely eluting analytes based on revision to data review checklist.
  - Revised Section 12.8.1 and 12.8.2 to reflect both DoD and method criteria.
  - Revised Section 13 to reflect current practice.

  - Added Section 17.1.5 describing mass assignments for benzoic acid and 3,5-dimethylphenol to distinguish the two closely eluting compounds
  - Removed Table 12 which referenced method 625 and renumbered remaining tables that followed it.
  - Updated Table 15 to include tune, breakdown and ICAL requirements that were inadvertently omitted in previous version.
  - Updated all tables to reflect current target analyte list and routine spike compounds
  - Formatting and editorial changes throughout.
- Revision 7, dated 29 August 2014
  - Corrected references from 8270C to 8270D.
- Revision 6, dated 9 April 2014
  - Added Table 16, Specific DoD QSM 5.0 and DoE QSAS 3.0 Requirements for 8270D.
  - Updated calibration standards and their corresponding sublists throughout the SOP (including text, tables and appendices).
    - 1,1-Biphenyl, Acetophenone, 3-Methylphenol, 1,2,4,5-Tetrachlorobenzene, 1,3-Dinitrobenzene and 2,3,4,6-Tetrachlorophenol moved into the HSL sublist
    - 4,4’-Methylene bis(2-chloroaniline), 6-Methylchrysene, Acrylamide, Dibenz(a,h)acridine, and Quinoline moved into the AP9 sublist.
  - Modified the large volume injection (LVI) injection volume to 2.5 µL and internal standard concentration to 40 µg/mL.
  - Formatting and editorial changes throughout.
  - Added reference to DoD QSM 5.0
- Revision 5, dated 19 August 2013
  - Added statement to Section 2.1 that LVI must not be used on SC samples.
- Revision 4, dated 27 February 2013
  - Added information to analyze water extracts using Large Volume Injection throughout the SOP
  - Added Tables LVI-1 and LVI-2 for LVI calibration standards
  - Removed AFCEE calibration curve (no longer used)
  - Revised sections 9.1, 10.1 and 10.2 to reflect current practice
  - Formatting and editorial changes throughout
- Revision 3, dated 4 January 2013
  - Changed storage of extracts from freezer to refrigerator.
- Revision 2, dated 30 November 2012
  - Deleted Section 5.1.5 – About the use of Separatory Funnels
  - Updated the Hazardous Materials table in Section 5.2 to reflect current solvent used.
  - Updated and clarified language in Attachments to reflect current practices.
- Revision 1.1, dated 01 December 2011
  - Added note to section 1.1.1 and Appendix A restricting use of Best Practice method
  - Revised sections 9.5, 9.6 and 9.7 to clarify use of flags and documentation in narrative for failed QC

  - Revised section 9.8.1 to clarify modifications might be made to accommodate the chemistry of the sample.
  - Added statement to 11.5.3 to flag data if target analyte reported for failed CCV.
  - Expanded the discussion in section 17.1.1 to clarify how the use of RT windows stipulated in this SOP meets or exceeds the requirements of Method 8270D.
  - Clarified reference from EPA for source of inverse weighted least squares regression for calibrations.
- Revision 1.0, dated 31 January 2011
  - Updated Table 3, Suggested Instrument Conditions
  - Added components and changed spike levels in Table 7, 8270D LCS Compounds
  - Added low level calibration standard to Table 11, Calibration Levels, Primary Standard
  - Minor grammatical, spelling and formatting changes were made throughout.

Earlier revision histories have been archived and are available upon request.

Table 1.

TAL Primary Standard and Standard Reporting Limits

Analytes	**CAS Number**	**Standard Reporting Limits**	
		Aqueous (µg/L)	**Low Soil/Sediment (µg/kg)**
Pyridine	110-86-1	20	660
N-Nitrosodimethylamine	62-75-9	10	330
Aniline	62-53-3	10	330
Phenol	108-95-2	10	330
Bis(2-chloroethyl)ether	111-44-4	10	330
2-Chlorophenol	95-57-8	10	330
1,3-Dichlorobenzene	541-73-1	4	330
1,4-Dichlorobenzene	106-46-7	4	330
Benzyl alcohol	100-51-6	10	330
1,2-Dichlorobenzene	95-50-1	4	330
2-Methylphenol	95-48-7	10	330
2,2’-oxybis(1-chloropropane)	108-60-1	10	330
4-Methylphenol	106-44-5	10	330
N-Nitroso-di-n-propylamine	621-64-7	10	330
Hexachloroethane	67-72-1	10	330
Nitrobenzene	98-95-3	10	330
Isophorone	78-59-1	10	330
2-Nitrophenol	88-75-5	10	330
2,4-Dimethylphenol	105-67-9	10	330
Benzoic acid	65-85-0	50	1600
Bis(2-chloroethoxy)methane	111-91-1	10	330
2,4-Dichlorophenol	120-83-2	10	330
1,2,4-Trichlorobenzene	120-82-1	10	330
Naphthalene	91-20-3	10	330
4-Chloroaniline	106-47-8	10	330
Hexachlorobutadiene	87-68-3	10	330
1,2,4,5-Tetrachlorobenzene	95-94-3	10	330
4-Chloro-3-methylphenol	59-50-7	10	330
2-Methylnaphthalene	91-57-6	10	330

Analytes	CAS Number	Standard Reporting Limits	
		Aqueous (µg/L)	**Low Soil/Sediment (µg/kg)**
Hexachlorocyclopentadiene	77-47-4	50	1600
2,4,6-Trichlorophenol	88-06-2	10	330
2,4,5-Trichlorophenol	95-95-4	10	330
2-Chloronaphthalene	91-58-7	4	330
2-Nitroaniline	88-74-4	10	1600
Dimethyl phthalate	131-11-3	4	330
1,3-Dinitrobenzene	99-65-0	10	330
Acenaphthylene	208-96-8	4	330
3-Nitroaniline	99-09-2	10	1600
Acenaphthene	83-32-9	4	330
2,4-Dinitrophenol	51-28-5	30	1600
4-Nitrophenol	100-02-7	10	1600
Dibenzofuran	132-64-9	4	330
2,3,4,6-Tetrachlorophenol	58-90-2	50	1600
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330

Table 1.
TAL Primary Standard and Standard Reporting Limits (cont.)

Analytes	CAS Number	Standard Reporting Limits	
		Aqueous (µg/L)	**Low Soil/Sediment (µg/kg)**
Diethylphthalate	84-66-2	4	330
4-Chlorophenyl phenyl ether	7005-72-3	10	330
Fluorene	86-73-7	4	330
4-Nitroaniline	100-01-6	10	1600
4,6-Dinitro-2-methylphenol	534-52-1	20	1600
N-Nitrosodiphenylamine	86-30-6	10	330
Azobenzene	103-33-3	10	330
4-Bromophenyl phenyl ether	101-55-3	10	330
Hexachlorobenzene[3]	118-74-1	10	330
Pentachlorophenol	87-86-5	50	1600
Phenanthrene	85-01-8	4	330
Anthracene	120-12-7	4	330
Carbazole	86-74-8	4	330
Di-n-butyl phthalate	84-74-2	4	330
Fluoranthene	206-44-0	4	330
Benzidine	92-87-5	100	3300
Pyrene	129-00-0	10	330
Butyl benzyl phthalate	85-68-7	4	330
3,3'-Dichlorobenzidine	91-94-1	50	1600
Benzo(a)anthracene	56-55-3	4	330
Bis(2-ethylhexyl)phthalate	117-81-7	10	330
4,4-Methylenebis(2-chloroaniline)	101-14-4	100	330
Chrysene	218-01-9	4	330
Di-n-octylphthalate	117-84-0	4	330
Benzo(b)fluoranthene	205-99-2	4	330
Benzo(k)fluoranthene	207-08-9	4	330
Benzo(a)pyrene	50-32-8	4	330

Analytes	CAS Number	Standard Reporting Limits	
		Aqueous (µg/L)	Low Soil/Sediment (µg/kg)
Indeno(1,2,3-cd)pyrene	193-39-5	4	330
Diethyl phthalate	84-66-2	4	660
Dibenz(a,h)anthracene	53-70-3	4	330
Benzo(g,h,i)perylene	191-24-2	4	330
Acetophenone	98-86-2	10	330
3/4-Methylphenol	15831-10-4	10	330
1,4-Dioxane	54841-74-6	20	660
Benzaldehyde	100-52-7	10	330
2,6-Dichlorophenol	87-65-0	10	330
1,1-Biphenyl	92-52-4	10	330

1. The TAL primary standard is the standard normally used. Additional standards, such as the Appendix IX standard (Table 2) may be necessary to include all target analytes required for some clients.
2. 2,2'-Oxybis(1-chloropropane) was formerly known as bis(2-chloroisopropyl)ether.
3. May also be analyzed by method 8081, which can achieve lower reporting limits.

Table 2.
TAL Appendix IX Standard Reporting Limits

Semivolatiles	CAS Number	Standard Reporting Limits	
		Aqueous (µg/L)	Low Soil/Sediment (µg/kg)
2-Picoline	109-06-8	20	660
N-Nitrosomethylethylamine	10595-95-6	10	330
Methyl methanesulfonate	66-27-3	10	330
N-Nitrosodiethylamine	55-18-5	10	330
Ethyl methanesulfonate	62-50-0	10	330
Pentachloroethane	76-01-7	50	1600
N-Nitrosopyrrolidine	930-55-2	10	330
N-Nitrosomorpholine	59-89-2	10	330
o-Toluidine	95-53-4	10	660
N-Nitrosopiperidine	100-75-4	10	330
O, O’, O”-Triethylphosphorothioate[2]	126-68-1	50	1600
a,a-Dimethyl-phenethylamine	122-09-8	50	1600
Hexachloropropene	1888-71-7	100	3300
p-Phenylenediamine	106-50-3	100	1600
n-Nitrosodi-n-butylamine	924-16-3	10	330
Safrole	94-59-7	50	1600
Isosafrole	120-58-1	20	660
1,4-Dinitrobenzene	100-25-4	10	330
1,4-Naphthoquinone	130-15-4	50	1600
Pentachlorobenzene	608-93-5	10	330
1-Naphthylamine	134-32-7	10	330
2-Naphthylamine	91-59-8	10	330
5-Nitro-o-toluidine	99-55-8	20	660
Thionazin[2]	297-97-2	10	1600
1,3,5-Trinitrobenzene	99-35-4	50	1600
Sulfotepp[2]	3689-24-5	50	1000
Phorate[2]	298-02-2	50	1600
Phenacetin	62-44-2	20	660
Diallate[3]	2303-16-4	20	660
Dimethoate[2]	60-51-5	20	660
4-Aminobiphenyl	92-67-1	50	1600
Pentachloronitrobenzene	82-68-8	50	1600
Pronamide	23950-58-5	20	660
Disulfoton[2]	298-04-4	50	1600
2-secbutyl-4,6-dinitrophenol (Dinoseb)	88-85-7	10	660
Methyl Parathion[2]	298-00-0	50	1600
1-chloronaphthalene	90-13-1	10	330
4-Nitroquinoline-1-oxide	56-57-5	100	3300
Parathion	56-38-2	50	1600
Methapyrilene	91-80-5	50	1600

Table 2.
TAL Appendix IX Standard Reporting Limits (cont.)

Semivolatiles	CAS Number	Standard Reporting Limits	
		Aqueous (µg/L)	Low Soil/Sediment (µg/kg)
Aramite	140-57-8	20	660
Isodrin[3]	465-73-6	10	330
p-(Dimethylamino)azobenzene	60-11-7	20	660
p-Chlorobenzilate	510-15-6	10	330
3,3'-Dimethylbenzidine	119-93-7	20	660
2-Acetylaminofluorene	53-96-3	100	3300
Dibenz(a,j)acridine	224-42-0	10	660
7,12-Dimethylbenz(a)anthracene	57-97-6	20	660
3-Methylcholanthrene	56-49-5	20	660
Diphenylamine	122-39-4	10	330

1. The Appendix IX standard contains additional analytes required for the Appendix IX list. The TAL primary standard must also be analyzed to include all of the Appendix IX list.
2. May also be analyzed by method 8141, which can achieve lower reporting limits.
3. May also be analyzed by method 8081, which can achieve lower reporting limits.

Table 3.
Suggested Instrument Conditions[1]

Parameter	Settings	
	Standard Analysis	**Large Volume Injection**
Mass Range:	35 - 500 amu	35-500 amu
Scan Time:	≤ 1 second/scan	≤ 1 second/scan
Initial Column Temperature/Hold Time:	55 °C for 1 minute	55 °C for 1.5 minute
Column Temperature Program:	55-250 °C at 25 °C/min 250-315°C at 5°/min	55 - 250 °C at 25 °C/min 250 - 315 °C at 28 °C/min
Final Column Temperature/Hold Time:	315 °C (until at least one minute after benzo(g,h,i)perylene has eluted)	315 °C (until at least one minute after benzo(g,h,i)perylene has eluted)
Injector Temperature:	250 °C	250 °C
Transfer Line Temperature:	300 °C	300 °C
Source Temperature:	According to manufacturer's specifications	According to manufacturer's specifications
Injector:	Restek liner #23300.5 or equivalent	Restek liner #23300.5 or equivalent
Syringe	5 or 10 µL	10 µL
Sample Volume:	0.5 µl	5 µL
Carrier Gas:	Helium at 3.4 mL/min	Helium at 3.4 mL/min

[1] The GC parameters should be optimized to provide appropriate resolution for benzo(b)fluoranthene and benzo(k)fluoranthene and dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene.

Table 4.
DFTPP Key Ions and Ion Abundance Criteria

Mass	Ion Abundance Criteria
51	30 - 60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40 - 60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5 - 9% of mass 198
275	10 - 30% of mass 198
365	> 1% of mass 198
441	Present, but less than mass 443
442	> 40% of mass 198
443	17 – 23% of mass 442

Table 5.
Characteristic Ions, Primary Standard (in alpha-numeric order)

Analyte	Primary	Secondary	Tertiary	IS	Surr
1,1-Biphenyl	154	153	76	3	2
1,2,4,5-Tetrachlorobenzene	216	214	218	2	4
1,2,4-Trichlorobenzene	180	182	145	2	4
1,2-Dichlorobenzene	146	148	113	1	4
1,3-Dichlorobenzene	146	148	113	1	4
1,3-Dinitrobenzene	168	50	76	3	2
1,4-Dichlorobenzene	146	148	113	1	4
1,4-Dichlorobenzene-d_4 (Internal Standard)	152	150	115	1	-
1,4-Dioxane	88	58	-	1	3
2,2'-oxybis(1-chloropropane)[1]	45	77	79	1	4
2,3,4,6-Tetrachlorophenol	232	230	131	3	2
2,4,5-Trichlorophenol	196	198	200	3	1
2,4,6-Tribromophenol (Surrogate Standard)	330	332	141	3	1
2,4,6-Trichlorophenol	196	198	200	3	1
2,4-Dichlorophenol	162	164	98	2	3
2,4-Dimethylphenol	107	121	122	2	3
2,4-Dinitrophenol	184	63	154	3	1
2,4-Dinitrotoluene	165	63	89	3	2
2,6-Dichlorophenol	162	164	63	2	4
2,6-Dinitrotoluene	165	63	89	3	2
2-Chloronaphthalene	162	164	127	3	2
2-Chlorophenol	128	64	130	1	3
2-Fluorobiphenyl (Surrogate Standard)	172	171	170	3	2
2-Fluorophenol (Surrogate Standard)	112	64	63	1	3
2-Methylnaphthalene	142	141	115	2	2
2-Methylphenol	108	107	77	1	3
2-Nitroaniline	65	92	138	3	2
2-Nitrophenol	139	65	109	2	3
3,3'-Dichlorobenzidine	252	254	126	5	2
3/4-Methylphenol	108	107	77	1	3
3-Nitroaniline	138	108	92	3	2
4,6-Dinitro-2-methylphenol	198	105	51	4	1
4-Bromophenylphenylether	248	250	141	4	2
4-Chloro-3-methylphenol	107	144	142	2	1
4-Chloroaniline	127	129	65	2	4
4-Chlorophenylphenylether	204	206	141	3	2
4-Methylphenol	108	107	79	1	3
4-Nitroaniline	138	92	108	3	2
4-Nitrophenol	109	139	65	3	1
Acenaphthene	153	152	154	3	6
Acenaphthene-d_{10} (Internal Standard)	164	162	160	3	-
Acenaphthylene	152	151	153	3	6
Acetophenone	105	77	120	1	3
Aniline	93	66	-	1	3
Anthracene	178	179	176	4	6
Azobenzene	77	182	105	3	2
Benzaldehyde	106	105	77	1	--
Benzidine	184	92	185	5	6

Table 5 (continued)
Characteristic Ions, Primary Standard (in alpha-numeric order)

Analyte	Primary	Secondary	Tertiary	IS	Surr
Benzo(a)anthracene	228	229	226	5	6
Benzo(a)pyrene	252	253	125	6	6
Benzo(b)fluoranthene	252	253	125	6	6
Benzo(g,h,i)perylene	276	138	277	6	6
Benzo(k)fluoranthene	252	253	125	6	6
Benzoic Acid	105	122	77	2	3
Benzyl Alcohol	108	79	77	1	4
Bis(2-chloroethoxy)methane	93	95	123	2	4
Bis(2-chloroethyl)ether	93	63	95	1	4
Bis(2-ethylhexyl)phthalate	149	167	279	5	2
Butylbenzylphthalate	149	91	206	5	2
Carbazole	167	166	139	4	1
Chrysene	228	226	229	5	6
Chrysene-d$_{12}$ (Internal Standard)	240	120	236	5	-
Dibenz(a,h)anthracene	278	139	279	6	2
Dibenzofuran	168	139	84	3	2
Diethylphthalate	149	177	150	3	2
Dimethylphthalate	163	194	164	3	2
Di-n-butylphthalate	149	150	104	4	2
Di-n-octylphthalate	149	167	43	5	2
Famphur	218	93	125	5	6
Fluoranthene	202	101	100	4	6
Fluorene	166	165	167	3	6
Hexachlorobenzene	284	142	249	4	2
Hexachlorobutadiene	225	223	227	2	4
Hexachlorocyclopentadiene	237	235	271	3	2
Hexachloroethane	117	201	199	1	4
Indeno(1,2,3-cd)pyrene	276	138	277	5	6
Isophorone	82	95	138	2	4
Naphthalene	128	129	127	2	6
Naphthalene-d$_8$ (Internal Standard)	136	68	54	2	-
Nitrobenzene	77	123	65	2	4
Nitrobenzene-d$_5$ (Surrogate Standard)	82	128	54	2	4
N-Nitrosodimethylamine	74	42	-	1	3
N-Nitroso-di-n-propylamine	70	42	101,130	1	4
N-Nitrosodiphenylamine	169	168	167	4	2
Pentachlorophenol	266	264	268	4	1
Perylene-d$_{12}$ (Internal Standard)	264	260	265	6	-
Phenanthrene	178	179	176	4	6
Phenanthrene-d$_{10}$ (Internal Standard)	188	94	80	4	-
Phenol	94	65	66	1	5
Phenol-d$_5$ (Surrogate Standard)	99	42	71	1	5
Pyrene	202	101	100	5	6
Pyridine	79	52	-	1	3
Terphenyl-d$_{14}$ (Surrogate Standard)	244	122	212	5	6

[1] 2,2’oxybis(1-chloropropane) was formally known as bis(2-chloroisopropyl)ether.

Table 6.
Characteristic Ions, Appendix IX Standard (in alpha-numeric order)

Analyte	Primary	Secondary	Tertiary	IS	SURR
1,3,5-Trinitrobenzene	213	75	120	4	1
1,4-Dinitrobenzene	168	75	122	3	2
1,4-Naphthoquinone	158	104	102	3	2
1-Naphthylamine	143	115	--	3	2
2-Acetylaminofluorene	181	180	223	5	6
2-Naphthylamine	143	115	--	3	2
2-Picoline	93	66	92	1	3
2-sec-butyl-4,6-dinitrophenol (Dinoseb)	211	163	147	4	1
3,3'-Dimethylbenzidine	212	106	--	5	6
3-Methylcholanthrene	268	252	253	6	6
4-Aminobiphenyl	169	168	115	4	1
4-Nitroquinoline-1-oxide	190	128	160	4	6
5-Nitro-o-toluidine	152	77	106	3	2
7,12-Dimethylbenz(a)anthracene	256	241	120	6	6
a,a-Dimethyl-phenethylamine	58	91	--	2	4
Aramite 1	185	319	--	5	6
Aramite 2	185	319	--	5	6
Diallate	86	234	--	4	1
Dibenz(a,j)acridine	279	280	--	6	6
Dimethoate	87	93	125	4	1
Diphenylamine	169	168	167	4	2
Disulfoton	88	97	89	4	1
Ethyl methanesulfonate	79	109	97	1	3
Hexachloropropene	213	215	211	2	4
Isodrin	193	66	195	4	6
Isosafrole 1	162	104	131	3	2
Isosafrole 2	162	104	131	3	2
Methapyrilene	97	58	--	4	6
Methyl methanesulfonate	80	79	65	1	3
Methyl parathion	109	125	263	4	1
N-Nitrosodiethylamine	102	44	57	1	3
N-Nitrosodi-n-butylamine	84	57	41	2	4
N-Nitrosomethylethylamine	88	42	43	1	3
N-Nitrosomorpholine	116	56	86	1	3
N-Nitrosopiperidine	114	42	55	2	4
N-Nitrosopyrrolidine	100	41	42	1	3
O,O’,O”-Triethyl-Phosphorothioate	198	121	93	2	4
o-Toluidine	106	107	77	1	3
p-(Dimethylamino)azobenzene	120	225	77	5	6

Table 6. (continued)
Characteristic Ions, Appendix IX Standard (in alpha-numeric order)

Analyte	Primary	Secondary	Tertiary	IS	SURR
Parathion	109	97	291	4	1
p-Chlorobenzilate	251	139	253	5	6
Pentachlorobenzene	250	248	252	3	2
Pentachloroethane	117	119	167	1	3
Pentachloronitrobenzene	237	142	214	4	1
Phenacetin	108	179	109	4	1
Phorate	75	97	121	4	1
p-Phenylenediamine	108	80	54	2	6
Pronamide	173	175	255	4	1
Safrole	162	104	77	2	4
Sulfotepp	97	322	202	4	1
Thionazin	97	96	143	3	2

Table 7.
8270D LCS Compounds

LCS Compounds	Spiking Level ng/µL in extract
1,2,4,5-Tetrachlorobenzene	80
1,1-Biphenyl	80
1,2,4-Trichlorobenzene	80
1,2-Dichlorobenzene	80
1,3-Dichlorobenzene	80
1,3-Dinitrobenzene	80
1,4-Dichlorobenzene	80
1,4-Dioxane	80
1-Methylnaphthalene	80
2-2’-Oxybis(1-chloropropane)	80
2,3,4,6-Tetrachlorophenol	80
2,4,5-Trichlorophenol	80
2,4,6-Trichlorophenol	80
2,4-Dichlorophenol	80
2,4-Dimethylphenol	80
2,4-Dinitrophenol	160
2,4-Dinitrotoluene	80
2,6-Dichlorophenol	80
2,6-Dinitrotoluene	80
2-Chloronaphthalene	80

Table 7 (cont.)
8270D LCS Compounds

LCS Compounds	Spiking Level ng/µL in extract
2-Chlorophenol	80
2-Methylnaphthalene	80
2-Methylphenol	80
2-Nitroaniline	80
2-Nitrophenol	80
3,3-Dichlorobenzidine	80
3&4-Methylphenol	80
3-Methylphenol	80
3-Nitroaniline	80
4,6-Dinitro-2-methylphenol	160
4-Bromophenyl phenyl ether	80
4-Chloro-3-methylphenol	80
4-Chloroaniline	80
4-Chlorophenyl phenyl ether	80
4-Methylphenol	80
4-Nitroanliline	80
4-Nitrophenol	160
Acenaphthene	80
Acenaphthylene	80
Acetophenonoe	80
Aniline	80
Anthracene	80
Azobenzene	80
Benzidine	80
Benzaldehyde	80
Benzo[a]anthracene	80
Benzo[b]fluoranthene	80
Benzo[k]fluoranthene	80
Benzoic acid	80
Benzo[g,h,i]perylene	80
Benzo[a]pyrene	80
Benzyl alcohol	80
Bis(2-chloroethoxy)methane	80
Bis(2-ethylhexyl) phthalate	80

Table 7 (cont.)
8270D LCS Compounds

LCS Compounds	Spiking Level ng/µL in extract
Bis(2-chloroethyl)ether	80
Caprolactam	80
Carbazole	80
Chrysene	80
Di-n-butyl phthalate	80
Di-n-octyl phthalate	80
Dibenz(a,h)anthracene	80
Dibenzofuran	80
Diethyl phthalate	80
Dimethyl phthalate	80
Fluoranthene	80
Fluorene	80
Hexachlorobenzene	80
Hexachlorobutadiene	80
Hexachlorocyclopentadiene	80
Hexachloroethane	80
Indeno(1,2,3-cd)pyrene	80
Isophorone	80
Naphthalene	80
Nitrobenzene	80
N-Nitrosodimethylamine	80
N-Nitrosodi-n-propylamine	80
N-Nitrosodiphenylamine	80
Pentachlorophenol	160
Phenanthrene	80
Phenol	80
Pyrene	80
Pyridine	80

Table 8.
TCLP LCS Compounds

LCS Compounds	Spiking Level, ng/µL in extract
1,4-Dichlorobenzene	50
2,4-Dinitrotoluene	50
Hexachlorobenzene	50
Hexachlorobutadiene	50
Hexachloroethane	50
2-Methylphenol	50
3/4-Methylphenol	100
Nitrobenzene	50
Pentachlorophenol	100
Pyridine	50
2,4,5-Trichlorophenol	50
2,4,6-Trichlorophenol	50

Recovery limits for the LCS and for matrix spikes are generated from historical data and are maintained by the QA group.

Table 9
8270D Surrogate Compounds

Surrogate Compounds	Standard Analysis ng/µL in extract	LVI Analysis ng/µL in extract
Nitrobenzene-d_5	100	25
2-Fluorobiphenyl	100	25
Terphenyl-d_{14}	100	25
Phenol-d_5	100	25
2-Fluorophenol	100	25
2,4,6-Tribromophenol	100	25

Table 10.
Calibration Levels[1], Primary (HSL) Standard, µg/mL

Analyte	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Pyridine	-	10	20	50	80	120	160	200
1,4-Dioxane	4	10	20	50	80	120	160	200
N-nitrosodimethylamine	-	10	20	50	80	120	160	200
Aniline	-	10	20	50	80	120	160	200
Phenol	-	10	20	50	80	120	160	200
Bis(2-chloroethyl)ether	-	10	20	50	80	120	160	200
2-Chlorophenol	-	10	20	50	80	120	160	200
1,3-Dichlorobenzene	4	10	20	50	80	120	160	200
1,4-Dichlorobenzene	4	10	20	50	80	120	160	200
Benzyl alcohol	-	10	20	50	80	120	160	200
1,2-Dichlorobenzene	4	10	20	50	80	120	160	200
2-Methylphenol	-	10	20	50	80	120	160	200
2,2'-oxybis(1-chloropropane)[2]	-	10	20	50	80	120	160	200
4-Methylphenol	-	10	20	50	80	120	160	200
3-Methylphenol	-	10	20	50	80	120	160	200
Acetophenone	4	10	20	50	80	120	160	200
N-Nitroso-di-n-propylamine	-	10	20	50	80	120	160	200
Hexachloroethane	4	10	20	50	80	120	160	200
Nitrobenzene	-	10	20	50	80	120	160	200
Isophorone	-	10	20	50	80	120	160	200
2-Nitrophenol	-	10	20	50	80	120	160	200
2,4-Dimethylphenol	-	10	20	50	80	120	160	200
Benzoic acid	-	--	20	50	80	120	160	200
Bis(2-chloroethoxy)methane	-	10	20	50	80	120	160	200
2,4-Dichlorophenol	-	10	20	50	80	120	160	200
1,2,4-Trichlorobenzene	4	10	20	50	80	120	160	200
Naphthalene	4	10	20	50	80	120	160	200
4-Chloroaniline	-	10	20	50	80	120	160	200
Hexachlorobutadiene	-	10	20	50	80	120	160	200
1,2,4,5-Tetrachlorobenzene	-	10	20	50	80	120	160	200
4-Chloro-3-methylphenol	-	10	20	50	80	120	160	200
2-Methylnaphthalene	4	10	20	50	80	120	160	200
Hexachlorocyclopentadiene	-	--	20	50	80	120	160	200
2,4,6-Trichlorophenol	-	10	20	50	80	120	160	200
2,4,5-Trichlorophenol	-	10	20	50	80	120	160	200
2-Chloronaphthalene	4	10	20	50	80	120	160	200
2-Nitroaniline	-	--	20	50	80	120	160	200
Dimethyl phthalate	4	10	20	50	80	120	160	200
1,3-Dinitrobenzene	-	10	20	50	80	120	160	200
Acenaphthylene	4	10	20	50	80	120	160	200
3-Nitroaniline	-	--	20	50	80	120	160	200
Acenaphthene	4	10	20	50	80	120	160	200
2,4-Dinitrophenol	-	20	40	100	160	240	320	400
4-Nitrophenol	8	20	40	100	160	240	320	400
Dibenzofuran	4	10	20	50	80	120	160	200
2,3,4,6-Tetrachlorophenol	-	10	20	50	80	120	160	200
2,4-Dinitrotoluene	-	10	20	50	80	120	160	200
2,6-Dinitrotoluene	-	10	20	50	80	120	160	200

Table 10. (continued)
Calibration Levels, Primary (HSL) Standard, µg/mL

Analyte	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**	**L7**	**L8**
Diethylphthalate	4	10	20	50	80	120	160	200
4-Chlorophenyl phenyl ether	-	10	20	50	80	120	160	200
Fluorene	4	10	20	50	80	120	160	200
4-Nitroaniline	-	--	20	50	80	120	160	200
4,6-Dinitro-2-methylphenol	-	20	40	100	160	240	320	400
N-Nitrosodiphenylamine	-	10	20	50	80	120	160	200
Azobenzene[3]	4	10	20	50	80	120	160	200
4-Bromophenyl phenyl ether	-	10	20	50	80	120	160	200
Hexachlorobenzene	-	10	20	50	80	120	160	200
Pentachlorophenol	-	20	40	100	160	240	320	400
Phenanthrene	4	10	20	50	80	120	160	200
Anthracene	4	10	20	50	80	120	160	200
Carbazole	4	10	20	50	80	120	160	200
Di-n-butyl phthalate	4	10	20	50	80	120	160	200
Fluoranthene	4	10	20	50	80	120	160	200
Benzidine	-	--	20	50	80	120	160	200
Pyrene	4	10	20	50	80	120	160	200
Butyl benzyl phthalate	4	10	20	50	80	120	160	200
3,3'-Dichlorobenzidine	-	--	20	50	80	120	160	200
Benzo(a)anthracene	4	10	20	50	80	120	160	200
Bis(2-ethylhexyl)phthalate	4	10	20	50	80	120	160	200
Chrysene	4	10	20	50	80	120	160	200
Di-n-octylphthalate	4	10	20	50	80	120	160	200
Benzo(b)fluoranthene	4	10	20	50	80	120	160	200
Benzo(k)fluoranthene	4	10	20	50	80	120	160	200
Benzo(a)pyrene	4	10	20	50	80	120	160	200
Indeno(1,2,3-cd)pyrene	4	10	20	50	80	120	160	200
Dibenz(a,h)anthracene	4	10	20	50	80	120	160	200
Benzo(g,h,i)perylene	4	10	20	50	80	120	160	200
1,1-Biphenyl	-	10	20	50	80	120	160	200
Benzaldehyde	-	10	20	50	80	120	160	200
2,6-Dichlorphenol	-	10	20	50	80	120	160	200

[1] All compounds are spiked in all standard levels (4, 10, 20, 50, 80, 120, 160 and 200 μg/mL). Levels listed in this table are the required spike levels needed in order to calibrate to at the reporting limit for each compound. Additional lower-level standards may be included in the calibrations as long as the ICAL criteria are met.

[2] 2,2'oxybis(1-chloropropane) was formally known as bis(2-chloroisopropyl)ether

[3] Azobenzene is formed by decomposition of 1,2-diphenlyhydrazine. If 1,2-diphenylhydrazine is requested, it will be analyzed as azobenzene.

Table 11.
Calibration Levels, Appendix IX Standard, µg/mL

Semivolatiles	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Level 7**
2-Picoline	10	20	50	80	120	160	200
N-Nitrosomethylethylamine	10	20	50	80	120	160	200
Methyl methanesulfonate	10	20	50	80	120	160	200
N-Nitrosodiethylamine	10	20	50	80	120	160	200
Ethyl methanesulfonate	10	20	50	80	120	160	200
Pentachloroethane	--	20	50	80	120	160	200
N-Nitrosopyrrolidine	10	20	50	80	120	160	200
N-Nitrosomorpholine	10	20	50	80	120	160	200
o-Toluidine	10	20	50	80	120	160	200
N-Nitrosopiperidine	10	20	50	80	120	160	200
O,O',O"-Triethyl-Phosphorothioate	--	20	50	80	120	160	200
a,a-Dimethyl-phenethylamine	--	20	50	80	120	160	200
Hexachloropropene	--	20	50	80	120	160	200
p-Phenylenediamine	--	20	50	80	120	160	200
n-Nitrosodi-n-butylamine	10	20	50	80	120	160	200
Safrole	--	20	50	80	120	160	200
Isosafrole 1 + 2	10	20	50	80	120	160	200
1,4-Dinitrobenzene	10	20	50	80	120	160	200
1,4-Naphthoquinone	--	20	50	80	120	160	200
Pentachlorobenzene	10	20	50	80	120	160	200
1-Naphthylamine	10	20	50	80	120	160	200
2-Naphthylamine	10	20	50	80	120	160	200
N-Nitro-o-toluidine	10	20	50	80	120	160	200
Thionazin	10	20	50	80	120	160	200
1,3,5-Trinitrobenzene	--	20	50	80	120	160	200
Sulfotepp	--	20	50	80	120	160	200
Phorate	--	20	50	80	120	160	200
Phenacetin	10	20	50	80	120	160	200
Diallate 1 + 2	10	20	50	80	120	160	200
Dimethoate	10	20	50	80	120	160	200
4-Aminobiphenyl	--	20	50	80	120	160	200
Pentachloronitrobenzene	--	20	50	80	120	160	200
Pronamide	10	20	50	80	120	160	200
Disulfoton	--	20	50	80	120	160	200
2-secbutyl-4,6-dinitrophenol (Dinoseb)	10	20	50	80	120	160	200
Methyl parathion	--	20	50	80	120	160	200
4-Nitroquinoline-1-oxide	--	20	50	80	120	160	200
Parathion	--	20	50	80	120	160	200
Isodrin	10	20	50	80	120	160	200
Methapyrilene	--	20	50	80	120	160	200
Aramite 1 and 2	10	20	50	80	120	160	200
p-(Dimethylamino)azobenzene	10	20	50	80	120	160	200
p-Chlorobenzilate	10	20	50	80	120	160	200
3,3'-Dimethylbenzidine	10	20	50	80	120	160	200
2-Acetylaminofluorene	--	20	50	80	120	160	200
Dibenz (a,j)acridine	10	20	50	80	120	160	200
7,12-Dimethylbenz(a) anthracene	10	20	50	80	120	160	200
3-Methylcholanthrene	10	20	50	80	120	160	200
Diphenlyamine	10	20	50	80	120	160	200

Table 12.
Analytically Reliably Performing Compounds

Acenaphthene
Acenaphthylene
Acetophenone
Aniline
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Benzoic acid
Benzyl alcohol
Bis(2-chloroethoxy)methane
Bis(2-chloroethyl)ether
Bis(2-ethylhexyl)phthalate
4-Bromophenyl phenyl ether
Butyl benzyl phthalate
Caprolactam
Carbazole
4-Chloroaniline[1]
4-Chloro-3-methylphenol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl phenyl ether
Chrysene
Dibenz(a,h)anthracene
Dibenzofuran
1,4-Dioxane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
Diethyl phthalate
2,4-Dimethylphenol
Dimethyl phthalate
Di-n-butyl phthalate
4,6-Dinitro-2-methylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
1,2-Diphenylhydrazine (as Azobenzene)
Di-n-octyl phthalate
Famphur
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorocyclopentadiene[1]
Hexachlorobutadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
1-Methylnaphthalene
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline[1]
4-Nitroaniline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
N-Nitrosodimethylamine
N-Nitroso-di-n-propylamine
N-Nitrosodiphenylamine
2,2’-Oxybis(1-chloropropane)
aka "bis(2-chloroisopropyl) ether"
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
Pyridine
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

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[1] Even though these analytes perform reliably through the GC/MS, they are known poor performers through the extraction procedure.

Table 13.
Poorly Performing Compounds

2-Acetylaminofluorene
4-Aminobiphenyl
Aramite (#1)
Aramite (#2)
Benzidine
1,1-Biphenyl
Chlorobenzilate
Diallate (#1)
Diallate (#2)
Dibenz(a,j)acridine
2,6-Dichlorophenol
Dimethoate
p-(Dimethylamino)azobenzene
7,12-Dimethylbenz(a)anthracene
3,3'-Dimethylbenzidine
α,α-Dimethylphenethylamine
1,3-Dinitrobenzene
1,4-Dinitrobenzene
Diphenylamine

Disulfoton
Ethyl methanesulfonate
Hexachlorophene
Hexachloropropene
Isosafrole (#1)
Isosafrole (#2)
Isodrin
Methapyrilene
3-Methylcholanthrene
4,4’-Methylenebis(2-chloroaniline)
Methyl methanesulfonate
Methyl Parathion
1-Naphthylamine
2-Naphthylamine
1,4-Naphthoquinone
4-Nitroquinoline-1-oxide
N-Nitrosodiethylamine
N-Nitrosodi-n-butylamine
N-Nitrosomethylethylamine

N-Nitrosomorpholine
N-Nitrosopiperidine
N-Nitrosopyrrolidine
Pentachlorobenzene
Pentachloroethane
Pentachloronitrobenzene
Phenacetin
p-Phenylenediamine
Phorate
2-Picoline
Pronamide
Safrole
2-secbutyl-4,6-dinitrophenol (Dinoseb)
Sulfotepp
1,2,4,5-Tetrachlorobenzene
2,3,4,6-Tetrachlorophenol
Thionazin
O,O’,O”-Triethylphosphorothioate
1,3,5-Trinitrobenzene

Table 14.
Minimum Response Factor Criteria for Initial and Continuing Calibration Verification

Analyte	Minimum Response Factor (RF)
Benzaldehyde	0.010
Phenol	0.800
Bis(2-chloroethyl)ether	0.700
2-Chlorophenol	0.800
2-Methylphenol	0.700
2,2'-Oxybis(1-chloropropane)[1]	0.010
Acetophenone	0.010
4-Methylphenol	0.600
N-Nitroso-di-n-propylamine	0.500
Hexachloroethane	0.300
Nitrobenzene	0.200
Isophorone	0.400
2-Nitrophenol	0.100
2,4-Dimethylphenol	0.200
Bis(2-chloroethoxy)methane	0.300
2,4-Dichlorophenol	0.200
Naphthalene	0.700
4-Chloroaniline	0.010
Hexachlorobutadiene	0.010
Caprolactam	0.010
4-Chloro-3-methylphenol	0.200
2-Methylnaphthalene	0.400
Hexachlorocyclopentadiene	0.050
2,4,6-Trichlorophenol	0.200
2,4,5-Trichlorophenol	0.200
1,1'-Biphenyl	0.010
2-Chloronaphthalene	0.800
2-Nitroaniline	0.010
Dimethylphthalate	0.010
Acenaphthylene	0.900
2,6-Dinitrotoluene	0.200
3-Nitroaniline	0.010
Acenaphthene	0.900
2,4-Dinitrophenol	0.010
Dibenzofuran	0.800
4-Nitrophenol	0.010
2,4-Dinitrotoluene	0.200
Diethylphthalate	0.010
1,2,4,5-Tetrachlorobenzene	0.010
Fluorene	0.900
4-Chlorophenylphenylether	0.400
4-Nitroaniline	0.010
4,6-Dinitro-2-methylphenol	0.010
N-Nitrosodiphenylamine	0.010
4-Bromophenylphenylether	0.100

[1] 2,2'-Oxybis(1-chloropropane) was formerly known as bis(2-chloroisopropyl)ether

Table 14
Minimum Response Factor Criteria for Initial and Continuing Calibration Verification (cont.)

Analyte	**Minimum Response Factor (RF)**
Hexachlorobenzene	0.100
Atrazine	0.010
Pentachlorophenol	0.050
Phenanthrene	0.700
Anthracene	0.700
Carbazole	0.010
Di-n-butylphthalate	0.010
Fluoranthene	0.600
Pyrene	0.600
Butylbenzylphthalate	0.010
Benzo(a)anthracene	0.800
3,3'-Dichlorobenzidine	0.010
Chrysene	0.700
Bis(2-ethylhexyl)phthalate	0.010
Di-n-octylphthalate	0.010
Benzo(b)fluoranthene	0.700
Benzo(k)fluoranthene	0.700
Benzo(a)pyrene	0.700
Indeno(1,2,3-cd)pyrene	0.500
Dibenz(a,h)anthracene	0.400
Benzo(g,h,i)perylene	0.500
2,3,4,6-Tetrachlorophenol	0.010

Note: All target compounds not listed in this table will be assigned a minimum response factor (RF) of 0.01

Table 15

Specific DoD QSM 5.0 and DOE QSAS 3.0 Requirements for 8270D

This table includes components of the DoD QSM 5.0 and DoE QSAS 3.0 that are different from TestAmerica's standard procedures, for a complete description of requirements, see DV-QA-024P. Also listed are the variances that TestAmerica is requesting for this analysis; these alternate criteria are only used with project-specific approval.

Requirement	Variance (if allowed)	DoD QSM 5.0 and DoE QSAS 3.0
Tune Check	--	Perform tune check prior to calibration and prior to each period of every 12 hours during sample analysis. Use method specified ion abundance criteria for BFB or DFTPP. If unsuccessful, retune and verify. No samples shall be analyzed without a valid tune.
Performance Check (Method 8270 only)	--	Performed daily at the beginning of each 12-hour period prior to analysis of samples. Degradation must be ≤20% for DDT. Any problems must be corrected. Do not run samples until degradation is ≤ 20%. Benzidine and pentachlorophenol should be present at their normal responses and peak tailing should not exceed a tailing factor of 2. Correct problem and reanalyze.
Initial Calibration (ICAL) for all analytes including surrogates	--	Perform a minimum 5 point calibration for all analytes prior to sample analysis. (Minimum 6 points for non-linear). Acceptance Criteria options: Option 1: RSD for each analyte $\leq$ 15% Option 2: Linear least squares regression for each analyte: $r^2 \geq 0.99$ ($r \geq 0.995$) Option 3: Non-linear least square regression (quadratic) for each analyte, $r^2 \geq 0.99$. Additional method requirements for evaluation must be met: See method SOPs for details. (e.g., CCCs, SPCCs, low calibration standard analysis and recovery criteria, etc.) Any problems must be corrected and ICAL repeated. No sample can be run until ICAL is successful.
Initial Calibration Verification (ICV)	 4PP	All analytes must be within ± 20% of the true value. Allow ± 30% of true value for known poor performers only if these compounds are not identified as critical compounds of concern by the client for the project under consideration.
Continuing calibration Verification (CCV/CCVC))	 4PP 3HR 7MS	Run before sample and at the end of the analytical batch (end of 12 hours). Acceptance limits for all analytes is ± 20% of true value for the CCV at start of 12 hours. If any analytes fail in a CCV, recalibrate and re-analyze all affected samples or immediately (within one hour) analyze two consecutive CCVs and if both pass for the analytes that failed, the CCV is acceptable. Closing CCV (CCVC) has an acceptance limit of ± 20% of true value. Allow ±30% of true value for known poor performers if these compounds are not identified as critical compounds of concern by the client. If the CCV is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project. Allow ± 50% for end of analytical batch excluding poor performing compounds. Reanalysis performed due to failed closing CCV only for the analytes identified by the client as critical compounds of concern for the project, and to report qualified results for other analytes. (7MS)
Internal Standards (IS)	 8ISRT	RT must be ± 10 sec. from RT of the midpoint standard in the ICAL. RT must be ± 30 sec. from RT of the midpoint standard in the ICAL. Daily routine column

Requirement	Variance (if allowed)	DoD QSM 5.0 and DoE QSAS 3.0
		maintenance often results in larger RT changes than 10 sec. within a short time.
LCS		Include all analyte(s) in LCS that are required to be reported, including surrogates, except those compounds listed as “Additional Analytes” by TestAmerica. These compounds are rarely requested and historical limits may not accurately reflect current performance.
	4PP	If the LCS recovery is above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project (3HR).
	3HR	Otherwise, correct any problems then re-prep and reanalyze the LCS and all associated samples for failed analytes. If insufficient sample, then apply Q-flag to specific analyte(s) in all samples in the associated prep batch. Flagging is only appropriate when samples cannot be reanalyzed unless 3HR is accepted by the client.
	1SME	Marginal exceedances are not allowed for critical chemicals of concern (risk drivers). Client must notify TestAmerica of these targets or if marginal exceedances will not be allowed. (1SME)
Surrogates		For QC and field samples, correct any problems, then re-prep and reanalyze all failed samples for failed surrogates in the associated prep batch. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.
	3HR	If surrogate recoveries are above the project acceptance limits and there are no detections in the samples, TestAmerica will report the non-detect results with a case narrative comment in addition to applying any data qualifier flags required by the project.

Table LVI-1.
LVI Calibration Levels, Primary (HSL) Standard, µg/mL

Analyte	L1	L2	L3	L4	L5	L6	L7	L8
Pyridine	1	2.5	5	12.5	20	30	40	50
N-nitrosodimethylamine	1	2.5	5	12.5	20	30	40	50
Aniline	1	2.5	5	12.5	20	30	40	50
Phenol	1	2.5	5	12.5	20	30	40	50
Bis(2-chloroethyl)ether	1	2.5	5	12.5	20	30	40	50
2-Chlorophenol	1	2.5	5	12.5	20	30	40	50
1,3-Dichlorobenzene	1	2.5	5	12.5	20	30	40	50
1,4-Dichlorobenzene	1	2.5	5	12.5	20	30	40	50
Benzyl alcohol	1	2.5	5	12.5	20	30	40	50
1,2-Dichlorobenzene	1	2.5	5	12.5	20	30	40	50
2-Methylphenol	1	2.5	5	12.5	20	30	40	50
2,2'-oxybis(1-chloropropane)[1]	1	2.5	5	12.5	20	30	40	50
4-Methylphenol	1	2.5	5	12.5	20	30	40	50
3-Methylphenol	1	2.5	5	12.5	20	30	40	50
Acetophenone	1	2.5	5	12.5	20	30	40	50
N-Nitroso-di-n-propylamine	1	2.5	5	12.5	20	30	40	50
Hexachloroethane	1	2.5	5	12.5	20	30	40	50
Nitrobenzene	1	2.5	5	12.5	20	30	40	50
Isophorone	1	2.5	5	12.5	20	30	40	50
2-Nitrophenol	1	2.5	5	12.5	20	30	40	50
2,4-Dimethylphenol	1	2.5	5	12.5	20	30	40	50
Benzoic acid	2	5	10	25	40	60	80	100
Bis(2-chloroethoxy)methane	1	2.5	5	12.5	20	30	40	50
2,4-Dichlorophenol	1	2.5	5	12.5	20	30	40	50
1,2,4-Trichlorobenzene	1	2.5	5	12.5	20	30	40	50
Naphthalene	1	2.5	5	12.5	20	30	40	50
4-Chloroaniline	1	2.5	5	12.5	20	30	40	50
Hexachlorobutadiene	1	2.5	5	12.5	20	30	40	50
4-Chloro-3-methylphenol	1	2.5	5	12.5	20	30	40	50
2-Methylnaphthalene	1	2.5	5	12.5	20	30	40	50
Hexachlorocyclopentadiene	1	2.5	5	12.5	20	30	40	50
1,2,4,5-Tetrachlorobenzene	1	2.5	5	12.5	20	30	40	50
2,4,6-Trichlorophenol	1	2.5	5	12.5	20	30	40	50
2,4,5-Trichlorophenol	1	2.5	5	12.5	20	30	40	50
2-Chloronaphthalene	1	2.5	5	12.5	20	30	40	50
2-Nitroaniline	1	2.5	5	12.5	20	30	40	50
Dimethyl phthalate	1	2.5	5	12.5	20	30	40	50
1,3-Dinitrobenzene	1	2.5	5	12.5	20	30	40	50
Acenaphthylene	1	2.5	5	12.5	20	30	40	50
3-Nitroaniline	1	2.5	5	12.5	20	30	40	50
Acenaphthene	1	2.5	5	12.5	20	30	40	50
2,4-Dinitrophenol	2	5	10	25	40	60	80	100
4-Nitrophenol	2	5	10	25	40	60	80	100
Dibenzofuran	1	2.5	5	12.5	20	30	40	50
2,3,4,6-Tetrachlorophenol	1	2.5	5	12.5	20	30	40	50
2,4-Dinitrotoluene	1	2.5	5	12.5	20	30	40	50
2,6-Dinitrotoluene	1	2.5	5	12.5	20	30	40	50

Table LVI-1. (continued)
LVI Calibration Levels, Primary Standard, µg/mL

Analyte	L1	L2	L3	L4	L5	L6	L7	L8
Diethylphthalate	1	2.5	5	12.5	20	30	40	50
4-Chlorophenyl phenyl ether	1	2.5	5	12.5	20	30	40	50
Fluorene	1	2.5	5	12.5	20	30	40	50
4-Nitroaniline	1	2.5	5	12.5	20	30	40	50
4,6-Dinitro-2-methylphenol	2	5	10	25	40	60	80	100
N-Nitrosodiphenylamine	1	2.5	5	12.5	20	30	40	50
Azobenzene[2]	1	2.5	5	12.5	20	30	40	50
4-Bromophenyl phenyl ether	1	2.5	5	12.5	20	30	40	50
Hexachlorobenzene	1	2.5	5	12.5	20	30	40	50
Pentachlorophenol	2	5	10	25	40	60	80	100
Phenanthrene	1	2.5	5	12.5	20	30	40	50
Anthracene	1	2.5	5	12.5	20	30	40	50
Carbazole	1	2.5	5	12.5	20	30	40	50
Di-n-butyl phthalate	1	2.5	5	12.5	20	30	40	50
Fluoranthene	1	2.5	5	12.5	20	30	40	50
Benzidine	1	2.5	5	12.5	20	30	40	50
Pyrene	1	2.5	5	12.5	20	30	40	50
Butyl benzyl phthalate	1	2.5	5	12.5	20	30	40	50
3,3'-Dichlorobenzidine	1	2.5	5	12.5	20	30	40	50
Benzo(a)anthracene	1	2.5	5	12.5	20	30	40	50
Bis(2-ethylhexyl)phthalate	1	2.5	5	12.5	20	30	40	50
Chrysene	1	2.5	5	12.5	20	30	40	50
Di-n-octylphthalate	1	2.5	5	12.5	20	30	40	50
Benzo(b)fluoranthene	1	2.5	5	12.5	20	30	40	50
Benzo(k)fluoranthene	1	2.5	5	12.5	20	30	40	50
Benzo(a)pyrene	1	2.5	5	12.5	20	30	40	50
Indeno(1,2,3-cd)pyrene	1	2.5	5	12.5	20	30	40	50
Dibenz(a,h)anthracene	1	2.5	5	12.5	20	30	40	50
Benzo(g,h,i)perylene	1	2.5	5	12.5	20	30	40	50
2,6-Dichlorophenol	--	2.5	5	12.5	20	30	40	50

[1] 2,2’oxybis(1-chloropropane) was formally known as bis(2-chloroisopropyl)ether

[2] Azobenzene is formed by decomposition of 1,2-diphenlyhydrazine. If 1,2-diphenylhydrazine is requested, it will be analyzed as azobenzene.

Table LVI-2.
LVI Calibration Levels, Appendix IX Standard, µg/mL

Semivolatiles	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
2-Picoline	2.5	5	12.5	20	30	40	50
N-Nitrosomethylethylamine	2.5	5	12.5	20	30	40	50
Methyl methanesulfonate	2.5	5	12.5	20	30	40	50
N-Nitrosodiethylamine	2.5	5	12.5	20	30	40	50
Ethyl methanesulfonate	2.5	5	12.5	20	30	40	50
Pentachloroethane	2.5	5	12.5	20	30	40	50
N-Nitrosopyrrolidine	2.5	5	12.5	20	30	40	50
N-Nitrosomorpholine	2.5	5	12.5	20	30	40	50
o-Toluidine	2.5	5	12.5	20	30	40	50
N-Nitrosopiperidine	2.5	5	12.5	20	30	40	50
O,O',O"-Triethyl-Phosphorothioate	2.5	5	12.5	20	30	40	50
alpha,alpha-Dimethyl-phenethylamine	2.5	5	12.5	20	30	40	50
Hexachloropropene	2.5	5	12.5	20	30	40	50
p-Phenylenediamine	2.5	5	12.5	20	30	40	50
n-Nitrosodi-n-butylamine	2.5	5	12.5	20	30	40	50
Safrole	2.5	5	12.5	20	30	40	50
Isosafrole 1 + 2	2.5	5	12.5	20	30	40	50
1,4-Dinitrobenzene	2.5	5	12.5	20	30	40	50
1,4-Naphthoquinone	2.5	5	12.5	20	30	40	50
Pentachlorobenzene	2.5	5	12.5	20	30	40	50
1-Naphthylamine	2.5	5	12.5	20	30	40	50
2-Naphthylamine	2.5	5	12.5	20	30	40	50
N-Nitro-o-toluidine	2.5	5	12.5	20	30	40	50
Thionazin	2.5	5	12.5	20	30	40	50
1,3,5-Trinitrobenzene	2.5	5	12.5	20	30	40	50
Sulfotepp	2.5	5	12.5	20	30	40	50
Phorate	2.5	5	12.5	20	30	40	50
Phenacetin	2.5	5	12.5	20	30	40	50
Diallate 1 + 2	2.5	5	12.5	20	30	40	50
Dimethoate	2.5	5	12.5	20	30	40	50
4-Aminobiphenyl	2.5	5	12.5	20	30	40	50
Pentachloronitrobenzene	2.5	5	12.5	20	30	40	50
Pronamide	2.5	5	12.5	20	30	40	50
Disulfoton	2.5	5	12.5	20	30	40	50
2-secbutyl-4,6-dinitrophenol (Dinoseb)	2.5	5	12.5	20	30	40	50
Methyl parathion	2.5	5	12.5	20	30	40	50
4-Nitroquinoline-1-oxide	2.5	5	12.5	20	30	40	50
Parathion	2.5	5	12.5	20	30	40	50

Table LVI-2. (continued)
LVI Calibration Levels, Appendix IX Standard, µg/mL

Semivolatiles	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Level 7**
Isodrin	2.5	5	12.5	20	30	40	50
Methapyrilene	2.5	5	12.5	20	30	40	50
Aramite 1 and 2	2.5	5	12.5	20	30	40	50
p-(Dimethylamino) azobenzene	2.5	5	12.5	20	30	40	50
p-Chlorobenzilate	2.5	5	12.5	20	30	40	50
3,3'-Dimethylbenzidine	2.5	5	12.5	20	30	40	50
2-Acetylaminofluorene	2.5	5	12.5	20	30	40	50
Dibenz (a,j)acridine	2.5	5	12.5	20	30	40	50
7,12-Dimethylbenz(a) anthracene	2.5	5	12.5	20	30	40	50
3-Methylcholanthrene	2.5	5	12.5	20	30	40	50

APPENDIX A

Modifications Required for Analysis of Samples Following Method 8270 Best Practice (8270D_LL)

REQUIREMENTS FOR METHOD 8270 BEST PRACTICE (8270D_LL)

- Method Best Practice is utilized to obtain lower reporting limits while still providing full scan data. The standard analyte list and reporting limits are listed in Table A-1.

- This method is only applicable to the analysis of low level samples aqueous samples. The appropriate range for aqueous samples is 1 to 100 ug/L. Attempts to analyze samples with concentrations much higher than this for target compounds, or high concentrations of non-target compounds will likely result in a decline in the quality control parameters for the method. Once the instrument has been adversely impacted by high level samples, it may not be possible to bring it back into control in a reasonable time frame.

- The laboratory currently performs this method with only a base only extraction and analyzed for only 1,4-Dioxane or N-Nitrosodimethylamine.

- The extraction is the same with one exception. The final volume of the extract is 2 mL.

- The tune period for this method is defined as 12 hours.

- Initial calibration curve requirements are as follows:
  - Same as for 8270 detailed in Section 11.4 of this SOP.
  - The calibrations levels are shown in Table A-2.

- Continuing calibration verification requirements are as follows:
  - Same as for 8270 detailed in Section 11.9 of this SOP, except that 7 calibration point levels are used.

- Matrix Spike and LCS requirements are as follows:
  - The spike levels are listed in Table A-3.

- Surrogates: The surrogate concentrations are listed in Table A-4.

- Instrument Conditions are shown in Table A-5.

- Internal Standard and Surrogate associations are provided in Table A-6.

Table A-1.
TAL Method 8270D_LL Standard Reporting Limits

Analytes	CAS Number	Aqueous, µg/L
N-Nitrosodimethylamine	62-75-9	1
1,4-Dioxane	123-91-2	1

Table A-2.
Method 8270D_LL Calibration Levels

Calibration Level	Calibration Concentration, µg/mL
1	0.25
2	0.50
3	1.00
4	2.50
5	5.00
6	7.50
7	10.0
8	12.5
9	20.0
10	40.0
ICV/CCV	7.5

Additional analytes in the calibration standards are not analyzed by Method 8270D_LL.

Table A-3.
Method 8270D_LL LCS Spike Concentrations

LCS Compounds	Spiking Level, µg/L
N-Nitrosodimethylamine	10
1,4-Dioxane	10

Additional analytes in the spike mix are not analyzed.

Table A-4.
8270D_LL Surrogate Compounds

Surrogate Compounds	Spiking Level, ng/µL in extract
Nitrobenzene-d_5	5
2-Fluorobiphenyl	5
Terphenyl-d_{14}	5
Phenol-d_5	5
2-Fluorophenol	5
2,4,6-Tribromophenol	5

Additional analytes in the spike mix are not monitored.

Table A-5.
Suggested Instrument Conditions for 8270D_LL

Mass Range:	35 - 500 amu
Scan Time:	≤1 second/scan
Initial Column Temperature/Hold Time:	50 °C for 1 minutes
Column Temperature Program:	50 - 320 °C at 35°C/min.
Final Column Temperature/Hold Time:	325 °C/4 min hold
Injector Temperature:	275 °C
Transfer Line Temperature:	290 °C
Source Temperature:	230 °C
Injector:	Single Taper Direct Connect Liner /splitless
Sample Volume:	0.5 µl
Carrier Gas:	Helium at 1.0mL/min.
Column:	DB-5 Capillary 20m x 0.18mm x 0.36 um film thickness

Table A-6.

Internal Standard and Surrogate Association for 8270_LL Base-Only Extraction (in alpha-numeric order)

Analyte	IS	Surr
1,4-Dichlorobenzene-d_4 (Internal Standard)	1	-
1,4-Dioxane	**1**	**2**
2-Fluorobiphenyl (Surrogate Standard)	3	2
Acenaphthene-d_{10} (Internal Standard)	3	-
Chrysene-d_{12} (Internal Standard)	5	-
Naphthalene-d_8 (Internal Standard)	2	-
Nitrobenzene-d_5 (Surrogate Standard)	2	4
N-Nitrosodimethylamine	**1**	**2**
Perylene-d_{12} (Internal Standard)	6	-
Phenanthrene-d_{10} (Internal Standard)	4	-
Terphenyl-d_{14} (Surrogate Standard)	5	6

APPENDIX B

Suggested Instrument Maintenance Schedules - Mass Spectrometer & Gas Chromatograph

MASS SPECTROMETER Instrument Maintenance Schedule

Daily (when used)	Weekly	As Needed	Quarterly	Annually
Check for sufficient gas supply. Check for correct column flow and/or inlet pressure	Check mass calibration (PFTBA or FC-43).	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between service contract maintenance.	Check vacuum, relays, gas pressures, and flows.	Replace the exhaust filters on the mechanical rough pump every 1 to 2 years.
Check temperatures of injector, detector. Verify temperature programs.		Replace electron multiplier when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.		Change the oil in the mechanical rough pump.
Check inlets, septa.		Clean source, including all ceramics and lenses. Source cleaning is indicated by a variety of symptoms, including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.		Relubricate the turbomolecular pump-bearing wick.
Check baseline level.		Repair/replace jet separator.		
Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds.		Replace filaments when both filaments burn out or performance indicates the need for replacement.		

APPENDIX B

Suggested Instrument Maintenance Schedules - Mass Spectrometer & Gas Chromatograph (cont.)

GAS CHROMATOGRAPH Instrument Maintenance Schedule (*For GC/MS only.*)

Daily (when used)	***As Needed***
Check for sufficient supply of carrier and detector gases. Check for correct column flow and/or inlet pressures.	Replace front portion of column packing or guard column or break off front portion of capillary columns. Replace column if this fails to restore column performance or when column performance indicates it is required (e.g., peak tailing, poor resolution, high backgrounds, etc.).
Check temperatures of injectors and detectors. Verify temperature programs.	Change glass wool plug in injection port and/or replace injection port liner when front portion of column packing is changed or front portion of capillary column is removed.
Check inlets, septa. Clean injector port.	Replace septa.
Check baseline level.	Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).
Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks.	Repair or replace flow controller if constant gas flow cannot be maintained.
	Reactivate flow controller filter dryers when the presence of moisture is suspected.
	Autosampler: Replace syringe, fill wash bottle, dispose of waste bottle contents.

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Title: Extraction of Aqueous Samples by Separatory Funnel, SW846 3510C and EPA 600 Series

Approvals (Signature/Date):

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Doug Gomer 10/29/18
Doug Gomer Date
Health & Safety Manager/Coordinator

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Roxanne Sullivan Date
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Richard Clinkscales Date
Laboratory Director

Facility Distribution No. ___________ **Distributed To:**___________________________

1.0 Scope and Application

1.1 This Standard Operating Procedure (SOP) is applicable to the solvent extraction of organic compounds from water samples, TCLP leachates, and SPLP leachates, using a separatory funnel. This SOP based on SW-846 Method 3510C, EPA 608, EPA 610, EPA 614, AK102, NWTPH-Dx, and Oklahoma DRO method.

1.2 The determinative methods used in conjunction with this procedure are listed in Table 1. This extraction procedure may be used for additional methods when appropriate pH and spiking mixtures are used.

1.3 This procedure does not include the concentration and cleanup steps. See SOP DV-OP-0007, “Concentration of Organic Extracts”, for details concerning the concentration and cleanup of extracts.

2.0 Summary of Method

A measured volume of sample, is placed in a separatory funnel. The pH is adjusted as required for the efficient extraction of specific compounds. The organic compounds are extracted with three portions of methylene chloride. The water phase is discarded. The organic phase is dried using sodium sulfate.

3.0 Definitions

Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, *Quality Control Program*, for definitions of general analytical and QA/QC terms.

3.1 **Extraction Holding Time**: The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.2 **Preparation Batch**: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards

3.3 **Method Comments:** The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client. Please reference WI-DV-0032 for details on Method Comments.

3.4 **Quality Assurance Summary (QAS)**: Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in LIMS. In these situations, laboratory Project Managers describe the special requirements in a written QAS. QASs are posted on a public drive for easy accessibility by all lab employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.5 **Aliquot**: A part that is a definite fraction of a whole; as in "take an aliquot of a sample for testing or analysis." In the context of this SOP, "aliquot" is also used as a verb, meaning to take all or part of a sample for preparation, extraction, and/or analysis.

3.6 **Reagent Water** (aka ELGA water – water generated from ELGA water polishing units): Water with a resistivity of 1 Megohm-cm or greater. The TestAmerica Denver deionized water supply meets this requirement with a resistivity of at least 10 Megohm-cm.

4.0 Interferences

4.1 Chemical and physical interferences may be encountered when analyzing samples using this method.

4.2 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

4.3 Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented in an NCM.

4.4 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them. Especially take note of the possibility of phthalate contamination from gloves. Gloves should be changed out frequently and whenever they come in contact with solvent. Glassware should be handled in a fashion that keeps gloves away from the interior and mouth of the glassware.

4.5 The decomposition of some analytes has been demonstrated under basic extraction conditions. Organochlorine pesticides may dechlorinate, phthalate esters may exchange, and phenol may react to form tannates. These reactions increase with increasing pH, and are decreased by the shorter reaction times available in Method 3510C. Method 3510C is preferred over Method 3520C for the analysis of these classes of compounds. However, the recovery of phenols is optimized by using Method 3520C and performing the initial extraction at the acid pH.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 The use of separatory funnels to extract samples using methylene chloride creates excessive pressure very rapidly. Initial venting should be done immediately after the separatory funnel has been sealed and inverted. Vent the funnel into the hood away from people and other samples. This is considered a high-risk activity. Either a face shield must be worn over safety glasses or goggles must be worn when it is performed.

5.3.2 Glass centrifuge tubes can break in the centrifuge if proper care is not taken. This can lead to a hazardous material spill and endanger employees. Do not exceed the manufacturer's recommended maximum RPM for glass containers. Normally speeds greater than 2700 rpm are not advisable.

5.3.3 The procedure calls for the use of an electric rotator. The rotator is equipped with a safety latch that does not allow the rotator to rotate even if the power switch is turned on. The separatory funnels are secured to the rotator using straps. During the procedure it will be necessary to loosen the straps in order to un-stopper the separatory funnels. Whenever the straps are loose, the safety latch must be fastened to prevent the rotator from rotating.

5.3.4 Glasswool is a carcinogen and therefore should be handled in a hood to avoid inhalation of dust.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Materials with Serious or Significant Hazard Rating

Material [(1)]	Hazards	Exposure Limit [(2)]	Signs and Symptoms of Exposure
Methylene Chloride	Carcinogen Irritant	25 ppm (TWA) 125 ppm (STEL)	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness, and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Sodium Hydroxide	Corrosive Poison	2 mg/m3	Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat, and runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes and can cause burns that may result in permanent impairment of vision, even blindness with greater exposures.
Hydrochloric Acid	Corrosive Poison	5 ppm (Ceiling)	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Sulfuric Acid	Corrosive Carcinogen	1 mg/m3	Inhalation may cause irritation of the respiratory tract with burning pain the nose and throat, coughing, wheezing, shortness of breath, and pulmonary edema. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Causes skin burns. Causes severe eye burns. May cause irreversible eye injury, blindness, permanent corneal opacification.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit			

6.0 Equipment and Supplies

NOTE: All glassware used in this procedure is cleaned following SOP DV-OP-0004. In addition, the glassware is rinsed with methylene chloride immediately prior to use.

6.1 Supplies

- Separatory funnel, 2-liter with polytetrafluoroethylene (PTFE) stopcock and stopper.
- Separatory funnel, 500-mL with polytetrafluoroethylene (PTFE) stopcock and stopper.
- Separatory funnel rack and mechanical rotator.

- Balance, ≥ 1400 g capacity, accurate to ± 1 g, calibration checked daily per SOP DV-QA-0014.
- pH indicator paper, wide range.
- Class A Graduated Cylinder, sizes ranging from 50 mL to 1 L.
- Media bottles, 300 mL with Teflon-lined caps or capped with aluminum foil.
- Media bottles, 100 mL with Teflon-lined caps or capped with aluminum foil.
- Disposable pipettes, various volumes.
- Stemless glass funnel.
- Glass wool, baked at 400 °C for four hours.
- Mechanical pipette, 1 mL, positive displacement, with disposable tips, calibrated per SOP DV-QA-0008.
- Aluminum foil.
- Paper towels.

6.2 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Reagent Water

TestAmerica Denver has two ELGA water purification systems. The water coming from the ELGA system should be 18-18.2 Mohm-cm. The performance of the water polishing system is checked daily and recorded per SOP DV-QA-0026.

7.2 Methylene Chloride

Each lot of solvent is tested following SOP CA-Q-S-001 DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.3 Acids and Bases

7.3.1 1:1 Sulfuric Acid (H_2SO_4), *TALS Reagent ID "1:1 H2SO4"*

Place an ice water bath on a stir plate. Place a container with a magnetic stir bar in the bath. While stirring, slowly add 1 part concentrated reagent grade sulfuric acid (36N) to 1 part water from the ELGA purification system. Assign a 1 year expiration date from the date made or the vender expiration date, whichever is shorter.

7.3.2 10N Sodium Hydroxide (NaOH), *TALS Reagent ID "10N_NaOH"*

Purchased at ready-to-use concentration from commercial vendors. Assign a 1 year expiration date from the date opened or the vender expiration date, whichever is shorter.

7.3.3 1N Hydrochloric Acid (HCl), *TALS Reagent ID "1N_HCl"*

Dilute 100 mL of stock reagent grade, concentrated HCl to 1000 mL with reagent water.

7.4 Baked Sodium Sulfate, 12-60 mesh

Heat sodium sulfate in a 400 °C oven for at least four hours. Store in tightly closed container.

7.5 Baked Sodium Chloride

Bake in 400 °C oven for at least 4 hours.

7.6 Standards

Please reference SOP DV-OP-0020 and WI-DV-0009 for information regarding the surrogate and spike standards used in this procedure.

8.0 <u>Sample Collection, Preservation, Shipment and Storage</u>

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix and Method	Sample Container	Min. Sample Size	Preservation	Holding Time[1]	Reference
Water	Amber Glass	1000 mL	Cool, $\leq 6^{o}C$	7 Days	40 CFR Part 136.3
Water for Method AK 102	Amber Glass	1000 mL	Cool, $\leq 6^{o}C$ and pH ≤ 2 with HCl	14 Days if properly preserved. 7 Days if un-preserved.	Method AK 102
Water for Method Oklahoma DRO	Amber Glass	1000 mL	Cool, $\leq 6^{o}C$ and pH ≤ 2 with HCl	7 Days	Oklahoma Dept. of Environmental Quality
Water for Method NWTPH-DX	Amber Glass	1000 mL	Cool, $\leq 6^{o}C$ and pH ≤ 2 with HCl	7 Days	NWTPH-Dx
Water for Method 8082 or 8082A	Amber Glass	1000 mL	Cool, $\leq 6^{o}C$	None [2]	SW-846 Chapter 4, Revision 4, Feb 2007
Water for Method 8081 or 8082 by Large Volume Injection	Amber Glass	250 mL	Cool, $\leq 6^{o}C$	7 Days	40 CFR Part 136.3
Water for Method 8270SIM by Large Volume Injection	Amber Glass	250 mL	Cool, $\leq 6^{o}C$	7 Days	40 CFR Part 136.3
TCLP Leachates	Glass	200 mL for 8270 100 mL for 8081 100mL for 8141	Cool, $\leq 6^{o}C$	7 Days from the start of the leach	SW-846 1311
SPLP Leachates	Glass	1000 mL	Cool, $\leq 6^{o}C$	7 Days from the start of the leach	SW-846 1312

[1] Exclusive of analysis.

[2] Some regulatory agencies do not accept SW-846 Revision 4 of Chapter 4 and will require a 1 week hold time for method 8082 and 8082A. The states of California, South Carolina, Pennsylvania, and Connecticut require a 1 week hold time.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Assurance Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.3 Method Blank (MB)

9.3.1 One method blank must be processed with each preparation batch. The method blank is processed and analyzed just as if it were a field sample.

9.3.2 The method blank for batches of aqueous samples for Large Volume Injection (prep method 3510C_LVI) consists of 250mL of reagent water free of any of the analyte(s) of interest.

9.3.3 The method blank for batches of aqueous samples for all other methods consists of 1 L of reagent water free of any of the analyte(s) of interest.

9.3.4 The method blank for batches of TCLP leachates for methods 8081 and 8141 consists of 100 mL of leach fluid.

9.3.5 The method blank for batches of TCLP leachates for method 8270 consists of 200 mL of leach fluid.

9.3.6 The method blank for batches of SPLP leachates consists of 1 L of leach fluid.

9.4 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)

9.4.1 At least one LCS must be processed with each preparation batch. The LCS is carried through the entire analytical procedure just as if it were a sample.

9.4.2 The LCS for batches of aqueous samples for Large Volume Injection (prep method 3510C_LVI) consists of 250mL of reagent water to which the analyte(s) of interest are added at known concentrations.

9.4.3 For aqueous sample batches for all other methods, the LCS consists of 1 L of reagent water to which the analyte(s) of interest are added at known concentration.

9.4.4 For methods 8081 and 8141 TCLP leachates, the LCS consists of 100 mL of leach fluid to which the analyte(s) of interest are added at known concentration.

9.4.5 For method 8270 TCLP leachates, the LCS consists of 200 mL of leach fluid to which the analyte(s) of interest are added at known concentration.

9.4.6 For SPLP leachates, the LCS consists of 1 L of leach fluid to which the analyte(s) of interest are added at known concentration.

9.4.7 Method 608, 614, 610 requires a LCS at a 10% frequency. In other words one LCS is required for a batch of 10 or less samples. A LCSD is required for a batch of 11 or more samples.

9.4.8 Method AK102 requires LCS and a LCSD for every batch for every spike compound.

9.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.5.1 One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

9.5.2 If insufficient sample volume is available for MS/MSD, an NCM must be written and a LCSD must be prepared unless Method Comments indicate otherwise. DoD requires the MS/MSD to be assigned by the client. When there is no assigned MS/MSD or there is not enough sample volume provided an LCSD must be prepared.

9.5.3 Method 608, 610, and 614 requires one matrix spike for every 10 samples. If the batch has more than 10 samples, then two matrix spikes must be performed. The two matrix spikes are to be performed on two different samples. If there is insufficient sample volume for matrix spikes, then a LCSD must be performed.

9.5.4 Method NWTPH-Dx requires a matrix spike and a matrix spike duplicate for every 10 samples. If insufficient sample volume is available for MS/MSD, a NCM must be written and a LCS and LCSD must be performed for every 10 samples.

9.6 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

10.0 <u>Procedure</u>

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

10.4 Critical Procedural Considerations

10.4.1 As stated throughout this SOP, analysts must review the Method Comments and any applicable QASs before starting work. This review is also documented on the Organic Extraction Checklist (see WI-DV-0009).

10.4.2 Analyst must focus on using clean technique throughout this procedure. Any parts or pipettes that come into direct contact with dirty surfaces or any other separatory funnel than the designated one should be cleaned or disposed of before coming into contact with the sample.

10.5 Assemble and clean the glassware immediately before use.

NOTE: Rotate glassware; do <u>**not**</u> use specific glassware or positions for the MB and LCS/LCSD.

10.5.1 Place a stopcock in each separatory funnel. For 1-liter extractions use a 2000 mL separatory funnel. For 250 mL, 200 mL and 100 mL extractions, use a 500 mL separatory funnel. Place a stopper for each separatory funnel on a clean sheet of aluminum foil that is marked with individual positions for each stopper. This is done to prevent cross-contamination.

NOTE: Samples logged with method 3510_LVI are for Large Volume Injection methods and require 250 mL initial volumes. Samples logged for 8270 with a TCLP pre-prep require 200mL initial volumes. Samples logged for 8081 and 8141 with a TCLP pre-prep require 100 mL initial volumes.

10.5.2 For each separatory funnel, plug a glass funnel with baked glass wool and add baked sodium sulfate. Place the funnel on a media bottle and place the media bottle below the separatory funnel.

10.5.3 Rinse each separatory funnel once with methylene chloride. Be sure that all surfaces come into contact with the solvent. Drain the methylene chloride into the media bottle through the sodium sulfate.

10.5.4 Rinse the sodium sulfate with additional methylene chloride if the first rinse did not completely saturate the sodium sulfate.

10.5.5 Allow the methylene chloride to drain completely into the media bottle. Swirl the media bottle to ensure all surfaces come into contact with the solvent. Add additional methylene chloride to the rinse if necessary.

10.5.6 Discard the methylene chloride.

10.5.7 Label each media bottle with the sample ID or batch QC ID.

10.6 Prepare LCS and Method Blank Samples

NOTE: For SW-846 methods if there is not a MS/MSD pair in the batch then perform a LCS/LCSD. Methods 608, 610, and 614 require a LCS and LCSD in batches of 11 samples or more or if there are no Matrix Spikes in batches of 10 or less.

10.6.1 For aqueous sample batches logged for Large Volume Injection, (3510_LVI), pour 250 mL of reagent water into the separatory funnels marked for the LCSs and the MB.

10.6.2 For all other aqueous sample batches, pour 1 liter of reagent water into the separatory funnels marked for the LCSs and the MB.

10.6.3 For 8270 TCLP leachates, use a 250 mL or 500 mL Class A graduated cylinder to measure out 200 mL of the appropriate leach fluid for each MB and LCS and LCSD. Record the volume to the nearest mL. Place the leachate bottle beside the separatory funnel so a second analyst can check that the correct leach fluid was used.

10.6.4 For 8081 and 8141 TCLP leachates, use a 100 mL or 250 mL Class A graduated cylinder to measure out 100 mL of the appropriate leach fluid for each MB and LCS and LCSD. Record the volume to the nearest mL. Place the leachate bottle beside the separatory funnel so a second analyst can check that the correct leach fluid was used.

10.6.5 For SPLP leachates, use a 1000 mL Class A graduated cylinder to measure out 1000 mL of the appropriate leach fluid for each MB and LCS and LCSD. Record the volume to the nearest 10 mL. Place the leachate bottle beside the separatory funnel so a second analyst can check that the correct leach fluid was used.

10.7 Measure the initial sample pH of the samples.

10.7.1 Measure the initial sample pH with wide-range pH paper and record the pH on the extraction bench sheet.

10.7.2 If the sample is logged for AK102_103, Okla_DRO, or NWTPH_Dx the samples should have been field preserved. See Section 8. If the samples are not preserved, an NCM should be written.

10.8 Aliquot the samples

10.8.1 For 8270 TCLP leachates, use a 250 mL or 500 mL Class A graduated cylinder to measure out 200 mL of the leachate. Record the volume to the nearest mL. Place the leachate bottle beside the separatory funnel so a second analyst can check that the correct leach fluid was used.

10.8.2 For 8081 and 8141 TCLP leachates, use a 100 mL or 250 mL Class A graduated cylinder to measure out 100 mL of the leachate. Record the volume to the nearest mL. Place the leachate bottle beside the separatory funnel so a second analyst can check that the correct leach fluid was used.

10.8.3 For SPLP leachates, use a 1 Liter Class A graduated cylinder to measure out 1000 mL of the leachate. Record the volume to the nearest 10 mL. Place the leachate bottle beside the separatory funnel so a second analyst can check that the correct leach fluid was used.

10.8.4 For water samples, it should be noted that TestAmerica Denver routinely aliquots gravimetrically. This is done to prevent cross-contamination due to volumetric glassware and to provide a more accurate initial volume measurement. However, some clients and regulatory programs require the laboratory to aliquot samples volumetrically. The Method Comments and QASs must be read before samples are aliquotted to check for this requirement. If samples are to be aliquotted volumetrically, use Class A volumetric glassware only and proceed to Section 10.8.6

10.8.5 Weigh the bottle (250 mL amber bottles for 3510C_LVI or 1000 mL amber bottles for all other aqueous samples) and record the gross weight to the nearest gram. If there is any indication that the sample's density is not 1 g = 1 mL, then measure the density of the sample using a calibrated pipette and an analytical balance. The weight of the sample extraction will be corrected for the density later. See Section 11 for the calculation. For example, normally a 1 liter bottle weighs 500 g when empty and when filled completely can only hold 1060 mL, therefore a full bottle weighing more than 1560 g is an indication that either the sample density is greater than 1g or the sample bottle contains a lot of sediment. Document any sample with a density greater than 1 g in an NCM.

10.8.6 Inspect the samples for large amounts of sediment that may interfere with the extraction of the sample by causing excessive emulsions or clogging the stop-cock.

10.8.6.1 If the sample contains so much sediment that the entire sample volume cannot be extracted, decant the sample into the separatory funnel (or a 1 L graduated cylinder if volumetric aliquotting is required), careful not to transfer the sediment. Write a NCM to document the sediment and that it prevented the entire sample volume from being extracted and the sample container from being solvent rinsed. This is considered a deviation and must be documented in a NCM.

10.8.6.2 If the sample does not contain a significant amount of sediment, then the entire sample volume will be used in the extraction.

10.8.6.3 For the 600 method series: if there is no more than an inch of sediment in the bottom of the sample bottle, shake the sample well and determine if the sediment resettles in approximately 1 minute. If not, the density of the sediment is likely to be low enough to stay suspended and not block the sidearm.

10.8.6.4 For the 600 method series: if the density of the sediment is high and likely to cause a problem in the extraction or if there is more than an inch of sediment contact the PM so that the client’s input can be obtained. Not extracting the entire sample and rinsing the bottle with the extraction solvent is a method deviation. If the client concurs that the sample can be decanted write an NCM to describe the deviation from the procedure.

10.8.7 Place the sample containers in front of the separatory funnel labeled for that sample. A second analyst should then check the labels to make sure the correct sample is being extracted. This check is documented in the Organic Extraction Checklist (WI-DV-0009)

10.9 If volumetric aliquotting is required, transfer the entire sample into a Class A graduated cylinder and record the volume on the benchsheet. If the sample bottle contains more than 1000 mL, a 100 mL Class A graduated cylinder can be used to complete the measurement. The entire sample volume must be used. Record the volume to the nearest 10 mL. Then pour the sample into the labeled separatory funnel. Place the used graduated cylinder in front of the appropriate separatory funnel so it can be solvent rinsed later.

NOTE: A 1000 mL Class A graduated cylinder is not accurate enough to measure to the nearest 1 mL. Therefore all samples that are aliquoted using a 1000 mL Class A graduated cylinder will have the initial volume recorded to the nearest 10 mL. This accuracy is sufficient.

10.10 If volumetric aliquotting is not required, pour the sample directly into the separatory funnel. Place the empty sample container in front of the appropriate separatory funnel so it can be solvent rinsed.

10.11 Add Surrogates to All Field Samples and QC Samples

10.11.1 The standards should be allowed to come to room temperature before spiking the samples. Record the ID of the standard used on the benchsheet.

NOTE: The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch Reference work instruction WI-DV-0009 to determine the appropriate standard and the appropriate volume required.

10.11.2 Only one batch should be surrogated at a time to ensure the correct standards are used.

10.11.3 Add the appropriate volume of the appropriate working surrogate standard to the separatory funnel for each sample, MB, LCS, and MS/MSD. Record the ID of the standard used on the bench sheet. Reference work instruction WI-DV-0009 to determine the appropriate standard and the appropriate volume required.

10.12 Add Spikes to all LCS's and MS/MSDs

10.12.1 Add the appropriate volume of the appropriate working spike standard to the separatory funnels for the MS/MSD, LCS and/or LCSD samples. Record the ID of the standard used on the bench sheet. Reference work instruction WI-DV-0009 to determine the appropriate standard and the appropriate volume required.

10.13 Add approximately 6g (1 teaspoon) of NaCl to all samples and all QC samples. This is done to give the reagent water used in the MBs and LCSs some ionic strength to more closely mimic the matrix of actual water samples and to aide in the extraction of the more polar target compounds. Record the lot number of the sodium chloride on the bench sheet.

NOTE: Per the South Carolina QAS, do NOT add NaCl to South Carolina samples or associated QC. South Carolina samples should be prepared separately from other samples in order to meet this requirement.

10.14 Adjust pH of Field Samples and QC Samples

Adjust the sample pH as indicated in the chart below using a minimum amount of 1:1 sulfuric acid (or 1 M hydrochloric acid for Methods AK102, Okla_DRO and NWTPH_Dx) or 10 N sodium hydroxide, as necessary. Record the adjusted pH and the lot number of the acid or base on the bench sheet. For TCLP leachates by method 8270, usually 1 mL of 1:1 sulfuric acid is sufficient.

NOTE: TCLP Leachates may have pH of < 5. In those cases, the pH should be adjusted per the table below.

Method	Initial Extraction pH	Secondary Extraction pH
All 8270 methods *except* SIM.	1 – 2	If samples are TCLP leachates extract at 14. If samples are water extract at 11 - 12
All 8270 SIM methods	As Received	None
All 8081, 8082 and 608 methods.	5 - 9	None
All 8141 and 614 methods	5-8	None
All 8015 methods	As Received	None
All 8310 and 610 methods	As Received	None
AK102_103 Okla_DRO NWTPH_Dx	If samples are preserved between pH 1 – 2, then acidify the MB and LCS. Otherwise extract as received and document insufficient preservation in an NCM.	None

10.15 For 1 Liter samples, add 60 mL of methylene chloride to each empty sample container, unless the entire sample volume was not used. For 250 mL or smaller samples, add 30 mL of methylene chloride to each empty sample container, unless the entire sample volume was not used. Cap the container and shake gently to rinse all internal surfaces of the bottle. Pour the methylene chloride from the sample container into the appropriate separatory funnel. If a graduated cylinder was used to aliquot volumetrically, rinse the cylinder and add that rinse to the separatory funnel as well. Record the lot number of the methylene chloride on the bench sheet. If the sample contained significant sediment and the entire sample contents could not be extracted, do not rinse the empty sample container, but instead add the solvent directly to the separatory funnel. If the solvent rinse of the sample container cannot be performed, prepare a NCM.

10.16 For water samples that were aliquotted gravimetrically, reweigh the bottle and calculate the initial sample volume by subtracting the empty bottles weight from the full bottles weight, assuming a density of 1 g = 1 mL. If there is any indication that the samples density is not 1 g = 1 mL then measure the density of the sample and correct the calculated initial volume accordingly using the formula in Section 11. Document abnormal sample density in an NCM. For example, normally a 1 liter bottle when filled completely can only hold 1060 mL, therefore an initial volume greater than 1060mL is an indication that the density is not 1 g. Document any sample with a density greater than 1 g in an NCM.

10.17 If the initial volume is less than 80% of the nominal volume, the sample reporting limits and method detection limits will be elevated substantially. Document this in a NCM.

10.18 Stopper and rotate the separatory funnel for 3 minutes with periodic venting to release excess pressure. Document the extraction date and time on the benchsheet.

WARNING: Methylene chloride creates excessive pressure very rapidly! Therefore, initial venting should be done immediately after the separatory funnel has been sealed and shaken a few seconds. Vent into hood away from people and other samples. A face shield or goggles must be worn during venting.

10.19 Allow the organic layer to separate from the water phase for at least 5 minutes or until complete visible separation has been achieved. This can take up to 10 minutes. If the emulsion interface between layers is more than one-third the size of the solvent layer, use mechanical techniques to complete the phase separation. The optimum technique depends upon the sample and may include stirring, pouring the solvent layer and emulsion back through the top of the separatory funnel (pour-back), or centrifugation. The emulsion could also be filtered through the glass funnel by adding additional sodium sulfate to remove all water in the emulsion. This technique should only be used after other techniques have failed to make complete phase separation and only after the last shake.

NOTE 1: If an emulsion forms, the analyst does not have to wait a complete 5 minutes before attempting to break the emulsion with pour-backs and centrifuge. Start employing the mechanical techniques right away to achieve phase separation.

NOTE 2: As much as 15 to 20 mL of methylene chloride is expected to dissolve in 1 L of water. Thus, solvent recovery could be as low as 35 mL from the first shake and still be acceptable. Subsequent shakes should recover at least 50 mL of solvent.

10.20 Drain the lower methylene chloride layer into the sodium sulfate filled glass funnel. Allow the methylene chloride to drain completely into the media bottle. Rinse the sodium sulfate with a small amount of methylene chloride to ensure that all compounds of interest are collected in the media bottle. Record the lot number of the sodium sulfate on the bench sheet. If the sodium sulfate becomes saturated with water, add more to the funnel or replace the existing sodium sulfate with fresh drying agent.

10.21 Repeat the extraction two more times for a total of 3 extractions. Collect all three methylene chloride extracts in the same media bottle. For the 2nd and 3rd extractions it is not necessary to wait 5 minutes to allow the solvent to separate from the water; a 3 minute wait time should be sufficient.

10.22 For the base/neutral and acid extractable method 8270, adjust the pH of the samples according to chart in Section 10.14. For 8270 TCLP leachates an excess of base is required to effectively extract pyridine, therefore at least 7 mL of base should be used to ensure the pH is 14. Then extract the sample 3 more times. For these extractions, it is not necessary to wait 5 minutes to allow the solvent to separate from the water; a 3 minute wait time should be sufficient.

NOTE: For 8270 water extractions please note that typically 2 mL of acid is needed to achieve a pH 1-2; 5 mL of base is typically required to achieve the pH of 11-12.

10.23 Cap the media bottle with a Teflon-lined cap or aluminum foil and submit for concentration and possible clean-up steps.

10.24 Dispose of the solvent-saturated water remaining in the separatory funnel in the appropriate waste container. See Section 14.

10.25 Initial weights and volumes of samples are entered into LIMS, and the transcribed data must be verified by a second person. This verification is documented on the Organic Extraction Checklists (see WI-DV-0009).

10.26 Troubleshooting

10.26.1 If the sample appears very dark or viscous or in any way un-like water, stop and test the sample's miscibility before attempting to extract the sample by this procedure. Place a few milliliters of sample in a vial with methylene chloride. Cap and shake. If the sample is miscible in methylene chloride, the sample should be re-logged as a waste matrix with a prep method of 3580A.

10.27 Maintenance

10.27.1 Approximately every 6 months, the centrifuge should be lubricated.

10.27.2 Contact the Facilities Manager immediately if the rotator is observed to be making un-familiar noises or rotating in a "jerking" manner.

11.0 Data Analysis and Calculations

11.1 Initial Volume calculation

$$InitialVolume(mL) = \frac{FullBottle(g) - EmptyBottle(g)}{Density(g/mL)}$$

11.2 The initial data review is performed by the analyst and a second-level review is performed by the area supervisor or designee. Both reviews are documented on DV-F-0045 Organic Extraction Department Checklist. See SOP DV-QA-0020 for more detail on the review process.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Limit of Quantitation Verification (LOQV)

The verification of the limit of quantitation (LOQ or LLOQ) is performed quarterly for work performed according to the DOD/DOE QSM 5.0 or for programs which require the use of Method 8270D, Revision 5. A blank matrix is spiked at 1-2 the laboratory RL and carried through the entire preparation and analytical procedures. Recoveries are assessed based on historical limits.

12.3 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.3.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.3.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.3.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.3.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

12.3.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.4 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the

IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

The volume of spike solutions prepared is minimized to reduce the volume of expired standard solutions requiring hazardous waste disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Methylene chloride – Waste Stream B

14.2.2 Solid waste/sodium sulfate – Waste Stream D

14.2.3 Basic aqueous sample waste saturated with methylene chloride – Waste Stream X.

14.2.4 Acidic aqueous sample waste saturated with methylene chloride – Waste Stream Y.

14.2.5 Neutral aqueous sample waste saturated with methylene chloride – Waste Stream X or Waste Stream Y.

14.2.6 Expired Standards/Reagents – Contact Waste Coordinator for guidance

NOTE: Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of these materials.

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005, Method 3510C, Separatory Funnel Liquid-Liquid Extraction, Revision 3, December 1996.

15.2 Code of Federal Regulations, Title 40 – Protection of the Environment, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, Appendix A – Methods for

Organic Chemical Analysis of Municipal and Industrial Wastewater, Method 608, Organochlorine Pesticides and PCBs.

15.3 Code of Federal Regulations, Title 40 – Protection of the Environment, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, Appendix A – Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, Method 610, Polynuclear Aromatic Hydrocarbons.

15.4 Code of Federal Regulations, Title 40 – Protection of the Environment, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, Appendix A – Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, Method 614, Organophosphorous Pesticides.

15.5 Alaska Method AK102, “For the Determination of Diesel Range Organics”, Version 04/08/02.

15.6 Alaska Method AK103, “For the Determination of Residual Range Organics”, Version 04/08/02.

15.7 NWTPH-Dx “Semi-Volatile Petroleum Products Method for Soil and Water.

15.8 Oklahoma Department of Environmental Quality Methods 8000/8100 (Modified) Diesel Range Organics (DRO) Revision 4.1 Date 10/22/97

16.0 Modifications:

16.1 Modifications from SW-846 Method 3510C

16.1.1 Section 7.1 of the method calls for initial sample volume to be determined volumetrically either by measuring out exactly 1 liter or marking the meniscus on the sample container and later determining the volume of water required to fill the bottle back up to the mark. This SOP allows the initial sample volume to be determined by weight in order to achieve a more accurate initial volume and to avoid cross-contamination via glassware.

16.1.2 Section 7.5 of the method calls for shaking the separatory funnel 1-2 minutes. This SOP calls for shaking the separatory funnel for 3 minutes.

16.1.3 Section 7.6 of the method calls for allowing the organic layer to separate from the water phase for a minimum of 10 minutes. This SOP calls for allowing the organic layer to separate from the water phase for a minimum of 5 minutes after the first extraction and a minimum of 3 minutes for subsequent extractions, up to 10 minutes if the separation is not complete.

16.1.4 The source method does not call for the use of sodium chloride. This procedure calls for the addition of approximately 6g of sodium chloride to all samples and all QC samples in order to help the extraction efficiency.

16.1.5 The source method calls for samples to be extracted for method 8141 at the pH they are received. This procedure calls for the extraction to be performed at a pH between 5 and 8. This is done per guidelines found in Section 2 and Section 8 of SW-846 8141B.

16.2 Modifications from 40 CFR Method 608 and 610

16.2.1 Section 10.1 of the method calls for initial sample volume to be determined volumetrically. This SOP allows the initial sample volume to be determined by weight.

16.2.2 Section 10.2 of the method calls for shaking the separatory funnel 1-2 minutes. This SOP calls for shaking the separatory funnel for 3 minutes.

16.2.3 Section 10.2 of the method calls for allowing the organic layer to separate from the water phase for a minimum of 10 minutes. This SOP calls for allowing the organic layer to separate from the water phase for a minimum of 5 minutes after the first extraction and a minimum of 3 minutes for subsequent extractions, up to 10 minutes if the separation is not complete.

16.2.4 Section 10.3 of the method calls for rinsing the sample collection bottle with the 60 mL methylene chloride aliquot for the second and third extraction as well as the first extraction. This SOP calls for rinsing the sample collection bottle with only the first 60-mL methylene chloride aliquot.

16.2.5 The source method does not call for the use of sodium chloride. This procedure calls for the addition of approximately 6g of sodium chloride to all samples and all QC samples in order to help the extraction efficiency.

16.3 Modifications from 40 CFR Method 614

16.3.1 Section 10.1 of the method calls for initial sample volume to be determined volumetrically. This SOP allows the initial sample volume to be determined by weight.

16.3.2 Section 10.2 of the method calls for the extraction to be performed with at 15% v/v methylene chloride in hexane solvent. This procedure uses methylene chloride for the extraction. SOP DV-OP-0007 calls for the methylene chloride extract to be concentrated and exchanged to hexane.

16.3.3 Section 10.2 of the method calls for shaking the separatory funnel 1-2 minutes. This SOP calls for shaking the separatory funnel for 3 minutes.

16.3.4 Section 10.2 of the method calls for allowing the organic layer to separate from the water phase for a minimum of 10 minutes. This SOP calls for allowing the organic layer to separate from the water phase for a minimum of 5 minutes after the first extraction and a minimum of 3 minutes for subsequent extractions, up to 10 minutes if the separation is not complete.

16.3.5 Section 10.3 of the method calls for rinsing the sample collection bottle with the 60 mL solvent aliquot for the second and third extraction as well as the first extraction. This SOP calls for rinsing the sample collection bottle with only the first 60-mL methylene chloride aliquot.

16.3.6 The source method does not call for the use of sodium chloride. This procedure calls for the addition of approximately 6g of sodium chloride to all samples and all QC samples in order to help the extraction efficiency.

16.4 Modifications from Method AK 102

16.4.1 Section 9.1.1.1 of the method calls for using no more than 1 liter of sample and to determine the volume either by measuring out exactly 1 liter or marking the meniscus on the sample container and later determining the volume of water required to fill the bottle back up to the mark. This SOP allows the initial sample volume to be determined by weight in order to achieve a more accurate initial volume and to avoid cross-contamination via glassware. This SOP allows for the extraction of more than 1 L as it calls for the use of the entire sample volume.

16.4.2 Section 9.1.1.6 of the method says to allow the water and solvent layers to separate for approximately 10 minutes. This SOP calls for the allowing the organic layer to separate from the water phase for a minimum of 5 minutes after the first extraction and a minimum of 3 minutes for subsequent extractions, up to 10 minutes if the separation is not complete.

16.4.3 The source method does not call for the use of sodium chloride. This procedure calls for the addition of approximately 6g of sodium chloride to all samples and all QC samples in order to help the extraction efficiency.

16.5 Modifications from Method NWTPH-Dx

16.5.1 The method calls for determining the initial volume of the sample my marking the meniscus on the bottle and later determining the volume of tap water required to fill the bottle back up to the mark. This SOP allows the initial sample volume to be determined by weight in order to achieve a more accurate initial volume and to avoid cross-contamination via glassware.

16.5.2 The method calls for shaking the separatory funnel for one minute. This SOP calls for the separatory funnel to be shaken for at least three minutes.

16.5.3 The source method does not call for the use of sodium chloride. This procedure calls for the addition of approximately 6g of sodium chloride to all samples and all QC samples in order to help the extraction efficiency.

16.6 Modifications from Oklahoma DRO

16.6.1 The method calls for aliquotting 800 mL to 900 mL of the sample volumetrically. This SOP calls for the initial sample volume to be determined by weight in order to achieve a more accurate initial volume and to avoid cross-contamination via glassware. This SOP allows for the extraction of more than 1 L as it calls for the use of the entire sample volume.

16.6.2 The method calls for extracting using 50 mL of solvent. This SOP calls for the extraction to be done using at least 60 mL of solvent.

16.6.3 The method calls for shaking the separatory funnel for two minutes. This SOP calls for the separatory funnel to be shaken for at least three minutes.

16.6.4 The method calls for a method blank and LCS to be analyzed every 10 samples. This SOP calls for a method blank and LCS to be analyzed every batch of 20 samples.

16.6.5 The source method does not call for the use of sodium chloride. This procedure calls for the addition of approximately 6g of sodium chloride to all samples and all QC samples in order to help the extraction efficiency.

17.0 Attachments

Table 1. Determinative Methods Using Separatory Funnel Extractions

18.0 Revision History

- **Revision 18.0, October 31, 2018**
  - Updated the last sentence in the copyrighted information section.
  - Updated MDL SOP number.
  - Added note to section 10.13 per South Carolina requirement.
  - Corrected references to WI-DV-009 to correct document ID, WI-DV-0009 throughout.

- **Revision 17.0, December 31, 2017**
  - Adjusted the volumes in the note in section 10.22 to reflect current practice.

- **Revision 16.0, August 16, 2017**
  - Updated and rearranged section 10.8.6 – 10.15 to account for adjustment of procedure. Surrogate and spike standards will now be added to samples in extraction vessel, rather than sample container.

- **Revision 15.0, June 30, 2017**
  - Paragraph with reference to QAM for basic definitions was added to Section 3.0
  - Removed previous Section 9.2 Initial Performance Studies, renumbered remaining Sections
  - Updated current Section 9.3.1 – removed “At least” for the one MB requirement
  - Added DoD requirements regarding MS/MSD (LCSD) to Section 9.5.2
  - Added current Section 10.2 regarding NCM documentation
  - The note was added to section 10.22 indicating the typical amounts of acid or base needed to achieve dual pHs for 8270 water extractions.
  - Added Section 11.2 regarding data review

  - Added current Section 12.2 LOQV information
  - Fixed numbering and section references throughout SOP
  - Removed Method 610 from Table 1. Lab no longer performing method.

- **Revision 14.0, June 30, 2016**
  - Added Section 3.6 – definition of reagent water
  - Revised the table in Section 8 to reflect the nominal leachate volume for method 8141.
  - Updated sections 9.4.4, 9.5.4, 10.4.1, and 10.5.4 to include 8141 TCLP.
  - Added Section 10.2 - recording of support equipment IDs
  - Added note to Section 10.4 regarding the rotation of glassware
  - Added reference to method 8141 TCLP leachates to Section 10.7.2
  - Removed references to preparation of Wyoming Leachates throughout. Lab no longer performs Wyoming Leach method
  - Added Sections 10.7.6.3 and 10.7.6.4 to provide guidance for 600 method series in relation to sediment and decanting issues.
  - Updated Section 12 to be consistent with other SOPs
  - Renumbered paragraphs throughout due to the removal of the WY Leachate prep

- **Revision 13, August 31, 2015**
  - Annual Technical Review.
  - Removed the Notes from Section 2 and Section 10.9 regarding South Carolina. The laboratory no longer holds South Carolina certification for this method.
  - Added detail to Section 10.12 and 10.20 on how much acid and base is normally required to adjust the pH of leachates for method 8270.

- **Revision 12.0, August 31, 2014**
  - Revised Section 2 to remove references to initial volume. The procedure is used on waters and leachates with a variety of initial volumes. That detail is documented later in the procedure and was therefore removed from the summary found in Section 2.
  - Added a comment to Section 9.1.2 that states: “This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated.”
  - Section 9 was revised to remove Acceptance Criteria and Corrective Action details. This information is found in the analytical procedures.
  - Removed the Note following Section 10.4.2 that instructs the analyst to check the samples for sodium thiosulfate preservation. TestAmerica Denver does not analyze drinking water samples by this procedure and therefore this preservation is not needed.
  - All references to 8270 by LVI were removed. TestAmerica Denver does not extract samples by this procedure for 8270 by LVI. Instead the samples are extracted by 3520C under DV-OP-0008.
  - The table in Section 10.12 was revised to make it easier to read and locate the correct Method.
  - Troubleshooting and Maintenance sections were added per DoD QSM 5.0 requirements.

- **Revision 11.0, August 19, 2013**
  - Added statement to Section 2.0 that LVI must not be used on SC samples

- **Revision 10.0, May 14, 2013**
  - The procedure was revised to instruct the analyst to allow the organic and aqueous phases to separate for a minimum of 5 minutes after the first extraction and 3 minutes after subsequent extractions.
  - The procedure was revised to increase the amount of sodium chloride added to samples and QC from 3g to 6g.
  - Section 5 was revised to include the hazards of glasswool and to instruct the analysts to handle it only in a fumehood.
  - Section 8 was revised to change the hold-time calculation for leachates from the start of the leaching procedure instead of the completion of the leaching procedure. This was done to ensure the holding times are contiguous.
  - Section 10.13 was revised to instruct the analyst to extract 250 mL to 100 mL samples with 30 mL of solvent instead of 15 mL of solvent. This was done to increase extraction efficiency while still reducing solvent usage.
  - Sections 2.0, 9.1 and 10.1 were updated to reflect current practice.

- **Revision 9.0, January 15, 2013**
  - Section 10.9 was updated to include note to eliminate use of salt in South Carolina samples.

- **Revision 8.0, September 25, 2012**
  - This procedure was updated to include instructions on how to extract 8270 water samples for Large Volume Injection.

- **Revision 7.0, January 31, 2012**
  - Annual Technical Review
  - Updated Section 6.2 to describe the requirements for computer software and hardware
  - Updated Section 7.0 to describe requirements for Reagents and Standards.
  - Updated Section 8.0 to state PCBs by method 8082 have no holding time as per SW-846 Update 4 and that samples for analysis by NW-TPH have a 7 day hold time, even if acid preserved.
  - Updated Section 9.1.4 and Section 10.1 to accurately describe the NCM notification system.
  - Updated Section 10.4 and 10.6 to state the appropriate size of the graduated cylinders to be used to measure out 100 mL and 200 mL of leachate.
  - Updated Sections 10.6.6 and 10.14 to give guidance to the analyst when a density check of a sample is required.
  - Updated Section 10.9 to give more detail on how much sodium chloride should be added to the samples.
  - Updated Section 16 to include the method modification of the sodium chloride addition.
  - Updated Table 1 to reflect the current analytical SOPs.
  - Corrected grammatical and formatting errors

- **Revision 6.0 dated January 10, 2011**

- Added note to Section 6 that sodium sulfate should be stored in tightly closed container.
- Revised Section 7 to reference DV-OP-00020 for information about surrogate and spike standards.
- Corrected Section 7.1 to indicate that the reagent water should be 18 to 18.2 Mohm/cm.
- Revised procedure to include details on the extraction of Wyoming Leachates.
- Added references to methods NWTPH-Dx, and Oklahoma DRO.
- Added Section 6.2 computer software and hardware.
- Section 8 was revised to give more detail on the preservation and hold times for methods AK102, AK103, NWTPH-Dx, and Oklahoma DRO.
- Revised Section 9 to include more detail on QC requirements for methods AK102_103, NWTPH-Dx, and Oklahoma DRO.
- Revised Section 10 to clarify that when 1 liter graduated cylinders are used to measure the initial volume of the water samples, that the volume should be recorded to the nearest 10 mL.
- Revised Section 10 to instruct that if samples for methods AK102_103, NWTPH-Dx, and Oklahoma DRO are received preserved, then the MB and the LCS samples should also be acidified with HCl. Otherwise the samples are extracted as received.
- Revised Section 16 to include more detail on modification from methods AK102_103, NWTPH-Dx, and Oklahoma DRO
- Revised the procedure to call for the 2nd fraction of 8270 TCLP leachates to be extracted at a pH of 14 instead of the pH 11 to 12 used in water samples. This was done to help the recovery of pyridine.

Earlier revision histories have been archived and are available upon request.

TABLE 1.

Determinative Methods Using Separatory Funnel Extractions

Method Description	*Determinative Method*	*SOP*
Diesel Range Organics & Jet Fuels	SW-846 8015, California LUFT Method, Alaska Methods AK102 & AK103 SW-846 8015C	DV-GC-0027
Chlorinated Pesticides	SW-846 8081A SW-846 8081B EPA Method 608	DV-GC-0020 DV-GC-0016
Polychlorinated Biphenyls	SW-846 8082 SW-846 8082A EPA Method 608	DV-GC-0021 DV-GC-0016
Organophosphorus Pesticides	SW-846 8141A, & EPA Method 614	DV-GC-0017
Polynuclear Aromatic Hydrocarbons (PAH)	SW-846 8310	DV-LC-0009
Semi-volatiles by GC/MS	SW-846 8270 SW-846 8270D	DV-MS-0011 DV-MS-0012
PAH by GC/MS SIM	SW-846 8270	DV-MS-0002

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Title: Concentration and Clean-up of Organic Extracts [SW-846, 3510C, 3520C, 3540C, 3546, 3550B, 3550C, 3620C, 3660B, 3665A, ASTM Method D7065-11, and EPA 600 Series Methods]

Approvals (Signature/Date):

Amelia Byl 11/30/2018
Amelia Byl Date
Technical Specialist

Doug Gomer 11/30/18
Doug Gomer Date
Health & Safety Manager / Coordinator

Roxanne Sullivan 11/30/18
Roxanne Sullivan Date
Quality Assurance Manager

11/30/18
Richard Clinkscales Date
Laboratory Director

Facility Distribution No. ___________ **Distributed To:**_______________________

1.0 Scope and Application

1.1 This standard operating procedure (SOP) provides instructions for the concentration, and if necessary, cleanup, of solvent extracts of organic compounds from water samples, soil samples, TCLP leachates, and SPLP leachates. This SOP is based on SW-846 Methods 3510C, 3520C, 3540C, 3546, 3550B, 3550C, 3620C, 3630C, 3660B, 3665A, ASTM Method D7065-11, and EPA 600 Series methods.

1.2 The determinative methods and extraction methods used in conjunction with this procedure are listed in Attachment 1.

1.3 This procedure does not include the extraction steps. See the following SOPs for the applicable extraction procedures:

DV-OP-0006:	Extraction of Aqueous Samples by Separatory Funnel, SW-846 3510C and EPA 600 Series
DV-OP-0008:	Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C, and Method 625 and ASTM Method D7065-11
DV-OP-0010:	Soxhlet Extraction of Solid Samples, SW-846 3540C
DV-OP-0015:	Microwave Extraction of Solid Samples, SW-846 3546
DV-OP-0016:	Ultrasonic Extraction of Solid Samples, SW-846 3550B and 3550C
DV-OP-0021:	Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C for Low-Level NDMA by GC/CI/MS/MS

NOTE: This SOP does not include the concentration steps of extracts for Herbicides by method 8151A or Herbicides by method 8321. See DV-OP-0011 and DV-LC-0014 respectively.

2.0 Summary of Method

Sample extracts are concentrated to a specific final volume using an S-EVAP, N-EVAP, or Turbo-Vap. Some methods require a solvent exchange. If necessary, various clean-up techniques are performed before the extract is sent for analysis.

3.0 Definitions

Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, Quality Control Program, for definitions of general analytical and QA/QC terms.

3.1 **Extraction Holding Time:** The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.2 **Preparation Batch:** A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards.

3.3 **Method Comments:** The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client. See WI-DV-0032

3.4 **Quality Assurance Summary (QAS):** Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the special instructions/Method Comments field in LIMS. In those situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

4.0 Interferences

Chemical and physical interferences may be encountered when analyzing samples using this method.

4.1 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

4.2 Visual interferences or anomalies (such as foaming, emulsions, odor, more than one layer of extract, etc.) must be documented.

4.3 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.4 Due to the low reporting limits and the potential for contamination, the extracts that are to be analyzed for NDMA by 8270D_SIM_LL must be concentrated in glassware designated for that method. K-D flasks, concentrator tubes, stem-less glass funnels, and Snyder columns will be clearly marked and segregated for this purpose.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 In order to limit the emission of methylene chloride, TestAmerica Denver uses a solvent recovery system. The system condenses and collects methylene chloride that has been evaporated off the sample extracts while on the S-EVAP.

5.1.1.1 Each analyst must inspect the system before using it to ensure the collection tubes are in good condition, the in-process tanks are not full, and the chiller is operating correctly.

5.1.1.2 While concentrating methylene chloride or methylene chloride / acetone extracts on the S-Evap, the analyst must check the level of the solvent collected in the in-process tanks at a frequency to ensure the tank will not be overfilled. A tank will not be filled more than 90%. The analyst may use a timer set at 30 minute intervals to help remind the analyst to check the level of the solvent collected in the in-process tanks.

5.1.1.3 The solvent recovery system will never be used for the collection of ether due to the potential danger to analysts if the system were to fail during operation.

5.1.2 Glasswool is a carcinogen and therefore should be handled in a hood to avoid inhalation of dust.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material	Hazards	Exposure Limit (1)	Signs and Symptoms of Exposure
Acetonitrile	Flammable Irritant Poison	40 ppm TWA	Exposure may cause cyanide poisoning resulting in reddening of the skin and eyes and pupil dilation. Effects of overexposure are often delayed due to the slow formation of cyanide ions in the body. May cause nose and throat irritation, flushing of the face, tightening of the chest. Also may cause headache, nausea, abdominal pain, convulsions, shock.
Hexane	Flammable	50 ppm TWA	Causes irritation to eyes, skin and respiratory tract. Aspiration hazard if swallowed. Can

Material	Hazards	Exposure Limit (1)	Signs and Symptoms of Exposure
	Irritant		enter lungs and cause damage. May cause nervous system effects. Breathing vapors may cause drowsiness and dizziness. Causes redness and pain to the skin and eyes.
Methanol	Flammable Irritant Poison	200 ppm TWA	Methanol evaporates at room temperature. Inhalation, ingestion and/or eye and skin contact can all possibly cause light-headedness, nausea, headache, and drowsiness. Prolonged exposure can lead to permanent blindness.
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Mercury	Corrosive Irritant Highly Toxic	0.05 mg/m^3 TWA	May be fatal if inhaled. May cause respiratory tract irritation. May be harmful if absorbed through skin. May cause skin irritation.
Methylene Chloride	Irritant Carcinogen	25 ppm TWA 125 ppm STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness, and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

NOTE 1: All glassware used in this procedure is cleaned following SOP# DV-OP-0004. In addition, the glassware is rinsed with methylene chloride immediately prior to use. Rotate glassware; do **not** use specific glassware or positions for the MB and LCS/LCSD.

NOTE 2: Due to the low reporting limits and the potential for contamination, the extracts that are to be analyzed for NDMA method 8270D_SIM_LL and PAHs by method 8270C_SIM_LL must be concentrated in glassware designated for that method. K-D flasks, glass funnels, concentrator tubes, and snyder columns will be clearly marked and segregated for this purpose.

6.1 All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

6.2 Kuderna-Danish (K-D) flasks.

6.3 Concentrator tubes for K-D flasks, un-graduated, approximately 10 mL.

6.4 Concentrator tubes for K-D flasks, graduated at 1mL, calibration checked before use following the steps detailed in DV-QA-0008.

6.5 Snyder columns, 3-ball with ground glass joints at top and bottom

6.6 Manual, adjustable positive-displacement pipette and bottle-top re-pipettor, used to dispense 1 to 20 mL. Calibration is checked following the steps detailed in DV-QA-0008.

6.7 Extract Storage Vials – variety of sizes, clear and amber

6.8 Pasteur pipettes – 6 inch and 9 inch in length.

6.9 Stem-less glass funnels

6.10 Glass wool, baked at 400°C for four hours.

6.11 Boiling Chips – contaminant free, approximately 10/40 mesh Teflon®, PTFE. For concentrating extracts to a final volume greater than 1mL.

6.12 Boiling Chips – contaminant free, carborundum #12 granules, for concentrating extracts to a 1mL final volume. These boiling chips are sufficiently small as to not add any error to the 1mL final volume.

6.13 Solvent Recovery System – includes re-circulating chiller, set no higher than 12°C, cooling condensers, Teflon® PTFE tubing and In-Process Tanks with quick-connect attachments

6.14 S-Evap, thermostat controlled water bath

6.15 N-Evap, thermostat controlled water bath with regulated nitrogen supply

6.16 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Methylene Chloride

Each lot of solvent is tested following CA-Q-S-001 or before it is put into use. QA personnel post the list of approved lots at solvent storage areas. For solvents packaged in CYCLETAINERS, that have not been previously tested per CA-Q-S-001, the first batch of samples prepared with a new lot of solvent is monitored and reported to the QA group per the instructions in CA-Q-S-001 DV-1. If any problems are identified, use of the solvent is suspended until further testing can be done and determines the solvent is acceptable.

7.2 Hexane

For solvents packaged in bottles, each lot of solvent is tested following CA-Q-S-001 before it is put into use. QA personnel post the list of approved lots at solvent storage areas. For solvents packaged in CYCLETAINERS, the first batch of samples prepared with a new lot of solvent is monitored and reported to the QA group per the instructions in CA-Q-S-001 DV-1. If any problems are identified, use of the solvent is suspended until further testing can be done and determines the solvent is acceptable.

7.3 Methanol, HPLC Grade

Each lot of solvent is tested following CA-Q-S-001 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.4 Acetone

Each lot of solvent is tested following CA-Q-S-001 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.5 Acetonitrile

Each lot of solvent is tested following CA-Q-S-001 DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.6 Baked Sodium Sulfate, 12-60 mesh

Heat sodium sulfate in a 400°C oven for at least four hours.

7.7 Sulfuric Acid, Concentrated

For use in PCB extract clean-up.

7.8 Florisil Solution, (FlorisilSol)

Add 900mL of hexane to a Class A graduated cylinder. Add 100 mL of Acetone to the same graduated cylinder for a final volume of 1000 mL. Pour the mixture into a 1 L amber bottle.

7.9 Florisil Cartridges,

Purchased ready to use. 1000 mg in 6 mL tube. Stored in a desiccator after opening. Restek part number 24034 or equivalent.

7.10 Anhydrous Silica Gel, 60-100 mesh, (SiGel60-100UA)

Sigma Aldrich part number 23799-1KG or equivalent

7.11 Activated Anhydrous Silica Gel, 60-100 mesh, (Active_SilGel)

Bake Silica Gel from Section 7.10 above at 400°C for at least 4 hours. Store in a desiccator.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Sample extracts waiting to be concentrated are stored refrigerated at 0°C - 6°C in glass bottles or flasks and capped with Teflon-lined lids or aluminum foil. Final sample extracts are stored in glass vials with Teflon-lined lids. See Table 3 for details on storage vial types. Final concentrated extracts are stored refrigerated at 0°C - 6°C. Extracts have a holding time of 40 days from the date of extraction to the date of analysis.

8.2 All sample extracts, before or after concentration, are stored separately from standards.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, *QA/QC Requirements for Federal Programs.* This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 12.0 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

At least one method blank must be processed with each preparation batch. The method blank for batches of aqueous samples consists of reagent water, and for batches of soil samples, consists of Ottawa sand, both of which are free of any of the analyte(s) of interest. The method blank for batches of TCLP and SPLP leachates consists of leach fluid. The method blank is processed and analyzed just as if it were a field sample.

9.5 Laboratory Control Sample (LCS)

9.5.1 At least one LCS must be processed with each preparation batch. For aqueous sample batches, the LCS consists of reagent water to which the analyte(s) of interest are added at known concentration. For soil sample batches, the LCS consists of Ottawa sand to which the analyte(s) of interest are added at a known concentration. For TCLP and SPLP leachates, the LCS consists of leach fluid to which the analyte(s) of interest are added at known concentration. The LCS is carried through the entire analytical procedure just as if it were a sample.

9.5.2 EPA Methods 608, 610, 614, and 625 require a LCS at a 10% frequency. In other words, one LCS is required for a batch of 10 or less samples. A LCSD is required for a batch of 11 or more samples.

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.6.1 One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

9.6.2 EPA Methods 608, 610, 614, and 625 require one matrix spike for every 10 samples. If the batch has more than 10 samples, then two matrix spikes must be performed. The two matrix spikes are to be performed on two different samples.

9.6.3 If insufficient sample volume is available for MS/MSD, an NCM must be written and a LCSD must be prepared.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Critical Procedural Considerations

NOTE: Rotate glassware; do **not** use specific glassware or positions for the MB and LCS/LCSD.

10.3.1 As stated throughout this SOP, analysts must review Method Comments and any applicable QASs before starting work. This review is also documented on the Organic Extraction Checklist (see WI-DV-0009).

10.3.2 Analyst must focus on using clean technique throughout this procedure. Any parts or pipettes that come into direct contact with dirty surfaces should be cleaned or disposed of before coming into contact with the sample.

10.3.3 According to the type of sample and any cleanup procedures needed, different final solvents and volumes will be required. Refer to WI-DV-0009 for the appropriate final solvents and final volumes.

10.4 Refer to WI-DV-0009 to determine if the extract is to be concentrated by the Kuderna-Danish / N-Evap method described in Section 10.5 and 10.6, or the Turbo-Vap method described in Section 10.6.6

10.5 Concentration by the Kuderna-Danish Method (S-evap)

10.5.1 Refer to WI-DV-0009. If the extract is to be concentrated to a 1 mL final volume, use a 1 mL graduated concentrator tube. For extracts that are to be concentrated to any other final volume, use an un-graduated concentrator tube.

10.5.2 Assemble the Kuderna-Danish concentrator by attaching the appropriate concentrator tube to the 500 mL K-D flask with a clip. Make sure the attachment is firm at the joint. While wearing cut-resistant gloves, tighten the joint with your fingertips and thumb. Do NOT over-tighten. Refer to Attachment 3 for configuration of the Kuderna-Danish concentrator.

NOTE: Due to the low reporting limits and the potential for contamination, the extracts that are to be analyzed for NDMA by method 8270D_SIM_LL and PAHs by method 8270C_SIM_LL must be concentrated in glassware designated for those methods. K-D flasks, concentrator tubes, and Snyder columns will be clearly marked and segregated for this purpose.

10.5.3 Rinse the apparatus with methylene chloride. Discard the rinse solvent into the appropriate waste container. Care should be taken to ensure all surfaces of the glass are coated with solvent.

10.5.4 If the extract is to be concentrated to a 1 mL final volume, add 2-3 carborundum granules to the K-D concentrator. If the extract is to be concentrated to a final volume greater than 1 mL, add 1-2 Teflon® boiling chips to each K-D concentrator.

10.5.5 If the sample extracts have not been filtered through sodium sulfate at the time of extraction, or if the sample extract have visible water, then the extracts must be dried at this point. Plug a glass funnel with baked glass wool and add approximately 1 teaspoon of baked sodium sulfate. Rinse the funnel and the sodium sulfate with methylene chloride and place it on top of the K-D. During the quantitative transfer in section 10.5.6 the extract will be filtered through the sodium sulfate.

NOTE 1: Glass wool dust is a carcinogen and therefore glass wool should only be handled in a hood to avoid inhaling any glass particles. Once covered with sodium sulfate, it can be removed from the hood.

NOTE 2: If the extract contains more water than can be easily removed by filtering through 1 teaspoon of sodium sulfate, either more sodium sulfate can be used or a solvent-rinsed separatory funnel can be used to separate the water out of the extract. A NCM should be prepared if this is necessary.

10.5.6 Quantitatively transfer the sample extract to the K-D flask. Transfer the sample label to the K-D flask. Perform a quantitative transfer of the extract by rinsing the sample extract container with methylene chloride and adding the rinse solvent to the K-D. If the extract is being filtered through sodium sulfate, be sure to rinse the sodium sulfate well to ensure no target compounds are left on the sodium sulfate. Allow the solvent to drain from the sodium sulfate into the K-D flask then discard the sodium sulfate.

10.5.7 Turn a three-ball Snyder column upside down and rinse with methylene chloride, then rinse the bottom joint with methylene chloride. Attach the Snyder column to the top of the K-D concentrator as shown in Attachment 3.

10.5.8 Place the K-D concentrator on a s-evap water bath so that the tip of the receiver tube is submerged. The water level should not reach the joint between the concentrator tube and the K-D flask. Refer to WI-DV-0009 for the correct water bath temperature. Record both the observed and the corrected temperature on the benchsheet.

10.5.9 For extracts that are methylene chloride or 50/50 methylene chloride/acetone, attach the solvent recovery system tube to the top of the Snyder column. At the appropriate rate of distillation, the balls will actively chatter but the chambers should not flood.

NOTE 1: For extracts for analysis for low-level NDMA by method 8270D_SIM_LL and PAHs by 8270C_SIM_LL, the solvent recovery system will not be used to avoid possible contamination.

NOTE 2: At this time, a timer may be set for 30 minute intervals as a reminder to check the in-process solvent tanks.

10.5.10 If the method does not require a solvent exchange, skip to Section 10.5.12. If the method requires a solvent exchange, continue on to Section 10.5.11.

10.5.11 If the method requires a solvent exchange at this time, detach the solvent recovery system tube from the top of the Snyder column and add the appropriate exchange solvent through the top of the Snyder column. The exchange solvent should be added when the extract has concentrated to a level that it forms a quarter-sized pool of solvent in the bottom of the K-D. Refer to WI-DV-0009 for details of exchange solvents and volumes. Mark the K-D flask and sample label to indicate the exchange has been performed. There is no need to re-attach the solvent recovery system at this time as the majority of the methylene chloride has already been evaporated and collected.

10.5.12 Continue to concentrate the sample on the s-evap water bath back down to 10-15 mL, or just below the K-D and concentrator tube joint. At this point the boiling sample is just barely splashing above the top of the receiver tube.

NOTE: It is very important not to concentrate to dryness as analytes will be lost. Some of the analyses, especially for 8270 and 8015, are especially temperature sensitive and the sample should be taken off the water bath as soon as possible to avoid losing analytes. The 8081 surrogate TCMX is fairly volatile and can be lost if the extract is allowed to concentrate too low either before or after hexane exchange. If the analyst has concerns that the extract might have concentrated too low, they should notify their supervisor and/or write a NCM.

10.5.13 Remove the K-D concentrator from the water bath. Rinse the Snyder column down with a minimal amount of solvent. If the extract was exchanged, use the exchange solvent to perform the rinse, otherwise use methylene chloride.

10.5.14 Allow the extract to cool to room temperature, about 10 minutes.

10.5.15 After the extract is allowed to cool, if the level of the extract is above the level of the concentrator tube joint, add a fresh boiling chip and return the K-D concentrator to the water bath.

10.5.16 After the extract is cool, remove the snyder column. Remove the clip holding the K-D flask and concentrator tube together. Use a Kim-wipe to dry the water off of the joint area so that water does not get into the extract. Remove the concentrator tube from the K-D flask and rinse the lower K-D flask joint into the concentrator tube with methylene chloride or the appropriate exchange solvent.

10.6 Nitrogen Evaporation (N-Evap) to Final Concentration.

10.6.1 N-evap needles should be cleaned weekly by soaking overnight in methylene chloride. This is documented in the N-evap needle log-book.

10.6.2 At the beginning of each shift, the N-evap needles should be wiped clean with a Kim-wipe soaked in methylene chloride to remove any potential contamination. If a needle comes in contact with an extract, then it needs to be cleaned before being used on the next extract.

10.6.3 Place the concentrator tube on the nitrogen evaporator. The temperature of the water bath should be at least 5°C below the boiling temperature of the solvent being evaporated (See Attachment 2). Lower the needle down to the sample so that a small dimple forms on the surface of the solvent. The stream of nitrogen should be gentle enough that it does not cause the extract to splash. Record both the observed and the actual temperature on the benchsheet.

10.6.4 During the course of the evaporation, rinse the sides of the concentrator tube with approximately 1 mL of clean solvent. The rinse should occur when the solvent gets close to the final volume. Concentrate the solvent to just below the final volume and remove from the nitrogen evaporator.

10.6.5 Transfer the extract into the appropriate vial. Refer to WI-DV-0009 for the appropriate final volume and correct vial.

10.6.5.1 If the extracts are to have a final volume of 1 mL, they should be in 1 mL graduated concentrator tubes. Using a Pasteur pipette, or a solvent wash bottle, add the appropriate solvent to the tube until the extract meniscus reaches the 1 mL gradation. Then using the Pasteur pipette transfer the extract to a labeled 2 mL amber glass vial.

10.6.5.2 For extracts with a final volume greater than 1mL, the vials should be calibrated using the manual, adjustable positive-displacement pipette or bottle-top re-pipettor. Document the pipette ID used on the batch record. Pipette the correct volume of clean solvent into the vial and mark the bottom of the meniscus with a thin marker. Discard the solvent. Transfer the extract into the vial using a Pasteur pipette and rinse the concentrator tube with solvent. Transfer the rinse to the vial. Bring the meniscus of the solvent up to the marked line. Cap with a Teflon-lined cap.

NOTE 1: The final concentration and volume measurement steps are critical. Use care when concentrating and make certain that the final volume measurement is accurate.

NOTE 2: Some extracts might not concentrate down to the required final volume. If the extract is very dark and viscous, or an oil layer or precipitate starts to form, a higher final volume can be used. This should be documented in an NCM.

10.6.6 After the extract has been transferred to the appropriate vial, rinse the concentrator tube with methylene chloride before washing per DV-OP-0004. This is important to remove any residual contamination.

10.7 TurboVap Method

10.7.1 Turn on the TurboVap and adjust the water temperature to 40°C. Turn the nitrogen supply on. Record both the observed and the actual temperature on the benchsheet.

10.7.2 Switch the endpoint sensor to “Manual”.

10.7.3 Adjust the water bath level. The water level should be at least 1 inch above the extract level.

10.7.4 Turn on the nitrogen gas and adjust the gas pressure to approximately 12 psi. Lower pressure may be used if needed to prevent samples from splashing out of the TurboVap tubes.

10.7.5 Rinse the TurboVap tube with methylene chloride or the solvent the extract is in. Discard the waste.

10.7.6 Transfer the sample to the TurboVap tube. For 8141 soils extracted by soxhlet, dry the extract first by filtering through a funnel with baked sodium sulfate. Rinse the sample extract container with clean solvent and transfer to the TurboVap tube. Do not fill the TurboVap tubes over the fill line or approximately ¾ full.

10.7.7 Place the TurboVap tube into the TurboVap and turn on nitrogen to the position the tube is in.

10.7.8 Close the lid. You should be able to see the sample extracts swirling in the tubes.

NOTE: If the extract splashes when the nitrogen flow starts, transfer a portion of the extract back into the original extract container, or lower the gas pressure.

10.7.9 As the extract concentrates, transfer the remainder of the extract in to the appropriate Turbovap tube. Rinse the sample container with a few milliliters of methylene chloride or appropriate solvent and transfer to the Turbovap tube.

10.7.10 During the concentration rinse the Turbovap tube walls with a few milliliters of solvent 1 or 2 times.

10.7.11 If a solvent exchange is required, concentrate to about 5 mL and add the exchange solvent. After the exchange solvent is added, swirl the extract to make sure the extract is well mixed. Concentrate back down to slightly less than the appropriate volume. Refer to Attachment 3 for details of exchange solvents and final volumes.

10.7.12 Transfer the extract into the appropriate vial.

10.7.12.1 Currently, the TurboVap is only used to concentrate extracts with final volumes greater than 1 mL. Ask the supervisor for guidance if a project requires a 1 mL final volume by TurboVap.

10.7.12.2 For extracts with a final volume greater than 1 mL, the vials should be calibrated using the manual, adjustable pipette or bottle-top re-pipettor. Document the pipette ID used on the batch record. Pipette the correct volume of clean solvent into the vial and mark the bottom of the meniscus with a thin marker. Discard the solvent. Transfer the extract to the vial using a Pasteur pipette and rinse the concentrator tube with solvent. Transfer the rinse to the vial. Bring the meniscus of the solvent up to the marked line. Cap with a Teflon-lined cap.

10.7.12.3 Rinse the Turbovap tube with methylene chloride 2-3 times before washing. Turbovap tubes are not baked. They are cleaned in accordance with DV-OP-0004. If the Turbovap tubes need to be used again before they are dry, rinse with acetone to dry the Turbovap tube.

10.8 Cleanup Techniques

NOTE: If any sample in a batch requires a clean-up, the batch QC must also undergo the same clean-up technique.

10.8.1 Florisil Cartridge Cleanup

Florisil can be used to remove low-medium molecular weight polar hydrocarbon interfering compounds from pesticide extracts. The laboratory will use Florisil cleanups whenever water extracts have any color, whenever soil extracts have any color darker than a Post-It® Note, or whenever there is clear evidence of interferences, such as significant interfering peaks in the RT range for the target pesticide compounds or failing sample surrogate recoveries. Extracts that are to be analyzed for kepone will not be florisil cleaned, because florisil will remove kepone from the extract.

NOTE: Florisil cartridge performance checks are conducted for every lot of Florisil before use. Add 1.0 mL of the Florisil check solution described in Attachment 4 to a pre-rinsed Florisil cartridge. Following the procedure described below, load and elute the 1mL of check solution through the Florisil cartridge. Bring the final volume back down to 1.0 mL in hexane. The test sample must show 80-115 % recovery of the controlled analytes with < 5% trichlorophenol recovery, and no peaks interfering with target compounds can be detected. The non-controlled analytes will be monitored for problems, but do not have to pass the 80-115% limits. If the check fails, repeat the test. If the re-check fails, contact QA for guidance.

10.8.1.1 Clean the manifold and ports

Prior to each use, the top and underside of the manifold lid must be wiped down with hexane and a Kim-wipe to prevent any cross-contamination. The manifold ports must be left open and placed in a jar with fresh acetonitrile, in a sonication bath for a minimum of 30 minutes. The jar used in the soak and sonication of the ports must be replaced weekly to ensure it does not spread contamination. This is documented in the Organic Extraction Weekly Cleaning Logbook.

10.8.1.2 Place one Florisil cartridge into the vacuum manifold for each extract. Make sure all valves are closed.

10.8.1.3 Add approximately 6 mL of hexane to each cartridge by filling the tube.

10.8.1.4 Slowly open the valves to allow a few drops of hexane to pass through, then close the valve and allow the hexane to soak the cartridge for at least 5 minutes.

10.8.1.5 Slowly open the valves again and allow the hexane to drain through the cartridge but close the valve when the solvent level is right above the glass frit. Do not allow the cartridges to go dry. If cartridges go dry, repeat the conditioning step.

10.8.1.6 Remove the manifold top and place one clean, labeled 16 x 125 mm disposable glass test tube in each position for each of the samples. Replace the manifold top. Make sure that the solvent line from each cartridge is placed inside the appropriate tube.

10.8.1.7 Add exactly 2.0 mL of the concentrated extract to the appropriate Florisil cartridge. Turn the valve to the on position.

10.8.1.8 Allow the extract to gravity drip through the cartridge. The flow through the cartridges should be drop-wise, not streaming.

10.8.1.9 Just before the extract level drops below the glass frit, fill the cartridge with (90:10) Florisil solution. Allow this to pass through the cartridge, then just before it falls below the glass frit again, fill the cartridge again with (90:10) Florisil solution.

10.8.1.10 Allow all of the 90:10 solution to gravity drip through the cartridges.

10.8.1.11 After visible solvent has been allowed to gravity drip through the cartridge, apply the vacuum to pull remaining solvent through cartridge, typically no more than 5 seconds.

NOTE: Do not use the vacuum to recover solvent from the cartridge before gravity drip is complete. Doing so could result in the interfering compounds that should be retained in the packing to come through into the cleaned extract.

10.8.1.12 Remove the tubes from the vacuum manifold and concentrate them back down to just below 2.0 mL on the nitrogen evaporator. Quantitatively transfer the extract to a 4mL vial that has been calibrated to hold 2.0 mL and bring the extracts up to the 2.0 mL calibration mark with hexane.

10.8.1.13 Discard the used cartridges.

10.8.2 Sulfur Removal

NOTE: This step is typically performed by the instrument analyst, as it is performed after extracts are concentrated to final volume.

Sulfur can be removed by one of three methods: mercury, copper, or tetrabutylammonium sulfite (TBA), according to laboratory preference. If the sulfur concentration is such that crystallization occurs in the concentrated extract, centrifuge the extract to settle the crystals, and carefully draw off the sample extract with a disposable pipette, leaving the excess sulfur in the centrifuge tube. Transfer the extract to a clean concentrator tube before proceeding with further sulfur cleanup.

10.8.2.1 Sulfur Removal with Elemental Mercury

NOTE: Use Mercury in a hood and sparingly in order to minimize exposure and disposal costs.

10.8.2.1.1 Transfer approximately 2 mL of sample extract into a clean Teflon-sealed vial.

10.8.2.1.2 Add one to three drops of mercury to the extract vial and seal.

10.8.2.1.3 Shake well for 15-30 seconds. If prolonged shaking is required, use a mechanical shaker.

10.8.2.1.4 Remove the extract from the mercury using a disposable pipette and transfer to a clean vial.

10.8.2.1.5 If the mercury turns black, sulfur was present. Decant or pipette off the extract to a clean vial and repeat the procedure by adding one to three drops of fresh mercury. Do this until the mercury does not turn black.

10.8.2.1.6 If the extract is cloudy, filter the extract through a 1um disposable syringe filter.

10.8.2.1.7 Properly dispose of the mercury waste.

10.8.2.2 Sulfur Removal with Copper Powder

NOTE: This technique requires the copper powder to be very reactive, as demonstrated by a bright and shiny appearance. A pre-cleaned, activated copper may be purchased from a valid vendor. If manual preparation of reactive copper is performed, take care to remove all traces of acid in order to prevent degradation of some analytes.

10.8.2.2.1 Weigh out copper into a 20 mL VOA VIAL assuming two grams of copper needed per sample.

10.8.2.2.2 Remove oxides by treating with 10% nitric acid.

10.8.2.2.3 Rinse the copper with DI organic-free water three times to remove all traces of acid.

10.8.2.2.4 Rinse the copper with acetone and dry under a stream of nitrogen.

10.8.2.2.5 Add approximately 2 grams of the copper powder to a 2 mL vial with approximately 1ml of sample extract and shake vigorously on a mechanical shaker for at least one minute.

10.8.2.2.6 After phase separate, draw off extract and transfer to a clean vial.

10.8.3 Sulfuric Acid Cleanup

NOTE: This step is typically performed by the instrument analyst, as it is performed after extracts are concentrated to final volume.

10.8.3.1 Add 1 mL of concentrated sulfuric acid to approximately 2 mL of sample extract in a Teflon capped vial.

CAUTION: There must be no water or acetone present in the extract or the reaction may shatter the sample container.

10.8.3.2 Vortex for about 5 seconds and allow to settle. (Centrifuge if necessary)

10.8.3.3 Remove the sample extract (top layer) from the acid using a Pasteur pipette and transfer to a clean vial.

CAUTION: It is not necessary to remove all the extract since the final volume is already determined. Transferring any amount of sulfuric acid along with the extract will result in extremely rapid degradation of the chromatographic column

10.8.3.4 If the sulfuric acid layer becomes highly colored after shaking with the sample extract, transfer the hexane extract to a clean vial and repeat the cleanup procedure until color is no longer being removed by the acid, or a maximum of 5 acid cleanups.

10.8.3.5 Properly dispose of the acid waste.

10.8.4 Silica Gel Clean-up for DRO extracts

10.8.4.1 Samples requiring silica gel clean-up for the Oklahoma DRO method should follow the procedure in section 10.8.4.1, which includes the addition of a reverse surrogate. Samples requesting silica gel clean-up for other DRO methods should follow the procedure in section 10.8.4.1.2, which does not include an additional surrogate.

10.8.4.1.1 If the sample is logged for method 3630C_M, concentrate the extract and all associated QC to slightly below 1 mL on the N-Evap. Add 100uL of the “SilicaGelSurr” standard to each extract and then bring the extracts to a 1 mL final volume with methylene chloride. Transfer to the appropriate final extract vial per section 10.6. Proceed to section 10.8.4.2.

10.8.4.1.2 If the sample is not logged for method 3630C_M but silica gel clean-up is still requested, no further surrogate is added. Concentrate to 1 mL final volume normally per section 10.6. Proceed to section 10.8.4.2.

NOTE: Please note that some projects require analysis of extract that has been silica gel cleaned as well as analysis of extract that has not been cleaned. Due to the limited final volume of the extract, samples requiring analysis of both cleaned and un-cleaned extract must be extracted twice, and in separate batches with separate QC.

10.8.4.2 Add approximately 0.05 g of activated silica gel to the extract, cap, and vortex for approximately 15 seconds. Allow the silica gel to settle.

10.8.4.3 Transfer the extract to a new vial, leaving the silica gel behind. Submit for analysis.

10.9 Documentation

All observations are recorded either directly into LIMS or on the hard-copy benchsheets. Any hand-written data recorded on the hard-copy benchsheets are transferred into LIMS before extracts are delivered to the analytical group. The hard-copy benchsheets are then saved and scanned into pdf files and sent to QA for archiving.

10.10 Maintenance

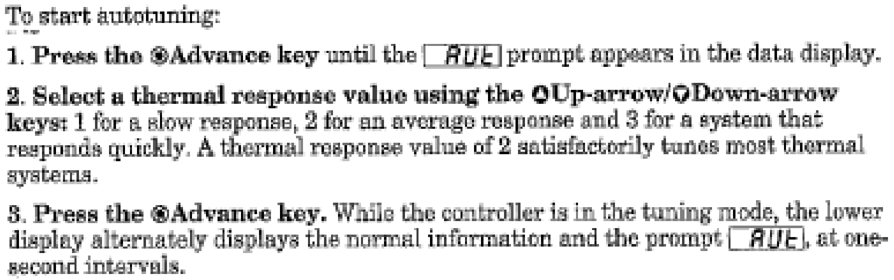
10.10.1 The chiller that operates the solvent recovery system should be checked periodically to ensure the water level is sufficient.

10.10.2 The SPE ports and valves used in the florisil are open and placed in a jar with fresh acetonitrile, in a sonication bath for a minimum of 30 minutes. The jar used in the soak and sonication of the ports must be replaced weekly to mitigate the risk of contamination. This is documented in the Organic Extraction Weekly Cleaning Logbook.

10.10.3 The N-Evap needles are removed once a week and soaked overnight in a jar of methylene chloride. This is documented in the Organic Extraction Weekly

Cleaning Logbook.

10.10.4 The water bath used in the concentration of extracts has a thermostat that occasionally needs auto-tuned to keep the bath temperature within a narrow range. Record both the observed and the actual temperature on the benchsheet.



To start autotuning:

1. **Press the ⊛Advance key** until the AUt prompt appears in the data display.

2. **Select a thermal response value using the ○Up-arrow/▽Down-arrow keys:** 1 for a slow response, 2 for an average response and 3 for a system that responds quickly. A thermal response value of 2 satisfactorily tunes most thermal systems.

3. **Press the ⊛Advance key.** While the controller is in the tuning mode, the lower display alternately displays the normal information and the prompt AUt, at one-second intervals.

10.11 Troubleshooting

Unusual sample matrix may cause problems. If the extracts do not behave normally, contact a supervisor or senior analyst if you are unsure how to proceed. Document all observations and anomalies in a NCM.

11.0 Calibration

Not applicable to this procedure. See the determinative methods for calibration of the analytical instrumentation.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory’s MDL policy in CA-Q-S-006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the

QC check sample should be equivalent to a mid- level calibration.

12.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

12.2.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Environmental Health & Safety Manual, and DV-HS-001P, "Waste Management Plan."

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Methylene chloride – Waste Stream B

14.2.2 Flammable Solvents – Waste Stream C

14.2.3 1:1 MeCl2:Acetone – Waste Stream CA

14.2.4 Solid waste/sodium sulfate – Waste Stream D

14.3 Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Waste Coordinator for proper management of these materials.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, January 2005.

15.1.1 Method 3510C, Separatory Funnel Liquid-Liquid Extraction, Revision 3, December 1996.

15.1.2 Method 3520C, Continuous Liquid-Liquid Extraction, Revision 3, December 1996.

15.1.3 Method 3550B, Ultrasonic Extraction, Revision 2, December 1996.

15.1.4 Method 3550C, Ultrasonic Extraction, Revision 3, February 2007.

15.1.5 Method 3540C, Soxhlet Extraction, Revision 3, December 1996.

15.1.6 Method 3546, Microwave Extraction, Revision 0, February 2006.

15.1.7 Method 3620C, Florisil Cleanup, Revision 3, February 2007.

15.1.8 Method 3660B, Sulfur Cleanup, Revision 2, December 1996.

15.1.9 Method 3660A, Sulfur Cleanup, Revision 1, July 1992.

15.1.10 Method 3665A, Sulfuric Acid/Permagante Cleanup, Revision 1, December 1996.

15.1.11 Method 3630C, Silica Gel Cleanup, Revision 3, December 1996.

15.2 Code of Federal Regulations, Title 40 – Protection of the Environment, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, Appendix A – Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater

15.2.1 Method 608, Organochlorine Pesticides and PCBs.

15.2.2 Method 610, Polynuclear Aromatic Hydrocarbons.

15.2.3 Method 614, The Determination of Organophosphorus Pesticides in Municipal and Industrial Wastewater

15.2.4 Method 625, Base/Neutrals and Acids.

15.3 ASTM D7065-11, Standard Test Method for Determination of Nonylphenols, Bisphenol A, p-tert-Octylphenol, Nonylphenol Monoethoxylate, and Nonylphenol Diethoxylate in Environmental Waters by Gas Chromatography Mass SpectrometryMethod Modifications:

16.0 Modifications

16.1 Method SW-846 3665A calls for the clean-up to be performed using 1:1 Sulfuric Acid:H_2O. This procedure calls for the clean-up to be performed using concentrated sulfuric acid.

16.2 ASTM D7065-11 calls for the samples to be concentrated to a 0.5 mL final volume. This procedure calls for a 1 mL final volume.

16.3 Method SW-846 3620C calls for the florisil lot check to be performed using a standard containing the some pesticides at various concentrations from 5 ug/L to 50 ug/L. Per the source method, 1 mL of the standard is diluted to 2 mL (for concentrations between 2.5 ug/L and 25 ug/L) and the cleanup is then carried out and the cleaned extract concentrated to 1 mL for a final concentration of 5 ug/L to 50 ug/L. This procedure calls for the lot check to be performed using a standard containing all the pesticides at the same concentration of 50 ug/L. 1 mL of this standard is cleaned up without prior dilution and then concentrated back down to 1 mL.

16.4 Method SW-846 3620C states that the florisil lot check passes if the pesticide recoveries are between 80% and 110% recovery. This procedure says the lot check passes if the pesticide recoveries are between 80% and 115%. This is done to match the CCV control limits.

16.5 Method SW-846 3620C states that the florisil lot check is to be performed using a standard containing the 2,4,5-Trichlorophenol at 0.1 ug/L. Per the source method, 0.5 mL of this standard is diluted to 2 mL (for a concentration of 0.025 ug/L) and the cleanup is then carried out and the cleaned extract concentrated to 1 mL for a concentration of 0.05 ug/L. This procedure calls for the lot check to be performed using a standard containing 2,4,5-trichlorophenol at 100 ug/L. 1 mL of this standard is cleaned up without prior dilution and then concentrated back down to 1 mL.

16.6 Method SW-846 3620C Section 11.1.3 states to condition the florisil cartridge with 4 mL of hexane. This procedure calls for 5 mL of hexane to be used. This is done for convenience.

16.7 Method SW-846 3630C calls for the silica gel clean-up to be performed with a column or SPE cartridge. This procedure calls for the silica gel to be added directly to the extract and mixed. The reverse surrogate used indicates if the clean-up is effective.

17.0 Attachments

Attachment 1: Determinative and Extraction Methods Used in Conjunction with this SOP.
Attachment 2: Boiling Points of Solvents
Attachment 3: Kuderna-Danish Concentrator
Attachment 4: Florisil Check Solution

18.0 Revision History

- Revision 13, dated 30 November 2018
  - Annual Review
  - Addition note to section 1.3 indicating correct SOP reference for concentration of 8321 herbicides.
  - Updated condenser setting information in section 6.13 to reflect current practice.
  - Updated note in section 10.5.9 to reflect current practice.
  - Adjusted wording in section 10.8.1.2 to clarify “extracts” rather than “samples.”
  - Minor language adjustments insections 10.8.1.11 and 10.8.1.12 to clarify the application of the vacuum during recovery of florisil-cleaned extracts.
  - Added notes to sections 10.8.2 and 10.8.3 to specify that these steps are typically performed my instrument analysts.
  - Updated section 10.8.4 to provide clarification and reflect current practice.
  - Updated reference to Laboratory MDL Procedure CA-Q-S-006.
- Revision 12, dated 31 October 2017
  - Annual Review
- Revision 11, dated 31 October 2016
  - Added the paragraph referencing the QAM for general definitions in Section 3.0
  - Added the requirement to document the ID of pipettes used in Sections 6.1, 10.6.5.2 and 10.7.12.2.
  - Updated Section 10.1 to reflect current practices
  - Added the specification of using the S-evap for concentration in Sections 10.5, 10.5.8 and 10.5.12
  - Added the requirement to document both the observed and actual temperature in Sections 10.6.3 and 10.10.4
- Revision 10 dated 31 December 2015
  - Updated formatting and numbering throughout the document
  - Revised method code references to reflect current practice
  - Numbered NOTES where there were multiples (Sections 6.0, 10.4.5, 10.4.9, 10.5.5.2)
  - Updated drive reference in Section 6.1
  - Updated “Reagent Grade Chemicals” definition in Section 7.0 to be consistent with other SOPs
  - Added statement in Section 8 to specify that extracts are stored separately from standards
  - Updated Section 9.1 to be consistent with other SOPs
  - Added new section 10.2 for consistency with other SOPs
  - Added NOTE to Section 10.3
  - Added a requirement to Section 10.6.6 to rinse all concentrator tubes with methylene chloride before washing

    - Removed the reference to South Carolina in Section 10.8.2. The laboratory no longer holds certification for South Carolina by this method
    - Updated Section 12 to be consistent with other SOPs
    - Added NOTE to Section 14.3
    - Revised the concentration of 2,4,5-Trichlorophenol in the Florisil Check Solution described in Attachment 4.
        - The compound used to be at a concentration of 0.1 ug/mL in the standard
        - It is now at a concentration of 0.5 ug/mL
        - One mL of the standard is used in the Florisil check procedure, resulting in 0.5 µg of the compound loaded onto the 6 g of Florisil
    - Removed references to DV-MS-0005 in Section 1 and Attachment 1, the laboratory no longer performs this procedure
- Revision 9 dated 31 December 2014
    - Section 5.1.1.2 and Section 10.4.9 were revised to match current practice on the use of the solvent recovery system.
    - Section 6.1 Computer Software and Hardware was added.
    - Section 7.6 Baked Sodium Sulfate was revised to match current practice and the latest revision of CA-Q-S-001 DV-1.
    - Section 7.11 was revised to correct the TAL Reagent ID.
    - Section 9.1 was revised to include the statement "This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated".
    - Section 9.4, 9.5, 9.6, and 9.7 were revised to remove information on Acceptance Criteria and Corrective Action. This information can be found in the analytical and QA SOPs.
    - Section 10.4.5 was revised to instruct the analyst to use approximately 1 teaspoon of sodium sulfate to dry extracts. This was done to limit the extract's exposure to sodium sulfate which can cause low recoveries for some acid compounds. A note was also added to this section to instruct the analyst to use more sodium sulfate or a separatory funnel to remove water if a teaspoon of sodium sulfate is not sufficient.
    - The Note in Section 10.4.12 was revised to instruct the analyst to write an NCM and/or notify their supervisor if they have a concern that an extract concentrated too low.
    - Section 10.7.1 Florisil Clean-up was revised to give guidance on what to do if the florisil check fails.
    - Section 10.7.1 was revised to instruct the analyst to not use the vacuum to pull all of the solvent from the cartridge. This was done to prevent interfering compounds and 2,4,5-TCP from eluting off of the cartridge.
    - Section 10.7.1 and Attachment 4 Florisil Check Solution were revised to indicate which compounds are controlled and which compounds are monitored. In addition, surrogate compounds were added to the solution.
    - Section 10.7.1 and 10.9 were revised to instruct the analyst to soak the SPE ports in a jar with the valves open instead of disassembling the valves.
    - Section 10.7.3 was revised to instruct the analyst to perform the clean-up on approximately 2mL of extract. This was done to match current practice.
    - Section 10.7.4 Silica Gel Clean-up and Sections 15.1 and 16.0 were revised to match current practice.
    - Section 10.9 Maintenance was revised to include instructions on how to tune the water bath thermostat.
    - Attachment 3 – Concentration Summary was removed and replaced with WI-DV-0009. All other Attachments were re-numbered.
- Revision 8 dated 13 December 2013

  - The procedure was revised to include ASTM D7065-11.
  - The procedure was revised to include steps for silica gel clean-up for DRO extracts.
  - Section 7 was revised to include details on the Florisil Solution and Florisil cartridges. These details were lacking in previous revisions.
  - Section 10.4.2 was revised to give more detail on how to safely tighten the ground glass joint between the KD and concentrator tube.
  - Section 10.6.3 was revised to give more detail about the required water level in the Turbo-Vap.
  - Maintenance and Troubleshooting sections were added as Sections 10.8 and 10.9.
  - Section 16 was revised to include method modifications from SW-846 3620C.
  - Attachment 1 was updated to reflect the current SOPs in use in the laboratory.
  - Attachment 3 was updated.
- Revision 7 dated 5 December 2012
  - Section 5 and Section 10.4.5 were revised to instruct the analysts to handle glass wool in a hood to avoid breathing in the dust.
  - Revised Section 10.4.8 to instruct the analysts to document both the observed and corrected temperatures.
  - Section 10.7.1.11 was revised to describe in more detail how the florisiled extracts are taken to the 2 mL final volume.
  - Section 14.2 was revised to include the waste stream for 1:1 MeCl2:Acetone – Waste Stream CA.
  - Attachment 1 was revised to include DV-OP-0015 as an acceptable extraction for Diesel Range Organics.
  - Attachment 3 was revised to include details on 8081/3510_LL concentration steps.
- Revision 6.0 dated 14 October 2011
  - The procedure was revised to remove instructions on how to concentrate and clean up extract for method 8070 and 607. TestAmerica Denver no longer supports these methods.
  - Section 1.3 was corrected to give the correct SOP number to Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C for Low-Level NDMA by GC/CI/MS/MS.
  - Section 7.5 was revised to state acetonitrile is tested before use. Previously this solvent was not tested before use.
  - The procedure was revised to include instructions that all extracts for analysis by method 8081, 8082, or 608 to be hexane exchanged only after concentration on the S-Evap. Previously the SOP instructed analysts to add the hexane exchange before the S-Evap for extracts that were concentrated by microwave extraction. This resulted in poor hexane exchanges, therefore the extracts are now concentrated before the exchange.
  - The procedure was revised to instruct analysts not to use the solvent recovery system when concentrating samples for analysis of low-level NDMA by GC/CI/MS/MS. This was done to eliminate a possible source of contamination in this ppt level analysis.
  - The procedure was revised to instruct analysts to use concentrated sulfuric acid in the acid clean up of PCB extracts.
  - The procedure was revised to clarify the exact steps used in the sulfur removal with mercury.

Earlier revision histories have been archived and are available upon request.

Attachment 1.

Determinative and Extraction Methods Used in Conjunction with this SOP

Method Description	Determinative Method	Determinative Method SOP	Extraction Method	Extraction Method SOP
Diesel Range Organics & Jet Fuels	SW-846 8015B, 8015C, 8015D, California LUFT Method, & AK102 & AK103, NW-TPH, OK DRO	DV-GC-0027	WATER: SW-846 3510C, AK102 AK103 NW-TPH OK DRO SOIL: SW-846 3550B/C SW-846 3546 AK102, AK103 NW-TPH OK DRO	WATER: DV-OP-0006 SOIL: DV-OP-0016 or DV-OP-0015
Chlorinated Pesticides	SW-846 8081A, 8081B & EPA Method 608	DV-GC-0020 DV-GC-0016	WATER: SW-846 3510C SOIL: SW-846 3550B/C SW-846 3546	WATER: DV-OP-0006 SOIL: DV-OP-0016 or DV-OP-0015
Polychlorinated Biphenyls	SW-846 8082, 8082A EPA Method 608	DV-GC-0021 DV-GC-0016	WATER: SW-846 3510C SOIL: SW-846 3550B/C SW-846 3546	WATER: DV-OP-0006 SOIL: DV-OP-0016 or DV-OP-0015
Organo-phosphorus Pesticides	SW-846 8141A, 8141B, & EPA Method 614	DV-GC-0017	WATER: SW-846 3510C SOIL: SW-846 3540C	WATER: DV-OP-0006 SOIL: DV-OP-0010
Polynuclear Aromatic Hydrocarbons	SW-846 8310 & EPA Method 610	DV-LC-0009	WATER: SW-846 3510C SOIL: SW-846 3550B/C	WATER: DV-OP-0006 SOIL: DV-OP-0016
Semi-volatiles by GC/MS	SW-846 8270C, 8270D & EPA 625	DV-MS-0011 DV-MS-0012	WATER: SW-846 3510C SW-846 3520C SOIL: SW-846 3550B/C	WATER: DV-OP-0006 or DV-OP-0008 SOIL: DV-OP-0016
Low-Level Semi-Volatiles by GC/MS	SW-846 8270C	DV-MS-0011	WATER: SW-846 3520C	WATER: DV-OP-0008
Polynuclear Aromatic Hydrocarbons by GC/MS SIM	SW-846 8270C SIM	DV-MS-0002	WATER: SW-846 3510C SOIL: SW-846 3550B/C SW-846 3546	WATER: DV-OP-0008 SOIL: DV-OP-0016 or DV-OP-0015
Isotope Dilution Analysis of n-Nitrosodimethylamine by GCMS SIM using LVI	SOP	DV-MS-0015	WATER: SW-846 3520C SOIL: SW-846 3550B/C	WATER: DV-OP-0021 SOIL: DV-OP-0016

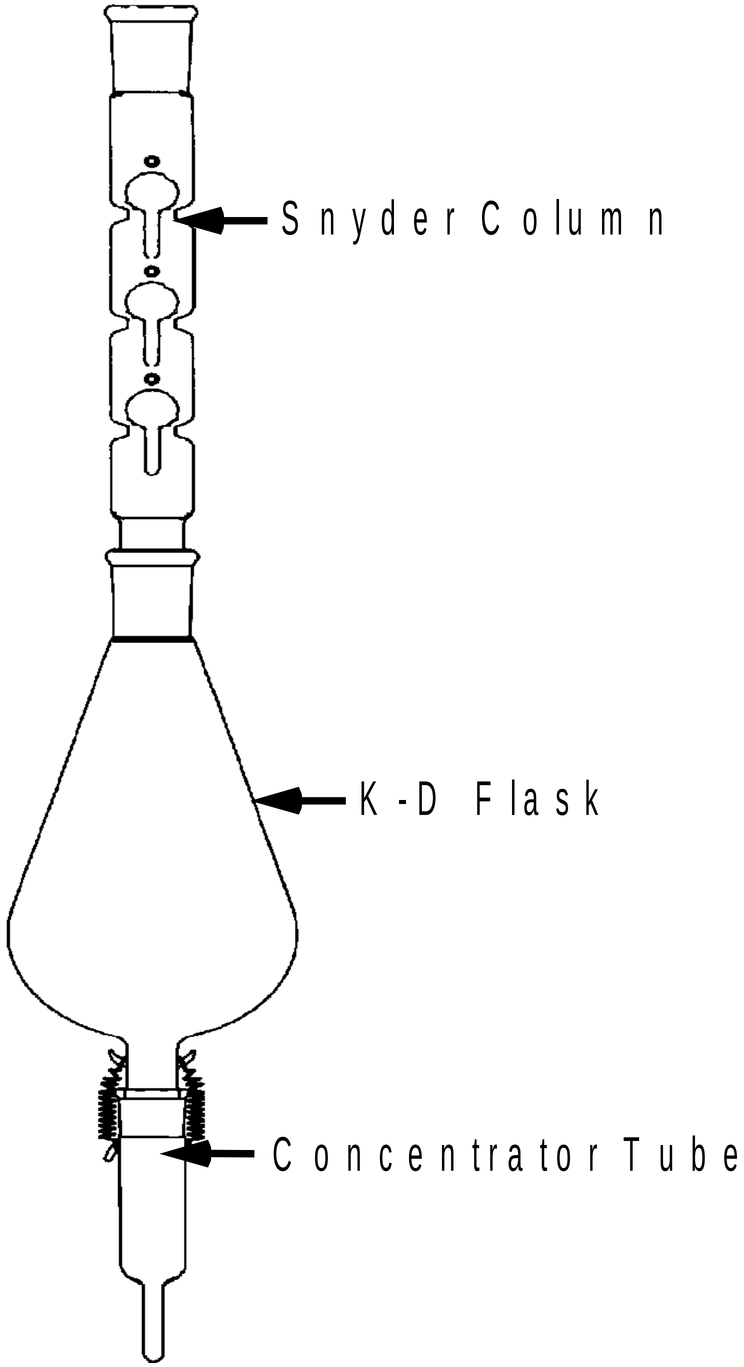
Attachment 2.

Boiling Points of Solvents

Solvent	Boiling Point (°C)
Methylene chloride	40
Acetone	56
Hexane	69
Methanol	65
Acetonitrile	82

Attachment 3.

Kuderna-Danish Concentrator



Attachment 4.

Florisil Check Solution
Prepared in Hexane

Compound	Concentration	Control
2,4,5-Trichlorophenol	0.05ug/mL	Y
Alpha-BHC	0.05ug/mL	Y
Alpha-Chlordane	0.05ug/mL	N
Aldrin	0.05ug/mL	N
Beta-BHC	0.05ug/mL	N
Dieldrin	0.05ug/mL	Y
Endosulfan I	0.05ug/mL	Y
Endosulfan II	0.05ug/mL	N
Endosulfan sulfate	0.05ug/mL	N
Endrin	0.05ug/mL	Y
Endrin Aldehyde	0.05ug/mL	N
Endrin Ketone	0.05ug/mL	N
Gamma-BHC	0.05ug/mL	Y
Gamma-Chlordane	0.05ug/mL	N
Heptachlor	0.05ug/mL	Y
Heptachlor expoxide	0.05ug/mL	N
Methoxychlor	0.05ug/mL	Y
4,4-DDD	0.05ug/mL	Y
4,4-DDE	0.05ug/mL	N
4,4-DDT	0.05ug/mL	Y
Tetrachloro-m-xylene	0.02ug/mL	Y
Decachlorobiphenyl	0.02ug/mL	Y

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TestAmerica Denver

Electronic Document Cover

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Title: Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C and Methods 625 and 627 and ASTM Method D7065-11

Approvals (Signature/Date):

Amelia Byl August 31, 2018
Amelia Byl Date
Technical Specialist

Doug Gomer 8/28/18
Doug GOmer Date
Health & Safety Manager / Coordinator

Roxanne Sullivan 8/29/89
Roxanne Sullivan Date
Quality Assurance Manager

8/29/18
Richard Clinkscales Date
Laboratory Director

Facility Distribution No. ____________ **Distributed To:**__________________________

1.0 Scope and Application

1.1 This Standard Operating Procedure (SOP) is applicable to the solvent extraction of organic compounds from aqueous samples, TCLP leachates, and SPLP leachates using a continuous liquid/liquid extractor (CLLE). This SOP is based on SW-846 Method 3520C and EPA Method 625 and ASTM Method D7065-11.

1.2 The determinative methods used in conjunction with this procedure are listed in Table 1. This extraction procedure may be used for additional methods when appropriate pH and spiking mixtures are used.

1.3 This procedure does not include the concentration and cleanup steps. See SOP DV-OP-0007, "Concentration and Clean-up of Organic Extracts", for details concerning the concentration and cleanup of extracts.

1.4 This procedure does not include the extraction of samples for low-level NDMA analysis by 8270D_SIM_LL. The CLLE extraction procedure utilized for that analysis is described in DV-OP-0021.

2.0 Summary of Method

A measured volume of sample is placed in a continuous liquid/liquid extractor (CLLE). The pH is adjusted, as required, for the efficient extraction of specific compounds. The organic compounds are extracted with methylene chloride for a designated length of time. A second extraction at a different pH also may be required. The water phase is discarded.

3.0 Definitions

3.1 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, *Quality Control Program*, for definitions of general analytical and QA/QC terms.

3.2 Aliquot: A part which is a definite fraction of a whole; as in a "sample aliquot for testing or analysis." "Aliquot" is also used as a verb meaning to take all or part of a sample for preparation, extraction, and/or analysis.

3.3 Extraction Holding Time: The elapsed time, expressed in days, from the date of collection of the sample to the date of extraction, i.e., the date solvent comes in contact with the sample. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.4 Preparation Batch: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards.

3.5 Quality Assurance Summary (QAS): Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in LIMS. In those situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all laboratory employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.6 Reagent Water (aka ELGA water – water generated from ELGA water polishing units) - Water with a resistivity of 1 Megohm-cm or greater. The TestAmerica Denver deionized water supply meets this requirement with a resistivity of at least 10 Megohm-cm.

4.0 Interferences

4.1 Chemical and physical interferences may be encountered when analyzing samples using this method.

4.2 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

4.3 Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented.

4.4 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them. Especially take note of the possibility of phthalate contamination from gloves. Gloves should be changed out frequently and whenever they come in contact with solvent. Glassware should be handled in a fashion that keeps gloves away from the interior and mouth of the glassware.

4.5 The decomposition of some analytes has been demonstrated under basic extraction conditions. Organochlorine pesticides may dechlorinate, phthalate esters may exchange, and phenol may react to form tannates. These reactions increase with increasing pH, and are decreased by the shorter reaction times available in Method 3510C. Method 3510C is preferred over Method 3520C for the analysis of these classes of compounds. However, using Method 3520C and performing the initial extraction at the acid pH optimizes the recovery of phenols.

4.6 The recovery of some target analytes and the surrogate 2-fluorobiphenyl can be reduced if proper care isn't taken to target the pH during the base extraction to 11-12. It is not recommended to add excess base that will cause the sample pH to be greater than 12.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 CLLE glassware is often times fragile and awkward to use. Care should be taken to prevent breakage and injury. During the course of the procedure it might be necessary to adjust the height of the heating mantle. This will cause the CLLE body to tilt. Do not tilt the CLLE body more than 15 degrees to avoid stressing the glass and making the CLLE unstable. The condenser bank has been equipped with plastic holders to steady the CLLEs and to prevent them from tipping. See Attachment 1 for troubleshooting.

5.1.2 The procedure requires that the ground glass joints are fitted tightly to prevent loss of the extract. Cut resistant gloves will be worn when assembling or dis-assembling the ground glass joints to protect against cuts if the glass were to break.

5.1.3 The procedure calls for the use of condensers. In times of high humidity, water may collect on the outside of the condensers and collect inside the condenser holders. If the condenser holders and not emptied, they may overflow and excess water may then drip onto the bench top. This is an electrical hazard if electrical cords are also on the bench tops. In order to protect the electrical receptacles, cord connectors, and attachment plugs from wet conditions, excess water must be removed from the condenser cups before it overflows onto the bench top. If possible, secure electrical cords above the benchtop.

5.1.4 CLLE glassware that is full of water, should not be lifted by the arm, but by the top. The arm may not be able to support the full weight of the full CLLE.

5.1.5 When adding sodium hydroxide to the extractor, care should be taken to not get the base on the ground glass joints as the base will “glue” the joint together. If base does get on a ground glass joint, rinse it off with reagent water.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Materials with Serious or Significant Hazard Rating

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Methylene Chloride	Carcinogen Irritant	25 ppm (TWA) 125 ppm (STEL)	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, & headache. Causes irritation, redness, & pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Sodium Hydroxide	Corrosive Poison	2 mg/m3	Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat, and runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes and can cause burns that may result in permanent impairment of vision, even blindness with greater exposures.
Sulfuric Acid	Corrosive Carcinogen	1 mg/m3	Inhalation may cause irritation of the respiratory tract with burning pain, coughing, wheezing, shortness of breath, and pulmonary edema. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Causes skin & severe eye burns. May cause irreversible eye injury, blindness, permanent corneal opacification.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit			

6.0 Equipment and Supplies

NOTE: All glassware used in this procedure is cleaned following SOP DV-OP-0004. In addition, the CLLEs are dried with acetone and then rinsed with methylene chloride twice prior to use.

6.1 Supplies

6.1.1 Continuous Liquid-Liquid Extractor (CLLE) equipped with ground glass joints and polytetrafluoroethylene (PTFE) stopcock. (See Figure 1.) This procedure uses both 1000mL and 250mL extractors.

6.1.2 250mL boiling flask with ground glass joint

6.1.3 Boiling Chips, contaminant free, approximately 10/40 mesh, Teflon®, PTFE

6.1.4 Cooling Condensers, Allihn or Friedrichs style

6.1.5 Re-circulating Chiller – kept at 5°C to 10°C

6.1.6 Heating Mantle, Rheostat controlled, or Hotplate with temperature control. If hotplates are used then an aluminum cup must also be used to evenly heat the boiling flasks

6.1.7 Balance, ≥ 1600 g capacity, accurate to ± 1 g, calibration checked daily per SOP DV-QA-0014

6.1.8 pH indicator paper, wide range

6.1.9 Class A Graduated Cylinder, 1 L in size

6.1.10 Teflon® stir rods

6.1.11 Mechanical pipette, adjustable 0.125 to 1mL positive displacement, with disposable tips, calibration checked daily per SOP DV-QA-0008

6.1.12 Aluminum foil

6.1.13 Disposable Pasteur Pipettes – used to take initial pH of sample

6.2 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Reagent Water

TestAmerica Denver utilizes ELGA water purification systems to generate reagent water. The water coming from the ELGA system should be 18-18.2 Mohm-cm. The performance of the water polishing system is checked daily and recorded per SOP DV-QA-0026.

7.2 Methylene Chloride

Each lot of solvent is tested following Corporate SOP CA-Q-S-001 or TestAmerica Denver SOP CA-Q-S-001 DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.3 Acids and Bases

7.3.1 1:1 Sulfuric Acid, (1:1 H2SO4)

Place an ice water bath on a stir plate. Place a container with a magnetic stir bar in the bath. While stirring, slowly add 1 part concentrated reagent grade sulfuric acid (36 N) to 1 part water from the ELGA purification system. Assign a 1 year expiration date from the date made or the vender expiration date, whichever is shorter.

7.3.2 10N Sodium Hydroxide (10N_NaOH)

Purchased at ready-to-use concentration from commercial vendors. Assign a 1 year expiration date from the date opened or the vender expiration date, whichever is shorter.

7.4 Baked Sodium Chloride

Bake in 400 °C oven for at least 4 hours. Assign an expiration date of 1 year after date opened, unless vender expiration date is shorter.

7.5 Standards

Please reference SOP DV-OP-00020 and WI-DV-0009 for information regarding the surrogate and spike standards used in this procedure.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time[1]	Reference
Waters for Methods 8270C, 8270D, and 625	Amber Glass	1000 mL	Cool, $\leq 6^{o}$C, not frozen	7 Days	40 CFR Part 136.3 SW-846 Table 4-1
TCLP Leachates for Methods 8270C and 8270D	Glass	200 mL	Cool, $\leq 6^{o}$C, not frozen	7 Days from the start of the leach	SW-846 1311
SPLP Leachates for Methods 8270C and 8270D	Glass	1000 mL	Cool, $\leq 6^{o}$C, not frozen	7 Days from the start of the leach	SW-846 1312
Waters for Method D7065_11	Amber Glass	1000 mL	H_2SO_4 to a pH of 2 Cool, $\leq 6^{o}$C, not frozen	28 Days	D7065_11

[1] Exclusive of analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD/DOE QSM 5.0 or 5.1 unless otherwise stated. Any deviation or exceptions from QSM 5.0 or 5.1 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 12 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

One method blank must be processed with each preparation batch.

9.4.1 The method blank for batches of aqueous samples consists of 1 L of reagent water, which is free of any of the analyte(s) of interest.

9.4.2 The method blank for batches of TCLP leachates consists of 200 mL of leach fluid.

9.4.3 The method blank for batches of SPLP leachates consists of 1 L of leach fluid. The method blank is processed and analyzed just as if it were a field sample.

9.5 Laboratory Control Sample (LCS)

9.5.1 At least one LCS must be processed with each preparation batch.

9.5.1.1 For aqueous sample batches, the LCS consists of 1 L of reagent water to which the analyte(s) of interest are added at known concentration.

9.5.1.2 For TCLP leachates, the LCS consists of 200 mL of leach fluid to which the analyte(s) of interest are added at known concentration.

9.5.1.3 For SPLP leachates, the LCS consists of 1 L of leach fluid to which the analyte(s) of interest are added at known concentration.

9.5.2 The LCS is carried through the entire analytical procedure just as if it were a sample.

9.5.3 Method 625 requires a LCS at a 10% frequency. In other words one LCS is required for a batch of 10 or less samples. A LCSD is required for a batch of 11 or more samples.

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.6.1 One MS/MSD pair should be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

9.6.2 Method 625 requires one matrix spike for every 10 samples. If the batch has more than 10 samples, then two matrix spikes must be performed. The two matrix spikes are to be performed on two different samples. If a client requests a MS and MSD for method 625, the MS and MSD shall be performed, but an NCM should be prepared documenting the deviation from the source method.

9.6.3 If insufficient sample volume is available for MS/MSD for SW-846, or for MS for method 625, an NCM must be written and a LCSD must be prepared.

9.6.4 DoD requires the MS/MSD to be assigned by the client. When there is no assigned MS/MSD or there is not enough sample volume provided an LCSD must be prepared.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.1 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.2 All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

10.3 Critical Procedural Considerations

10.3.1 As stated throughout this SOP, analysts must review Method Comments and any applicable QASs before starting work. This review is also documented on the Organic Extraction Checklist (see WI-DV-0009).

10.3.2 Analysts must focus on using clean technique throughout this procedure. Any parts or pipettes that come into direct contact with dirty surfaces or any piece of glassware other than the designated one should be cleaned or disposed of before coming into contact with the sample.

10.3.3 If problems arise during the extraction, see Attachment 1: Troubleshooting Guide.

10.4 Assemble and Clean the Glassware Immediately Before Use

NOTE: Rotate glassware; do **not** use specific glassware or positions for the MB and LCS/LCSD.

10.4.1 For each sample and QC sample, rinse a 250 mL boiling flask with methylene chloride. Add a few boiling chips and fill with about 150 mL of methylene chloride.

10.4.2 For each sample and QC sample, rinse a CLLE once with acetone to ensure the CLLE is dry, and then rinse two times with methylene chloride. Make sure the stop-cock is open during the rinses. Then fill the bottom of the CLLEs with methylene chloride to a level approximately 2 cm above the opening of the solvent flow arm, or to a level that fills the funnel bottom completely. (See Figure 1.)

10.4.3 Cap the CLLE with aluminum foil to prevent contamination or solvent evaporation.

10.4.4 Set the CLLE with the stop-cock open on a stand under a slot hood and in front of a heating mantle or hotplate with a metal cup. Attach the 250 mL boiling flask containing methylene chloride and boiling chips to the side arm of the CLLE and place a heating mantle or hotplate with metal cup under the flask.

10.4.5 Label each boiling flask with the sample ID or batch QC ID. Also include on the label what fraction (acid or base) if the method calls for extraction at a secondary pH. (See Section 10.13).

10.5 Prepare LCS and Method Blank Samples

NOTE: For SW-846 methods if there is not a MS/MSD pair in the batch then perform a LCS/LCSD. Method 625 requires a LCS and LCSD in batches of 11 or more samples or if there is not a MS in batches of 10 or less samples.

10.5.1 For aqueous sample batches, dissolve approximately 6 g (approximately 1 tsp.) of baked NaCl to 1 liter of reagent water. With the stopcock of the CLLE open, pour this water into the CLLEs marked for the LCS's and MB until the methylene chloride in the bottom of the CLLE starts to spill over through the solvent flow arm and into the boiling flask. Be careful not to allow water to spill over. You may need to add additional methylene chloride to the CLLE to prevent water from entering the solvent flow arm.

10.5.2 For TCLP batches, prepare the LCS's and method blanks using 200 mL of the appropriate leach fluid. For SPLP batches, prepare the LCS using 1 liter of the appropriate leach fluid. Add reagent water as necessary to the CLLE to cause the methylene chloride to begin to pour through the solvent flow arm and into the boiling flask. Place the leachate bottle beside the CLLE so a second analyst can check that the correct blank fluid was used. This is documented on the Organic Extraction Worksheet (WI-DV-0009).

10.6 Prepare the samples and the MS/MSDs

10.6.1 Measure and the initial sample pH with wide-range pH paper and record the pH on the extraction bench sheet. Note any observations in an NCM. Usually samples have pH between 6 and 8. If the pH is outside of this range, an NCM should be prepared.

10.6.2 For TCLP leachates, use a Class A graduated cylinder to measure out 200 mL into the labeled CLLE. Add reagent water to the CLLE to ensure proper flow. For SPLP leachates, either use a Class A graduated cylinder to measure out 1000 mL into the labeled CLLE, or if the leachate was delivered in a 1 liter bottle from the TCLP lab, then the leachate can be aliquotted gravimetrically following the procedure in Section 10.6.3. Place the leachate container beside the CLLE so that a second analyst can check the labels. This is documented on the Organic Extraction Worksheet (WI-DV-0009).

10.6.3 For aqueous samples, it should be noted that TestAmerica Denver routinely aliquots samples gravimetrically. This is done to prevent cross-contamination due to volumetric glassware and to provide a more accurate initial volume measurement. However, some clients and regulatory programs require the laboratory to aliquot samples volumetrically. The client requirements and QASs must be read before samples are aliquotted to check for this requirement. If samples are to be aliquotted volumetrically, use Class A volumetric glassware only and proceed to Section 10.6.5.

10.6.4 Weigh the bottle containing the approximately 1 liter sample and record the gross weight to the nearest gram. If there is any indication that the sample's density is not 1g=1mL, then measure the density of the sample. Normally a full 1 liter bottle should weigh no more than 1560 g and a full 250 mL bottle should weigh no more than 424 g. If the density of the sample is 1.01g/mL or greater, adjust the gross weight of the sample.

10.6.5 Inspect the samples for large amounts of sediment that may interfere with the extraction of the sample by clogging the solvent flow arm.

10.6.5.1 If the sample contains so much sediment that the entire sample volume cannot be extracted, decant the sample into a clean 1-liter amber (or a 1 L graduated cylinder if volumetric aliquotting is required), be careful not to transfer the sediment. Write a NCM to document the sediment and that it prevented the entire sample volume from being extracted and the sample container from being rinsed. This is considered a deviation and must be documented in a NCM.

10.6.5.2 If the sample does not contain a significant amount of sediment, then the entire sample volume will be used in the extractionFor the 600 method series: if there is no more than an inch of sediment in the bottom of the sample bottle, shake the sample well and determine if the sediment resettles in approximately 1 minute. If not, the density of the sediment is likely to be low enough to stay suspended and not block the sidearm.

10.6.5.3 For the 600 method series: if the density of the sediment is high and likely to cause a problem in the side arm or there is more than an inch of sediment contact the PM so that the client's input can be obtained. Not extracting the entire sample and rinsing the bottle with the extraction solvent is a method deviation. If the client concurs that the sample can be decanted write an NCM to describe the deviation from the procedure.

10.6.6 Add NaCl to all samples and MS/MSDs

10.6.6.1 Add approximately 6 grams (approximately 1 tsp.) of baked NaCl to each sample container (or the appropriate secondary container, if the sample was decanted in section 10.6.5). Cap and invert the bottle several times to dissolve.

10.6.7 Place the sample containers in front of the CLLE labeled for that sample. A second analyst should then check the labels to make sure the correct sample is being extracted. This check is documented in the Organic Review Checklist (WI-DV-0009)

10.7 If volumetric aliquotting is required, transfer the entire sample into a 1 L Class A graduated cylinder and record the volume on the benchsheet. If the sample bottle contains more than 1000 mL, a 100 mL Class A graduated cylinder can be used to complete the measurement. The entire sample volume must be used. Record the volume to the nearest 10 mL. Then pour the sample into the labeled CLLE on top of the methylene chloride. Rinse the sample container and the graduated cylinder with methylene chloride and add the rinse to the CLLE.

NOTE: A 1000 mL Class A graduated cylinder is not accurate enough to measure to the nearest 1 mL. Therefore all samples that are aliquoted using a 1000 mL Class A graduated cylinder will have the initial volume recorded to the nearest 10 mL. This accuracy is sufficient.

10.8 If volumetric aliquotting is not required, pour the sample directly into the CLLE on top of the methylene chloride. Rinse the sample container with methylene chloride and add the rinse to the CLLE. When rinsing 1 liter bottles at least 40 mL of solvent should be used. When rinsing 250 mL bottles, at least 20 mL of solvent should be used.

NOTE: It is very important to use sufficient solvent to perform the rinse. A bottle-top pump can be used to ensure that at the correct volume of solvent was used. The sample container should then be capped and shaken to ensure a good rinse of the internal surface area of the bottle. Failure to do so may cause low terphenyl-d14 surrogate recoveries.

10.9 Be careful to allow only the methylene chloride in the bottom of the CLLE to spill over into the boiling flask, and not to allow water to spill over. Add additional methylene chloride or reagent water to the CLLE if needed to ensure proper solvent flow.

10.10 Add Surrogates to All Field Samples and QC Samples

10.10.1 Add the appropriate volume of the appropriate working surrogate standard to the CLLE for each sample, MS/MSD, LCS, and MB. Record the ID of the standard used on the bench sheet. Reference work instruction WI-DV-0009 to determine the appropriate standard and the appropriate volume.

10.11 Add Spikes to all LCS's and MS/MSDs

10.11.1 Add the appropriate volume of the appropriate working spike standard to the CLLEs for the MS/MSD, LCS and/or LCSD samples. Record the ID of the standard used on the bench sheet. Note that the standard should be allowed to come to room temperature before spiking the samples. Record the time on the benchsheet as the Batch Open time.

NOTE: The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-0009.

10.12 Reweigh the bottle and document the weight as the Tare Weight in LIMS. LIMS will then calculate the initial sample volume by subtracting the empty bottle's weight from the full bottle's weight, assuming a density of 1g=1mL. If the sample's density is not 1g=1mL, then correct the calculated initial volume accordingly. See Section 11 for the calculation. Document abnormal sample density in an NCM.

10.13 If the initial volume is less than 800 mL for 1 liter extractions, the sample reporting limits and method detection limits will be elevated substantially and this should be documented in a NCM.

10.14 Adjust pH of Field Samples and QC Samples

10.14.1 Adjust the sample pH as indicated in the chart below using a minimum amount of 1:1 sulfuric acid or 10 N sodium hydroxide, as necessary.

NOTE: Samples for nonylphenols by method D7056_11 should be received in sulfuric acid preserved bottles. If the samples are received with an initial pH ≤2, then acid is not added to the samples. Acid should be added to the MB and any LCSs to reach a pH ≤2.

10.14.2 When adjusting neutral 1 liter samples to a pH of 1-2, start by adding 2 mL of the 1:1 sulfuric acid. When adjusting neutral 250 mL samples to a pH of 1-2, start by adding 0.5mL of the 1:1 sulfuric acid.

10.14.3 Use a Teflon® stir rod to mix the sample and check the pH using wide-range pH paper. Record the adjusted pH and the lot number of the acid on the bench sheet. If more acid is required, continue adding the acid in 1 mL increments until the proper pH is achieved and document on the benchsheet and in an NCM how many milliliters of acid were required.

NOTE: It is important to use Teflon® stir rods whenever possible instead of glass rods or pipettes as the glass will scratch the extractor bodies.

10.14.4 When adjusting neutral samples to a pH of 14 for 8270_LL when only 1,4-Dioxane or NDMA are requested, start by adding 10 mL of the sodium hydroxide. Use a Teflon® stir rod to mix the sample and check the pH using wide range pH paper. Record the adjusted pH and the lot number of the base on the bench sheet. If more than 10 mL of sodium hydroxide is required, continue adding the base in 1 mL increments until the proper pH is achieved and document in an observation NCM how many milliliters of base were required. It is important to try to achieve a pH of 14 in order to most effectively extract the 1,4-dioxane.

Extraction Method	Initial Extraction pH	Secondary Extraction pH
3520C *625_Prep*	1 – 2	11 - 12
3520C_Base	14	None
D7065_11_W_Prep	1-2	None

10.15 Start the Initial Extraction

10.15.1 Attach the cold condenser (chilled at 5°C to10°C). Check that the hoses are not kinked. Check the temperature and water level of the chiller.

10.15.2 Turn on the heating mantle or hotplate. The read-out for the digital heating mantles or hotplates should read between the ranges of 405-425; the analog heating mantles or hotplates should read at 60 or 6. Please note the latter is model dependent. Check again for boiling chips in the boiling flask and inspect joints for leaks once solvent has begun cycling. Leaks might appear as frost that forms as the methylene chloride evaporates. The methylene chloride in the round bottom flask should be boiling steadily, but not too rapidly that the condenser cannot condense the vapor as fast as it is being generated.

10.15.3 Record the date and the time the extraction started on the bench sheet. It is important to check the samples approximately 15 minutes after starting them to ensure they are running properly and solvent loss is not occurring.

10.15.4 Extract the samples for the time indicated in the chart below.

Extraction Method Code	Analytical Method Code	Extraction Duration
3520C	All Methods	18-24 Hours
625_Prep	625	24 Hours
D7065_11_W_Prep	D7065_11	18-24 Hours
3520C_Base	All Methods	18-24 Hours

10.15.5 At the end of the extraction, turn off the heating mantle or hotplate and allow the extractor to cool. Record the date and time the extraction stopped on the bench sheet.

10.15.6 Remove the boiling flask, cap tightly with aluminum foil, and store refrigerated until concentration. If a second extraction at basic pH is required, continue on to Section 10.16. If a second extraction is not required, go to Section 10.18.

10.16 Start the Secondary Base Extraction

10.16.1 Attach a boiling flask with fresh methylene chloride and boiling chips to the CLLE. Label each boiling flask with the sample ID or batch QC ID.

10.16.2 Remove the condenser. Using a minimum amount of sodium hydroxide, adjust the pH of the sample in the extractor body to a pH of 11-12 for the methods indicated in Section 10.14.

10.16.3 When adjusting 1 liter samples, to a pH of 11-12, usually 5 mL of base is needed. When adjusting 250mL samples to a pH of 11-12, usually 1.2mL of base is needed.

10.16.4 Use a Teflon ® stir rod to mix the sample. Measure with wide-range pH paper and record the adjusted pH and the lot number of the base used on the bench sheet. If more base is needed add it in 1mL increments until a pH of 11-12 is reached. Document in an NCM how many milliliters of base were required. It is important to try to achieve a pH between 11-12. A pH above 12 might be detrimental to the recovery of some target analytes.

10.16.5 Re-attach the cold condenser, turn on the heating mantle or hotplate, and inspect the joints for leaks. Record the date and time the extraction started on the bench sheet.

10.16.6 Extract for the time indicated in Section 10.16.4.

10.16.7 At the end of the second extraction, turn off the heating mantle or hotplate and allow the extractor to cool. Record the date and time the extraction stopped on the bench sheet.

10.16.8 Remove the boiling flask, cap tightly with aluminum foil, and store refrigerated until concentration.

10.17 Disposal of Waste

10.17.1 Dispose of the methylene chloride remaining in the CLLE body in the methylene chloride Waste Stream B.

10.17.2 Dispose of the solvent-saturated water remaining in the CLLE in Waste Stream X if pH is neutral or basic.

10.17.3 Dispose of the solvent-saturated water remaining in the CLLE in Waste Stream Y if the pH is acidic.

10.18 Initial weights and volumes of samples and all extraction dates/times and reagents are entered into TALS, and the transcribed data must be verified by a second person. This verification is documented on the Organic Extraction Checklist (see WI-DV-0009).

10.19 Wash glassware following SOP DV-OP-0004.

10.20 Troubleshooting

10.20.1 See Attachment 1 for troubleshooting guide.

10.21 Maintenance – See QA SOPs for balance maintenance and pipette maintenance.

11.0 Data Analysis and Calculations

11.1 Initial Volume calculation

$$InitialVolume(mL) = \frac{FullBottle(g) - EmptyBottle(g)}{Density(g/mL)}$$

11.2 The initial data review is performed by the analyst and a second-level review is performed by the area supervisor or designee. Both reviews are documented on DV-F-0045 Organic Extraction Department Checklist. See SOP DV-QA-0020 for more detail on the review process.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-0006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Limit of Quantitation Verification (LOQV)

The verification of the limit of quantitation (LOQ or LLOQ) is performed quarterly for work performed according to the DOD/DOE QSM 5.0 or for programs which require the use of Method 8270D, Revision 5. A blank matrix is spiked at 1-2 the laboratory RL and carried through the entire preparation and analytical procedures. Recoveries are assessed based on historical limits.

12.3 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.3.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.3.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.3.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.3.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

12.3.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.4 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

12.5 Calibration

N/A

12.6 Sample Analysis

N/A

13.0 Pollution Control

The volume of spike solutions prepared is minimized to reduce the volume of expired standard solutions requiring hazardous waste disposal.

The laboratory currently purchases only low-solvent extractors that allow the procedure to be performed with approximately 50mL of methylene chloride in the bottom of the extractor body.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, “Waste Management and Pollution Prevention”, of the Environmental Health and Safety Manual, and HS-001, “Waste Management Program.”

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Methylene chloride – Waste Stream B

14.2.2 Neutral aqueous sample waste saturated with methylene chloride – Waste Stream X.

14.2.3 Basic aqueous sample waste saturated with methylene chloride – Waste Stream X.

14.2.4 Acid aqueous sample waste saturated with methylene chloride – Waste Stream Y.

14.2.5 Expired Standards/Reagents – Contact Waste Coordinator for guidance

NOTE: Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. . Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure**.**

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005, Method 3520C, Continuous Liquid-Liquid Extraction, Revision 3, December 1996.

15.2 Code of Federal Regulations, Title 40 – Protection of the Environment, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, Appendix A – Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, Method 625.

15.3 ASTM D7065-11, Standard Test Method for Determination of Nonylphenols, Bisphenol A, p-tert-Octylphenol, Nonylphenol Monoethoxylate, and Nonylphenol Diethoxylate in Environmental Waters by Gas Chromatography Mass Spectrometry.

16.0 Modifications:

16.1 Modifications from SW-846 Method 3520C

16.1.1 Section 7.1 of the method calls for initial sample volume to be determined volumetrically. This SOP allows the initial sample volume to be determined by weight.

16.1.2 Section 7.7 of the method states that if the acid and base extracts are not to be analyzed separately, then the boiling flask and solvent does not need to be changed, but may be used for the second pH extraction. This is currently not the practice here at TestAmerica Denver in order to prevent loss of some of the compounds that would extract in the first 18-hour extraction.

16.1.3 Table 1 of the method calls for the secondary extraction pH for method 8270C to be >11. This SOP calls for the secondary extraction pH for method 8270C to be between 11 and 12. Guidance is given in order to prevent the pH of the secondary extraction from being greater than 12 as this has been demonstrated to produce lower recoveries of some target compounds including the surrogate 2-flurobiphenyl.

16.2 Modifications from 40 CFR Method 625

16.2.1 Section 2.1 of the method calls for extracting the method at a pH greater than 11 and then again at a pH less than 2. This SOP calls for the acid extraction to be performed first followed by the base extraction. This is done to improve the recoveries of the phenols.

16.2.2 Section 11.2 of the method calls for initial sample volume to be determined volumetrically. This SOP allows the initial sample volume to be determined by weight.

16.2.3 The Method calls for the acid and base extracts to be concentrated and analyzed separately. This SOP calls for the extracts to be combined, then concentrated and analyzed.

16.3 Modifications from ASTM D7065-11

16.3.1 Section 6.2 of the source method calls for the glassware to be baked at 250°C for 15 to 30 minutes. This procedure references DV-OP-0004 for glassware cleaning in which the CLLEs are not baked, but dried with acetone.

16.3.2 Section 13.1 of the source method calls for the initial sample volume to be determined volumetrically. This SOP allows the initial sample volume to be determined by weight.

16.3.3 Section 13.1 of the source method calls for the sample container to be rinsed twice with 100mL portions of methylene chloride and the rinsed added to the extractor. This SOP calls for the sample container to be rinsed with at least 40mL of solvent. The extractor used in this procedure will not hold 200mL of solvent rinse.

17.0 Attachments

Figure 1. Continuous Liquid-Liquid Extractor (CLLE)

Table 1. Determinative Methods Using CLLE Extractions

Attachment 1. Trouble-shooting Guide

18.0 Revision History

Revision 14.0 dated 8/31/18

- Updated and rearranged section 10 to reflect current practice. NaCl is added to the sample container rather than to the CLLE, to allow salt to dissolve and avoid clogging the extraction vessel.
- Updated 16.3.3 to reflect procedure change that occurred in revision 13 of this SOP.
- Changed references to WI-DV-009 to correct ID, WI-DV-0009

Revision 13.0 dated 8/16/17

- Updated and rearranged section 10.6.5 – 10.15 to account for adjustment of procedure. Surrogate and spike standards will now be added to samples in extraction vessel, rather than sample container.
- Changed wording in 10.10.1 and 10.11.1 to clarify that surrogate and spike standards are added to the extraction vessel.

Revision 12.0 dated 6/30/17

- Removed all references of method 3520C LVI
- Added current Section 3.1 referencing the QAM for general definitions
- Removed “At least” from Section 9.4 regarding the number of required MB in a batch
- Added reference to QSM 5.1 to Section 9.1.2
- Added Section 9.6.4 regarding the need for an LCSD when there is no MS/MSD
- Added current Section 11.2 regarding data review
- Added current Section 12.2 regarding LOQVs and renumbered remaining sections

Revision 11.0 dated 6/30/16

- Added Sectrion 3.5, definition of Reagent water.

- Added Section 10.3, recording of support equipment IDs
- Updated Sections 10.5.3 and 10.5.4 to reflect the correct order of operations.
- Updated Sections 10.7.5.2 through 10.7.5.4 to provide guidance for 8000 and 600 method series in relation to sediment and decanting issues.
- Updated Section 10.17.2 to indicate the temperature ranges for the digital and analog read-out heating mantles or hotplates.

Revision 10.0 dated 11/30/15

- Updated formatting and number throughout the document
- Updated the mechanical pipette listed in Section 6.1 to be adjustable from 0.125mL to 1mL.
- Updated Section 6.2 to be consistent with other SOPs
- Updated "Reagent Grade Chemicals" definition in Section 7.0 to be consistent with other SOPs
- Updated Section 9.1 to be consistent with other SOPs
- Added NOTE to Section 10.4
- Removed the NOTE in Section 10.5.1 about South Carolina. The lab is not longer certified for this method by the state of South Carolina.
- Added guidance in Section 10.6.4 on when the sample volume should be adjusted for density.
- Added guidance in Section 10.16.3 for the analyst to check the extraction 15 minutes after it started.
- Updated Section 10.16.4 to instruct the analyst to extract the samples for 18-24 hours for all 3520C extractions.
- Updated Sections 12.1 through 12.3 to be consistent with other SOPs
- Added NOTE to Section 14.2.5

Revision 9.0 dated 12/31/14

- Sections 5.1.4 and 5.1.5 were added to give more guidance on how to safely handle the extractors and to prevent ground glass joints from sticking.
- Section 8 was revised to correct the holding time for leachates. The holding time starts at the beginning of the leach.
- Section 9.1.2 was revised to state the procedure meets all criteria for DoD QSM 5.0.
- Section 9.4, 9.5, 9.6, and 9.7 were revised to remove the Acceptance Criteria and the Corrective Action sections. This information can be found in the analytical SOPs listed in Table 1.
- Section 10.4.2 was revised to instruct the analyst to use 1L extractors for TCLP leachates. This was done to match current practice.
- Section 10.6.1 was revised to give more guidance on when an NCM is required for sample pH.
- Section 10.9.1 was revised to give more guidance on how to ensure the sodium chloride is dissolved into the sample.
- Section 10.15.3 was revised to explain why it is important to Teflon stir rods to stir the sample instead of glass rods.
- Section 10.15 was revised to clarify what methods require which extraction pH.
- Section 10.16.4 was revised to clarify what methods require which extraction time.
- Sections 10.18 and 14.2 were revised to include the waste stream for acidic sample waste.

Revision 8.0 dated 12/11/13

- The procedure was revised to reference nonylphenols by ASTM Method D7056-11. Previously the method reference was 8270C SIM.
- The procedure was revised to include details on the reduced volume extraction used for Large Volume Injection (LVI) analysis.
- Replaced reference to GC/CI/MS/MS for low-level NDMA analysis with 8270D_SIM_LL. TestAmerica Denver no longer supports the GC/CI/MS/MS analysis.
- Instructions were added to Section 5 to address the safety issue caused by excess water condensing off of the cold-water condensers and collecting near electrical equipment.
- Sodium thiosulfate was removed from the procedure. Sodium thiosulfate is used as a treatment for chlorinated samples, and since TestAmerica Denver does not hold drinking water certification for the methods described in this SOP, the reagent is not needed.
- Section 8 was revised to include sample collection, preservation, and holding time requirements for ASTM Method D7056-11 and for samples analyzed by 8270 by Large Volume Injection. Preservation temperature range was updated to be consistent with EPAs current terminology used in 40 CFR Part 136 and SW-846.
- Note in Section 9.5 was added regarding DoD QSM 5.0 requirements for marginal exceedances.
- Section 9.6 was revised to instruct the analyst to document in an NCM when MS samples are not extracted a the frequency detailed in the source method 625.
- A note was added to Section 10.5 instructing the analyst that South Carolina does not accept LVI.
- The procedure was revised to instruct the analyst to add 6g of baked sodium chloride to each sample and each QC sample. This is done to increase sample extraction efficiency.

Revision 7.0 dated 10/19/12

- Section 6.0 was revised to make it explicitly clear that CLLEs are rinsed twice with methylene chloride before use.
- Section 10.9 was revised to give more detail on the solvent rinse of the sample bottle.
- Section 10.13.3 was revised to instruct the analyst to add 10mL of base. It is the laboratory’s experience that 10mL of base is required to reach a pH of 14.
- Section 10.15.2 was revised to instruct the analyst to add 5mL of base. It is the laboratory’s experience that 5mL of base is usually sufficient to reach a pH of 11 to 12.

Revision 6.0 dated 09/23/11

- This procedure was revised to remove instructions for the extraction of samples for Method 607. TestAmerica Denver no longer supports this method.
- This procedure was revised to remove instructions for the extraction of samples for PAH compounds by method 8270C SIM. TestAmerica Denver extracts water samples for PAH compounds by method 8270C SIM by separatory funnel. See DV-OP-0006.
- The procedure was revised to include instructions for the extraction of samples for nonylphenols by method 8270C SIM.
- Section 1 of this procedure was revised to correct the SOP reference for the extraction of samples for low-level NDMA analysis by GC/CI/MS/MS. The correct SOP is DV-OP-0021.
- Section 7.6 was revised to remove instructions on the preparation of surrogate and spike standards. Please reference SOP DV-OP-00020 and WI-DV-009 for information

regarding the surrogate and spike standards used in this procedure. Tables 2 through 5 were removed.

- Sections 9.6 and 10.3 were revised to clarify that for method 625 if a MS is not performed in a batch of 10 or less samples, then a LCSD is required.
- Section 10.13.3 was revised to require an extraction at a pH of 14 whenever NDMA or 1,4-dioxane are the only compounds requested by method 8270C_LL.
- Various typographical errors were corrected.
- Section 6 was revised to clarify CLLEs are dried with acetone.
- Section 10.2.2 was revised to clarify how much methylene chloride should be added to the CLLE.
- Section 10.4 was revised to clarify that full sample containers should weigh less than 1560g, and if a sample container weighs more, a density check needs to be performed.
- Section 10.13.2 was revised to instruct the analyst to continue adding acid in 1mL increments if the first 2mL aliquot was insufficient.
- Attachment 1 was revised to include more troubleshooting tips.

Earlier revision histories have been archived and are available upon request.

FIGURE 1.

1000mL Continuous Liquid-Liquid Extractor (CLLE)

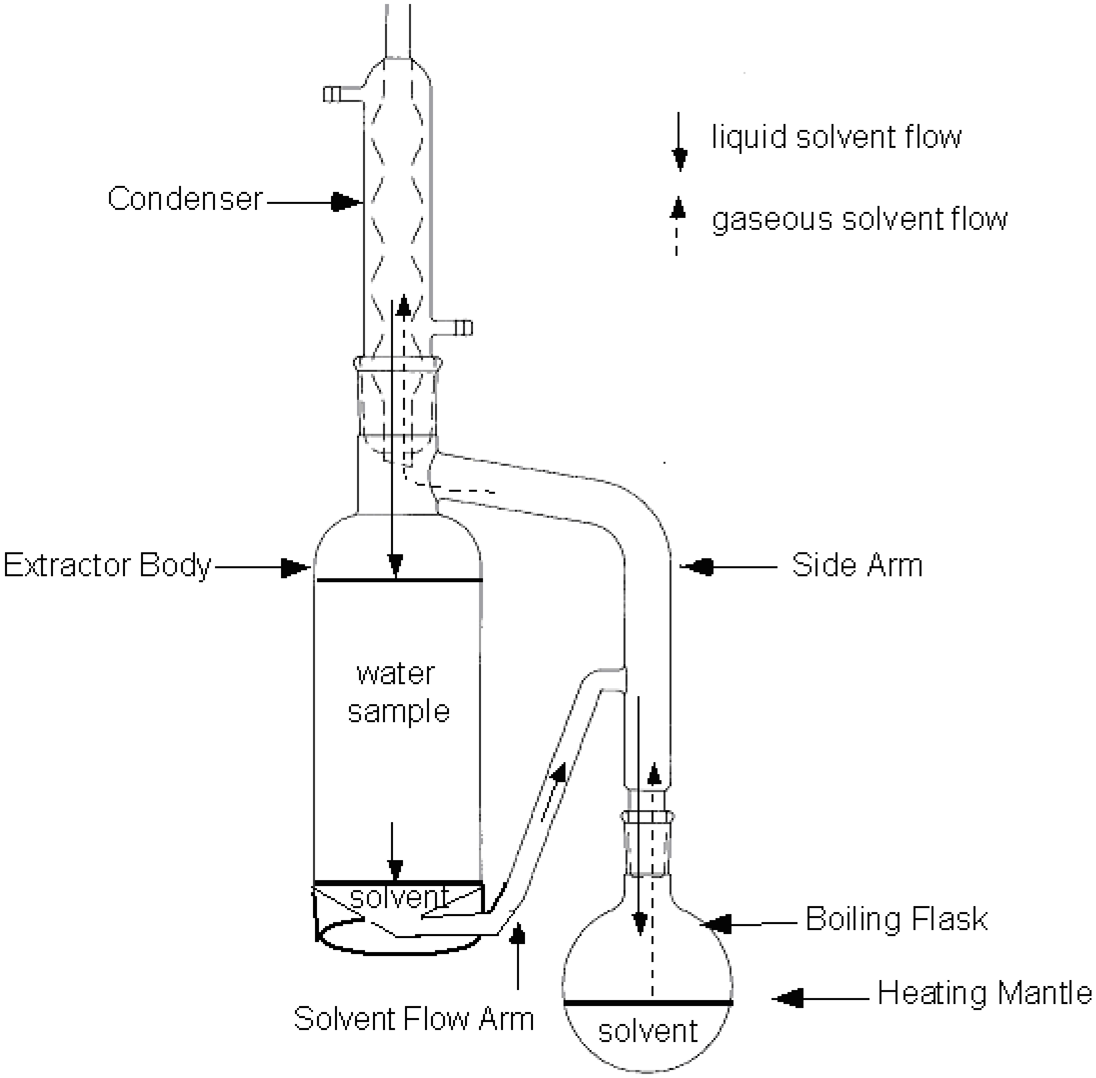

TABLE 1.

Determinative Methods Using CLLE Extractions

Method Description	*Determinative Method*	*SOP*
Semi-Volatiles by GC/MS	SW-846 8270C EPA Method 625	DV-MS-0011
Semi-Volatiles by GC/MS	SW-846 8270D	DV-MS-0012
Low-Level Semi-Volatiles by GC/MS Best Practice	SW-846 8270	DV-MS-0011
Nonylphenols by GC/MS SIM	SW-846 8270C SIM	DV-MS-0014

ATTACHMENT 1.

Trouble-shooting Guide

Burn-ups - *Whenever one of these things happen, document it in an NCM, and on the benchsheet!*

- **Is the stopcock closed?** If yes, then the sample never extracted. The solvent just went up the arm, condensed, and collected in the body of the CLLE. At this point the boiling flask can be very hot because it was boiled dry, so turn off the heating mantle. It is best if you replace the boiling flask with a new empty flask with new boiling chips because the old boiling chips could be ruined. Once the new empty boiling flask is on the arm, open the stopcock and the solvent will spill over the arm and into the flask. Turn on the heating mantle and start the 18 or 24 extraction clock over.

- **Is the condenser warm?** If yes, then the extraction is most likely ruined, especially if the boiling flask was dry. If there is sample volume and hold time remaining, then the sample should be re-extracted. If there is no sample volume remaining, then get a cold condenser on the CLLE, add more solvent and continue with the extraction. If there is sample remaining, but hold time has expired we need to save this extraction because it is the only one in hold. So get a cold condenser on the CLLE, but start the re-extraction ASAP.

- **Is there a loose joint?** If yes, then the extraction is most likely ruined. Follow corrective actions for warn condenser above.

- **Was the CLLE not topped off?** If the answers to numbers 1, 2, and 3 above is no, then look at the solvent return arm. If the return arm is not full, then maybe the CLLE was never topped off and the solvent just went up the arm, condensed, and collected in the body of the CLLE. Follow corrective actions for closed stopcock above.

Flooded Arms

- If the arm is equipped with a Snyder column, the arm might have become flooded because the solvent was boiling too fast and flooded the chambers of the Snyder column. When this happens, the solvent level in the round bottom flask might actually be low because the solvent is boiling out of the flask faster than it can flow back in. If this is the case, turn down the temperature of the heating mantle.

- If the flask and arm contain only solvent, just let the extraction finish. At the end of the extraction time, close the stopcock while the heating mantle is still on. Monitor the CLLE closely as the solvent boils and collects in the body of the CLLE. When the solvent level is low enough to remove the flask, turn off the heating mantle and let it cool. Remove the flask and cap with foil. If a second extraction is needed, place an empty boiling flask on the arm and open the stopcock. The excess solvent from the first extraction will flow into the empty boiling flask. Add more solvent if needed.

- If the flask and arm contain solvent and water, turn off the heating mantle and let the boiling flask cool. If there remains enough solvent in the boiling flask, close the stopcock and boil off enough solvent so you can remove the boiling flask. Once solvent level is low enough, then turn off heating mantle and allow it to cool. Then remove boiling flask and pour the water and solvent from the flask into the CLLE body while the stopcock is closed. Re-attach the boiling flask, open the stopcock, and allow the solvent to flow into the flask. If this doesn't work, the sample and all the solvent needs to be transferred to a larger CLLE.

- If the flask and arm contains solvent and water, and the step above didn't work or there is not enough solvent left in the boiling flask to attempt the step above, turn off the heating mantle and let the boiling flask cool. Rinse a 2L separatory funnel with methylene chloride. When the boiling flask is cool, remove the condenser from the CLLE, grasp the CLLE at the body and at the joint with the boiling flask and pour the sample and the solvent into the rinsed separatory funnel. This needs to be done in a hood and you will need to have someone help you. Add a few more boiling chips to the boiling flask and place the empty CLLE back on the stand under the slot hood. Drain the methylene chloride from the separatory funnel into the body of the CLLE. Once all the methylene chloride has been transferred, continue to drain the water into the CLLE body on top of the methylene chloride. The water level in the CLLE will reach a high enough level that it will force the solvent over into the boiling flask. If the solvent level in the body of the CLLE gets too low, stop and add more solvent to the CLLE body to prevent water from going into the boiling flask. Rinse the separatory funnel with methylene chloride and add it to the CLLE.

Stuck Joints

- **Stuck Condenser** If the condenser is stuck, first close the stopcock and remove the boiling flask. Put on cut-resistant gloves. Try to loosen the joint with the cut-resistant gloves. Try rocking the joint back and forth. Try to gently twist both clock-wise and counter-clock-wise. If this doesn't work, heat the outside of the joint with the torch, but be sure not to keep the flame on one part of the glass, instead keep moving the flame. Watch for vapor bubbles between the glass joints as an indication the joint is loosening. Try to loosen the joint again. Repeat a few times. If heating the outside of the joint is not working, let the glass cool for about 30 minutes then come back and try again. If it is still stuck, unplug the condenser and empty the CLLE. Then soak the stuck joint in soapy water overnight.

- **Stuck Boiling Flask** If the boiling flask is stuck, first close the stopcock and remove the condenser. Put on cut-resistant gloves. Try to loosen the joint with the cut-resistant gloves. Try to loosen the joint both clock-wise and counter-clock-wise. If this doesn't work, tap the joint downward with a heavy object and try again. A plastic media-bottle cap can be used.

- **Stuck CLLE Body** If the CLLE body is stuck to the stand, close the stopcock and remove the condenser and the boiling flask. If possible, remove the plastic support from the rack with by removing the screws that hold it in place. Then lift the CLLE and the plastic support off the rack and empty the CLLE. Run hot water over the CLLE and plastic support to separate the glass from the plastic.

Solvent not Boiling

- If the heating mantle is hot, but the solvent is not boiling, check to see if there are boiling chips. Even if there are boiling chips, they might have stopped working. Turn off the heating mantle, allow the solvent to cool to room temp, remove flask, add boiling chips and return flask to CLLE.

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THE LEADER IN ENVIRONMENTAL TESTING

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Title: INCREMENTAL SAMPLING METHODOLOGY FOR SOILS AND SEDIMENTS [ASTM D 6323]

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1.0 Scope and Application

1.1 The purpose of this procedure is to obtain sub-samples from client provided samples which represent the concentration of the analytes of interest in the entire parent sample. This is based on the guidance in ASTM Standard D-6323 “Laboratory Subsampling of Media Related to Waste Management Activities,” a DoD Quality Systems Manual (QSM) requirement.

1.2 This procedure applies to soils, sediments and other particulate matter. This method is highly dependent on client provided Data Quality Objectives. This procedure presents the laboratory’s standard approach, but details at all stages of this procedure can vary from project to project. All project-specific variations must be documented and approved in writing. It is important that the analyst always check special project instructions in the TestAmerica LIMS (TALS) before proceeding.

1.3 TestAmerica has used incremental sampling methodology (ISM) for non-volatile organics (e.g., explosives residues by Method 8330), prior to acid digestion for metals analysis (e.g., Method 3050), and prior to analysis for volatile organics collected in multiple increments in the field and preserved in methanol (e.g., Method 5035). It can be used for a wide range of other analytical methods as well. However, this procedure is not applicable to soil samples to be analyzed for volatile organic compounds in which the entire sample provided by the lab’s client is used for a single analysis (see the lab’s volatile organics SOP for details).

1.4 This SOP addresses the pre-preparation of samples. The details of the twelve QC Elements, not otherwise addressed, are described in the associated preparation and/or analytical SOPs.

2.0 Summary of Method

2.1 For non-volatile analytes, the entire sample received from the client is air dried to a constant weight. Large non-representative pieces (rocks and twigs that will not pass through the sieve) may be removed manually. Other extraneous materials are removed by sieving. A mortar and pestle or sieve shaker or mechanical disaggregator may be used to break up soil agglomerates during the sieving process. Depending on the analytical method to be used after subsampling, and project objectives, the sample may be ground. The grinding option available at the laboratory is the ring-and-puck mill. A subsample is then taken using a multi-incremental approach.

2.2 ISM for Metals Analysis - the routine approach is to air dry, sieve to sub-10 mesh (2.1 mm), and collect 10 gram subsamples using 30 increments. The expectation is that the variability due to subsampling error will then be no more than 15% relative standard deviation (RSD) (see ASTM D-6323 for explanation and guidance for other acceptable variations). The Method 3050B digestion reagents are then increased proportionally to maintain the same chemistry as is used for 1 gram subsamples.

2.3 ISM for Explosives Analysis - the routine approach is to air dry, sieve to sub-10 mesh, grind (if logged for grinding), and collect 10 gram subsamples using 30 increments. If the samples are from firing points, then ring-and-puck grinding is required. The goal is to achieve 10% or less RSD from subsampling variability. Further details for explosives are given in SOP DV-OP-0018 and are not discussed in this SOP.

2.4 ISM for Volatile Analysis – the multi-incremental sampling is done in the field, where the 30 increments of 5 grams each are added to a septum-cap bottle containing 200 mL methanol provided by the laboratory. From that point on, the lab's procedure for medium level soils (SOP DV-MS-0002) is followed.

2.5 The basic formula to use when working with clients to select the optimal approach for other methods or other precision objectives is given in Attachment 1 to this SOP. The Attachment defines the trade off between subsample size, particle size, and the desired level of precision.

3.0 Definitions

3.1 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and Policy DV-QA-003P, *Quality Control Program*, for definitions of general analytical and QA/QC terms.

3.2 Sample or Client Sample – refers to the entire quantity of material delivered to the laboratory for testing.

3.3 Subsample – refers to the portion of sample taken in the laboratory for a given analysis. The objective of this procedure is to ensure that the subsample is a reasonably accurate representation of the entire sample.

4.0 Interferences

4.1 If multi-incremental or equivalent systematic sampling processes are not employed in the field, then the extra laboratory effort entailed in this SOP may add little or no improvement in results.

4.2 Potential loss of lighter semi-volatile compounds (e.g., naphthalene) through the drying and grinding process has not been well studied. Before employing the procedure for such compounds, the possible loss of lighter compounds should be discussed with the client and if possible, investigated before the procedure is performed.

4.3 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or contamination causing misinterpretation of results. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by running blanks.

4.4 Contamination by carryover can occur when a low concentration sample is processed immediately following a high concentration sample. For this reason, special care must be taken to follow the equipment cleaning steps.

4.5 As described in this SOP, the lab does not routinely grind samples for metals testing. It is expected that detection limits and reporting limits for some metals would have to be elevated based on long-term blank results if grinding is required.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, TestAmerica Denver Addendum to the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Anyone working in the grinding room needs to be enrolled in the Hearing Conservation Program. See DV-HS-0010 for details. Personnel operating grinding equipment are required to wear ear plugs when the equipment is turned on. When standing next to the Humbolt mechanical disaggregator described in Section 6.1.7 during operation, the decibel levels are above 80 decibels, therefore anyone operating the disaggregator must be enrolled in the Hearing Conservation Program and wear hearing protection. While the disaggregator is running, the decibel levels in the room are below 80 decibels, therefore personnel not enrolled in the Hearing Conservation Program can be in the room. Hearing protection is always available to every analyst and they are encouraged to use it.

5.3.2 Operations involving the handling of samples outside of sealed containers, e.g., sieving, are conducted in ventilation hoods to avoid exposure to dust. Dust masks are available for use in the grinding room, but are optional.

5.3.3 Operations involving the grinding of radioactive samples can be particularly hazardous due to the increased potential for exposure from airborne dust. If a sample is labeled as “CAT 1”, “CAT 2”, “CAT 3” or “CAT 4” and requires grinding through the ring and puck, contact the Radiation Safety Officer (RSO) immediately.

5.4 Primary Chemical and Material Hazards – cleaning solvents

MATERIAL	HAZARDS	EXPOSURE LIMIT (1)	SIGNS AND SYMPTOMS OF EXPOSURE
Acetonitrile	Flammable Poison	40 ppm – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Acetone	Flammable	1,000 ppm – TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
(1) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Equipment

6.1.1 Balance, capable of measuring ± 0.01 g. Calibration checked per SOP DV-QA-0014.

6.1.2 Sieve Shaker – used to facilitate the sieving of large sample volumes.

6.1.3 Ring and Puck - The grinding bowl and puck are cleaned after each use by washing with soap and water with a plastic brush, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% acetonitrile solution in acetone. A final wipe down of the bowl and puck while still wet with solvent is done with a Kimwipe.

6.1.4 Trays – “baker’s rack” type stack for air drying soils

6.1.5 Drying tower – custom built tower similar to “baker’s rack” type stack for air drying soils, including air drying fans and air filters

6.1.6 Sieves - 10 and 30 mesh, brass for general use, stainless steel for metals testing. Sieves are cleaned after each use by washing with soap and water with a green plastic brillo pad (be careful not to damage the mesh), rinsing with hot tap water, rinsing with DI water. Prior to use, the sieves are rinsed with 10% acetonitrile in acetone and wiped with a Kimwipe. Sieves are allowed to dry in a hood prior to use.

6.1.7 Mortar and pestle – Porcelain, various sizes cleaned after each use by washing with soap and water, rinsing with hot tap water, and then rinsing with DI water. The mortars and pestles are rinsed with 10% acetonitrile in acetone, wiped with a Kimwipe, and allowed to dry in a hood prior to use.

6.1.8 Mechanical Disaggregator – Humbolt Manufacturing Part Number H-4199. Used in place of a mortar and pestle to quickly reduce cakes of dry soil. The stainless steel disaggregator reduces soil agglomerates and sieves the soil through a 10 mesh sieve. The mechanical disaggregator is used to break up soil agglomerates but it is not an alternative to the Ring and Puck. The mechanical disaggregator is cleaned after each sample by removing the hopper. The hopper is washed with soap and water, rinsed with tap water, rinsed with DI water, and then rinsed with 10% acetonitrile in acetone. The Hopper is then wiped dry with a laboratory tissue. The hammers and body of the disaggregator are cleaned after each sample by rinsing with DI water and wiping dry with a laboratory tissue.

6.2 Expendable Supplies

6.2.1 Subsampling tools:

6.2.1.1 Scored paper scoops (TAL-0150 and TAL-0150 LARGE from Commodity Management Services)

6.2.1.2 Plastic sample scoops – square-ended

6.2.2 Aluminum foil and aluminum dishes

6.2.3 Parchment paper to line trays for metals testing

6.2.4 Alconox detergent

6.2.5 Ottawa Sand – blank media for organics

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 10% Acetonitrile in Acetone – mix 100 mL of acetonitrile with 900 mL of acetone. This solution is used for rinsing purposes only so exact measurements are not required.

8.0 Sample Collection, Preservation, Shipment and Storage

Container Type	Preservative	Holding Time
Plastic or glass	By individual test *	By individual test *

After air drying, samples can be stored at room temperature. As a secondary option, after air drying, the samples can be placed directly into ziplock bags and stored in the refrigerated cooler.

* - Reference the analytical SOPs.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense

(DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver Policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.0 and 5.1 unless otherwise stated. Any deviation or exceptions from QSM requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Grinding Blanks

9.2.1 Ring and Puck Grinding Blanks.

Before each sample is processed through the ring and puck mill, the ring and puck will be cleaned per Section 6.1. Then approximately 200 g of Ottawa sand will be ground. This ground sand will be saved and labeled with the sample ID of the next sample ground with the suffix “blank”. After a batch of samples has been processed through the ring and puck, a composite will be generated using sub-aliquots from all blanks ground before the samples. This is done by placing approximately 1 tablespoon of material from each of the individual sample blanks in a clean re-sealable plastic bag. The bag is then sealed and the material is mixed and homogenized by shaking and kneading the bag. A 10 g aliquot is then removed from the bag and labeled as the batch grinding blank. This composite is extracted and analyzed in the same manner as the field samples.

Corrective Action: If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. Samples associated with a contaminated grinding blank with positive results for the same contaminant must be reprocessed and reanalyzed. If un-ground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative

9.3 Precision

9.3.1 On a project basis, the lab will discuss precision objectives with the client prior to initiating work. If evaluation of the RSD is needed, the laboratory will need to analyze at least one set of triplicate samples in every preparation batch. In other cases, the lab will employ duplicate matrix spikes and control limits will be expressed as relative percent difference (RPD).

9.3.2 If the client supplies multiple field samples to use for replicate testing, then the laboratory will compare results to acceptance limits and qualify data if the precision limits are not met. If the replicates are prepared from the single field sample that is dried, ground, and sieved, then the acceptability of each grinding batch can be controlled based on the precision objectives established for the project.

9.4 Other QC samples (method blank, LCS, and MS/MSD) are created after subsampling, and vary depending on the analytical method. See DV-OP-0018 for special QC requirements for explosives, which usually require grinding a standard reference material.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Dry the Samples

10.3.1 The entire contents of the sample container must be processed. It is not acceptable to remove any aliquots until after the sample has been dried, sieved, and ISM performed. If the client requests aliquots to be taken before the sample is dried, sieved, and ISM performed, an NCM should be written to document this was done per client request.

10.3.2 Depending on the sample size, the samples are laid out in aluminum pans, or on large trays lined with aluminum foil to dry. Some clients may request metals analysis on the dried samples. In those cases, samples are laid out on parchment paper.

10.3.3 Spread the samples out in a thin layer to facilitate drying. Use a disposable wooden spatula to break up any clumps and agglomerates.

10.3.4 The tray or pan that the sample is laid out into is labeled with the sample ID. A second analyst checks to make sure that the labels on the tray or pan match the labels on the client sample container to ensure samples are not accidently mixed up. This check is documented in TALS.

10.3.5 Place the samples in a drying tower, hood or well ventilated area at room temperature. Document in TALS the date and time the samples were laid out to dry. An electronic temperature recording device records the temperature of the room and the data is downloaded weekly.

10.3.6 When the samples appear to be dry enough that they can be sieved without caking, subsample approximately 15 grams into an appropriate weighing vessel and record the exact weight, the date, and the time (see Attachment 3). Set this 15 gram aliquot (still in the weighing vessel) next to the rest of the drying sample. Take care to use an appropriate weighing vessel for the analytical methods requested, as the aliquot removed in this step will still be included in the volume used for ISM (i.e., Do not use an aluminum weigh boat for samples requiring metals analysis).

10.3.7 After 2 hours, reweigh the aliquot in the same weighing vessel and record the exact weight, the date, and the time. If the weight of the sample is within 10% of the previous weight, proceed to Section 10.4.

10.4 Sieve the Samples

10.4.1 Clean the sieves prior to use following the instructions in Section 6.

10.4.2 Some samples may require the use of a mortar and pestle or a mechanical disaggregator to break up dried clumps. Refer to Section 6.1 on how to clean and rinse the mortar and pestles and the mechanical disaggregator before use.

10.4.3 Record the weight of the entire dried sample in the Worksheet tab in TALS. This is a requirement for DoD QSM 5.0 and 5.1.

10.4.4 Sieve the entire dried sample through the appropriate sized sieve. Care must be exercised not to eliminate soil agglomerates during this step. The soil can be broken into small pieces with a gloved hand or another instrument (a wooden spatula for example). If a gloved hand is used, care should be taken to change out gloves in between samples to prevent cross-contamination.

10.4.5 Remove large rocks, vegetation, and twigs that do not pass through the sieve. Mosses and other types of fine vegetation should be physically shredded while sieving to release trapped soil and residues. The only materials that should be eliminated by sieving are rocks and vegetation. All soil must be broken up to pass through the sieve.

10.4.6 Place any soil that does not pass through the sieve into a clean mortar. Break up soil agglomerates using the pestle or, as an alternative, use the mechanical disaggregator. Be sure to break up all soil so that it can pass through the sieve. Only extraneous material such as rocks and vegetation should be removed with the sieve. Describe all extraneous material that did not pass through the sieve in an NCM. Document the weight of any material that does not pass through the sieve. Document this weight either in the worksheet section of TALS or in an NCM. Label and retain this material that does not pass through the sieve.

10.4.7 Collect all of the material that passes through the sieve on a clean piece of foil or parchment paper.

10.4.8 An automatic sieve shaker can be used to help facilitate the sieving of samples. A receiver pan is placed under a sieve and the sample is added to the sieve. Then a lid or another receiver pan for a second sample is placed on top. The stack is then clamped inside the sieve shaker for no more than 30 minutes. Inspect the samples to ensure that only extraneous material such as rocks and vegetation were removed with the sieve. If needed use a mortar and pestle to break up soil agglomerates. Describe all extraneous material that did not pass through the sieve in an NCM. Document the weight of any material that does not pass through the sieve. Document this weight either in the worksheet section of TALS or in an NCM. Label and retain this material that does not pass through the sieve.

10.4.9 If metals or any other analyses are requested on the sample prior to grinding, perform ISM on the portion of the sample that passed through the sieve at this time before proceeding to any grinding steps in Section 10.6. Refer to Method Comments, Sample comments, and Login Comments for instructions if any other tests besides metals analyses are to be performed on an un-ground aliquot before proceeding to Section 10.6

10.5 Incremental Sampling Methodology for Metals and other methods requested on un-ground material.

10.5.1 Select an appropriate subsample container. For metals analyses, a 100 mL digestion cup is appropriate. For organic methods, an amber glass container is appropriate. Reach out to the departments performing the analysis for guidance on selecting the appropriate subsample container.

10.5.2 Remove the cap from the appropriate subsample container and place on a balance and tare. The entire sieved sample is spread out on a sheet of parchment paper to a 1 cm thickness.

10.5.3 Using a subsampling tool (described in section 6.2.1), take an appropriately sized subsample by collecting at least 30 increments from random locations through the entire thickness, top to bottom, of the layer of sieved material.

10.5.3.1 For methods 6010B, 6010C, 6020, and 6020A a 10 g - 11 g aliquot is required for each sample and each MS/MSD sample. Collect one extra 10 g - 11 g aliquot per sample in case re-digestion is needed.

10.5.3.2 For methods 7471A and 7471B, a 3 g - 3.3 g aliquot is required for each sample and each MS/MSD sample. Collect one extra 3g - 3.3g aliquot per sample in case re-digestion is needed.

10.5.3.3 For other methods, refer to method comments, sample comments, and login comments, or to the departments performing the analyses for instructions regarding aliquot size.

NOTE: Sub-out ISM samples will need to aliquoted into amber 40mL VOA vials and delivered to sample receiving with the appropriate paperwork. Aliquot size will vary and depends on the analysis needed.

10.5.4 Record the sample weight on the ISM Worksheet described in Attachment 2.

10.6 Grinding

The instructions in this section are to be used as a general procedure when grinding is requested prior to extraction and analysis for any method. Reference DV-OP-0018 for details on grinding samples for explosives analysis.

10.6.1 Ring and Puck Mill Grinding

10.6.1.1 See Section 6.1 on how to clean the ring and puck dish.

10.6.1.2 If the sample is logged for ring and puck grinding, a grinding blank per Section 9.3.1 consisting of baked Ottawa sand will be processed through the ring and puck dish before each sample. These individual blanks will be composited into one grinding blank for the associated samples and will be analyzed in addition to the normal extraction blank.

NOTE: When preparing the grinding blanks, it is not necessary to do five 60-second grinds. One 60-second grind of the Ottawa sand is sufficient.

10.6.1.3 After a grinding blank has been processed through a ring and puck dish, that blank is labeled as the blank associated to the next sample processed through that same dish. Do not clean the ring and puck dish after the blank.

10.6.1.4 In a hood, transfer the sample into a clean ring and puck dish. Do not overfill the dish (approximately 300 g of sample can fit in one dish). If needed, grind the sample in 300 g or smaller increments and recombine after the whole sample has been ground. The entire sample **must** be ground. Place the dish securely in the holder and close the door on the machine. Grind the sample for five 60-second periods with a one minute cooling time between grinds for a total of 5 minutes of grinding. Remove the dish and in a fume hood open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between two fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed.

10.6.1.5 If the sample reaches a flour-like consistency before all 5 one-minute grinds have been completed, then it might be beneficial to not perform all 5 grinds in order to avoid excessive heat and to avoid packing the sample onto the side of the grinder. If the analyst inspects the sample and it has flour like consistency before all 5 grinds are completed, they can make the decision to stop after less than 5 grinds. A NCM should be written to document the deviation from the source method and the reasoning.

NOTE: During the one-minute cooling time, the dish should be placed in a shallow ice water bath to facilitate cooling. Be sure the bath is shallow enough so that water does not get inside the dish.

NOTE: If multiple 300 g increments are used for grinding and the sample is recombined without mixing, it has been shown through Duplicate/Triplicate QC results that the sample is non-homogenous. To re-homogenize the sample, place the entire volume into a clean plastic bag, seal, and carefully shake the bag for 1 - 2 minutes until the sample is thoroughly mixed. Lay out the sample back on the foil/parchment paper.

10.7 Incremental Sampling after grinding.

10.7.1 Remove the cap from a 40 mL amber vial or other appropriate subsample container (refer to Section 10.5.1 for guidance) and place on a balance and tare. The entire ground sample is spread out on a sheet of parchment paper or aluminum foil to a 1 cm thickness.

10.7.2 Using a subsampling tool (described in Section 6.2.1), take an appropriately sized subsample by collecting at least 30 increments from random locations through the entire thickness, top to bottom, of the layer of ground material.

10.7.2.1 For explosives a 10 g to 11 g aliquot is required for each sample and each MS/MSD sample.

10.7.2.2 For other extractable methods a 30 - 33 g aliquot is common, but reference project instructions and method SOPs for more detail.

10.7.2.3 For other methods, refer to method comments, sample comments, and login comments, or to the departments performing the analyses for instructions regarding aliquot size.

10.7.3 Record the sample aliquot weight on the ISM Worksheet.

10.8 Maintenance

10.8.1 Approximately once a month, the cover on the Ring and Puck should be removed and any dirt should be cleaned up.

10.8.2 When excessive wear is noted, replace the hammers in the Mechanical Grinder.

10.8.3 Occasional lubrication of the Ring and Puck clamp is needed.

10.8.4 The o-rings in the Ring and Puck dishes should be replaced when worn.

10.9 Troubleshooting

Low recoveries for Tetryl in the explosives grinding LCS may be indicative of high temperatures during grinding. Review the cooling step noted in Section 10.6.1.5 in order to minimize the effect of the heat generated during the grinding process.

11.0 Calculations

Relative Standard Deviation

$$RSD = \frac{S}{\overline{X}}$$

Where: S = standard deviation

$\overline{X}$ = mean

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Limit of Quantitation Verification (LOQV)

The verification of the limit of quantitation (LOQ or LLOQ) is performed quarterly for work performed according to the DOD/DOE QSM 5.0 or 5.1 or for programs which require the use of Method 8270D, Revision 5. A blank matrix is spiked at 1 - 2 the laboratory reporting Limit (RL) and carried through the entire preparation and analytical procedure. Recoveries are assessed based on historical limits.

12.3 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.3.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.3.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.3.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.3.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

12.3.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.4 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

The use of organic solvents to complete the equipment cleaning steps is minimized. Quantities are limited to residues on equipment that quickly evaporate in a hood.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in Section 13 of the Corporate Environmental Health and Safety Manual, *Waste Management and Pollution Prevention*.

14.2 The following waste streams are produced when this method is carried out:

- Solid Waste – Waste Stream S
- Flammable Solvent Waste – Waste Stream C

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 "Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples," USEPA, November 2003.

15.2 "Standard Guide for Laboratory Subsampling of Media Related to Waste Management Activities" ASTM D 6323-98 (Reapproved 2003)

15.3 DoD Quality Systems Manual Version 5.0, 2009. Appendix B, Table 3.

15.4 DoD Quality Systems Manual Version 5.1, 2017. Table B-23.

16.0 Method Modifications

Item	Method	Modification
N/A	N/A	*No method modifications specified.*

17.0 Attachments

Attachment 1: Consideration of Fundamental Error in Selecting MIS Options
Attachment 2: ISM Worksheet
Attachment 3: ISM Constant Weight Worksheet

18.0 Revision History

Revision 11, dated 11 December 2018

- Minor formatting and language corrections throughout
- Replaced all references to “mechanical grinder” to read “mechanical disaggregator” to distinguish more clearly between grinding/milling and soil disaggregation.
- Added new part numbers for preferred subsampling tool to section 6.2.1.
- Added DoD 5.1 reference information to section 9.1.2.
- Added new drying tower to equipment section 6 and to section 10.3.5.
- Removed note in section 10.3.7 which allowed for skipping constant weight analysis for non-DOD samples.
- Added section 10.4.3 to meet DoD 5.1 requirement that dried sample is weighed prior to sieving.
- Removed notes regarding DoD 5.1 specific requirements from section 10.4.6 and 10.4.8, and incorporated these specific requirements into standard procedure for all samples. These requirements include weighing and retaining material that does not pass through the sieve.
- Added wording to 10.4.9 to allow for non-metals tests that are not ground.
- Added sections 10.5.1 and 10.7.1 regarding selection of appropriate subsample container.
- Changed “100 mL digestion cup” in section 10.5.2 to “the appropriate subsample container.”
- Corrected wording in 10.5.3 to read “the layer of sieved material” rather than “the layer of ground material.”
- Added sections 10.5.3.3 and 10.7.2.3 regarding aliquot sizes for methods other than metals.
- Changed language in section 10.7.2 from “a square ended spatula” to “a subsampling tool described in section 6.2.1.”
- Removed section 10.9.1 comment regarding securing ring and puck as it no longer requires securing. Added note about troubleshooting low tetryl recoveries.
- Revised MDL policy reference in section 12.1.

Revision 10, dated 3 October 2017

- Updated section 2.1 to clarify air drying to a constant weight.
- Updated section 8.0 to reflect the secondary storage option for air dried samples.
- Updated section 10.3.6 and 10.3.7 to demonstrate drying to a constant weight.
- Updated section 10.5.2 to reflect ISM Sub-out practices.
- Added attachment 3.

Revision 9, dated 28 February 2017

- Removed all references of the Ball Mill from the body of the instructions.
- Updated Section 3.1 to reference DV-QA-003P and QAM for general terms
- Updated Section 9.1 to be consistent with other SOPs
- Added current Sections 10.1 and 10.2 – NCM reference and instructions
- Updated Section 12 to include current MDL, LOQV, DOC and Training information
- Updated solid waste stream from D to S in Section 14.2

Revision 8, dated 29 February 2016

- Added aluminum dishes to Section 6.2
- Added Section 7.1 and 7.2
- Added what corrective action is used for Ring and Puck Grinding blanks that have hits in Section 9.4.1, as this differs from the corrective action for Ball Mill.
- Changed the acceptable weight range in Section 10.3.2.2 from 3-3.05 g to 3-3.3 g to be consistent with the 10% provided for other methods.
- Added more description to Section 10.4.2.2 to instruct the analyst not to wash the Ring and Puck dish at this step.
- Removed Section 10.6.5 that provided instruction about maintenance of the centrifuge as this equipment is not used in this SOP.
- Removed all revision histories 2010 and earlier (available upon request)

Revision 7, dated 28 February 2015

- Annual Technical Review
- Reformatted the SOP
- Added detail to Section 5.3.1 about the Humbolt mechanical grinder.
- Added information to Section 5 about the hazards of grinding radioactive samples.
- Revised Section 9.4.1 to give more detail on how the Ring and Puck composite grinding blanks are created.
- Revised Section 10.6 to include maintenance on the centrifuge.
- Added Attachment 2: ISM Worksheet

Revision 6, dated 05 February 2014

- Annual Technical Review
- Edited Section 6.1, subsection “Ball Mill” to allow for un-baked sand to be used in the cleaning of the ball mill stones and to allow the use of 1 pint cans.
- Edited Section 6.1, subsection “Sieves” to state a brillo pad can be used on the sieves so long as the mesh is not damaged.

- Added a comment to Section 9 stating that this procedure meets DoD QSM 5.0 criteria unless otherwise stated.
- Removed Acceptance Criteria information to Section 9. This information can be found in the analytical SOPs.
- Added a NOTE in Sections 10.4.1.1 and 10.4.2.4 giving instructions on how to ensure the sample is homogenous after it has been split into separate grinding containers and then later re-combined.
- Added Section 10.6 Maintenance and Section 10.7 Troubleshooting per DoD QSM 5.0.

Revision 5, dated 31 January 2013

- Annual Technical Review
- Added Section 1.4 to address the 12 QC Elements.
- Updated Section 2.3 and 10.4.1 to allow the use of Ball Mill grinding. The laboratory successfully completed a Method Validation for Ball Mill grinding and therefore is able to offer this to all clients.
- Section 6 was updated to include cleaning procedures for sieves, Ring and Puck dishes, Ball Mill stones, Mortar & Pestles, and Paint Cans.
- Section 2.1, Section 6, and Section 10.2.2 were updated to include the mechanical grinder that can be used in place of mortar and pestle for samples that do not require metal testing.
- Section 9.3.3 was updated to include acceptance criteria for Grinding Blanks for DoD samples.
- Section 10.3.1 was updated to instruct the analysts to aliquot the samples directly into 100mL digestion cups for metals analysis.
- Removed Attachment 2: How to Batch Samples in LIMS.

Revision 4.2, dated 31 January 2012

- Removed all references to Multi-Incremental Subsampling which is now trade-marked.
- Updated Section 6.1 to reflect the correct number of small and large grinding stones used in the Ball Mill grinding of samples.
- Updated Attachment 2.

Revision 4.1, dated 20 January 2011

- Added detail about the electronic temperature recording device that records the temperature of the room.
- Revised procedure to state that during the one-minute cooling time, the dish will be placed in a shallow ice water bath to facilitate cooling.
- Revised Attachment 2 to include the method Dry_Grind and more details on how to batch samples that are logged for both MULTI_INC and grinding methods.

Earlier revision histories have been archived and are available upon request.

Attachment 1

Consideration of Fundamental Error in Selecting MIS Options

The following formula given in ASTM D-6323 was used to produce the table that follows.

$$S^2 = 18 * f * e * d^3 / M_s$$

where,

S^2 = the relative variance of the contaminant concentration due to the fundamental error

f = shape factor, a dimensionless number, a value of 0.5 can be taken as typical (Pierre Gy, 1982)

e = the population’s average density (g/cm^3). For this table a typical soil density of 2.5 g/cm^3 was used.

d = the diameter of the largest particle in centimeters, and

M_s = the mass of the sample in grams

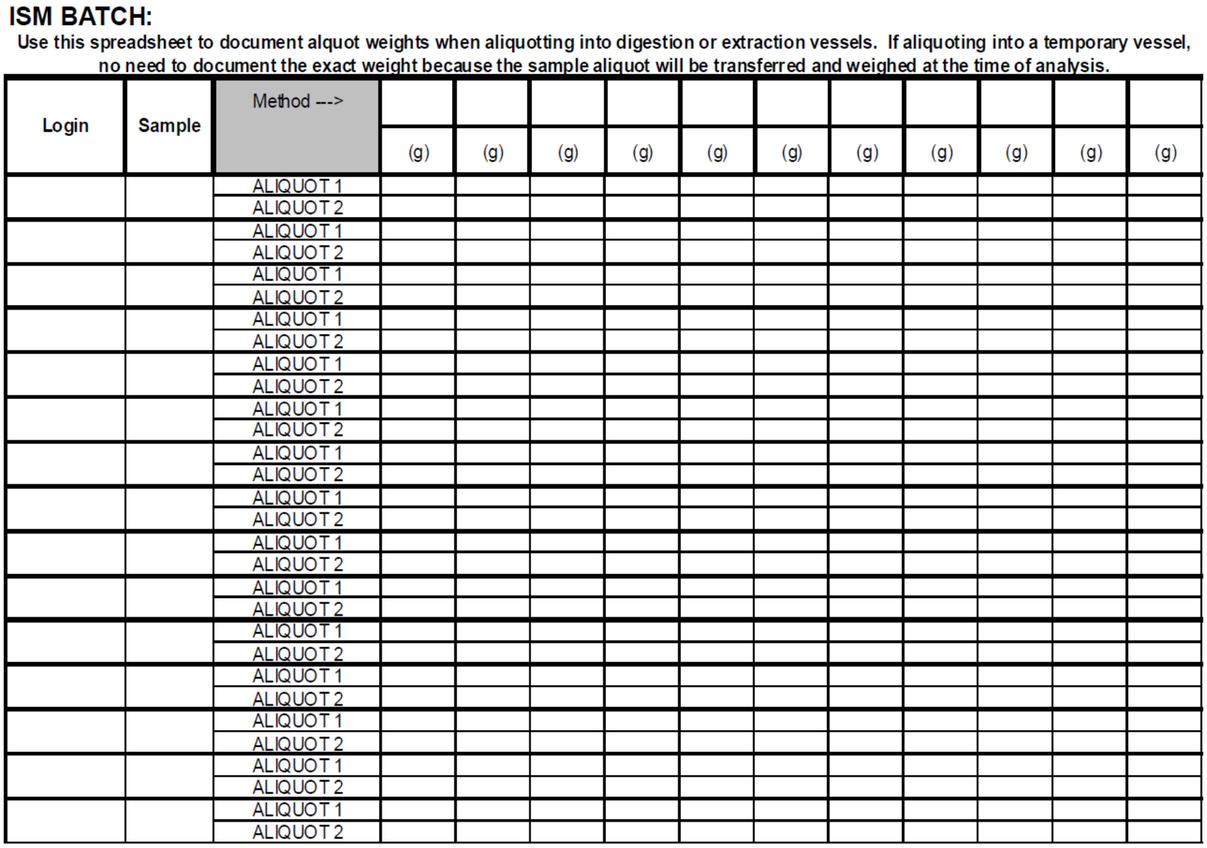
Sample Mass and Maximum Particle Size to Achieve a Desired RSD

Subsample Mass (g)	Sieve Size (US Standard Mesh)	At 5% RSD Max Size (cm)	At 10% RSD Max Size (cm)	At 15% RSD Max Size (cm)
0.1	35	0.02	0.04	0.05
1	18	0.05	0.08	0.10
2	13	0.06	0.10	0.13
5	12	0.08	0.13	0.17
10	10	0.10	0.16	0.22
30	7	0.15	0.24	0.31
50	6	0.18	0.28	0.37
100	5	0.22	0.35	0.46

Attachment 2

ISM Worksheet

G:/QA/Edit/FORMS/Organic Prep Forms/MASTER ISM Spreadsheet_Rev1



ISM BATCH:

Use this spreadsheet to document alquot weights when aliquotting into digestion or extraction vessels. If aliquoting into a temporary vessel, no need to document the exact weight because the sample aliquot will be transferred and weighed at the time of analysis.

Login	Sample	Method -->											
			(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)
		ALIQUOT 1											
		ALIQUOT 2											
		ALIQUOT 1											
		ALIQUOT 2											
		ALIQUOT 1											
		ALIQUOT 2											
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Attachment 3

ISM Constant Weight Worksheet

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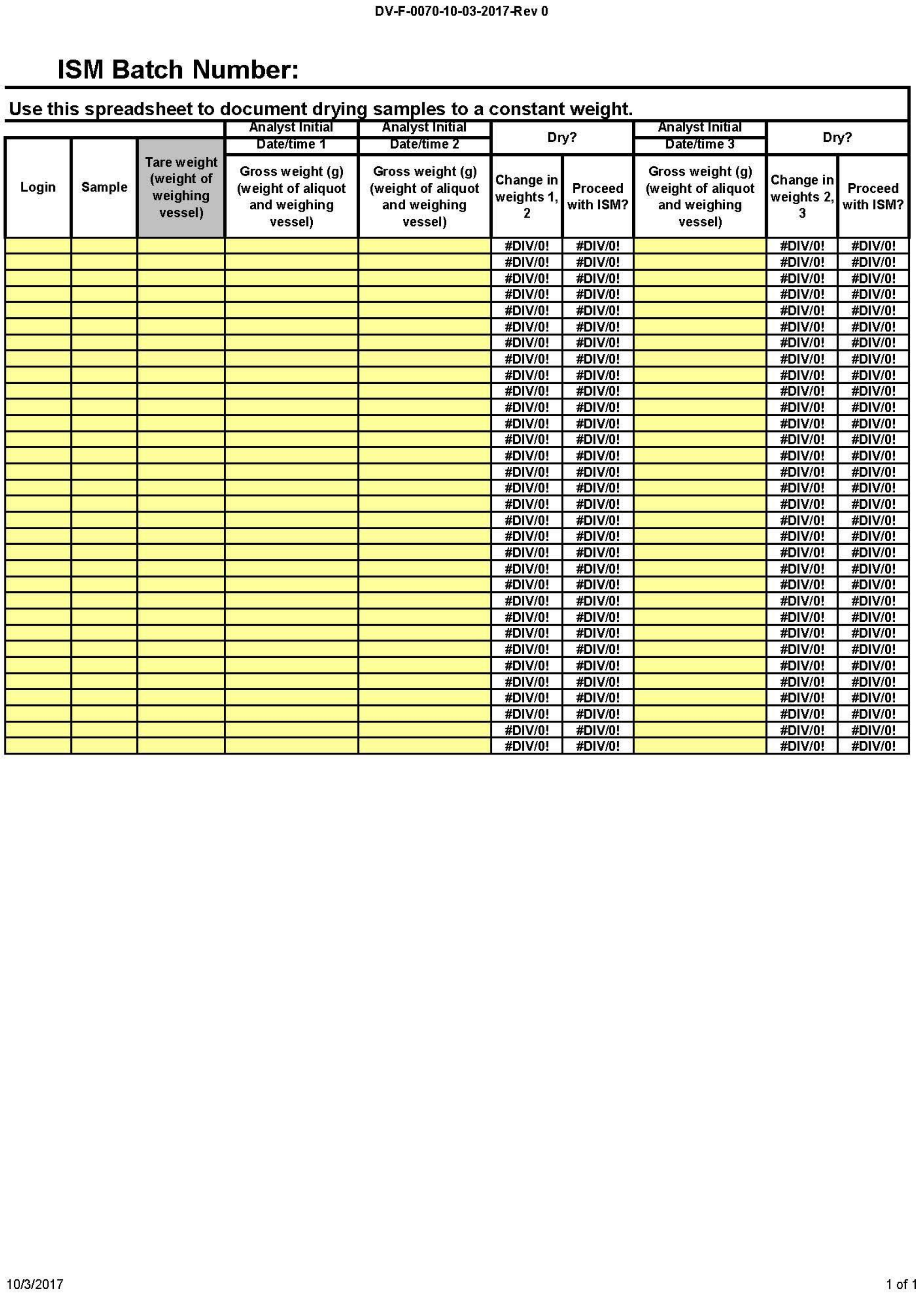

DV-F-0070-10-03-2017-Rev 0

ISM Batch Number:

Use this spreadsheet to document drying samples to a constant weight.

			Analyst Initial	Analyst Initial	Dry?		Analyst Initial	Dry?	
			Date/time 1	Date/time 2			Date/time 3		
Login	Sample	Tare weight (weight of weighing vessel)	Gross weight (g) (weight of aliquot and weighing vessel)	Gross weight (g) (weight of aliquot and weighing vessel)	Change in weights 1, 2	Proceed with ISM?	Gross weight (g) (weight of aliquot and weighing vessel)	Change in weights 2, 3	Proceed with ISM?
					#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
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THE LEADER IN ENVIRONMENTAL TESTING

Electronic Copy Only

Title: Microwave Extraction of Solid Samples by Method [SW-846 3546]

Approvals (Signature/Date):

Amelia Byl March 6, 2018
Amelia Byl Date
Technical Specialist

Doug Gomer 3/6/18
Doug Gomer Date
Health & Safety Manager / Coordinator

Roxanne Sullivan 3/6/18
Roxanne Sullivan Date
Quality Assurance Manager

3/6/18
Richard Clinkscales Date
Laboratory Director

Facility Distribution No. ____________ **Distributed To:**________________________

1.0 Scope and Application

1.1 This SOP is applicable to the solvent extraction of organic compounds from solid samples using microwave energy to produce elevated temperature and pressure conditions in a closed vessel containing the sample and organic solvent. This procedure achieves analyte recoveries equivalent to those from soxhlet or sonications methods, but uses less solvent. This SOP is based on SW-846 Method 3546.

1.2 The determinative methods used in conjunction with this procedure are listed in Table 1. This extraction procedure may be used for additional methods when appropriate solvents and spiking mixtures are used.

1.3 This procedure does not include the concentration and cleanup steps. See SOP DV-OP-0007, Concentration of Organic Extracts, for those details.

2.0 Summary of Method

A measured weight of sample, typically 15 g, is solvent extracted using a microwave extractor.

3.0 Definitions

Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, Quality Control Program, for definitions of general analytical and QA/QC terms.

3.1 **Extraction Holding Time**: The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.2 **Preparation Batch**: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards

3.3 **Method Comments:** The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client. Please reference WI-DV-0032 for details on Method Comments.

3.4 **Quality Assurance Summary (QAS)**: Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in LIMS. In these situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.5 **Aliquot**: A part that is a definite fraction of a whole; as in “take an aliquot of a sample for testing or analysis.” In the context of this SOP, “aliquot” is also used as a verb, meaning to take all or part of a sample for preparation, extraction, and/or analysis.

4.0 Interferences

4.1 Chemical and physical interferences may be encountered when analyzing samples using this method.

4.2 Sodium sulfate is not used in the extraction vessel. This is because salts are known to super heat when exposed to microwave energy. Samples are extracted without the addition of sodium sulfate, but the extracts are dried with sodium sulfate after the extraction, before concentration of the extracts. If the sample is excessively wet the aliquot can be divided among two or three extraction vessels and the extracts combined prior to concentration.

4.3 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section of this SOP (Section 9). Specific selection of reagents may be required to avoid introduction of contaminants.

4.4 Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented.

4.5 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.6 Paint chips are an especially difficult matrix to extract. Oftentimes the paint chips dissolve or partially dissolve in solvents and therefore can ruin glassware and extraction vessels. It is the laboratory’s experience that paint chips are best extracted by method SW-846 3580 instead of 3550C or 3546.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 A post-run cool down must be used after each extraction to prevent the possibility of operator burns. Pressure builds up in the closed vessel at high temperatures. Care should be taken when opening the vessel when it is above room temperature.

5.1.2 Samples that contain metal fragments or metal components of any kind should not be extracted by this procedure. These samples should be extracted by method SW-846 3550C instead. Care should be taken to inspect samples carefully as they are aliquotted.

5.1.3 Eye protection that satisfies ANSI Z87.1 (as described in the Corporate Safety Manual), laboratory coat, and appropriate gloves must be worn while performing this procedure. Nitrile gloves shall be worn when handling solvents; latex gloves may be worn when handling samples only; and cut resistant gloves shall be worn when washing glassware.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Methylene Chloride	Carcinogen Irritant	25 ppm (TWA) 125 ppm (STEL)	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness, and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Acetone	Flammable	1000 ppm (TWA)	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Nitric Acid	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous. It is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hexane	Flammable	50 ppm (TWA)	Prolonged or repeated contact with skin can cause defatting and dermatitis. Contact with eyes can cause redness, tearing, and blurred vision. Exposure can cause lung irritation, chest pain, and edema, which may be fatal.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

6.1 Equipment

6.1.1 Microwave extractor. Mars5: MarsExpress™CEM MARS® and Microwave extractor. Mars6: MarsExpress Plus™ CEM MARS®

At least once a year, power measurement calibration should be performed at 400 W, 800 W, and 1600 W. This calibration can be performed by the vender or by TestAmerica staff following the instructions in the Operations Manual for the microwave.

6.1.2 Microwave extraction vessels. 75 mL Teflon™ Express vessels with stopper and cap (CEM Corp.) in addition to 110 mL borosilicate glass tubes accompanying 110 mL Teflon™ Express Plus vessels with stopper and cap (CEM Corp).

6.1.3 Hand wrench to tighten the caps on the extraction vessels.

6.1.4 MARS 40 position carousel (CEM Corp) and 20 position carousel (CEM Corp)

6.1.5 Balance, >1400-g capacity, accurate to ± 0.1 g, calibrated daily per SOP DV-QA-0014.

6.2 Supplies

6.2.1 Media bottles, 100 mL or 250 mL capped with aluminum foil.

6.2.2 Stainless steel conical funnels

6.2.3 Ashless cellulose filter paper

6.2.4 Pipetter with disposable 1.0-mL tips, calibrated daily per SOP DV-QA-0008.

6.2.5 Metal spatulas or tongue depressors.

6.2.6 Solvent dispenser pump.

6.2.7 Filter flask.

6.2.8 Vacuum pump.

6.2.9 Washing tool for Teflon™ extractor vessels. This tool is a long thin sponge-like brush.

6.2.10 40 mL VOA vials and caps

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Methylene chloride – Each lot of solvent is tested following CA-Q-S-001 or CA-Q-S-001-DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.2 Acetone - Each lot of solvent is tested following CA-Q-S-001 or CA-Q-S-001-DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.3 Hexane - Each lot of solvent is tested following CA-Q-S-001 or CA-Q-S-001-DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.4 Baked Sodium Sulfate, 12-60 mesh - Heat sodium sulfate in a 400°C oven for at least four hours. QA personnel post the list of approved lots at solvent storage areas.

7.5 Baked Ottawa Sand – Heat Ottawa sand in a 400°C oven for at least four hours.

7.6 35% Nitric Acid – Dilute concentrated (70%) Nitric Acid 1:1 in water.

7.7 Standards - Please reference SOP DV-OP-0020 and WI-DV-0009 for information regarding the surrogate and spike standards used in this procedure.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time[1]	Reference
Soils for Method 8082A[2]	Glass with Teflon-lined lids	15 grams	Cool, $\leq 6^oC$	None	SW-846
Wipes for Method 8082A[2]	Glass with Teflon-lined lids	N/A	Cool, $\leq 6^oC$	None	SW-846
Soils for all other Methods, including 8082	Glass with Teflon-lined lids	15 grams	Cool, $\leq 6^oC$	14 days	SW-846
Wipes for all other Methods, including 8082	Glass with Teflon-lined lids	N/A	Cool, $\leq 6^oC$	14 days	SW-846

[1] Exclusive of analysis.

[2] Some regulatory agencies do not accept SW-846 Revision 4 of Chapter 4 and will require the 14 day holding time for Method 8082. The states of Alabama, California, Colorado, Connecticut, Nevada, New Jersey, Pennsylvania, and Rhode Island require the 14 day holding time for Method 8082.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 13 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

9.4.1 A method blank must be processed with each preparation batch. The method blank is processed and analyzed just as if it were a field sample.

9.4.2 The method blank consists of 15 g of baked Ottawa sand free of any of the analyte(s) of interest.

9.5 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)

9.5.1 At least one LCS must be processed with each preparation batch. The LCS is carried through the entire analytical procedure just as if it were a sample.

9.5.2 The LCS consists of 15 g of baked Ottawa sand to which the analyte(s) of interest are added at known concentration.

9.5.3 Method AK102 requires LCS and a LCSD for every batch for every spike compound.

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.6.1 One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

9.6.2 If insufficient sample volume is available for MS/MSD, an NCM must be written and a LCSD must be prepared.

9.6.3 DoD requires the MS/MSD to be assigned by the client. When there is no assigned MS/MSD or there is not enough sample volume provided a LCSD must be prepared.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must also be documented as a nonconformance, with a cause and corrective action described.

10.3 Critical Procedural Considerations

10.3.1 As stated throughout this SOP, analysts must review the LIMS Method Comments and any applicable QASs before starting work. This review is also documented on the Organic Extraction Checklist (see WI-DV-0009).

10.3.2 Analysts must focus on using clean technique throughout this procedure. Any parts or pipettes that come into direct contact with dirty surfaces or any other beaker or media bottle than the designated one should be cleaned or disposed of before coming into contact with the sample.

NOTE: Rotate glassware; do **not** use specific glassware, equipment or positions for the MB and LCS/LCSD.

10.4 Periodic cleaning.

10.4.1 **Mars5 Express Microwave Extractor. CEM Mars** At least once every four weeks, the extraction vessels must be cleaned using a “Clean Method” on the microwave. The method is under the User Directory with the settings that follow:

- Sample Type: Inorganic
- Control Type: Ramp to Temperature
- Power: 100%
- Ramp: 5 minutes to 180°C
- Hold: 10 minutes

10.4.2 **Mars6 Express Plus Microwave Extractor. CEM Mars** At least once every four weeks, the extraction vessels must be cleaned using a “Clean Method” on the microwave. The method is under the Classic Method, “Cleanup2” with the settings that follow:

- Sample Type: Inorganic
- Control Type: Ramp to Temperature
- Stage 1

- Power: 1600%
- Ramp: 15 minutes to 180°C
- Hold: 10 minutes
- Temperature guard : 200°C

10.4.3 Fill each tube with 30 mL of the nitric acid solution described in Section 7 and cap tightly. Place the tubes in the carousel, then run the “Clean Method”

10.4.4 Allow the vessels to cool, and then dispose of the nitric acid in waste stream J. Rinse the vessel with DI water three times.

10.4.5 Fill each tube with 30 mL of 1:1 Methylene Chloride: Acetone solution and cap tightly. Place the tubes in the carousel, then run the “Clean Method” again.

10.4.6 Allow the vessels to cool, and then dispose of the solvent in waste stream CA. Allow the vessels to air dry.

10.5 Assemble and Clean the Extraction Tubes Immediately Before Use.

10.5.1 If the microwave tube, cap, or plugs are wet, pre-rinse with acetone.

10.5.2 Rinse the microwave tube, cap and plug twice with methylene chloride. The plugs can be placed in a large glass jar to help facilitate the rinse.

10.5.3 Discard the solvent in the correct waste stream.

10.6 Aliquot Samples

10.6.1 If the sample is a soil, mix and homogenize samples according to the instructions provided in SOP DV-QA-0023, Subsampling. If the sample is a wipe, transfer the wipe to the extraction vessel.

10.6.2 Label microwave vessel with the sample ID, method, and batch number. The label needs to be flat.

NOTE: For method 8270 borosilicate glass tubes are to be used in housing the sample in addition to required QC; respectively. The Glass tubes will be inserted into the retaining vessel and capped for extraction.

This method is performed using the Mars6 Microwave only

10.6.3 Do not use specific vessels or carousel positions for the MB and LCS.

10.6.4 For each MB and LCS sample, weigh 15 g to 17 g of baked Ottawa sand into labeled VOA vials or similarly clean glass intermediate containers with a lid. Record a nominal weight of 15 g in the initial volume field, but record the actual weight to the nearest 0.1 g in the notes column.

10.6.5 For each sample and MS/MSD, weigh 15 g to 17 g of sample into labeled VOA vials or similarly clean glass intermediary containers with a lid. Record the weight to the nearest 0.1 g directly into LIMS or hand record the weight on the benchsheet.

NOTE: For wipe samples, the original sample containers that the wipes are received in should be used in place of the intermediary sample containers described above.

10.6.6 Cap the intermediary sample containers either with the appropriate lid or aluminum foil.

10.6.7 Place the labeled intermediary sample containers on a cart next to the sample container so that a second analyst can check the labels. This is documented on the Organic Extraction Checklists (See WI-DV-0009).

10.7 Prepare a bottle with a bottle-top dispenser with the appropriate solvent(s).

10.7.1 Methylene Chloride is used for soil and wipe samples for the following methods:

- SW-846 8015B
- SW-846 8015C
- SW-846 8015D
- Alaska Methods AK102 and AK103 (AK102_103)
- Low-Level NDMA (8270D_SIM_LL)

10.7.2 For soil extraction by all other methods, the solvents used are acetone and methylene chloride. These are added separately.

10.7.3 For wipe samples by method 8081 and 8082, the solvent used is hexane.

10.7.4 For wipe samples by method 8270 SIM, the solvent used is a 1:1 mixture of methylene chloride and acetone.

10.8 Add Surrogate and Spike Solutions

NOTE: The standards should be allowed to come to room temperature before spiking the samples.

NOTE: The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-0009.

10.8.1 Only one batch should be surrogated at a time to ensure the correct standards are used and to ensure the solvent is added as soon as possible to the samples. Document the standards and pipette(s) used on the benchsheet.

10.8.2 Using a calibrated pipette, add the appropriate volume of the appropriate working surrogate standard (see WI-DV-0009) to the intermediary container for each field sample and QC sample. Verify the ID of the standard used on the benchsheet.

10.8.3 Using a calibrated pipette, add the appropriate volume of the appropriate working spike standard (see DV-OP-0009) to the intermediary container for each field sample and QC sample. Verify the ID of the standard used on the benchsheet.

10.9 Making sure not to overflow the intermediary sample container, remove the cap, and slowly add approximately 15 mL of the appropriate solvent to the container. See below for the appropriate solvent:

NOTE: The solvent should be added as soon as possible after the addition of the surrogate and spiking standards to prevent loss of the more volatile compounds.

10.9.1 15 mL of methylene chloride is added to the container for soil and wipe samples for the following methods:

- SW-846 8015B, 8015C, and 8015D
- Alaska Methods AK102 and AK103 (AK102_103)
- Low-Level NDMA (8270D_SIM_LL)

10.9.2 15 mL of acetone is added to the intermediary container for all other soil samples.

10.9.3 15 mL of hexane is added to the container for wipe samples by method 8081 and 8082, the solvent used is hexane.

10.9.4 15 mL of 1:1 methylene chloride and acetone is added to container for wipe samples by method 8270 SIM.

10.10 Mix the contents of the intermediary sample container using a spatula or wooden tongue depressor for 30 seconds. Then, cap the intermediary sample container and use a vortex mixer to mix the contents of the intermediary sample container for an additional 30 seconds. This mixing must generate a thoroughly wetted and disaggregated sample slurry. If clay clumps or other sample aggregation is evident after 1 minute of combined manual and vortex mixing, sand may be added to facilitate disaggregation, followed by an additional minute of mixing (manual + vortex as described above). If sand is added during this step, document this in an NCM.

10.11 Transfer the mixed/wetted sample to a microwave extraction vessel using three 5 mL methylene chloride rinses. This will bring the total combined solvent volume to 30 mL.

NOTE: The solvent should completely cover and saturate the sample. Additional solvent may be needed depending on the matrix of the individual sample. The sample and solvent must not fill more than 2/3 of the vessel.

NOTE: If the sample matrix appears to be unusual, or especially wet, the combined sample/solvent mixture can be equally divided between two or three separate microwave extraction vessels. The vessels will be extracted independently, but the extracts will be re-combined before concentration. This will prevent the extraction vessels from over-heating and venting if the sample is unusually wet, oily, or bulky (if a 15 g aliquot would fill the tube more than ¾ full). If the sample is split into two or three separate vessels, document this in an NCM.

NOTE: For method 8270, the mixed/wetted sample or QC will be transferred into borosilicate glass tubes. The glass tubes are then inserted into the retaining vessel and capped for extraction.

10.12 Seal the vessels by placing the plug on top of the vessel, small side down, and hand tighten the cap over the plug.

NOTE: Care should be taken to ensure that the plug, the cap, and the threads of the vessel are clean of any material or debris.

10.13 After being sealed, the vessels must be inverted several times to ensure that the material is well mixed and saturated. It is recommended that when extracting with 100% methylene chloride to vent and re-cap the vessels before continuing to relieve excess pressure and thereby preventing the vessels from venting during the extraction.

NOTE: 8270 Samples extracted using the borosilicate glass tubes will not be inverted, as this will result in the sample + solvent spilling out of the glass tube into the retaining vessel.

10.14 Load vessels into the carousel.

10.14.1 There must be at least 8 vessels in the carousel. Adding blank vessels with sand and solvent may be necessary.

10.14.2 Balance the tubes around the carousel to ensure that all samples are exposed to an equal amount of energy during the extraction. See Attachment 1 for details. Only samples using the same extraction solvent should be placed in the same carrousel and run at the same time.

10.14.3 For the vessels to be correctly loaded in the carousel the cap should completely touch the top of the carousel with no other part of the extraction vessel visible.

10.15 Place the carousel into the microwave, making sure that it sits on the turning apparatus correctly. The carousel should be able to rotate. Close the door.

10.16 Mars5 Express: The Method Menu screen should indicate "Start Current Method" as being 3546 Full Xpress. Press the green "Start/Pause" button to begin the extraction.

NOTE: If a different method is shown, go to the "Load Method" on the menu screen. Choose "User directory" and place the cursor on the desired method. Press the "Home" button to return to the main menu, where the test highlighted will appear under the "Start Current Method".

10.16.1 The method is under the User Directory with the settings that follow:

- Sample Type: Organic
- Control Type: Ramp to Temperature
- Power: 100% (1600 W)
- Ramp: 20 minutes to 115°C
- Hold: 10 minutes

10.17 Mars6 ExpressPlus: The "One Touch Method" menu should be selected. Next, the "CEM 3546 glass 110C" method should be selected. At the bottom right hand corner of the screen should be a green "start" selection. Press the green "Start" button to begin the extraction.

NOTE: If a different method is shown, press the back arrow, found on the bottom left hand of the screen" until you reach the appropriate menu.

10.17.1 The method is under the CEM 3546 glass 110C" program with the settings that follow:

- Sample Type: Organic
- Control Type: Ramp to Temperature
- Stage 1
- Power: 500-1500W
- Ramp: 15 minutes to 110°C
- Hold: 15 minutes

10.17.2 When the extraction is complete, the vessels will need to return to room temperature prior to opening the vessels. The microwave will indicate the approximate temperature of the vessels.

CAUTION: If the carousel is removed from the microwave before the vessels are at room temperature, do NOT open the vessels. The vessels may be placed in a rack outside of the microwave to cool down.

10.17.3 The microwave contains a solvent sensor that will indicate the presence of solvent in the microwave and will stop the extraction. To minimize this, care needs to be taken not to overfill the vessel and to properly cap and tighten the vessel prior to extraction. If the solvent sensor indicates the presence of solvent, open the door and inspect the tops of the tubes for evidence of a solvent leak. If solvent has vented or leaked out of an extraction vessel, the sample must be re-aliquotted and the extraction started over. It is best to re-aliquot the sample into two or three separate extraction vessels to prevent over-heating again. Document this in an NCM.

10.18 Assemble and Clean Filter Funnels and Media Jars.

10.18.1 Without gloves on, fold a 18 cm diameter cellulose filter paper in quarters. Open the folds to create a cone. Place the filter paper in the bottom of a conical stainless steel funnel. Place the funnel on a 100 mL or 250 mL media bottle.

NOTE: For low-level NDMA samples by method 8270D_SIM_LL, use designated glass funnels instead of the stainless steel funnels and instead of re-usable media jars, use disposable amber bottles. This is done to prevent contamination.

10.18.2 Place approximately 1 tablespoon of baked sodium sulfate in the funnel. Rinse all surfaces of the funnel, the filter and the sodium sulfate with the extraction solvent (see Section 10.7), so all surfaces of the funnel, filter, and sodium sulfate are rinsed.

NOTE: When preparing glassware for the extraction of wipe samples, sodium sulfate is not necessary and the solvent used in the rinse should be the solvent used in the extraction of the wipe samples. (Normally hexane for methods 8081 and 8082).

10.18.3 Allow the solvent to drain completely into the media bottle. Swirl the media bottle to ensure all surfaces come into contact with the solvent. Add additional solvent to the rinse if necessary.

10.18.4 Pour the solvent out of the media bottle over the stem of the stainless steel funnel to rinse the funnel stem.

10.18.5 Discard the solvent in the correct waste stream.

10.19 Filter the Extracts

10.19.1 After the extraction method is complete and the vessels reach room temperature, quantitatively transfer the entire sample through solvent rinsed sodium sulfate funnels and into the media jar. The quantitative transfer is performed by rinsing the microwave extraction vessel at least three times with solvent.

NOTE: The quantitative rinse is vital in order to achieve good recoveries. The rinses should be significant enough that when done, the extract volume is between 75 mL and 100 mL.

NOTE: If the sample aliquot was split between two or three tubes, the extracts from all the tubes shall be combined at this time. Filter all of the extracts through the same sodium sulfate funnel and collect in the same media jar.

NOTE: During the 8270 extraction, it has been noted that solvent may be found in the retaining vessel after extractions. This contains analytes of interest and should be filtered into the funnel with the rest of the sample. Quantitatively rinse the glass tube; DO NOT rinse the retaining vessel.

10.19.2 Once the solvent has completely drained into the collection apparatus, rinse the funnel contents with 10 to 20 mL of additional solvent. Dispose of the solid sample and sodium sulfate into Waste Stream D and cap the media jar with aluminum foil.

NOTE: For 8270 extractions, dispose of the glass tube

10.20 If the extract contains visible solids, it will be necessary to filter the extract again prior to concentration.

10.21 Store the extract refrigerated at $\leq$ 6°C until concentration. Ensure that the extracts in 1:1 Methylene chloride:acetone are placed in a flammable rated refrigerator.

10.22 Handwritten notes on the benchsheet are entered into LIMS, and the transcribed data must be verified by a second person. This verification is documented on the Organic Extraction Checklists (see WI-DV-009).

10.23 All glassware and microwave tubes, plugs, and caps are washed according to DV-OP-0004.

10.24 Maintenance

10.24.1 As needed, wipe out the inside and outside of the microwave with a damp cloth.

10.24.2 See Section 10.4 for vessel cleaning.

10.24.3 At least once a year, power measurement calibration should be performed at 400 W, 800 W, and 1600 W. This calibration can be performed by the vender or by TestAmerica staff following the instructions in the Operations Manual for the microwave.

10.25 Troubleshooting

10.25.1 If it appears that the solvent sensor is malfunctioning, ensure that the sensor is aligned at a 45 degree upward angle on the back of the unit.

10.25.2 The snorkel vent should be set inside of a hood, but care should be taken so that the opening is not blocked. Make sure the snorkel does not press against the back of the hood.

11.0 Calibration

Not applicable to this procedure.

12.0 Calculations / Data Reduction

Not Applicable.

13.0 Method Performance

13.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in DV-QA-005P. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

13.2 Limit of Quantitation Verification (LOQV)

The verification of the limit of quantitation (LOQ or LLOQ) is performed quarterly for work performed according to the DOD/DOE QSM 5.0 or for programs which require the use of Method 8270D, Revision 5. A blank matrix is spiked at 1-2 the laboratory RL and carried through the entire preparation and analytical procedures. Recoveries are assessed based on historical limits.

13.3 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

13.3.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

13.3.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

13.3.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.3.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

13.3.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

13.4 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst’s IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 Pollution Control

The volume of spike solutions prepared is minimized to reduce the volume of expired standard solutions requiring hazardous waste disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method, the policies in section 13 of the Environmental Health and Safety Manual for “Waste Management and Pollution Prevention”, and the Waste Management procedure, DV-HS-001P.

15.2 Waste Streams Produced By This Method

15.2.1 Methylene chloride – Waste Stream B

15.2.2 1:1 MeCl2:Acetone – Waste Stream CA

15.2.3 Flammable solvent – Waste Stream C

15.2.4 Solid waste/sodium sulfate – Waste Stream D

15.2.5 Nitric Acid Waste – Waste Stream J

15.2.6 Expired Standards/Reagents – Contact Waste Coordinator for guidance

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16.0 References / Cross-References

16.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Method 3456 Microwave Extraction, Revision 0, February 2007.

16.2 Alaska Method AK102, “For the Determination of Diesel Range Organics”, Verision 04/08/02.

16.3 Alaska Method AK103, “For the Determination of Residual Range Organics”, Version 04/08/02.

16.4 NWTPH-HCID “Hydrocarbon Identification Method for Soil and Water”, Manchester Environmental Laboratory, Dept of Ecology, State of Washington.

17.0 Method Modifications:

17.1 SW-846 Method 3546 calls for samples to be either air-dried and ground or mixed with sodium sulfate prior to extraction. This procedure does not call of the air-drying of samples unless requested by the client as this may lead to loss of the more volatile compounds. Sodium sulfate is not used in the extraction vessel, rather the extracts are dried with sodium sulfate after extraction and prior to concentration. Salts are known to superheat when exposed to microwave energy.

17.2 SW-846 Method 3546 calls for samples to be aliquoted on a balance capable to weighing to 0.01 g. This SOP calls for a balance capable to weighing to 0.1 g as this is sufficient to report data to 3 significant figures.

17.3 SW-846 Method 3546 Section 1.4 states “2-20 g of material is usually necessary and can be accommodated by this extraction procedure." This SOP calls for 30-33 g of material.

17.4 SW-846 Method 3546 Section 11.7 states "Add approximately 25 mL of the appropriate solvent system to the vessel." This SOP calls for the addition of 25-30 mL of solvent.

17.5 Method NWTPH-Dx calls for samples to be extracted by method SW-846 3550C. Valid MDLs and IDOCs have been completed using both method SW-846 3550C and SW-846 3546 and they are comparable therefore method NWTPH-Dx is a possible determinative method by this procedure.

17.6 Method AK102 and AK103 calls for samples to be extracted by soxhlet. Valid MDLs and IDOCs have been completed using this procedure, therefore method AK102 and AK103 are listed as a possible determinative methods by this procedure.

18.0 Attachments

Table 1: Determinative Methods Using Microwave Extraction

Attachment 1: Proper Carousel Loading

19.0 Revision History

- Revision 8, March 6, 2018
  - Changed nominal sample weight from 30 grams to 15 grams in accordance with the microwave extraction best practices and standardization procedure provided by corporate QA. This change is reflected in sections 2.0, 8.0, 9.4, 9.5, and 10.6.
  - Changed all references to WI-DV-009 to correct document ID: WI-DV-0009.
  - Modified sections 10.6-10.11 to specify the use of the intermediary sample container required in order to implement the microwave extraction best practices and standardization procedure provided by corporate QA.
  - Modified section 10.7.2 to clarify that acetone and methylene chloride are added separately in accordance with the microwave extraction best practices and standardization procedure provided by corporate QA.
  - Modified, added, and/or rearranged sections 10.9-10.11 in accordance with the microwave extraction best practices and standardization procedure provided by corporate QA. This change involves modifying the addition of solvents, mixing of the sample/solvent mixture, and transferring from an intermediary container into the microwave extraction vessel.
  - Updated sections 6.1.1, 6.1.2, 6.1.4, 10.4.1, 10.4.2, 10.6.2, 10.6.5, 10.11, 10.14, 10.15, 10.15.1, 10.17.1, 10.17.2 with notes to reflect the usage of the new microwave for 8270 FS, HSL list analytes only.
- Revision 7, January 31, 2017
  - Annual Technical Review
  - Added paragraph to Section 3.0 referencing the QAM for general definitions

  - Added paragraph to Section 6.0 to record IDs of pipettes and equipment
  - Updated language in Section 9.6.3 requiring LCSDs when no MS/MSD
  - Added note to Section 10.3.2 on rotating glassware/equipment/positions
  - Added current Section 13.2 defining LOQV

- Revision 6, January 31, 2016

  - Annual Technical Review
  - Updated Section 9.1 to contain verbiage consistent with other SOPs
  - Added Section 9.6.3 regarding DoD MS/MSD requirements
  - Changed the “Clean Method” frequency from two to four weeks in Section 10.4.1
  - Changed the waste stream from C to CA in Section 10.4.5
  - Section 10.5.2 changed the rinse requirement to be performed twice.
  - Added Section 10.6.3 instructing not to use specific vessels or positions for the MB and LCS.
  - Modified Section 10.6.4 weight recording requirements
  - Added Section 10.6.6 – cap with aluminum foil
  - Added the documentation of the standards and pipette used in Section 10.8.1
  - Clarified the need to punch a hole in foil when spiking to Section 10.8.2 & 10.8.3
  - Clarified the process for adding solvent to vessels in Section 10.9
  - Added the requirement to place 1:1 Methylene chloride:acetone extracts in a flammable rated refrigerator to Section 10.18
  - Revised Section 13.1 – Method Detection Limit Study (MDL)
  - Revised Section 13.2 – Demonstration of Capabilities
  - Revised Section 13.3 - Training Requirements
  - Updated Section 17.4 to reflect the addition of 25-30 mL of solvent
  - Archived all revision histories 2010 and earlier

- Revision 5, January 31, 2015

  - Annual Technical Review
  - Reformatted SOP
  - Revised Section 7.4 to remove the requirement to test the sodium sulfate before use. This was done to reflect current practice in CA-Q-S-001-DV-1.
  - Added “NWTPH DRO” to the procedure
  - Revised Section 10.5.2 to state that the plugs and caps can be rinsed in a large glass jar.
  - Added a note in Section 10.15.1 to state that for method 8270D_SIM_LL, designated glass funnels and disposable amber bottles will be used to filter the extracts.
  - Added Sections 16.2-16.5 to list AK102, AK103, and NWTPH methods as references.
  - Removed Section 17.8, redundant with 17.5.
  - Updated Table 1 to reference the correct methods and SOPs.

- Revision 4, January 31, 2014

  - Annual Technical Review
  - Revised Section 1.2 to state that the procedure may be used for additional methods when appropriate solvents are used instead of pH as there are no pH adjustments made in the procedure.
  - Removed TeflonTM lined caps from the Equipment and Supplies list in Section 6 as the lab now uses aluminum foil.

  - Added footnote to the table in Section 10 stating some regulatory agencies do not accept SW-846 Revision 4 of Chapter 4 and will require 14 day hold time for method 8082A.
  - Revised Section 9.1.2 to state that this procedure meets all criteria of DoD QSM 5.0.
  - Revised Section 9.4 to clarify that one method blank is processed with each batch.
  - Removed "Acceptance Criteria" and "Corrective Action" information from Sections 9.4, 9.5, 9.6, and 9.7. This information can be found in the analytical SOPs.
  - Added a bullet point in Section 10 to clarify that any deviations discovered after the procedure is performed are to be documented in an NCM.
  - Revised Section 10 to remove the instruction to place the label towards the bottom of the vessel. This is not necessary. Also removed the requirement that the label must include the date. The label includes the batch number, which is unique and the date of extraction is recorded in the batch.
  - Revised the procedure to state the periodic acid cleaning of the tubes should be done at least once every two weeks instead of weekly.
  - Removed methods "NWTPH DRO" and "Okla_DRO" from the procedure. The lab does not perform microwave extraction for these methods at this time.
  - Added sub-sections for Maintenance and Troubleshooting to Section 10 per DoD QSM 5.0.
  - Added low-level NDMA and 8015D as a possible analytical method to Section 10 and to Table 1
  - Removed 8310 as a possible analytical method in Table 1.
  - Added Attachment 1 to give instructions on how to properly load the vessels in the carousel.

- Revision 3, January 31, 2013

  - Annual Technical Review
  - Sections 4.2 and 10.5.4 were revised to remove the optional addition of sodium sulfate to the samples before extraction. It was determined that the better option when dealing with wet samples is to split the sample into two or three tubes and re-combine the extracts before concentration.
  - Section 4 was revised to add instructions on how to deal with paint chip samples.
  - Section 5 was revised to add comments about the dangers of metal fragments in samples.
  - Section 6 was revised to include the requirement that the Power Measurement Calibration procedure be performed on the unit every year.
  - Section 8 was revised to update the hold times for Method SW-846 8082A.
  - Section 10.8 was revised to give more detail on how full the extraction vessel should be once solvent has been added.
  - Section 10.13.1 was revised to allow the carousel to be removed from the microwave unit before the vessels are cool so long as the vessels are not opened.
  - Section 10.15.1 was revised to add a note about the importance of quantitative transfers and rinses while filtering the extracts.
  - Section 10.15.1 was revised to add instructions to combine all extracts from samples that were originally split across two or three tubes.
  - Section 15 was revised to include the waste stream CA.
  - Added the Note to Table 1

- Revision 2.0, January 31, 2012
    - Annual Technical Review
    - Updated Section 4.2 and Section 10.5.4 to describe when sodium sulfate should be used in the extraction vessel.
    - Updated Section 6.0 to allow the use of aluminum foil to cap 100mL and 250mL media jars.
    - Updated Section 6.1 to include details on computer software and hardware.
    - Updated Section 7.0 to include details on the purity of reagents and standards.
    - Updated Section 9.1.4 and Section 10.1 to more accurately reflect the NCM process.
    - Corrected grammatical and formatting errors
    - Updated Section 10.3 to include a solvent cleaning after the weekly acid cleaning.
    - Updated Section 10.5.4, Section 10.7.2, and Section 10.7.3 to include an option to split the sample aliquot into two separate microwave vessels.
    - Updated Section 10.10 and 10.13.2 to give details on how to prevent vessels from over-heating and venting and steps to be taken if venting does occur.
    - Updated Section 10.16 to accurately reflect how the laboratory handles extracts with suspended sediment.
    - Updated Section 10.19 to reference SOP DV-OP-0004 on how to clean the microwave vessels.
- Revision 1 dated 01 Jan 2011
    - Added 8270C SIM as a valid determinative method by microwave extraction.
    - Changed the procedure to call for the extract to be filtered thru a conical steel funnel lined with cellulose filter paper instead of a glass funnel with glass wool. This was done to help remove sediment from the extracts.
    - Removed details about the surrogate and spike standards used in the extraction. This information can now be found in DV-OP-0020.
    - Added instructions to Section 7 on how to prepare the nitric acid solution used in the weekly cleaning of the tubes.
    - Changed the solvent used in the extraction of samples for method 8081 and 8082. The samples are now extracted in a 1:1 Mixture of MeCl2:Acetone instead of a 1:1 Mixture of MeCl2:Hexane.
    - Revised the procedure in Section 10.5 for aliquotting samples to state that 30 to 33g of sample should be used instead of 30±2g and that the weight should be recorded to the nearest 0.1g instead of the nearest mg.

Earlier revision histories have been archived and are available upon request.

TABLE 1.

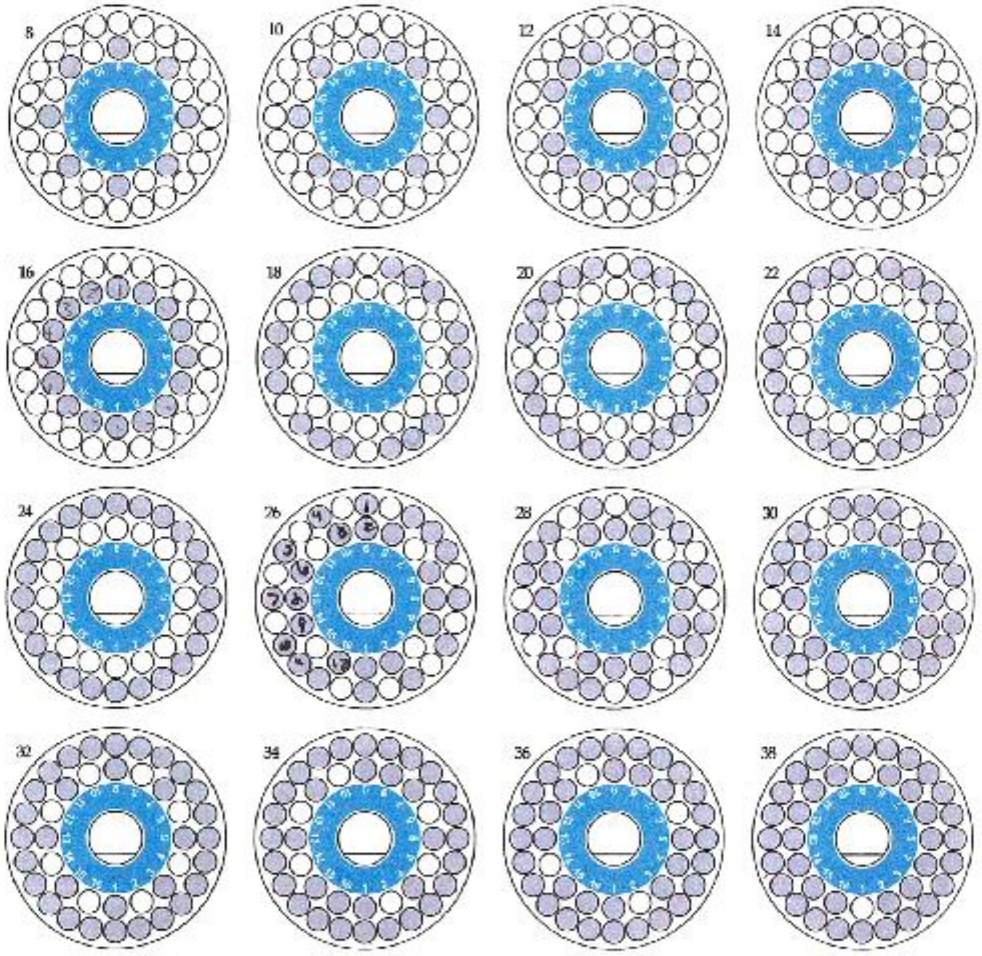
Determinative Methods Using Microwave Extraction

Method Description	Determinative Method	SOP
Chlorinated Pesticides	SW-846 8081A SW-846 8081B	DV-GC-0020
Polychlorinated Biphenyls (PCBs)	SW-846 8082 SW-846 8082A	DV-GC-0021
Diesel and Residual Range Organics	SW-846 8015B SW-846 8015C SW-846 8015D NWTPH-Dx AK102 AK103	DV-GC-0027
Polynuclear Aromatic Hydrocarbons by GC/MS SIM	SW-846 8270C SIM SW-846 8270D SIM	DV-MS-0002
Low-Level NDMA by Isotope Dilution, GC/MS SIM, Large Volume Injection	SW-846 8270C/D SIM	DV-MS-0015

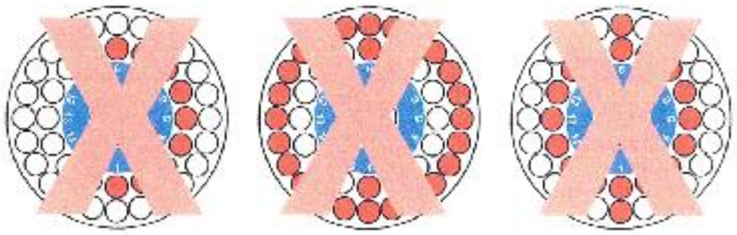
ATTACHMENT 1.

Proper Carousel Loading

Recommended distribution of MARSXpress vessels when turntable is less than capacity



Incorrect distribution: What not to do



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Title: Ultrasonic Extraction of Solid Samples [SW-846 3550B & 3550C]

Approvals (Signature/Date):

12/20/18
Andrew Pepping — Date
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Doug Gomer 12/20/18
Doug Gomer — Date
Health & Safety Manager / Coordinator

Roxanne Sullivan 12/20/18
Roxanne Sullivan — Date
Quality Assurance Manager

12/20/18
Richard Clinkscales — Date
Laboratory Director

Facility Distribution No. ___________ **Distributed To:**___________________________

1.0 Scope and Application

1.1 This SOP is applicable to the solvent extraction of organic compounds from solid samples, including wipes, using sonication (i.e., ultrasonic extraction). This SOP is based on SW-846 Method 3550B and 3550C.

1.2 The determinative methods used in conjunction with this procedure are listed in Table 1. This extraction procedure may be used for additional methods when appropriate spiking mixtures and extraction solvents are used.

1.3 This procedure does not include the concentration and cleanup steps. See SOP DV-OP-0007, Concentration of Organic Extracts, for those details.

2.0 Summary of Method

A measured weight of sample, typically 30 g, is mixed with anhydrous sodium sulfate to form a free flowing powder. This mixture is solvent extracted three times using an ultrasonic horn.

3.0 Definitions

Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, Quality Control Program, for definitions of general analytical and QA/QC terms.

3.1 Extraction Holding Time: The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.2 Preparation Batch: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards

3.3 Method Comments: The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client.

3.4 Quality Assurance Summary (QAS): Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in LIMS. In these situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.5 Aliquot: A part that is a definite fraction of a whole; as in “take an aliquot of a sample for testing or analysis.” In the context of this SOP, “aliquot” is also used as a verb, meaning to take all or part of a sample for preparation, extraction, and/or analysis.

4.0 Interferences

4.1 Chemical and physical interferences may be encountered when analyzing samples using this method.

4.2 In order to extract especially wet solids, the initial sample weight might have to be reduced in order to achieve a free-flowing mixture with the sodium sulfate. This can raise the reporting limits and method detection limits.

4.3 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section of this SOP (Section 9). Specific selection of reagents may be required to avoid introduction of contaminants.

4.4 Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented.

4.5 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.6 There are many sources of phthalate contamination in the laboratory. The most common of which are nitrile gloves. The analyst should never touch the inside of glassware with gloves. For the analysis of low-level phthalates by method 8270C SIM, common filter paper can introduce phthalate contamination. Therefore when samples are extracted for this analysis, the Method Comments will instruct the analyst that only glass wool can be used.

4.7 It has been observed that 8270 compounds benzoic acid, 2,4-dinitrophenol, and 4,6-dinitro-2-methylphenol will not recover well if the extract does not drain completely and quickly through the sodium sulfate. Therefore it is very important that a thorough rinse is performed – especially after the 1st sonication. Recoveries will also be improved if the filter paper and funnels used allow for quick drainage. It has been observed that Büchner funnels and glass fiber filter paper will slow drainage.

4.8 It has been observed that 8270 compound Benzidine will not recover well if the filter paper and sodium sulfate are not sufficiently rinsed. Therefore it is very important that a thorough rinse is performed – especially after the 1st sonication.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 Ultrasonic disrupters can produce high intensity noise and must be used in an area with adequate noise protection. During operation, the horns will be kept in a sound enclosure inside the fume hood to protect the analyst. If a sound enclosure is not used, then hearing protection is required when within 10 feet of an operating ultrasonic disrupter and the analyst must be in the Hearing Protection Program per DV-HS-0010, Hearing Conservation Program.

5.1.2 Eye protection that satisfies ANSI Z87.1 (as described in the Environmental Health and Safety Manual), laboratory coat, and appropriate gloves must be worn while performing this procedure. Nitrile gloves shall be worn when handling solvents; latex gloves may be worn when handling samples only; and cut resistant gloves shall be worn when washing glassware.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Methylene Chloride	Carcinogen Irritant Poison	25 ppm (TWA) 125 ppm (STEL)	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness, and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Hexane	Flammable	50 ppm (TWA)	Prolonged or repeated contact with skin can cause defatting and dermatitis. Contact with eyes can cause redness, tearing, and blurred vision. Exposure can cause lung irritation, chest pain, and edema, which may be fatal.

Acetone	Flammable	1000 ppm (TWA)	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

6.1 Sonicator, at least 300 watts.

6.2 Sonicator horn, ¾ inch

6.3 Balance, >1400-g capacity, accurate to ± 0.1 g, calibrated daily per SOP DV-QA-0014.

6.4 Beakers, 400 mL.

6.5 Media bottles, 250 mL.

6.6 Stainless steel conical funnels

6.7 Ashless cellulose filter paper

6.8 Glass wool - For the analysis of low-level phthalates by method 8270 SIM.

6.9 Pipetter with disposable 1.0-mL tips, calibrated daily per SOP DV-QA-0008.

6.10 Aluminum foil.

6.11 Wooden tongue depressors

6.12 Metal spatulas.

6.13 Solvent dispenser pump.

6.14 Filter flask.

6.15 Vacuum pump.

6.16 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1.1 Methylene chloride – Each lot of solvent is tested following SOP CA-Q-S-001 or CA-Q-W-001 DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.1.2 Acetone - Each lot of solvent is tested following SOP CA-Q-S-001 or CA-Q-W-001 DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.1.3 Hexane - Each lot of solvent is tested following SOP CA-Q-S-001 or CA-Q-W-001 DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.1.4 Baked Sodium Sulfate, 12-60 mesh - QA personnel post the list of approved lots at solvent storage areas. Heat sodium sulfate in a 400°C oven for at least four hours. Cool, covered tightly with foil, and store in tightly closed jars.

7.1.5 Baked Ottawa Sand – Heat Ottawa sand in a 400°C oven for at least four hours.

7.2 Standards

7.2.1 Please reference SOP DV-OP-0020 for information regarding the surrogate and spike standards used in this procedure.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time[1]	Reference
Soils for Method 8082A	Glass with Teflon-lined lids	30 grams	Cool, $\leq 6^{o}$C	None	SW-846
Wipes for Method 8082A	Glass with Teflon-lined lids	N/A	Cool, $\leq 6^{o}$C	None	SW-846

Soils for all other Methods, including 8082	Glass with Teflon-lined lids	30 grams	Cool, $\leq 6^oC$	14 days	SW-846
Wipes for all other Methods, including 8082	Glass with Teflon-lined lids	N/A	Cool, $\leq 6^oC$	14 days	SW-846

[1] Exclusive of analysis. Some regulatory agencies do not accept SW-846 Revision 4 of Chapter 4 and will require the 14 day holding time for both Methods 8082. The states of Alabama, California, Colorado, Connecticut, Nevada, New Jersey, Pennsylvania, and Rhode Island require the 14 day holding time for method 8082.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, *Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.1 unless otherwise stated. Any deviation or exceptions from QSM 5.1 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 13 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

9.4.1 One method blank must be processed with each preparation batch.

9.4.2 The method blank for batches of soil samples consists of 30 grams of baked Ottawa sand, which is free of any of the analyte(s) of interest.

9.4.3 TestAmerica Denver typically provides clients with clean filter paper or sterile gauze to use as wipes. In these cases, the laboratory prepares wipe-matrix MBs by spiking clean filter paper or gauze (of the same type that is provided to the client) with the surrogate compounds to be used for analysis. If the client uses a different type of material for the wipes, the client should provide a clean specimen of that material to be used for the MB. If the client does not provide a blank wipe in this case, the laboratory will prepare the MBs from filter paper or gauze, from the laboratory’s inventory, spiked with the surrogate compounds.

9.5 Laboratory Control Sample (LCS)

9.5.1 At least one LCS must be processed with each preparation batch. Some projects require two LCSs (LCS and LCSD) in every batch, therefore it is important to check special project instructions for each sample. Specifically, Alaska Methods AK102 and AK103 require an LCS and LCSD.

9.5.2 For soil sample batches, the LCS consists of 30 g of reagent sand to which the analyte(s) of interest are added at a known concentration.

9.5.3 LCSs for wipe-matrix samples are prepared by spiking the compounds of interest and surrogate compounds onto a piece of clean filter paper or sterile gauze. If the client uses a different type of material for the wipes, the client should provide blank wipe material to the laboratory for use in preparing the

LCS. If the client does not provide blank wipe material, the laboratory will prepare LCS using clean filter paper or sterile gauze, from the laboratory's inventory, spiked with the compounds of interest and surrogate compounds.

9.5.4 The LCS is carried through the entire analytical procedure just as if it were a sample.

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.6.1 One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis. MS/MSDs are not performed on wipe samples.

9.6.2 If insufficient sample volume is available for MS/MSD, an NCM must be written. For SW-846 methods a LCS/LCSD will be required in this case with the exception of work done under the AFCEE program which allows precision to be calculated using LCSs from different batches over the duration of the project.

9.6.3 DoD requires the MS/MSD to be assigned by the client. When there is no assigned MS/MSD or there is not enough sample volume provided a LCSD must be prepared.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

9.8 Sample Duplicates

A sample duplicate is a second aliquot of an environmental sample that is processed with the first aliquot of that sample. Sample duplicates are processed as independent samples within the same batch. The sample and duplicate results are compared to determine the effect of the sample matrix on the precision of the analytical process. As with the MS/MSD results, the sample duplicate precision results are not necessarily representative of the precision for other samples in the batch. Sample duplicates are performed when requested by the client. Sample duplicates do not count towards the 20 sample batch limit.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Specific glassware or equipment positions for the MB and LCS/LCSD are not to be used.

10.4 Critical Procedural Considerations

10.4.1 As stated throughout this SOP, analysts must review the Method Comments and any applicable QASs before starting work. This review is also documented on the Organic Extraction Checklist (see WI-DV-0009).

10.4.2 Analysts must focus on using clean technique throughout this procedure. Any parts or pipettes that come into direct contact with dirty surfaces or any other beaker or media bottle than the designated one should be cleaned or disposed of before coming into contact with the sample. Gloves should never come into contact with the inside of beakers, media jars, or steel funnels.

10.4.3 Sodium sulfate should be kept in closed containers when not in use. It is important to close the container when not actively using the sodium sulfate.

10.5 Sonicator Tuning and Horn Inspection

10.5.1 Every week the sonicator horns are inspected for pitting and the condition is recorded in the Sonicator logbook. The degree of pitting is decided based on the horn’s likeness to one of three reference images (attachment: Figure 1).

10.5.1.1 If the condition of the sonicator horn is determined to be poor. The sonicator must be removed from service until the probe is replaced.

10.5.2 If the sonicator is not self-tuning, the sonicator must be tuned once a week or whenever a new horn is installed. Tuning is documented in the sonicator maintenance log.

10.5.3 Starting at a power setting of 1, tune the sonicator so that the output is less than 20%.

10.5.4 Repeat the tune at a power setting of 5 and 10. At each power setting, tune the sonicator so that the output is less than 20%.

10.5.5 If the output is over 20%, consult your supervisor and the manufacturer's manual for troubleshooting help.

10.6 Assemble and clean the glassware immediately before use.

NOTE: Rotate glassware; do not use specific glassware or positions for the MB and LCS/LCSD.

10.6.1 Rinse 400-mL thick-walled beakers with methylene chloride.

NOTE: In order to prevent phthalate contamination, never touch the inside of a beaker with gloves on. When rinsing beakers be sure to keep gloves away from the mouth of the beaker.

10.6.2 Without gloves on, fold a 18 cm diameter cellulose filter paper in quarters. Open the folds to create a cone. Place the filter paper in the bottom of a conical stainless steel funnel. Place the funnel on a 250-mL media bottle.

NOTE: For low-level phthalate analysis by 8270 SIM, use glass wool in place of filter paper. Be sure not to touch the glass wool with gloves. Check the Method Comments to determine if this is necessary and see Section 4.6.

10.6.3 Place approximately 1 tablespoon of baked sodium sulfate in the funnel. Rinse all surfaces of the funnel, the filter and the sodium sulfate with methylene chloride or acetone/methylene chloride (depending on the extraction solvent, see Section 10.8) so all surfaces of the funnel, filter, and sodium sulfate are rinsed.

NOTE: When preparing glassware for the extraction of wipe samples, sodium sulfate is not necessary and the solvent used in the rinse should be the solvent used in the extraction of the wipe samples. (Normally hexane for methods 8081 and 8082).

10.6.4 Allow the solvent to drain completely into the media bottle. Swirl the media bottle to ensure all surfaces come into contact with the solvent. Add additional solvent to the rinse if necessary.

10.6.5 Pour the solvent out of the media bottle over the stem of the stainless steel funnel to rinse the funnel stem.

10.6.6 Discard the solvent in the correct waste stream.

10.7 Aliquot Samples

10.7.1 If the sample is a wipe, the sonication can be performed with the wipe in its original container if the original container is large enough. Otherwise, transfer the wipe and any solvent from the original container to a clean beaker.

10.7.2 For each MB and LCS, place a clean wipe into a labeled beaker and proceed to section 10.8.

10.7.3 If the sample is a soil, mix and homogenize samples according to the instructions provided in SOP DV-QA-0023, Subsampling. Use a disposable wooden spatula or a metal spatula that has been rinsed with methylene chloride and dried with a lab tissue.

10.7.4 Break the sample aliquot up into small pieces. The aliquot must not contain particles or clumps bigger than ½ inch in diameter in order to facilitate a complete extraction.

10.7.5 Label a 400-mL beaker with the sample ID, method, and batch number.

10.7.6 Weigh 30 to 33 g of sample into the labeled beaker. Record the weight to the nearest 0.1 g directly into the LIMS or hand record the weight on the benchsheet.

NOTE: Some clients may require the initial aliquot to be adjusted based on the percent moisture of the sample. In those cases, it might be necessary to aliquot more than 33 g of sample. If this is required, the Method Comments will state “Perform Calculation”. The laboratory’s LIMS (TALS) will calculate the required initial weight of wet sample needed to ensure at least 30 g of dry sample is included in the initial aliquot. In TALS, under the Batch Notes, enter a “1” in the “Perform Calculation” field. TALS will then calculate the required initial weight of wet sample needed under the “Target Amount” field in the Worksheet tab. Weigh out at least that mass of wet sample.

10.7.7 Add approximately 1 tablespoon of baked sodium sulfate to the beaker and mix well. If the sample is especially wet, more sodium sulfate will be needed to ensure the sample is free-flowing. If the sample is extremely wet, the initial sample weight might have to be reduced in order to keep the volume of sample and sodium sulfate in the beaker to a level that the horn can still thoroughly disrupt. Document in an NCM if additional sodium sulfate is added.

10.7.8 For each MB and LCS sample, weigh 30 to 33 g of baked Ottawa sand into labeled beakers. Add 1 tablespoon of baked sodium sulfate to the beaker and mix well. Record a nominal weight of 30 g in the initial volume field, but record the actual weight to the nearest 0.1 g in the notes column.

10.7.9 Cap the beaker tightly with aluminum foil.

10.7.10 Place the beaker on a cart next to the sample container so that a second analyst can check the labels. This is documented on the Organic Extraction Worksheet (See WI-DV-0009).

10.8 Prepare a bottle with a bottle-top dispenser with the appropriate solvent.

10.8.1 Methylene Chloride is used for soil and wipe samples for the following methods:

- SW-846 8015B
- SW-846 8015C
- SW-846 8015D
- Alaska Methods AK102 and AK103
- NWTPH-Dx
- Oklahoma DRO Method

10.8.2 For soil extraction of all other methods, the solvent used is a 1:1 mixture of methylene chloride and acetone.

10.8.3 For wipe samples by method 8081 and 8082, the solvent used is hexane.

10.8.4 For wipe samples by method 8270, the solvent used is a 1:1 mixture of methylene chloride and acetone.

10.9 Add Surrogate, Spikes, and Solvent to Field Samples and all QC samples.

10.9.1 The standards should be allowed to come to room temperature before spiking the samples. Record the ID of the standard and pipettor(s) used on the benchsheet.

NOTE: The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-0009 for Surrogate and spike volumes.

10.9.2 Only one batch should be surrogated at a time to ensure the correct standards are used and to ensure the solvent is added as soon as possible to the samples.

10.9.3 Ensure that the sample is free flowing before adding the surrogate standard. If the sample has become hard, gently tap the beaker to break up the solid, or pull back the foil and mix with a wooden spatula if necessary.

10.9.4 Using a calibrated pipette, add the appropriate volume of the appropriate working surrogate standard to the beaker for each field sample and method blank. Do this by punching a hole in the aluminum foil cap with the pipette tip.

10.9.5 Using a calibrated pipette, add the appropriate volume of the appropriate working spike standard to the beaker for each LCS, LCSD and MS/MSD. Do this by punching a 2nd hole in the aluminum foil cap with the pipette tip.

10.9.6 Immediately after the addition of the spike standard to the LCS, MS, & MSD sample, add approximately 100 mL of the appropriate solvent. Note that the solvent should be added as soon as possible after the addition of the spiking standards to prevent loss of the more volatile extractables. Sufficient solvent should be added so that the solvent level is at least ¾ inch above the solids.

NOTE: When hexane is used as the extraction solvent, use only enough to cover the wipe, i.e., approximately 50 mL. This will help facilitate the concentration of the extract later.

10.10 Rinse the disrupter horn with methylene chloride and wipe down with a clean laboratory tissue.

10.11 Place the bottom surface of the disrupter horn tip just below the surface of the solvent, but above the sediment layer.

10.12 Sonicate for three minutes, making sure the entire sample is agitated. The output should be set at 10 for the ¾-inch standard horn. The mode switch should be set on pulse, and the percent-duty cycle knob at 50%, for a total process time of 1:30 (1 minute 30 seconds).

10.13 Ensure the filter paper is wet before decanting and filtering occurs. Decant and filter the extract through the prepared stainless steel funnel into the media bottle. Immediately rinse the sodium sulfate in the funnel with at least 50 mL of solvent, ensuring that all sides of the filter paper have been rinsed also. **This is a critical step and must be performed as soon as the extract has drained from the funnel and must be done with at least 50 mL of solvent.**

NOTE: If proper rinsing has occurred, there should **not** be a significant yellow ring of residue (from the spike standards) around the top of the filter paper.

10.14 Repeat the extraction two more times with the appropriate solvent. Each time add sufficient solvent so that the solvent level is at least ¾ inch above the solids. If wipes are being extracted with hexane, then repeat two or more times with additional 50-mL portions of solvent.

10.15 Decant off the solvent after each sonication. After the third and final sonication, pour the entire extract into the funnel. Do not attempt to decant at this step but make every effort to recover all solvent from the beaker. If sufficient room in the media jar exists, rinse the beaker and/or the funnel with an additional 10 to 20 mL of solvent and add the rinse to the funnel.

10.16 Once the solvent has completely drained into the media bottle, dispose of the solid sample and the sodium sulfate into Waste Stream D and cap the media bottle containing the extract with aluminum foil.

10.17 Be sure to rinse the disrupter horn between samples following the procedure in Section 10.10.

10.18 If the extract contains visible solids, it will be necessary to filter the extract again. This filtration can be performed immediately before the concentration step by filtering the extract through another filter paper and funnel directly into the K-D apparatus. If the extract clogs the filter or filtration is extremely slow, the filter and funnel can be placed on a filter flask and a vacuum can be applied.

10.19 Place the extracts in a refrigerator until concentration, ensuring that the extracts in 1:1 methylene chloride:acetone are placed in a flammable rated refrigerator. Document on the benchsheet in which refrigerator the extracts are stored and the total extract count for the batch.

10.20 Handwritten notes on the benchsheet are entered into LIMS, and the transcribed data must be verified by a second person. This verification is documented on the Organic Extraction Checklist (see WI-DV-009).

10.21 Maintenance

10.21.1 Unless self tuning, the sonicators must be tuned once a week. See Section 10.4.

10.21.2 The probes must be inspected once a week and replaced if excessively worn.

10.22 Troubleshooting

10.22.1 If the sonicator is not working properly, (either not disrupting the soil sufficiently or over-loading) separate the converter from the horn and the horn from the probe. Always use the special wrenches to avoid damaging the parts. Clean all points of contact with either acetone or isopropyl alcohol and then re-assemble and tighten down with the wrenches.

10.22.2 If after following the steps in Section 10.21.1, the sonicator is still not working properly, try to isolate the problem by plugging the converter into a different control box. If the problem goes away, then the control box needs to be sent off for service. If the problem does not go away, proceed to Section 10.21.3.

10.22.3 If after following the steps in Sections 10.21.1 and 10.21.2 the sonicator is still not working properly, then the problem must be in the converter or the horn or probe. Switch the converter to determine if the converter needs to be sent off for repair. If the converter operates properly with a different horn and probe, then the probe needs to be replaced.

11.0 <u>Calibration</u>

Not applicable to this procedure.

12.0 <u>Calculations / Data Reduction</u>

Not Applicable.

13.0 <u>Method Performance</u>

13.1 <u>Method Detection Limit Study (MDL)</u>

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

13.2 <u>Limit of Quantitation Verification (LOQV)</u>

The verification of the limit of quantitation (LOQ or LLOQ) is performed quarterly for work performed according to the DOD/DOE QSM 5.0 or for programs which require the use of Method 8270D, Revision 5. A blank matrix is spiked at 1-2 the laboratory RL and carried through the entire preparation and analytical procedures. Recoveries are assessed based on historical limits.

13.3 <u>Demonstration of Capabilities</u>

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

13.3.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

13.3.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

13.3.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.3.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

13.3.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

13.4 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst’s IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 Pollution Control

The volume of spike solutions prepared is minimized to reduce the volume of expired standard solutions requiring hazardous waste disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method, the policies in section 13 of the Environmental Health and Safety Manual for “Waste Management and Pollution Prevention”, and the Waste Management procedure, DV-HS-001P.

15.2 Waste Streams Produced By This Method

15.2.1 Methylene chloride – Waste Stream B

15.2.2 Flammable solvent – Waste Stream C

15.2.3 1:1 MeCl2:Acetone – Waste Stream CA

15.2.4 Solid waste/sodium sulfate – Waste Stream D

15.2.5 Expired Standards/Reagents – Contact Waste Coordinator for guidance

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16.0 References / Cross-References

16.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Method 3550C Ultrasonic Extraction, Revision 3, February 2007.

16.2 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Method 3550B Ultrasonic Extraction, Revision 3, December 1996.

16.3 Alaska Method AK102, “For the Determination of Diesel Range Organics”, Version 04/08/02.

16.4 Alaska Method AK103, “For the Determination of Residual Range Organics”, Version 04/08/02.

16.5 Oklahoma Department of Environmental Quality, Methods 8000/8100 (modified) Diesel Range Organics (DRO), October 22, 1997 Rev. 4.1.

16.6 NWTPH-HCID “Hydrocarbon Identification Method for Soil and Water,” Manchester Environmental Laboratory, Dept. of Ecology, State of Washington.

17.0 Method Modifications:

17.1 SW-846 Method 3550C Section 11.3.5 calls for all three extractions to be filtered a second time through the same filter. The SOP only requires each extract to be filtered after each extraction process. The QC has shown great recovery with the use of only the filtration proceeding each extraction.

17.2 SW-846 Method 3550C Section 11.3 instructs that the surrogate and spike compounds should be added to the sample before the sample is mixed with sodium sulfate. This SOP calls for the sample to be mixed thoroughly with sodium sulfate before the surrogate and spike compounds are added. This is done per EPA Memo dated August 5, 2010 titled “Spiking (Prior To vs. After Sample Drying) Issue in SW-846 Organic Extraction Methods.”

17.3 SW-846 Method 3550C calls for the use of Büchner funnels and vacuum filtration of all extracts. This SOP calls for the use of conical funnels. This was done to prevent the extract from becoming trapped in the sodium sulfate in the Büchner funnel and specifically to improve the recoveries of benzoic acid, 2,4-dinitrophenol, and 4,6-dinitro-2-methylphenol.

17.4 Oklahoma Department of Environmental Quality method calls for the aliquot not to exceed 20 g. This procedure calls for the soil aliquot to be 30 g to 33 g.

17.5 Oklahoma Department of Environmental Quality DRO method calls for solvent to be added to the sample in a 1:1 ratio (milliliters of solvent to grams of sample). This procedure calls for 100 mL of solvent to be added to 30 g of sample.

17.6 Method from the state of Washington uses a 10 g soil sample that is shaken and processed in a sonic bath. This procedure calls for the soil aliquot to be 30 g to 33 g and is processed directly with a sonicator horn.

17.7 Methods 3550B and 3550C instruct the lab to determine the dry weight of the sample. This is performed according to SOP DV-WC-0023 and is not included in this SOP.

17.8 The medium/high concentration extraction procedure described in Methods 3550B and 3550C is not addressed in this SOP.

18.0 Revision History

Rev 12, dated 20 November 2018

- Added section 7.1.

Rev 11, dated 5 November 2018

- Revised last sentence in the Copyright Information section.
- Corrected MDL SOP Number in section 13.1.
- Added reference to WI-DV-0009 to section 10.9.1.

Rev 10, dated 31 July 2018

- Revised section 10.5.1 to reflect sonicator horn condition evaluation current practice.
- Added section 10.5.1.1 detailing corrective action required for poor sonicator horn condition.
- Added attachment Figure 1 to reference sonicator horn pitting conditions.

Rev 9, dated 31 March 2018

- Annual Review

Rev 8, dated 31 January 2017

- Added the paragraph to Section 3.0 referencing the QAM for general definitions
- Added Section 4.8 in reference to 8270 compound Benzidine.

- Added the paragraph to Section 6.0 regarding documentation of ID for equipment and pipettes
- Updated Section 9.4 clarifying the use of 1 MB per batch
- Updated Section 9.6.3 to require an LCSD when there is no MS/MSD
- Added note to Section 10.6 to rotate glassware and positions
- Updated Section 10.13 to include the rising of the filter paper in addition to the sodium sulfate.
- Added a note to section 10.13 that yellow ring residue should not be significant if proper rinsing has occurred.
- Updated the language regarding MDLs in Section 13.1 to make it consistent with other SOPs
- Added current Section 13.2 LOQV definition/explanation

Rev 7, dated 31 January 2016

- Annual Technical Review
- Removed “with Teflon lined caps” from Section 6.5
- Updated Section 7.1 to contain verbiage consistent with other SOPs
- Updated Section 9.1 to contain verbiage consistent with other SOPs
- Added “from the laboratory’s inventory” to Sections 9.4.3 & 9.5.3 regarding the filter paper or gauze used for Wipe QC samples
- Added Section 9.6.3 regarding DoD MS/MSD requirements
- Added Section 10.3 instructing to not use specific glassware or equipment positions for MB and LCS/LCSDs.
- Updated the Note in Section 10.6.2 to ensure that glass wool is not touched with gloves for low-level phthalate analysis
- Added the need to NCM when additional sodium sulfate is required to Section 10.7.7
- Added instruction to Section 10.7.8 regarding the recording of weights of QC samples
- Added the need to record the pipettor ID used in Section 10.9.1
- Added Section 10.9.3 to ensure sample is free flowing prior to adding the surrogate standard.
- Added the total process time (1 minute 30 seconds) to Section 10.12
- Removed the use of Teflon lined lids from Section 10.16
- Updated Section 10.19 to place 1:1 methylene chloride: acetone extracts in a flammable rated refrigerator
- Revised Section 13.1 – Method Detection Limit Study (MDL)
- Revised Section 13.2 – Demonstration of Capabilities
- Revised Section 13.3 - Training Requirements
- Archived all revision histories 2010 and earlier

Rev 6, dated 31 January 2015

- Annual Technical Review
- Reformatted SOP
- Revised Section 7.1.4 to remove the requirement to test the sodium sulfate before use. This was done to reflect current practice in CA-Q-S-001 DV-1
- Removed references to low-level NDMA method 8270D_SIM_LL. Soils are extracted by method 3546 instead of 3550C.
- Updated Table 1 with methods listed in this SOP and current analytical SOPs.

Rev 5, dated 15 January 2014

- Expanded footnote for HT table in Section 8
- Updated Section 10.6.1 to match the current TALS method for Low-level NDMA.
- Added Section 10.2
- Added Section 10.20 Maintenance.
- Added Section 10.21 Troubleshooting.
- Table 1 was updated to reflect the current SOPs.
- Revised Sections 9 and 10.1 to reflect current practice.
- Section 9 was revised to state this procedure meets all DoD QSM 5 criteria.
- Section 9.11 was revised to clarify that sample duplicates do not count toward the 20 sample batch limit.

Rev 4, dated 30 November 2012

- Updated Section 8 to indicate per SW-846 Revision 4, soils and wipes for analysis under Method 8082A do not have a holding time.
- Updated Section 9.9 to indicate that the DoD does not require LCSD.
- Updated Section 10.5.7 to indicate that the initial sample weight might have to be reduced for extremely wet samples.
- Section 10.5.5 was revised to remove the requirement to document the extraction date on the extract label.
- Updated Section 15 to include Waste Stream CA.

Rev 3.1, dated 30 November 2011

- Source method review
- Removed references to Method 8070; method no longer active at lab.
- Updated Section 9 to state that MBs and LCSs for wipe samples are created either from filter paper or sterile gauze.
- Added Section 9.11 to include definition and requirements for sample duplicate.
- Added a Note to Section 10.5.6 to describe how to adjust the initial aliquot mass to compensate for percent moisture.
- Updated Section 17 to exclude dry weight determination, high concentration method and Method NWTPH-HCID.
- Updated method references to include NWTPH-HCID.
- Updated SOP references in Table 1 to reflect active SOPs.
- Formatting and grammatical changes throughout

Earlier revision histories have been archived and are available upon request.

19.0 Attachments

Table 1: Determinative Methods Using Ultrasonic Extraction
Figure 1: Sonicator Horn Condition Reference Images.

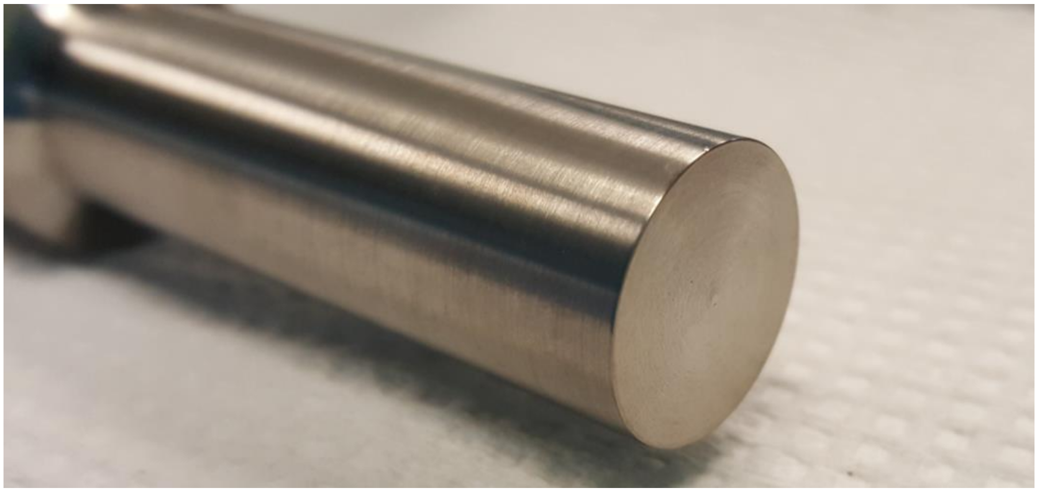
TABLE 1.

Determinative Methods Using Ultrasonic Extraction

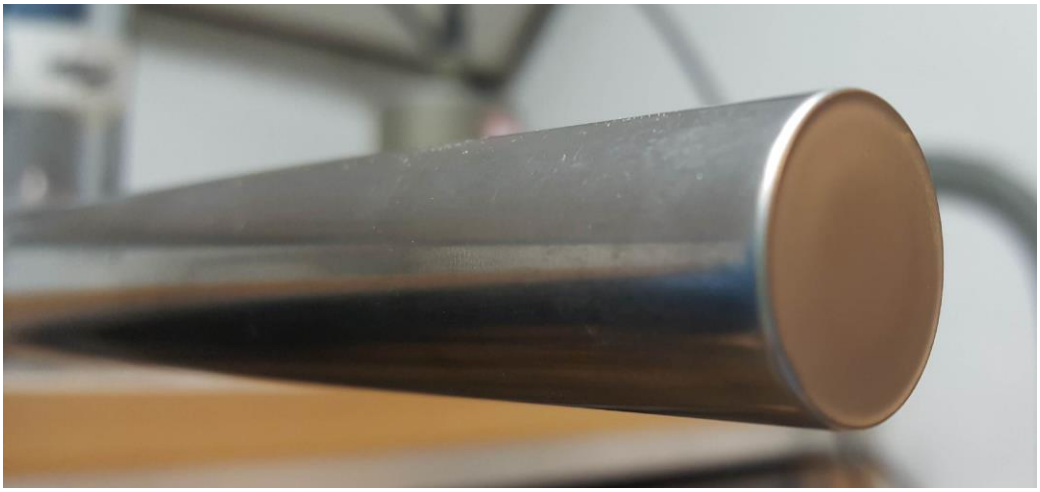
Method Description	Determinative Method	SOP
Diesel Range Organics, Jet Fuels, Motor Oil, Residual Range Organics	SW-846 8015B SW-846 8015C SW-846 8015D Alaska Methods AK102 & AK103 NWTPH-Dx Oklahoma DRO Method	DV-GC-0027
Chlorinated Pesticides	SW-846 8081A SW-846 8081B	DV-GC-0020
Polychlorinated Biphenyls	SW-846 8082 SW-846 8082A	DV-GC-0021
Polynuclear Aromatic Hydrocarbons	SW-846 8310	DV-LC-0009
Semi-volatiles by GC/MS	SW-846 8270C SW-846 8270D	DV-MS-0011 DV-MS-0012
Polynuclear Aromatic Hydrocarbons by GC/MS	SW-846 8270C SIM SW-846 8270D SIM	DV-MS-0002

Figure 1.

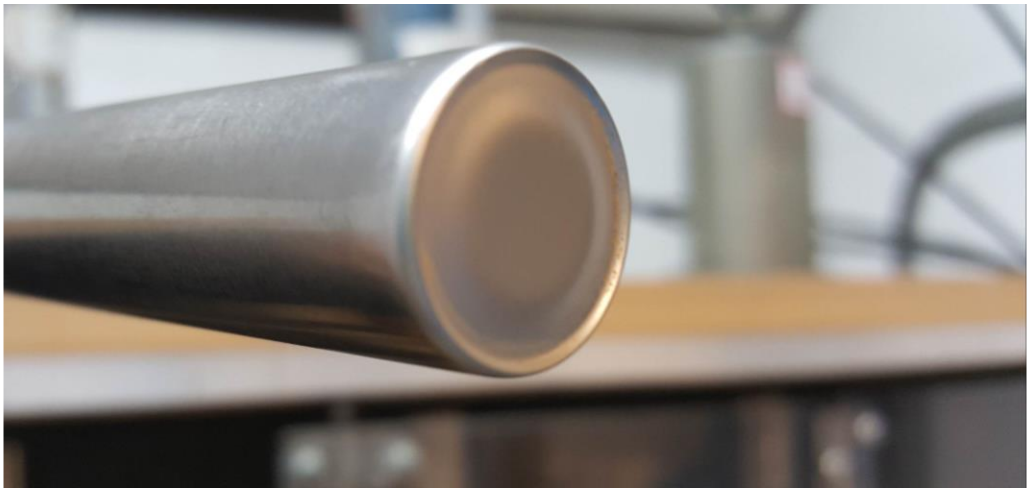
Sonicator Horn Condition Reference Images



Condition: good; no further action needed.



Condition: fine; minor pitting, monitor condition.



Condition: poor; heavy pitting, replace horn.

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Electronic Copy Only

Title: Solid Phase Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Water Samples [SW-846 3535A]

Approvals (Signature/Date):

12/10/18
Andrew Pepping — Date
Technical Specialist

Doug Gomer 12/10/18
Doug Gomer — Date
Health & Safety Manager / Coordinator

12/11/18
Roxanne Sullivan — Date
Quality Assurance Manager
Thomas Lill, signing for Roxanne Sullivan.

12/10/18
Richard Clinkscales — Date
Laboratory Director

Facility Distribution No. ___________

Distributed To:________________________

1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the extraction of nitroaromatic and nitroamine explosive residues by solid phase extraction (SPE) from aqueous samples. This procedure is based on SW-846 method 3535A.

1.2 This procedure does not describe the analysis of the extracts. For those details, see the following SOPs:

1.2.1 DV-LC-0002, *Analysis of Nitroaromatic and Nitroamine Explosive Compounds by HPLC*

1.2.2 DV-LC-0010, *Analysis of Nitroaromatic and Nitroamine Explosives Compounds by APCI/LC/MS*

2.0 Summary of Method

2.1 Aqueous samples undergo solid phase extraction (SPE). For samples that are to be analyzed by method 8330A or 8330B, 25 g of NaCl is added to a 500 mL sample aliquot and extracted. For samples that are to be analyzed by method 8321A or 8321B LC/MS, or by 8321B LCMSMS, a 1,000 mL aliquot is extracted. The analytes are absorbed onto the sorbent material in the SPE cartridge and then eluted with 2.5 mL of 0.1% acetic acid in acetonitrile. The concentrated extract is diluted 1:1 with an aqueous solution of calcium chloride prior to analysis by method 8330A or 8330B or with water prior to analysis by method 8321A or 8321B.

3.0 Definitions

3.1 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and Policy DV-QA-003P, *Quality Control Program*, for definitions of general analytical and QA/QC terms.

3.2 Explosives: As used in this SOP, the term “explosives” refers specifically to the analytes listed in the Tables of EPA Method 8330A, 8330B, and the DoD Quality Systems Manual (QSM). These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.3 SPE: Solid Phase Extraction

3.4 LIMS: Laboratory Information Management System

4.0 Interferences

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by running method blanks.

4.2 Contamination by carryover can occur when a low-concentration sample is analyzed immediately following a high-concentration sample.

4.3 The extraction of high-level samples can cause contamination in the extractions lab, especially on the solid-phase manifold. If water samples appear to have a red tint or if the extracts appear to be multi-phasic, the project manager and client should be contacted and care should be taken to minimize cross-contamination.

4.4 It has been determined that tetryl can adhere to the cartridge in such a manner that pure acetonitrile will not elute the compound off of the cartridge packing. It is surmised that tetryl may become ionized in the extraction procedure and adhere more tightly to the cartridge packing than the other explosives. Therefore the elution is performed with 0.1% acetic acid in acetonitrile. The lab has demonstrated increased recoveries for tetryl when this slightly acidic elution solvent is used.

4.5 Samples with suspended solids or sediment can cause the extraction cartridge to clog. It may be necessary to filter the samples before extraction to prevent this. If a sample is filtered prior to extraction, an NCM should be written.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual, and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.2 Specific Safety Concerns or Requirements

Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3 Primary Materials Used

5.3.1 The following is a list of materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not contain all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.

5.3.2 A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
ACETONITRILE	FLAMMABLE POISON	40 PPM – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
METHANOL	FLAMMABLE POISON IRRITANT	200 PPM - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.
PHOSPHORIC ACID	CORROSIVE	1 PPM - TWA	Ingestion can cause severe burns to the throat, mouth, and stomach, abdominal pain and nausea. Severe exposures by ingestion can lead to shock, circulatory collapse, and death. Inhalation is not an expected hazard unless misted. Corrosive, contact with skin or eyes can cause redness, pain, severe burns, blurred vision, and permanent eye damage.
ACETIC ACID, GLACIAL	CORROSIVE POISON FLAMMABLE	10 PPM – TWA	Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Can cause serious damage to the skin, including redness, pain, and burns. Contact with eyes may cause severe damage followed by loss of sight.
METHYLENE CHLORIDE	CARCINOGEN IRRITANT	25 PPM (TWA) 125 PPM (STEL)	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness, and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
(1) ALWAYS ADD ACID TO WATER TO PREVENT VIOLENT REACTIONS. (2) EXPOSURE LIMIT REFERS TO THE OSHA REGULATORY EXPOSURE LIMIT.			

6.0 Equipment and Supplies

6.1 Equipment

All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

6.1.1 Vacuum manifold for SPE cartridges. Capable of maintaining approximately 66 cm (26”) of Hg. After each use, the valves and tube caps are removed from the manifold, set to the open position and placed in a jar with acetonitrile. The jar is placed into a sonication bath for a minimum of 30 minutes. The jar used to sonicate the valves should be replaced at least weekly to avoid contamination.

6.1.2 Nitrogen evaporation apparatus (N-EVAP) for the concentration of some water extracts.

6.1.3 Balance capable of measuring ± 0.1 g. Calibration checked per SOP DV-QA-0014. Used to measure the initial sample mass and volume.

6.1.4 Pipettor with disposable 1.0 mL tips. Calibration checked per SOP DV-QA-0008. Used to add surrogate and spike standards to samples.

6.1.5 Pipettor with disposable 0.1 mL tips. Calibration checked per SOP DV-QA-0008. Used to add surrogate and spike solution to samples.

6.1.6 Pipettor capable of dispensing 5 to 50 mL. Calibration checked per SOP DV-QA-0008. Used to calibrate vials to hold 5 mL for the final volume determination for water extracts.

6.2 Supplies

6.2.1 pH paper, wide range.

6.2.2 Volumetric Flasks and Graduated Cylinders, glass, Class A, various sizes

6.2.3 Amber Glass Vials, 8.0 mL, with Teflon-lined screw caps. For the storage of final extracts. Vials used to store the final extracts are calibrated to hold a volume of 5 mL by using a calibrated pipette to deliver 5 mL of acetonitrile into the vial and marking the meniscus with a fine-tipped permanent marker. This volume is accurate to ± 2%.

6.2.4 Disposable pipettes, used for non-quantitative transfers only.

6.2.5 SPE Cartridges for Methods 8330A and 8330B (PoraPak RDX 6 cc tubes, Waters part no. WAT047220).

6.2.6 SPE Cartridges for method 8321A and 8321B (Strata SDB-L 500 mg packed into 6 mL tubes, Phenomenex part no. 8B-S014-HCH).

6.2.7 SPE tubing, non-PTFE in composition, with weights attached to one end. Tubes are cleaned before and after each use with acetonitrile followed by reagent water.

6.2.8 Miscellaneous laboratory apparatus (beakers, filter flasks, Büchner funnels, volumetric flasks, pipettes etc.). These should be disposable where possible, or marked and segregated for high-level versus low-level use.

6.2.9 Glass fiber filter paper, Ahlstrom, catalog number 1510-0900 or equivalent.

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent Water – TestAmerica Denver has three ELGA Analytical water purification systems equipped with UV lamps. The water coming from the ELGA system should have a resistivity of 18 - 18.2 Mohm-cm. The performance of the water polishing system is checked daily and recorded per SOP DV-QA-0026.

7.2 Acetonitrile, CH_3CN - HPLC grade (ACN) – Each lot of solvent is tested following CA-Q-S-001. QA personnel post the list of approved lots at solvent storage areas.

7.3 Phosphoric acid, 85% H_3PO_4 (Phosphor Acid) – Purchased ready to use. Used to make up the $CaCl_2$ Solution in Section 7.4**.**

7.4 Calcium Chloride Solution, 5 g/L (CaCl2_Sol) - Used to bring the 8330A and 8330B extracts up to volume.

Place 5 ± 0.05 g of reagent grade $CaCl_2$ into a one-liter volumetric flask containing approximately 500 mL of reagent water. Swirl the solution until the $CaCl_2$ is dissolved. Add approximately 1 mL of 85% H_3PO_4 to acidify the solution and make up to volume with reagent water.

7.5 Approximately 0.1% Acetic Acid in Acetonitrile (0.1%AAinACN) – Open a new 4-liter bottle of acetonitrile and add 4 mL of acetic acid. Cap and mix. This reagent is given a 1 year expiration date.

7.6 Baked Sodium Chloride – Added to 8330A or 8330B samples to facilitate the extraction of picric acid. Bake in 400 °C oven for at least 4 hours.

7.7 Methylene Chloride – Used to pre-condition the SPE cartridges.

7.8 Standards

7.8.1 Please reference SOP DV-OP-0020 and WI-DV-0009 for information regarding the surrogate and spike standards used in this procedure.

7.8.2 The LCS standards should remain in the freezer for storage. The standard is to be brought to room temperature before use.

8.0 Sample Collection, Preservation, Shipment and Storage

Method	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
8321A or 8321B	Amber glass; Teflon caps	1 Liter	Cool. ≤ 6 ^{o}C, not frozen	7 Days	SW-846 8330B
8330A or 8330b	Amber glass; Teflon caps	500 mL	Cool. ≤ 6 ^{o}C, not frozen	7 Days	SW-846 8330B

[1] Exclusive of Analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the TestAmerica LIMS (TALS) Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.0 and 5.1 unless otherwise stated. Any deviation or exceptions from QSM 5.0 or 5.1 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in TALS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 12.0 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

At least one method blank must be processed with each preparation batch. The method blank consists of reagent water, which is free of any of the analyte(s) of interest. The method blank is processed and analyzed just as if it were a field sample.

9.5 Laboratory Control Sample (LCS)

One LCS must be processed with each preparation batch (see Section 9.6.2). The LCS consists of reagent water to which the analyte(s) of interest are added at known concentration. The LCS is carried through the entire analytical procedure just as if it were a sample.

NOTE: If insufficient sample volume is available for an MS/MSD, an NCM must be written and a LCSD must be prepared.

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.6.1 One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

9.6.2 If insufficient sample volume is available for MS/MSD, an NCM must be written and a LCSD must be prepared.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Clean the SPE manifold and tubing - Pull acetonitrile, followed by water from the ELGA system, through each tube and each port on the vacuum manifold.

NOTE: For method 8321A and 8321B be sure to use the Strata SDB-L cartridges. For method 8330A and 8330B be sure to use the PoraPak RDX cartridges.

10.4 Precondition the SPE cartridge

10.4.1 **For method 8330:** Fill each cartridge two times with methylene chloride (12 mL total) and draw it through the column by gravity. Then fill each cartridge two times with acetonitrile (12 mL total) and draw it through the column by gravity.

10.4.2 **For method 8321:** Fill each cartridge two times with acetonitrile (12 mL total) and draw it through the column by gravity or using a vacuum manifold. Empty the in-process tank into waste stream C.

10.5 **Condition the SPE cartridge -** Fill the cartridge four times with reagent water and draw the water through the cartridge. Fill the cartridge a fifth time and close the valve to prevent the water from dripping through. Cap each cartridge using clean and dry caps.

10.6 **Prepare MBs and LCSs** – For every MB and LCS sample by method 8330A and 8330B, place 500 mL of reagent water in a disposable 500 mL Boston round bottom bottle. For every MB and LCS sample by method 8321A and 8321B, place 1,000 mL of reagent water in a disposable 1,000 mL Boston round bottle.

NOTE: Rotate glassware; do **not** use specific glassware or positions for the MB and LCS/LCSD.

10.7 **Inspect the water sample for the presence of sediment.** The sample must be free of particulate matter before it is introduced into the SPE extraction cartridge. Particulate matter will obstruct the media and cause the analysis to fail. If the samples have sediment or suspended solids, proceed to Section 10.8. If the samples are particulate free, proceed to Section 10.9.

10.8 **Filter Samples with Solids**. If the sample contains suspended solids or settled solids that will likely clog the solid phase cartridge, then the sample can be vacuum filtered though glass fiber filter paper to separate the solids from the water. Rinse a filter flask and a Büchner funnel lined with filter paper once with acetonitrile and twice with water. Under vacuum, filter the sample. Do not rinse the original sample container as this will incorrectly raise the initial volume of the sample. If there is no sediment remaining in the original sample container, return the sample to the original sample container. Whenever possible, the sample should be extracted directly from the original sample container. This will allow the sample container to be rinsed. If the original sample container contains sediment, the sample can be extracted in the filter flask. Write an NCM stating that the sample had to be filtered to remove suspended solids.

10.9 **Aliquot 8330 Samples received in 1 L ambers -** Whenever possible, the sample should be extracted directly from the original sample container. This will allow the sample container to be rinsed at the end of the procedure. If the original sample container is a 1,000 mL container and the requested method is 8330A or 8330B, then a 500 mL aliquot should be transferred to a new disposable 500 mL amber bottle. Write an NCM to document that the rinse of the original sample container could not be performed. Follow the procedures in Section 10.10 to aliquot either gravimetrically or volumetrically.

10.10 **Aliquot Samples -** It is the laboratory's standard procedure to aliquot samples gravimetrically. Check the Method Comments to see if volumetric aliquotting is required.

10.10.1 **Aliquot Gravimetrically -** Weigh the full sample bottle (either the original container or the filter flask) to the nearest gram using a top loading balance, and record the weight on the benchsheet. After the extraction, weigh the empty sample bottle, and record the weight. Subtract the empty bottle weight from the full bottle weight and record the difference as the sample volume in mL. If the initial volume is less than the nominal volume by 20% or more, prepare an NCM. If there is any indication that the density of the sample is not 1 g/mL, measure the density of the sample using a calibrated pipette and refer to Section 11.2. Proceed to Section 10.11.

10.10.2 **Aliquot Volumetrically -** For each sample, rinse a Class A graduated cylinder (500 mL for 8330, 1,000 mL for 8321) once with acetonitrile and twice with reagent water. Carefully pour the sample from the original container into the graduated cylinder, making sure that if any sediment is present, it is not transferred to the graduated cylinder. Record the volume to the nearest 10 mL. If the initial volume is less than the nominal volume by 20% or more, prepare an NCM. Transfer the sample back to the original sample container. Rinse the graduated cylinders with reagent water and add the rinse to the sample. If sediment was present in the original sample container the sample can be transferred from the graduated cylinder into a new amber glass bottle. Write an NCM to document that the rinse of the original sample container could not be performed. Place the original sample bottle beside the new sample bottle so a second analyst can check that the correct sample was aliquotted. Proceed to Section 10.11.

10.11 Salt the Samples for method 8330A and 8330B -- For methods 8330A and 8330B add 25 g of baked Sodium Chloride to every field sample and QC samples. This is done to facilitate the extraction of picric acid.

10.12 Add Surrogate Standards to Sample Containers - Add surrogate standard to each field sample and QC sample using a calibrated pipette. Reference WI-DV-0009 to determine the correct surrogate standard and the correct volume to be used. The surrogate standard should be added to the sample in the original sample container unless the sample had significant sediment, was received in the improper container, or aliquoted volumetrically. Record the ID of the standard and the pipette used on the bench sheet.

10.13 Add Spike Standards to Sample Containers - Add spike standard to each LCS, MS, and MSD sample using a calibrated pipette. Reference WI-DV-0009 to determine the correct spike standard and the correct volume of standard to be used. The spike standard should be added to the MS and MSD samples in the original sample containers unless the sample had significant sediment or was received in the improper container. Record the ID of the standard and the pipette used on the bench sheet.

NOTE: The addition of spikes and surrogates to samples must be done only after a second analyst has reviewed the batch. Reference work instruction WI-DV-0009. Also at this time the witness checks the sample labels to ensure samples are correctly identified.

10.14 Cap the samples and mix to ensure the salt, the surrogate, and the spike standards are mixed into the sample completely.

10.15 Connect the Tubing - Using the tubing that has been rinsed with acetonitrile and water, connect the cartridge to the sample container. If the extraction is being performed directly from the sample container care should be taken if there are solids that have settled to the bottom of the bottle. Clip the tubing so that the end is not resting on the bottom, but suspended above the solids.

10.16 Load the Sample onto the Cartridge

10.16.1 Begin drawing the sample through the cartridge at a rate of approximately 10 mL/minute. The solution should come out of the cartridge as individual drops. If the sample comes out of the cartridge in a stream instead of drops, the elution rate is too fast. 10 mL/minute is approximately 45 drops every 15 seconds.

10.16.2 Do not let the extraction tube go completely dry.

10.16.3 A cartridge is considered clogged if a flow rate of 4 mL/min. cannot be achieved. This is approximately 1 drop every second. If the cartridge clogs during sample loading, a second cartridge can be used for the sample and then extracts are combined. Alternatively, measure the amount of sample successfully extracted, and use that volume for the extraction constant. If this approach is used, then the surrogate and spike volumes must be corrected for the new initial volume. Narrate with an NCM. See Section 11 on how to calculate the actual surrogate and spike volumes.

10.16.4 Once the sample has been drawn into the tubing, rinse the walls of the sample container with at least 15 mL of reagent water. This will serve as the cartridge post-rinse. After all of the sample and the water used to rinse the container has gone through the line, close the valve and remove the line and the cap from the cartridge. It is important not to let the cartridge go dry, but to leave water in the cartridge.

10.17 Elute the Cartridge

10.17.1 Turn off the vacuum and remove the manifold lid. Wipe the needles dry with a laboratory tissue being careful not to spread contamination from needle to needle. The tissue used can be wetted with acetonitrile. Place the lid on a clean lab tissue. Place the vial holder inside the manifold and place 8 mL amber vials that have been calibrated to 5 mL inside the manifold on top of the vial holder. Replace the manifold lid and be sure that each valve needle is positioned inside a vial.

10.17.2 Using a serological pipette or a bottle-top re-pipettor, add 2.5 mL of 0.1% acetic acid in acetonitrile to each cartridge. Turn on the vacuum pump while the valves on the manifold are still closed, then quickly open and close each valve to create a vacuum in the cartridges. Turn off the vacuum pump and break the vacuum in the manifold. Open the valves to allow the 0.1% acetic acid in acetonitrile to slowly drip gravimetrically (approximately one drop in 5 seconds).

10.17.3 After the solution has stopped dripping, reapply the vacuum to ensure that the last portion of solvent is collected. This is a very important step.

10.17.4 If two cartridges were used, transfer all extracts into one collection vial and evaporate down to approximately 2.5 mL using a N-Evap. Continue to the next step.

10.18 Bring the extract up to the 5 mL final volume

10.18.1 For method 8330A and 8330B, add the calcium chloride solution to adjust the volume of the collected extract to the mark on the calibrated vial.

10.18.2 For method 8321A, add reagent water to adjust the volume of the collected extract to the mark on the calibrated vial.

10.19 Maintenance

10.19.1 As needed, the inside of the manifold block should be cleaned by washing with soap and water, rinsing with acetonitrile, and wiping with a laboratory tissue.

NOTE: The gasket covers should be checked weekly to ensure there are no signs of contamination showing such as discoloration etc, and to ensure that the gasket cover is not losing its seal.

10.19.2 After each use, the valves and tube caps are removed from the manifold, set to the open position and placed in a jar with acetonitrile and placed in a sonication bath for at least 30 minutes. If samples are suspected to be highly contaminated, a 1:1 mixture of acetonitrile and methylene chloride can be used.

10.19.3 Before and after each use, lines are rinsed with acetonitrile, followed by a water rinse.

10.19.4 Visually inspect lines after use and replace if there is any sign of contamination.

10.20 Troubleshooting

10.20.1 If the vacuum in not strong enough, change the seal on the manifold lid. Also check the pressure relief ball and replace it if cracked.

10.20.2 If a sample clogs the cartridge before a significant volume has been extracted, re-aliquot and re-prep the sample at a dilution. This can be done in the same batch, but the re-prep counts as an additional sample towards the 20 sample batch limit.

10.20.3 Consult a supervisor and/or the QA department with unusual sample matrices.

11.0 Calculations and Data Reduction

11.1 Volume of Surrogate or Spike Extracted = (V_{SA}) x (V_E) ÷ (V_I)

Where:

V_{SA} = Volume of Spike or Surrogate originally added.
V_E = Volume of Sample that was extracted through the cartridge
V_I = Volume of Sample that was originally spiked

Example: 0.1 mL of surrogate standard was added to a 253 mL sample.

During the extraction, the cartridge clogged and only 233 mL of sample was actually extracted.

Vol of Surrogate Extracted = 0.1 mL x 233 mL ÷ 253 mL = 0.092 mL

Therefore the initial volume on the benchsheet should be entered as 233 mL and the volume of surrogate should be entered as 0.092 mL.

11.2 Initial Volume

$$InitialVolume(mL) = \frac{FullBottle(g) - EmptyBottle(g)}{Density(g/mL)}$$

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

12.2.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

Solid phase extraction used for water samples greatly reduces the amount of solvent used compared to liquid/liquid extraction. Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in the Corporate Environmental Health and Safety Manual, and DV-HS-001P, *Waste Management Plan*.

14.1 The following waste streams are produced when this method is carried out:

14.1.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

14.1.2 Flammable solvent waste – Waste Stream C

14.1.3 Aqueous sample waste - Waste Stream X

14.1.4 Methylene chloride – Waste Stream B

14.1.5 Non-hazardous solid waste such as used cartridges can be disposed of in the regular trash.

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

15.1.1 Method 3535A, Solid-Phase Extraction (SPE), Revision 1, February 2007.

15.1.2 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

15.1.3 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

15.1.4 Method 8000C, Determinative Chromatographic Separations, Revision 3, March 2003.

15.1.5 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

15.1.6 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

16.0 Method Modifications:

16.1 Modifications from SW-846 8330

Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life
Stock standards	1,000,000 µg/L (1,000 ppm)	One year
Intermediate standards	2.5 to 1,000 µg/L	Thirty days
Working standards	1 to 500 µg/L	Daily

This SOP describes the use of 1,000 µg/L and 500 µg/L standards, which are assigned a six-month shelf life based on TestAmerica's experience with these materials.

16.2 Modifications from SW-846 3535A

16.2.1 Method 3535A prescribes a 1 liter sample volume. This SOP describes a 500 mL sample volume.

16.2.2 Method 3535A prescribes a 10 mL acetonitrile wash followed by a 30 mL water wash. This SOP describes a 12 mL methylene chloride wash followed by a 12 mL acetonitrile wash, followed by a 24 mL water wash. It is the lab's experience that the methylene chloride wash is helpful in removing interferences from the cartridge packing.

16.2.3 Method 3535A prescribes a 5mL acetonitrile elution. This SOP describes a 2.5 mL elution with approximately 0.1% acetic acid in acetonitrile. The lab has demonstrated increased recoveries for tetryl when this slightly acidic elution solvent is used. The extract is then brought to a 5 mL final volume with calcium chloride solution.

17.0 Attachments

None

18.0 Revision History

Revision 9 dated 11 December 2018

- Updated section 2.1 to reference 8321B by LCMSMS.
- Updated the definition of explosive in Section 3.2 with method references
- Corrected SOP reference in Section 7.2
- Removed vacuum draw from section 10.4.1 (preconditioning step for method 8330). Preconditioning should be done entirely by gravity draw for method 8330
- Rearranged sections 10.11 through 10.13 so that addition of salt occurs prior to addition of surrogate and spike standards. This allows salt to dissolve prior to loading onto the cartridge.
- Added note to 10.16.3 to clarify that an NCM should be generated.
- Added clarification to the container rinse in section 10.16.4 and absorbed “Wash the cartridge” section into 10.16.4. The post rinse is now included in the container rinse step.
- Updated MDL policy reference in section 12.1.
- Updated all references to WI-DV-009 to reference correct work instruction name, WI-DV-0009.
- Minor formatting and language corrections throughout

Revision 8 dated 31 October 2017

- Annual Review

Revision 7 dated 31 October 2016

- Updated section 3.1 to reflect consistent definition verbiage and reference to the QAM
- Added the paragraph associated to section 6.0 to document supporting equipment IDs
- Revised section 6.2.7 to indicate that non-PFTE tubing is used in lieu of Teflon lines and other verbiage.
- Updated the verbiage in section 6.3 to reflect current Software & Hardware information
- Revised section 7.8.2 removing requirement of sub-aliquoting the standard to match what the standards SOP outlines.
- Updated section 9.1 and subsection to reflect current and consistent verbiage regarding laboratory QA/QC requirements
- Removed reference to AFCEE in section 9.1.2
- Added LCSD required when no MS/MSD to sections 9.5.1 Note and 9.6.2
- Added the note to section 10.6 regarding the need to rotate glassware and extraction positions
- Added the note to section 10.20.1 to reflect the need of gasket cover maintenance
- Added section 10.20.4 to visually inspect lines after use and replace if contaminated
- Updated section 12.1, 12.2 and 12.3 to reflect current and consistent verbiage regarding laboratory method performance requirements.

Revision 6 dated 12 October 2015

- Section 16 was revised to describe method modifications in more detail.

Revision 5 dated 14 April 2015

- Annual Technical Review
- Removed reference to DV-LC-0025 “Analysis of Picric Acid by LC/MS/MS” from Section 1. The laboratory no longer maintains this method and SOP. Therefore the procedure was revised to remove the requirement to add 6M HCl to the samples for method 8321A.
- The procedure was revised to change the elution solvent from acetonitrile to 0.1% acetic acid in acetonitrile. This was done to improve the recoveries of tetryl. Section 4.4 was added to document the interference that was observed in tetryl which caused it not to fully elute when acetonitrile was used as the elution solvent. Added Section 16.3 to state this method modification.
- Section 4.5 was added to discuss how samples with sediment can interfere with the procedure.
- Section 10.16.1 was revised to better describe the proper rate of sample loading on the SPE cartridge.
- Added Section 15.5, reference for Method 8000C (required in Arizona)

Revision 4 dated May 30, 2014

- Annual Technical Review.
- Removed reference to DV-LC-0028 “Analysis of Nitroaromatic and Nitroamine Explosive Compounds by APCI/LC/MS/MS” from Section 1. The laboratory no longer maintains this method and SOP.
- Section 6.1 was revised to remove the requirement to disassemble the valves before soaking them in solvent.
- Section 7.2 was revised to require the testing of acetonitrile on a lot basis.
- Section 7.3 was revised to correct how the 6M HCl is prepared. The reagent is prepared using reagent water, HPLC grade water is not necessary.
- Section 7.9 was revised to instruct the analyst to only remove a portion of the LCS standard from the storage freezer each day.
- Updated table in section 8.0 and removed sections 8.1-8.3 as they were redundant with all info not in table.
- Revised Section 9.1 to state prep SOPs do not include acceptance criteria for QC samples – reference analytical SOPs.
- Section 9.1.2 was revised to state that this procedure meets all criteria of DoD QSM 5.0.
- Removed “Acceptance Criteria” and “Corrective Action” information from Section 9. This information can be found in the analytical SOPs.
- Revised Section 10.3 to include a methylene chloride rinse of the cartridge for method 8330. This was done to remove interferences. Methylene chloride was added to Section 5 Safety, Section 7 Reagents, and Section 14 Waste Management.
- Revised Section 10 to instruct the analyst to filter all samples with visible sediment, removing the instructions to decant samples that have settled solids.
- Added instructions to cap and mix the samples after the addition of the surrogate, spike, and acid or salt.
- Revised the instruction in Section 10.17 on how to prevent cross-contamination from the needles after the sample has been loaded onto the cartridge and before the cartridges have been eluted.
- Added sub-sections for Maintenance and Troubleshooting to Section 10 per DoD QSM 5.0.
- Updated section references to reflect revisions.
- Formatting changes throughout.

Revision 3 dated May 30, 2013

- Annual Technical Review
- Corrected formatting and grammatical errors.
- Section 6.1 was revised to give more detail on the cleaning of the valves and tube caps. The valves and tube caps should be sonicated in a jar of acetonitrile for at least 30 minutes before use. The jar uses should be replaced at least weekly.
- Section 6.2 was revised to remove aluminum foil and dishes as part of the supply list. These items are not used in the procedure.
- The procedure was revised to define reagent water as water coming from the ELGA purification system. The option for bottled HPLC water was removed. This was done to ensure consistency in the procedure and to reduce the cost and environmental impact of bottled water (shipping, empty bottle waste).
- Sections 10.6, 10.8, 10.9, and 10.10 were revised to instruct analysts to use disposable amber bottles instead of solvent-rinsed beakers. This was done to reduce the chance of cross-contamination and to reduce solvent usage and waste.

Revision 2.1 dated May 25, 2012

- Annual Technical Review
- Corrected formatting and grammatical errors.
- Updated Section 6.1 to incorporate the addition of 0.1 mL tips used to add surrogate and spike standards to samples.
- Revised Section 7.3 to state that 6M HCl Solution is added prior to extraction, when extracting for method 8321A or 8321B.
- Revised Section 7.7 to state that baked Sodium Chloride is used when extracting for method 8330A or 8330B.
- Updated Section 10.3 to more accurately describe the rinsing of all tubes and ports on the vacuum manifold.
- The instructions for aliquotting samples was moved to be before the instructions on surrogating and spiking the samples to match actual lab practice
- Updated Section 10.16 to include a reference to the Calculation Data Reduction Equation found in Section 11.
- Revised Section 11 to include a detailed equation, with example, on how to calculate the actual surrogate and spike volumes of samples when the extraction cannot be completed after use of a second cartridge.

Earlier revision histories have been archived and are available upon request.

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TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Electronic Copy Only

Title: Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples [SW-846 8330A & 8330B]

Approvals (Signature/Date):

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Facility Distribution No. ___________ **Distributed To:**_______________________

1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the extraction of nitroaromatic and nitroamine explosive residues from soil samples. This procedure is based on SW-846 8330A and 8330B, but can also be performed on samples for analysis by method SW-846 8321A.

1.2 This procedure does not describe the analysis of the extracts. For those details, see the following SOPs:

1.2.1 DV-LC-0002, *Analysis of Nitroaromatic and Nitroamine Explosive Compounds by HPLC.*

1.2.2 DV-LC-0010, *Analysis of Nitroaromatic and Nitroamine Explosives Compounds by APCI/LC/MS.*

1.2.3 DV-LC-0025, *Analysis of Picric Acid by LC/MS/MS.*

1.3 Application of 8330A versus 8330B

1.3.1 This procedure is for extraction by either Method 8330A or 8330B. The most important differences in the two source methods are the more rigorous sample collection and preparation measures in 8330B, which are designed to produce more representative results. The more rigorous 8330B process is specifically intended to complement the incremental field sampling process described in Appendix A of method 8330B. If incremental or equivalent systematic sampling processes are not employed in the field, then the extra laboratory homogenization and subsampling effort 8330B requires may add little or no improvement in the overall precision of results.

1.3.2 A larger sample size is used for 8330B (10 g) than is used for 8330A (2 g). A larger sieve size is used for 8330B (10 mesh) than is used for 8330A (30 mesh).

2.0 Summary of Method

Solid samples are air dried to a constant weight and sieved. Soil agglomerates are broken with a mortar and pestle, sieve shaker, or mechanical disaggregator. For samples requiring the more rigorous homogenization techniques found in method 8330B, the analyst employs a ring and puck grinder. The samples are extracted with a 0.1% acetic acid in acetonitrile mixture on a shaker table.

3.0 Definitions

3.1 Definition of terms used in this SOP may be found in the Glossary section of the TestAmerica Denver Quality Assurance Manual (QAM) or SOP DV-QA-003P, *Quality Control Program.*

3.2 **Explosives:** As used in this SOP, the term “explosives” refers specifically to the analytes listed in Table 1. These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.3 **TALS:** TestAmerica Laboratory Information Management System

3.4 **ISM:** Incremental Sampling Methodology - This is a requirement of method 8330B and describes the technique used to take a 10 g aliquot from a sample in at least 30 increments.

3.5 **Extraction Holding Time**: The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in TALS, and is the primary basis of prioritizing work.

3.6 **Preparation Batch**: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards.

3.7 **Grinding Batch:** A grinding batch is up to 20 samples processed through the same grinding procedure. When using the ring and puck mill, the grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner, due to the expiration of the grinding LCS.

3.8 **Method Comments:** The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client.

3.9 **Quality Assurance Summary (QAS)**: Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in TALS. In these situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.10 **Aliquot**: A part that is a definite fraction of a whole; as in “take an aliquot of a sample for testing or analysis.” In the context of this SOP, “aliquot” is also used as a verb, meaning to take all or part of a sample for preparation, extraction, and/or analysis.

4.0 Interferences

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by running method blanks.

4.2 Contamination by carryover can occur when a low-concentration sample is extracted immediately following a high-concentration sample.

4.3 Samples from an ammunition plant or depot usually contain analytes that were deposited via water and leaching and therefore are more uniformly dispersed. Therefore, as per SW-846 8330B Section 11.1.4.2, ring and puck is not necessary.

4.4 Samples from firing ranges and impact zones can contain particles of explosives at a variety of sizes, shapes, and compositions. Therefore the entire sample must be processed through a ring and puck prior to removal of the subsample for analysis. Samples collected at the firing point can contain nitrocellulose fibers. These fibers present a special problem in the grinding step. In order to get the fibers to release the target analytes they must be very finely ground. For these samples only the ring and puck should be used. The client needs to be consulted when selecting a grinding mechanism.

4.5 Tetryl decomposes rapidly with exposure to heat as well as methanol/water solution. All samples expected to contain tetryl should not be exposed to temperatures above room temperature.

5.0 <u>Safety</u>

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual, and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.2 Specific Safety Concerns or Requirements

5.2.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately. When tightening caps on 40 mL glass vials, cut resistant gloves must be worn.

WARNING: Soil samples with explosive concentrations greater than 2% cannot be accepted by the laboratory unless they have moisture content of 25% or greater. Under no circumstances shall a soil sample with an explosive concentration greater than 10% be accepted by the laboratory.

5.2.1.1 If a sample is expected to have an explosive concentration ≥ 2% (but less than 10%), the EH&S Coordinator and Group Leader shall be notified before any work is performed. Additional safety precautions may be implemented as required due to high concentrations of explosives.

5.2.1.2 Soil samples with high concentrations (between 2 and 10%) of explosives should not be ground using a mortar and pestle. Visual observation of a soil samples is important prior to grinding samples. Any samples containing metal fragments, powders, waxy appearing pieces, or other suspicious material should be brought to the attention of the Group Leader and the EH&S Coordinator before proceeding with the procedure. Bypassing the grinding step and proceeding to solvent dilution is an alternative for samples that are determined to be unsafe to grind.

5.2.2 Anyone working in the grinding room needs to be enrolled in the Hearing Conservation Program. See SOP DV-HS-0010 for details. Personnel operating the grinding equipment are required to wear ear plugs when the equipment is turned on. When standing next to the Humbolt mechanical grinder described in Section 6.1.11 during operation, the decibel levels are above 80 decibels, therefore anyone operating the grinder must be enrolled in the Hearing Conservation Program and wear hearing protection. While the grinder is running, the decibel levels in the room are below 80 decibels, therefore personnel not enrolled in the Hearing Conservation Program can be in the room. Hearing protection is always available to every analyst and they are encouraged to use it.

5.2.3 Operations involving handling samples outside of sealed containers are conducted in ventilation hoods to avoid exposure to dust. Dust masks are available for use, but are optional.

5.2.4 Operations involving the grinding of radioactive samples can be particularly hazardous due to the increased potential for exposure from airborne dust. If a sample is labeled as a “CAT 1”, “CAT 2”, “CAT 3” or “CAT 4” sample, and requires grinding thru the ring and puck, contact the RSO immediately.

5.3 Primary Materials Used

The following is a list of materials used in this method, which have a serious or significant hazard rating. ***This list does not contain all materials used in the method.*** The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
ACETONITRILE	Flammable Poison	40 PPM – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
METHANOL	Flammable Poison	200 PPM - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
	Irritant		headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.
ACETIC ACID, GLACIAL	Corrosive Poison Flammable Liquid and Vapor	10 PPM - TWA	Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Can cause serious damage to skin, including redness, pain, and burns. Contact with eyes may cause severe damage followed by loss of sight.
(1) ALWAYS ADD ACID TO WATER TO PREVENT VIOLENT REACTIONS. (2) EXPOSURE LIMIT REFERS TO THE OSHA REGULATORY EXPOSURE LIMIT.			

6.0 Equipment and Supplies

6.1 Equipment

All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

6.1.1 Balance, capable of measuring ± 0.01 g. Calibration checked per SOP DV-QA-0014.

6.1.2 Orbital shaker table, capable of maintaining 150 rpm for 18 hours.

6.1.3 Pipettor with disposable 1.0 mL tips, accurate to ± 2%, calibration checked daily in accordance with SOP DV-QA-0008.

6.1.4 Bottle-top pipettor, able to dispense 8 to 20 mL, accurate to ± 2%, calibration checked daily in accordance with SOP DV-QA-0008. If the pipettor does not have a digital display, then the calibration check should be performed whenever the pipette is adjusted.

6.1.5 Ring and Puck - for the grinding of soils per method 8330B

The grinding bowl and puck are cleaned after each use by washing with soap and water with a plastic brush, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% acetonitrile solution in acetone. A final wipe down of the bowl and puck while still wet with solvent is done with a Kimwipe (TNT in particular is reported to be prone to adhering to steel surface). In addition, sand blanks are used to monitor potential carry-over for each batch of samples (see Section 9.10.1 for details).

6.1.6 Sample drying systems

6.1.6.1 Trays – "baker's rack" type of stack for the air drying of soils per method 8330B Trays – "baker's rack" type of stack for the air drying of soils per method 8330B

6.1.6.2 Drying tower – custom built tower similar to "baker's rack" type stack for air drying soils, including drying fans and air filters.

6.1.7 Sieves, 10 and 30 mesh – Sieves are cleaned after each use by washing with soap and water and a green plastic brillo pad, (be careful not to damage the mesh), rinsing with hot tap water, rinsing with DI water. Prior to use, the sieves are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe. Sieves are allowed to dry in a hood prior to use.

6.1.8 Receiver pans and lids – Receiver pans are cleaned after each use by washing with soap and water, rinsing with hot tap water, rinsing with DI water. Prior to use, the receiver pans are rinsed with a 10% acetonitrile in acetone and wiped dry with a Kim Wipe.

6.1.9 Sieve shaker – used to facilitate the sieving of large sample volumes.

6.1.10 Mortar and pestle – cleaned after each use by washing with soap and water, rinsing with hot tap water, and then rinsing with DI water. Prior to use, the mortars and pestles are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe and allowed to dry in a hood prior to use.

6.1.11 Mechanical Disaggregator – Humbolt Manufacturing Part Number H-4199. Used in place of a mortar and pestle to quickly reduce cakes of dry soil. The disaggregator reduces soil agglomerates and sieves the soil through a 10 mesh sieve. The mechanical disaggregator is used to break up soil agglomerates, but it is not an alternative to Ring and Puck. The mechanical disaggregator is cleaned after each sample by removing the hopper. The hopper is washed with soap and water, rinsed with tap water, rinsed with DI water, and then rinsed with 90:10 Acetone:Acetonitrile. The Hopper is then wiped dried with a laboratory tissue. The hammers and body of the disaggregator are cleaned after each sample by rinsing with DI water and wiping dry with a laboratory tissue.

6.2 Supplies

6.2.1 Glass vials, various sizes.

6.2.1.1 Amber glass, 40 mL, with Teflon-lined screw caps for the sonication of soil samples.

6.2.1.2 Amber glass, 8.0 mL, with Teflon-lined screw caps, for the storage of final extracts.

6.2.2 Aluminum foil and aluminum dishes.

6.2.3 Parchment paper

6.2.4 0.2-µm PTFE syringe filters and disposable syringes.

6.2.5 Wooden spatulas – used to lay samples out to dry.

6.2.6 Subsampling tools:

6.2.6.1 Scored paper scoops (TAL-0150 and TAL-0150 LARGE from Commodity Management Services)

6.2.6.2 Plastic sample scoops – square-ended

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Ottawa Sand – baked at 400 °C for at least 4 hours.

7.2 Acetonitrile, CH_3CN - HPLC grade (ACN). Each lot is tested per CA-Q-S-001 DV-1.

7.3 Soil Extraction Solvent – approximately 0.1% acetic acid in acetonitrile – Open a new 4-liter bottle of acetonitrile and add 4 mL of acetic acid, then cap and mix. This reagent is given a 1 year expiration date.

7.4 Standards

Please reference SOP DV-OP-0020 for information regarding the surrogate and spike standards used in this procedure.

7.5 Grinding LCS Bulk Material

A standard is purchased in a matrix of -20/+70 Sieved Soil that contains the compounds at the concentrations listed in Table 2. This standard comes packaged in 500 g containers. This standard is stored in a refrigerator at 0 °C to 6 °C and is given a 1 year expiration date. After grinding the ground LCS is stored refrigerated and has a three day expiration date.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Soil samples to be extracted by method 8330A for analysis by method 8330A should be collected in eight-ounce wide mouth jars with Teflon-lined caps. When sampling for DoD projects that must comply with DoD QSM requirements for drying and sieving the entire contents of a soil sample container, a separate container should be used to collect a soil sample for this analysis.

8.2 For soil samples to be extracted by method 8330B for analysis by either method 8330B or method 8321A, it is not uncommon to receive samples of 1 kg or more. Samples may be shipped in wide mouth jars or clean plastic bags.

8.3 Sample extracts must be stored refrigerated in amber glass containers at ≤ 6 °C and not frozen.

8.4 Soil and sediment samples should be air dried at ambient temperature until dry enough to sieve. See Section 10.3 for details. Once the sample is air dried, the sample can be stored at room temperature.

8.5 All soil and sediment samples must be extracted within 14 days of collection and analyzed within 40 days after extraction begins.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Soils	Glass/ plastic	4 grams (8330A)/up to 1 kg (8330B)	Cool ≤ 6 °C	14 Days	SW846 8330A/B

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver Policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.1 unless otherwise stated. Any deviation or exceptions from QSM 5.1 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the TestAmerica LIMS (TALS) and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 0 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument. See QC Policy DV-QA-003P for further details.

Grinding Batches – A grinding batch is up to 20 samples processed through the same grinding procedure. When using the ring and puck mill, the grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner, due to the expiration of the grinding LCS.

9.4 Method Blank (MB)

A method blank (MB) must be prepared and analyzed with each batch of samples. The MB consists of Ottawa sand with surrogates added. The MB is created at the time of extraction after the samples have been dried, sieved, and ground and is then carried through all extraction and analysis steps. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data.

9.5 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)

One LCS must be analyzed with each batch of samples. The LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. The LCS is prepared by spiking the analytes of interest into Ottawa sand. The LCS is created at the time of sample extraction after the samples have been dried, sieved, and ground. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

NOTE: DoD requires the MS/MSD to be assigned by the client. When there is no assigned MS/MSD or there is not enough sample volume provided a LCSD is not required unless requested by the client.

9.6 Matrix Spike Sample (MS) and Matrix Spike Duplicate (MSD)

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. The soil matrix spikes are created at the time of extraction. Spikes and surrogate compounds are added after the sample has been dried, sieved, and ground. One MS/MSD pair must be processed for each preparation batch. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.

If insufficient sample volume is available for MS/MSD, a LCSD must be performed and an NCM must be written.

NOTE: DoD requires the MS/MSD to be assigned by the client. When there is no assigned MS/MSD or there is not enough sample volume provided a LCSD is not required unless requested by the client.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, DU, TRL, MS, and MSD) is spiked with surrogate compounds.

9.8 Sample Duplicate (DU)

A duplicate sample is required after ring and puck grinding is performed. A duplicate sample is also required for method 8330B, even if grinding is not performed. A sample duplicate is a second aliquot of one of the samples in the batch. Field blanks cannot be used for duplicate testing. The results for duplicates are reported separately, and cannot be averaged when reporting results. Sample duplicate results are used to evaluate the precision of the method. As such, results should be greater than or equal to the RL for a valid statistical comparison.

9.9 Sample Triplicates (TRL)

A triplicate sample is required after ring and puck is performed. A triplicate sample is also required for method 8330B, even if grinding is not performed. The lab will determine the %RSD as defined below. Results for the %RSD as well as the individual replicate results will be reported to the client. The method suggests that the %RSD for the subsampling error is acceptable if it is < 10%. For DoD QSM 5.1, the %RSD is acceptable if it is < 20% for results above the LOQ.

The percent relative standard deviation (%RSD) is calculated as follows:

$$\%RSD = \frac{s}{\overline{C}} \times 100\%$$

Where s is the standard deviation of the average concentration and is calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \overline{C})^2}{n-1}}$$

In the event that the laboratory is requested to perform the evaluation of field replicate precision, three field replicates designated by the client will be processed through the entire homogenization and extraction steps. The %RSD for these replicates will be calculated as indicated above and reported to the client.

9.10 Grinding Blank (GB)

9.10.1 Ring and Puck Grinding Blanks

Before each sample is processed through the ring and puck mill, the ring and puck will be cleaned per Section 6.1.5. Then approximately 200 g of Ottawa Sand will be ground. This ground sand will be saved and labeled with the sample ID of the next sample ground with the suffix “blank”. After a batch of samples has been processed through the ring and puck, a composite will be generated using sub-aliquots from all blanks ground before the samples. This is done by placing approximately 1 tablespoon of material from each of the individual sample blanks in a clean re-sealable plastic bag. The bag is then sealed and the material is mixed and homogenized by shaking and kneading the bag. A 10 g aliquot is then removed from the bag and labeled as the batch grinding blank. This composite is extracted and analyzed in the same manner as the field samples.

<u>Corrective Action</u>: If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. Samples associated with a contaminated grinding blank producing positive results for the same contaminant, must be reprocessed and reanalyzed. If un-ground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative.

9.11 Grinding LCS (LCSSRM)

One Grinding LCS must be ground and analyzed with each batch of samples that are processed through the ring and puck. The Grinding LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. The Grinding LCS is prepared by grinding a 500 g aliquot of the Grinding LCS Bulk Material described in Section 7.5 <u>without</u> having air-dried the material before hand. The Grinding LCS must be ground using the same grinding apparatus (ring and puck) as the samples were ground. The Grinding LCS is used to monitor the effects of the grinding process on the analytes of interest. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

<u>Corrective Action</u>: If the Grinding LCS fails the acceptance criteria, samples associated with the Grinding LCS must be reprocessed and reanalyzed. If un-ground sample is not available, then the results of the grinding LCS must be described in a non-conformance memo and discussed in the final report case narrative.

10.0 <u>Procedure</u>

NOTE: Rotate sieves and any applicable equipment; do **<u>not</u>** use specific sieves or equipment for the MB and LCS/LCSD.

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 **Dry the Samples –** Refer to the Flowchart in Appendix 1 and the batching instructions in Appendix 3.

10.3.1 Check the Method Comments to see if the samples are for a project with the Department of Defense (DoD), if yes, then the entire contents of the sample container must be dried. Check TALS to make sure the client sent more than one container if additional tests are being requested. If additional tests are logged and the client only sent one container, the Project Manager should be notified.

10.3.2 If the sample is logged for method 8330B, or for an ISM method, then the entire contents of the sample container must be dried. Check each sample to make sure the client sent more than one container if additional tests are being requested. If additional tests are logged and the client only sent one container, the Project Manager should be notified.

10.3.3 If the samples do not fall under the descriptions given in Section 10.3.1 or Section 10.3.2 then only a portion of the sample container needs to be dried. In these cases, lay out at least 20 g to dry.

10.3.4 Depending on the sample size, the samples are laid out in aluminum pans, or on large trays lined with aluminum foil to dry. Some clients may request metals analysis on the dried samples. In those cases, samples are laid out on parchment paper.

10.3.5 Spread the samples out in a thin layer to facilitate drying. Use a disposable wooden spatula to break up any clumps and agglomerates.

10.3.6 The tray or pan that the sample is laid out into is labeled with the sample ID. A second analyst checks to make sure that the labels on the tray or pan match the labels on the client sample container to ensure samples are not accidently mixed up. This check is documented in TALS.

10.3.7 Place the samples in a hood or well ventilated area at room temperature. Document in TALS the date and time the samples were laid out to dry. If the samples are very wet, a fan can be used to help facilitate the drying process, but care should be taken so that the air flow is not strong enough to cause cross-contamination between samples. An electronic temperature recording device records the temperature of the room and the data is downloaded weekly.

10.3.8 When the samples appear to be dry enough that they can be sieved without caking, subsample approximately 15 grams into an appropriate weighing vessel and record the exact weight, the date, and the time (see Appendix 5). Set this 15 gram aliquot (still in the weighing vessel) next to the rest of the drying sample. Take care to use an appropriate weighing vessel for the analytical methods requested, as the aliquot removed in this step will still be included in the volume used for ISM (i.e. Do not use an aluminum weigh boat for samples requiring metals analysis).

10.3.9 After 2 hours, reweigh the aliquot in the same weighing vessel and record the exact weight, the date, and the time. If the weight of the sample is within 10% of the previous weight, proceed to Section 10.4.

10.4 **Sieve the Samples -** Refer to the Flowchart in Appendix 2.

10.4.1 If the client requirements specify a particular sieve size, those instructions take precedence.

10.4.2 If the sample is logged for prep method “8330_P_2g” then a 30 mesh sieve should be used.

10.4.3 If the sample is logged for prep method “8330_Sonc_10g” then a 10 mesh sieve should be used.

10.4.4 Some clients will request metals analyses to be performed on the sieved sample. In those cases, a stainless steel sieve should be used. Brass sieves should be avoided.

10.4.5 Clean the sieves prior to use following the instructions in Section 6.1.7.

10.4.6 Some samples may require the use of a mortar and pestle or a mechanical disaggregator to break up dried clumps. Refer to Sections 6.1.10 and 6.1.11 on how to clean and rinse the mortar and pestles and the mechanical disaggregator before use.

10.4.7 Record the weight of the entire dried sample in the Worksheet tab in TALS. This is a requirement for DoD QSM 5.0 and 5.1.

10.4.8 Sieve the entire dried sample through the appropriate sized sieve. Care must be exercised not to eliminate soil agglomerates during this step. The soil can be broken into small pieces with a gloved hand or another instrument (a wooden spatula for example). If a gloved hand is used, care should be taken to change out gloves in between samples so not to cross-contaminate samples.

10.4.9 Remove large rocks, vegetation, and twigs that do not pass through the sieve. Mosses and other types of fine vegetation should be physically shredded while sieving to release trapped soil and residues. The only materials that should be eliminated by sieving are rocks and vegetation. All soil must be broken up to pass through the sieve.

10.4.10 Place any soil that does not pass through the sieve into a clean mortar. Break up soil agglomerates using the pestle. Or as an alternative use the mechanical disaggregator. Be sure to break up all soil so that it can pass through the sieve. Only extraneous material such as rocks and vegetation should be removed with the sieve. Describe all extraneous material that did not pass through the sieve in an NCM. Document the weight of any material that does not pass through the sieve. Document this weight either in the worksheet section of TALS or in an NCM. Label and retain this material that does not pass through the sieve.

10.4.11 Collect all of the material that passes through the sieve on a clean piece of foil or parchment paper.

10.4.12 An automatic sieve shaker can be used to help facilitate the sieving of samples. A receiver pan is placed under a sieve and the sample is added to the sieve. Then a lid or another receiver pan for a second sample is placed on top. The stack is then clamped inside the sieve shaker for no more than 30 minutes. Inspect the samples to ensure that only extraneous material such as rocks and vegetation should be removed with the sieve. If needed use a mortar and pestle to break up soil agglomerates. Describe all extraneous material that did not pass through the sieve in an NCM. Document the weight of any material that does not pass through the sieve. Document this weight either in the worksheet section of TALS or in an NCM. Label and retain this material that does not pass through the sieve.

10.5 Grind the Samples - Refer to the Flowchart in Appendix 2.

10.5.1 If the samples are not logged with a pre-prep method of “ISM_DD_SI_PM_SS,” skip this section and proceed to Section 10.6.

10.5.2 Ring and Puck Grinding *Samples logged for “ISM_DD_SI_PM_SS”*

10.5.2.1 See Section 6.1.5 on how to clean the ring and puck dish.

10.5.2.2 If the sample is logged for ring and puck grinding, a grinding blank per Section 9.10.1 consisting of baked Ottawa sand will be processed through the ring and puck dish before each sample. These individual blanks will be composited into one grinding blank for the associated samples and will be analyzed in addition to the normal extraction blank.

NOTE: When preparing the grinding blanks, it is not necessary to do five 60-second grinds. One 60-second grind of the Ottawa sand is sufficient.

10.5.2.3 After a grinding blank has been processed through a ring and puck dish, that blank is labeled as the blank associated to the next sample processed through that same dish. Do not clean the ring and puck dish after the blank.

10.5.2.4 Prepare a grinding LCS per Section 9.11 with every batch. The grinding LCS will be analyzed in addition to the normal extraction LCS.

NOTE: A grinding batch will consist of no more than 20 samples that have been ground within three days of each other. The grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner**.** A grinding batch must have one Grinding LCS, and at least one Grinding Blank. If more than one Grinding Blank is prepared, it must be very clear on the benchsheet which individual sample blanks were used to build each Grinding Blank.

10.5.2.5 In a hood, transfer the sample into a clean ring and puck dish. Do not overfill the dish (approximately 300 g of sample can fit in one dish). If needed, grind the sample in 300 g or smaller increments and recombine after all sample has been ground. The entire sample must be ground. Place the dish securely in the holder and close the door on the machine. Grind the sample in five 60-second periods with a one minute cooling time between grinds for a total of 5 minutes of grinding. Remove the dish and in a fume hood, open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between two fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed.

NOTE: During the one-minute cooling time, the dish should be placed in a shallow ice water bath to facilitate cooling. Be sure the bath is shallow enough so that water does not get inside the dish.

10.5.2.6 If the sample reaches a flour-like consistency before all 5 one-minute grinds have been completed, then it might be beneficial to <u>not</u> perform all 5 grinds in order to avoid excessive heat and to avoid packing the sample onto the side of the grinder. If the analyst inspects the sample and it has a flour-like consistency before all 5 grinds are completed, they can make the decision to stop after less than 5 grinds. An NCM should be written to document the deviation from the source method and the reasoning.

NOTE: If multiple 300 g increments are used for grinding and the sample is recombined, it has been shown through Duplicate/Triplicate QC results that the sample is non-homogenous. To re-homogenize the sample, place all volume in to a clean plastic bag, seal, and carefully shake the bag for 1-2 minutes until the sample is thoroughly mixed. Lay out the sample back on the foil/parchment paper. This must be done on all samples regardless if this sample will be used for DU/TRL QC.

10.6 Aliquot the Samples

10.6.1 All aliquots should be taken using a subsampling tool described in section 6.2.6. This is done to ensure that finer sample material does not fall off of the sampling tool, as can happen if a spatula was used instead. This is particularly necessary when samples are not ground to a consistent grain size using the ring and puck.

10.6.2 **2 Gram Aliquot – Extraction Method "8330_P_2g"** – Remove the cap from a labeled 40 mL amber vial and place the vial on a balance and tare. Spread the entire sample out to a thickness no greater than 1 cm. Use a disposable subsampling tool to build a 2.0 g to 2.2 g aliquot by taking at least five small portions from random locations through the entire thickness of the sample. Record the exact sample weights on the benchsheet and cap the vial with a Teflon™ lined lid. Save the remaining soil for possible re-extraction. Create an LCS and a method blank by placing 2.0 g to 2.2 g of baked Ottawa sand in labeled vials. Record a nominal weight of 2 g in the initial volume field, then record the actual weight to the nearest 0.1 g in the notes column.

10.6.3 **10 Gram Aliquot – Extraction Method "8330_Sonc_10g"** – Remove the cap from a labeled 40 mL amber vial and place the vial on a balance and tare. Spread the entire sample out to a thickness no greater than 1 cm. Use a disposable subsampling tool to build a 10 g to 11 g aliquot by taking at least thirty small portions from random locations through the entire thickness of the sample. Record the exact sample weights on the benchsheet and cap the vial with a Teflon™ lined lid. Save the remaining soil for possible re-extraction. Create a LCS and a method blank by placing 10 g to 11 g of baked Ottowa sand in labeled vials. Record a nominal weight of 2 g in the initial volume field, then record the actual weight to the nearest 0.1 g in the notes column. If the samples were ground create a grinding blank per Section 9.10, and take an aliquot from this composite. Aliquot the grinding LCS as you would a sample.

10.7 Add Surrogate, Spikes, and Solvent to the Samples

10.7.1 Refer to WI-DV-0009 for the correct surrogate and spike standards to use and the correct volume.

10.7.2 The surrogate and spikes standards are kept in a freezer, but should be allowed to come to room temperature before use. Record the ID of the standard and pipette(s) used on the benchsheet.

10.7.3 The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-0009.

10.7.4 Only one batch should be surrogated at a time to ensure the correct standards are used.

10.7.5 Using a calibrated pipette, add the appropriate volume of the appropriate working surrogate standard to each sample and each QC sample.

10.7.6 Using a calibrated pipette, add the appropriate volume of the appropriate working spike standard to each LCS and MS/MSD.

NOTE: Do not add the spike standard to the grinding LCS. The grinding LCS is created using the material described in Section 7.5 and already contains the analytes of interest.

10.8 Add Extraction Solvent

10.8.1 2 Gram Extraction – Extraction Method “8330_P_2g”

10.8.1.1 Taking into account the volume of surrogate and spike standard added to each sample, bring the extract volume up to 10 mL with the soil extraction solvent described in Section 7.3. Use either a 10 mL Class A graduated cylinder or a bottle top pump that has been calibration checked.

Example: If 0.5 mL of surrogate standard was added to a sample, add exactly 9.5 mL of the soil extraction solvent.

Example: If 0.5 mL of surrogate standard and 0.5 mL of spike standard was added to a LCS, add exactly 9 mL of the soil extraction solvent.

10.8.1.2 Proceed to Section 10.9.

10.8.2 10 Gram Extraction – Extraction Method “8330_Sonc_10g”

10.8.2.1 Taking into account the volume of surrogate and spike standard added to each sample, bring the extract volume up to 20 mL with the soil extraction solvent described in Section 7.3. Use either a 25 mL Class A graduated cylinder or a bottle top pump that has been calibration checked.

Example: If 1 mL of surrogate standard was added to a sample, add exactly 19 mL of the soil extraction solvent.

Example: If 1 mL of surrogate standard and 1 mL of spike standard was added to an LCS, add exactly 18 mL of the soil extraction solvent.

10.9 Extract the Samples

10.9.1 Cap vial with a Teflon-lined cap, vigorously hand shake the vial for one minute, or until all material is well mixed, and place it in a box. Place the box on the platform shaker so that the vials are lying on their side. Set the platform shaker at 150 rpm and allow the samples to be shaken for at least 18 hours. Record the start time on the benchsheet.

10.9.2 After the 18 hour extraction, remove the vials from the shaker table and record the stop time on the benchsheet.

10.9.3 If needed, centrifuge the vial at no more than 2,200 rpm to help separate the solids from the extract. Remove approximately 10 mL of the supernatant solution. Filter the supernatant solution using a 0.2-µm PTFE syringe discarding the first mL into the waste. Filter the remaining supernatant into a labeled 8-mL amber vial.

10.9.4 Submit the extract for analysis to the appropriate analytical lab.

10.10 Maintenance

10.10.1 Approximately once a month, the cover on the Ring and Puck should be removed and any dirt should be cleaned up.

10.10.2 When excessive wear is noted, replace the hammers in the Mechanical Disaggregator.

10.10.3 Occasional lubrication of the Ring and Puck clamp is needed.

10.10.4 The o-rings in the Ring and Puck dishes should be replaced when worn.

10.10.5 Every 6 months the centrifuge should be lubricated and tightened.

10.11 Troubleshooting

Low recoveries for Tetryl in the explosives grinding LCS may be indicative of high temperatures during grinding. Review the cooling step noted in Section 10.5.2.5 in order to minimize the effect of the heat generated during the grinding process.

11.0 Method Performance

11.1 Method Detection Limit (MDL)

A valid method detection limit (MDL) study for each analyte of interest must be performed prior to analyzing samples for the first time and verified annually thereafter. Separate soil MDL studies are performed for 8330A using 2 g and 8330B using 10 g of Ottawa sand. Separate soil MDL studies are performed for explosive method 8321A using 2 g of Ottowa sand and 8321A using 10 g of Ottowa sand. An MDL study for picric acid by method 8321A is performed using 10 g of Ottowa sand. An MDL study for explosives by 8321 LC/MS/MS is performed using 10 g of Ottowa sand. The procedure for determining detection limits is defined in Policy CA-Q-S-006. Quarterly MDLV and LOQV studies are performed for the DoD program (QSM 4.2 and 5.0).

11.2 Limit of Quantitation Verification (LOQV)

The verification of the limit of quantitation (LOQ or LLOQ) is performed quarterly for work performed according to the DOD/DOE QSM 5.0 or for programs that specify the requirement. A blank matrix is spiked at 1-2 the laboratory RL and carried through the entire preparation and analytical procedures. Recoveries are assessed based on historical limits.

11.3 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

11.3.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

11.3.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

11.3.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

11.3.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

11.3.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

11.4 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

12.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

13.0 Waste Management

13.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in Section 13, *Waste Management and Pollution Prevention*, of the Environmental Health and Safety Manual, and DV-HS-001P, *Waste Management Plan*.

13.2 The following waste streams are produced when this method is carried out:

13.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

13.2.2 Flammable solvent waste – Waste Stream C

13.2.3 Solid sample waste - Waste Stream D

13.2.4 Waste soil sample vials - Waste Stream A

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

14.0 References / Cross-References

14.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

14.1.1 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

14.1.2 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

14.1.3 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

14.1.4 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

14.2 DoD Environmental Data Quality Workgroup, Frequently Asked Questions (FAQs) Concerning the Implementation of EPA SW-846 Method 8330B, November, 2014.

15.0 Method Modifications:

15.1 Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life
Stock standards	1,000,000 µg/L (1,000 ppm)	One year
Intermediate standards	2.5 to 1,000 µg/L	Thirty days
Working standards	1 to 500 µg/L	Daily

This SOP assigns a six-month shelf life to the working level standard based on TestAmerica's experience with these materials. The standards are stored in a freezer.

16.0 Attachments

Table 1.	Analyte List
Table 2.	Grinding LCS Bulk Material
Appendix 1	Flowchart for Drying Explosive Soils
Appendix 2	Flowchart for Grinding and Sieving Soils
Appendix 3	Instructions for Batching in TALS
Appendix 4	ISM Worksheet
Appendix 5	ISM Constant Weight Worksheet

17.0 Revision History

- Revision 11, dated 12/12/2018
  - Changed references to WI-DV-009 to correct document ID, WI-DV-0009 throughout SOP.
  - Minor formatting and language corrections throughout.
  - Changed references to "mechanical grinder" to "mechanical disaggregator" throughout SOP, including sections 2.1, 6.1.11, 10.4.6, 10.4.9, 10.10.2. This was done to distinguish more clearly between grinding and soil disaggregation.
  - Added 6.1.6.2 to equipment section to include drying tower.
  - Expanded section 6.2.6 to include new subsampling tool.
  - Updated sections 9.1.2 and 9.9 to reference DoD 5.1 rather than DoD 5.0.
  - Removed note after 10.3.9 which allowed for skipping constant weight analysis for non-DoD samples.
  - Added section 10.4.7 to meet DoD requirement that entire dried sample is weighed prior to sieving.
  - Removed use of grinding stones from section 10.4.11.
  - Removed notes regarding client-specific requirements from sections 10.4.10 and 10.4.12, and incorporated these specific requirements into standard procedures for all samples. These requirements include weighing and retaining material that does not pass through the sieve.
  - Updated sections 10.6.1, 10.6.2, 10.6.3 to reference "subsampling tool" rather than

    - "square-ended scoop."
  - Removed section 10.11 comment regarding securing ring and puck as it no longer requires securing. Added note about troubleshooting low tetryl recoveries.
- Revision 10, dated 31 October 2018
  - Annual Review
- Added 10.3.8 Revision 9, dated 5 October 2017
  - Added wording to 2.1 to clarify that samples are dried to a constant weight.
  - Added 10.3.8 and 10.3.9 and removed 15.2 to include procedure for drying samples to a constant weight.
  - Added Appendix 5
- Revision 8, dated 2 December 2016
  - Added the comment requiring the documentation of equipment IDs to Section 6.1
  - Added Section 6.3 Computer Software and Hardware
  - Added Note to Section 9.5 requiring a LCSD when there is no volume for MS/MSD
  - Added Note to Section 10.0 regarding the rotation of sieves and equipment
  - Updated Section 10.5.2.4 to include the samples should be ground the same length of time as the LCSSRM, renumbered the notes and included a sample grind time exception.
  - Updated Section 10.5.3.5 to include Note 1 from Section 10.5.3.6.
  - Renumbered Note in Section 10.5.3.6
  - Updated Section 10.7.2 to reflect standard SOP
  - Removed the Ball Mill Grinder reference from the entire SOP.
- Revision 7, dated 31 January 2016
  - Annual Technical Review
  - Deleted previous Section 4.3 no longer applied – vegetation and rocks are removed
  - Added Section 4.6 regarding tetryl decomposing with exposure to heat.
  - Added paragraph to Section 7 to contain reagent grade verbiage consistent with other SOPs
  - Section 8.1 – clarified the paragraph to be specifically about method 8330A
  - Added "and not frozen" to section 8.3
  - Revised Section 9.1 to have consistent verbiage and instructions as other SOPs
  - Added Note to Section 9.6 regarding DoD MS/MSD requirements
  - Changed duplicate to triplicate in Section 9.9
  - Clarified instruction to not clean the ring and puck dish after the blank in Section 10.5.3.3
  - Added the weight recording requirements to Sections 10.6.2 & 10.6.3
  - Added "and pipette(s)" to Section 10.7.2
  - Changed the centrifuge speed from 2500 rpm to 2200 rpm and 5mL to 10mL volume of supernatant solution to remove in Section 10.9.3
  - Modified/Rearranged Section 11 to be consistent with other SOPs
  - Removed previous Section 11.1 "Initial Demonstration of Capability"
  - Added current Sections 11.2 "Demonstrations of Capabilities" & 11.3 "Training Requirements"
  - Reformatted Section 14 and added Section 14.2 – reference to DoD Frequently Asked Questions for 8330B
  - Removed references to AFCEE and USACOE throughout document as these programs were incorporated into the DoD program.
  - Removed all 2010 and earlier revision histories
- Revision 6, dated 31 January 2015

  - Annual Technical Review
  - Reformatted SOP.
  - Revised Section 3.7 and Section 9.2 to state that a Ball Mill grinding batch is opened and closed the same day, while a Ring and Puck grinding batch can be open for up to 3 days.
  - Revised Section 5.2.2 to give information on the hazards of the Humbolt grinder.
  - Revised Section 9.9.1 to give more detail on how the Ring and Puck composite grinding blanks are created.
  - Revised Section 10.3.2 and Appendix 1 to state that any sample logged with an ISM method must have the entire sample container dried.
  - Revised Section 10.10 to include maintenance on the centrifuge.
- Revision 5, dated 27 January 2014
  - Annual Technical Review
  - Removed Section 1.2.3, DV-LC-0028 no longer performed.
  - Added detail about sieve size to Section 1.3.2.
  - Edited Section 6.1, subsection “Ball Mill” to allow for un-baked sand to be used in the cleaning of the ball mill stones and to allow the use of 1 pint cans. The section was also revised to change the minimum time the stones have to be tumbled during the cleaning process from 3 hours to 2 hours. This was done based on analyst’s experience.
  - Edited Section 6.1, subsection “Sieves” to state a brillo pad can be used on the sieves so long as the mesh is not damaged.
  - Updated Section 9.1 to reflect current practice, added a comment stating that this procedure meets DoD QSM 5.0 criteria unless otherwise stated.
  - Removed Acceptance Criteria and Corrective Action information to Section 9. This information can be found in the analytical SOPs.
  - Revised Section 9.6 to state that if there is no volume for a MS/MSD, a LCSD must be performed.
  - Added information to Section 9.9 for DoD acceptance criteria for triplicates.
  - Updated sections 10.1, 10.2 and 11.2 to reflect current practice
  - Added a NOTE in Sections 10.5.2.1 and 10.5.3.6 giving instructions on how to ensure the sample is homogenous after it has been split into separate grinding containers and then later re-combined.
  - Added Section 10.5.3.6 giving guidance on what to do if the sample reaches a flour-like consistency before all 5 grinds have been completed. This was done to avoid over-heating samples and packing the sample against the grinding dish wall.
  - Added Section 10.10 Maintenance and Section 10.11 Troubleshooting per DoD QSM 5.0.
  - Updated Appendix 2 and Appendix 3 to reflect the current method names used in LIMS.
  - Formatting changes throughout
- Revision 4, dated 30 October 2012
  - Annual Technical Review
  - Section 4.6 was added to document the adverse affect headspace in the ball mill can has on the grinding LCS.
  - Section 6.1 and Section 10 were revised to include the description of the Spacer Can in the Ball Mill apparatus.
  - Section 6.1 and Section 10 were revised to include the Mechanical Grinder used as an alternative to mortar and pestle.
  - Section 9.6 was revised to state that LCSDs are not required for DoD work.

  - Section 10 was revised to reference the Explosive Review Checklist in WI-DV-0009.
  - Section 10.3.2 was revised to instruct the analyst to eliminate as much headspace as possible during the Ball Mill grinding step.
  - Appendix 3 was revised to give more detail on the steps taken to ensure all pre-ground ISM aliquots are taken before the sample is ground. It was also revised to include the use of the Explosive Extraction Checklist in WI-DV-0009.

- Revision 3, dated 10 October 2011
  - The procedure was revised to have the extraction performed by shaker table instead of cooled sonication bath. This was done to increase lab capacity and to create a more rugged extraction.
  - Section 5 was revised to include the requirement that analysts wear cut-resistant gloves when tightening vial caps.
  - Section 7.2 was revised to include the lot approval process for acetonitrile.
  - Sections 7.5 and 9.3 were revised to mandate a 3 day expiration date on the Grinding LCS after it has been ground.
  - Section 9.8 and 9.9 were revised to require a duplicate and triplicate whenever method 8330B is performed, not just when samples are ground.
  - Section 10.2.2 and 10.2.3 were revised to have the analyst use the prep method instead of the pre-prep method to determine sieve size. This is a simpler determination and matches the flow chart in Appendix 2.
  - Section 10.7.3 was revised to change the speed of the centrifuge to prevent the breakage of the extract vials.

- Revision 2, dated 11 January 2011
  - Details about the surrogate and spike standards used in this procedure have been moved to SOP DV-OP-0020.
  - Revised Section 9 to state that duplicates and triplicates are required when ring and puck or ball mill grinding is performed.
  - Revised the procedure to include instructions and details for the laboratory’s new LIMS.
  - Revised Section 4 to give more details on the grinding of samples.
  - The procedure was revised to state that samples should be ground on the ball mill for only 8 hours. At that time, the samples should be inspected and only ground longer if required.
  - Added detail in Section 10.1 about the electronic temperature monitoring device that records the temperature of the drying room.
  - Revised the flowcharts to be flowcharts only and not worksheets. All data is now recorded in TALs benchsheets.
  - Added instructions in Appendix 3 on how to batch samples in TALSs
  - Added the option to use an automatic sieve shaker.

Earlier revision histories have been archived and are available upon request.

Table 1. Analyte List

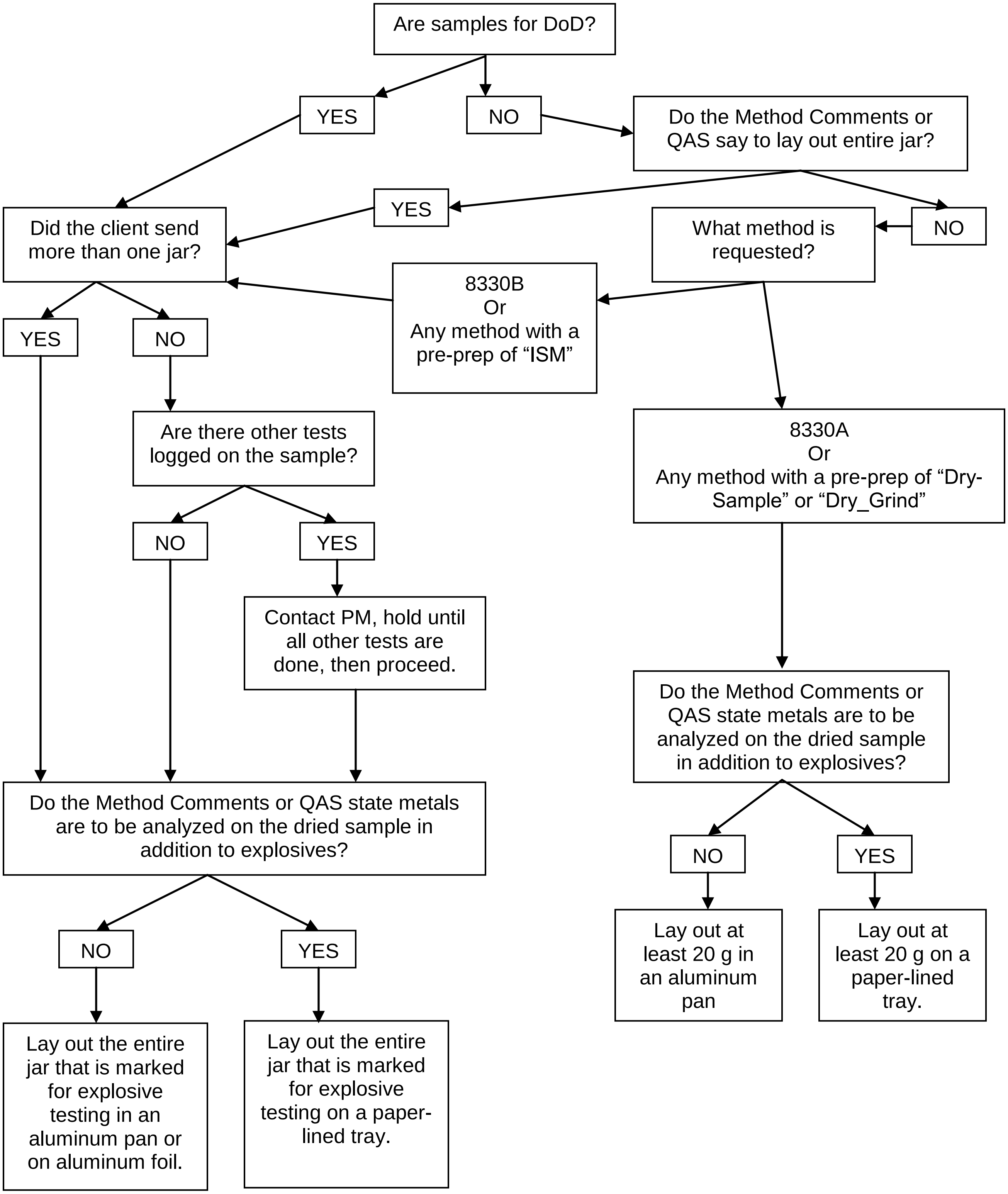
Compound	CAS #	Symbol
Octahydro-1,3,5,7-tetranitro-1,3,5,7,-tetrazocine	2691-41-0	HMX
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	RDX
1,3,5-Trinitrobenzene	99-35-4	1,3,5-TNB
1,3-Dinitrobenzene	99-65-0	1,3-DNB
Methyl-2,4,6-trinitrophenyl nitramine	479-45-8	Tetryl
Nitrobenzene	98-95-3	NB
2,4,6-Trinitrobenzene	118-96-7	2,4,6-TNT
4-Amino-2,6-dinitrotoluene	19406-51-0	4-Am-DNT
2-Amino-4,6-dinitrotoluene	35572-78-2	2-Am-DNT
2,6-Dinitrotoluene	606-20-2	2,6-DNT
2,4-Dinitrotoluene	121-14-2	2,4-DNT
2-Nitrotoluene	88-72-2	2-NT
4-Nitrotoluene	99-99-0	4-NT
3-Nitrotoluene	99-08-1	3-NT
Nitroglycerin	55-63-0	NG
PETN	78-11-5	PETN
2,4-Diamino-6-nitrotoluene**	6629-29-4	--
2,6-Diamino-4-nitrotoluene**	59229-75-3	--
Picric Acid	88-89-1	PA
1-Nitroso-3,5-dinitro-hexahydro-1,3,5-triazine**	5755-27-1	MNX
3,5-Dinitroaniline**	618-87-1	3,5-DNA
1,2-Dinitrobenzene (8330 surrogate)	528-29-0	1,2-DNB
Nitrobenzene-d5 (8321 surrogate)	--	NB-d5

** Compounds are only analyzed and spiked upon request.

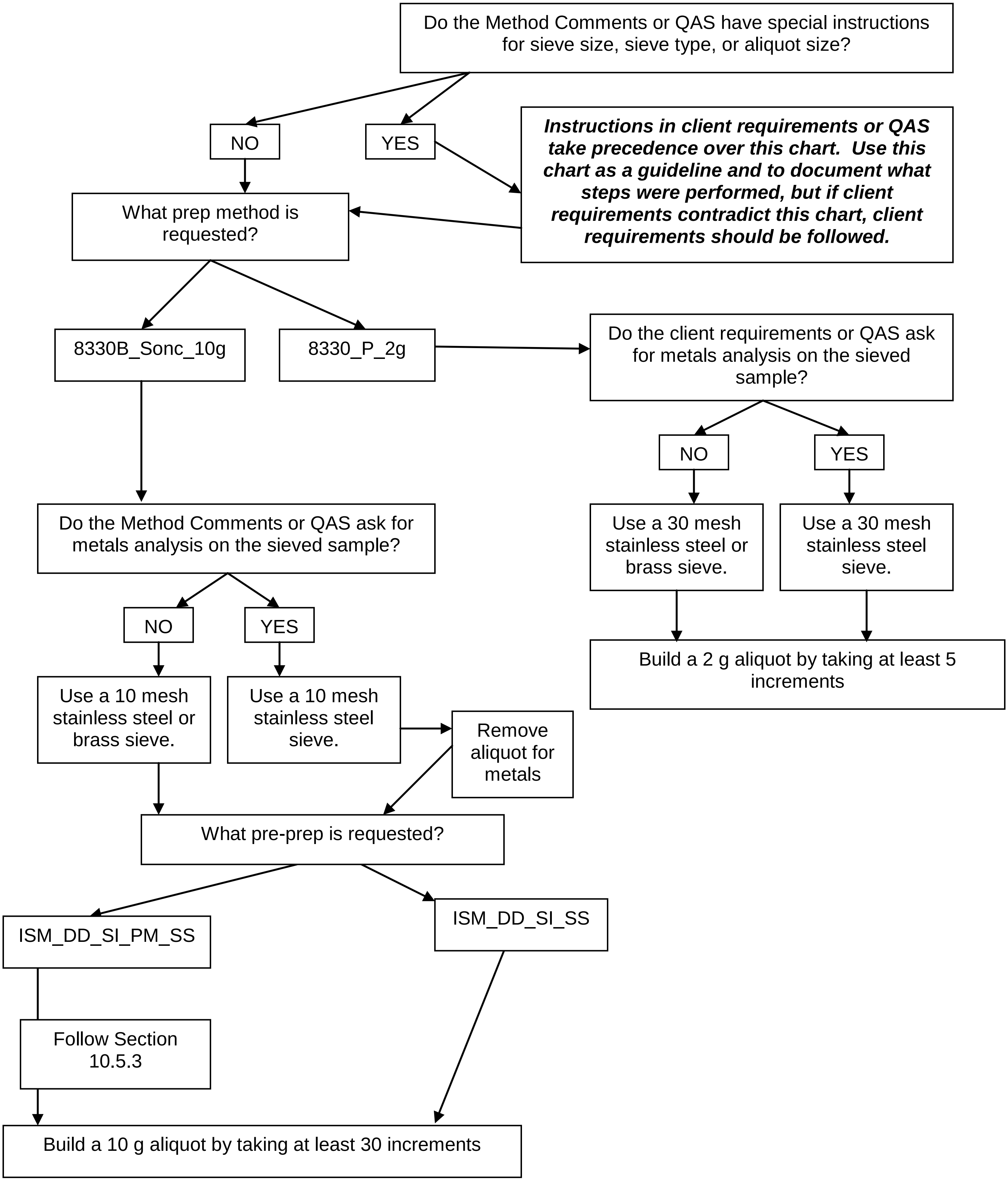
Table 2. Grinding LCS Bulk Material

Compound	Concentration (µg/Kg)
4-Amino-2,6-dinitrotoluene	600
2-Amino-4,6-dinitrotoluene	600
1,3-Dinitrobenzene	600
2,4-Dinitrotoluene	600
2,6-Dinitrotoluene	600
HMX (Octahydro-1,3,5,7-TNTC)	600
1,3,5-Trinitrobenzene	600
Nitrobenzene	600
2-Nitrotoluene	600
3-Nitrotoluene	600
4-Nitrotoluene	600
RDX (Hexahydro-1,3,5-TNTriaz)	600
Tetryl (Methyl-2,4,6-TNPN)	600
Nitroglycerin (Trinitroglycerin)	600
Pentaerythritol tetranitrate (PETN)	600
2,4,6-Trinitrotoluene	600

Appendix 1 – Flowchart and Worksheet for Drying Explosive Soils



Appendix 2 – Flowchart and Worksheet for Grinding and Sieving Explosive Soils



Appendix 3

How to Batch:

ISM_DD_SI_PM_SS (Dry, Disaggregate, Sieve, Ring & Puck, Subsample)
ISM_DD_SI_SS (Dry, Disaggreage, Sieve, Subsample)
Dry_Sample (Dry, Sieve, 2g prep)
Dry_Grind (Dry, Sieve, 2g Prep)

Overview

These five pre-prep methods can be logged in for not just for samples for explosives by 8330A or 8330B and 8321A or 8321B, but also for samples for metals analysis, or perchlorate, or any other method where the client is asking the lab to dry, sieve, and possibly grind the sample before extraction or digestion.

If one sample is logged in for 8330B and 6010B and 6020B and 7471A and all of these methods have the pre-prep of ISM_DD_SI_SS, the sample will show up on the backlog 4 times, (once for each analytical method). This would happen if the client wants us to dry, sieve, and perform ISM for each of these methods.

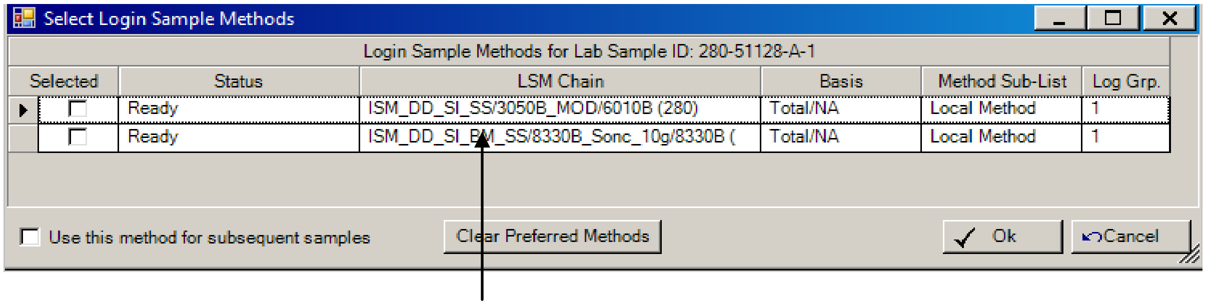
If one sample is logged in for 8330B with a pre-prep of ISM_DD_SI_PM_SS and the same sample is logged in for method 6010B with a pre-prep of ISM_DD_SI_SS, that means that the client wants us to dry, sieve the sample, perform ISM for method 6010B, then ring and puck and perform ISM for 8330B.

We will use a different status to indicate where the samples are.

- A status of “Batched” means the samples have been laid out to dry.
- A status of “Scheduled” on ISM_DD_SI_PM_SS means the samples have been laid out to dry, but possibly need ISM performed before grinding.
- A status of “Partial” means the samples have been sieved.
- A status of “2nd Level Review” on methods ISM_DD_SI_SS, Dry_Sample, or Dry_Grind means that the aliquots have been taken and someone has checked your work.
- A status of “2nd Level Review” on ISM_DD_SI_PM_SS means samples have completed the grinding.

Steps for Samples logged for <u>both</u> ISM_DD_SI_SS <u>and</u> Ring & Puck

1. Run the Dry/Sieve/Grind/ISM backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for ISM_DD_SI_SS for metals and ISM_DD_SI_PM_SS for explosives, you can easily see that the sample needs both preps.
2. Batch the samples under the ISM_DD_SI_SS method.
   NOTE: Do not put samples in the same batch that require different sieve sizes.
3. Scan your samples into the batch. A window will appear called “Select Login Sample Methods”.



Login Sample Methods for Lab Sample ID: 280-51128-A-1

Selected	Status	LSM Chain	Basis	Method Sub-List	Log Grp.
☐	Ready	ISM_DD_SI_SS/3050B_MOD/6010B (280)	Total/NA	Local Method	1
☐	Ready	ISM_DD_SI_PM_SS/8330B_Sonc_10g/8330B (	Total/NA	Local Method	1

4. Select only the methods that have ISM_DD_SI_SS as the pre-prep.
    a. You can only batch ISM samples under a ISM_DD_SI_SS batch.
    b. You can only batch ring and puck samples under a ISM_DD_SI_PM_SS batch.
    c. You can batch “Dry_Grind” and “Dry Sample” samples under the same batch.
5. Save the batch and print the benchsheet.
6. Print labels. Print one label for each method logged on each sample. Write on the label the analytical method.
7. Lay out the samples to dry. Place all of the labels on the sample tray for the sample. Also label the tray “Grinding Needed” if the sample is logged for Ring and Puck.
8. Set the Ring and Puck Methods to “Scheduled” in the backlog. Do not batch them at this time.
9. Sieve the samples and take the required ISM aliquots. Whenever possible, aliquot the samples directly in the digestion cup for metals, or microwave tube or beaker for organics and record the aliquot masses in the ISM worksheet in Appendix 4. Place the ISM aliquots on the tray with the sample so a 2nd analyst can perform a label check. Document these steps on the TALS batch sheet
10. The Notes field in the Worksheets tab can be used to document if there was rocks or vegetation that did not go thru the sieve. Write NCMs for any samples that contained rocks or vegetation that was removed from the sample.
11. In the Worksheet tab, you can record the weight of the sample before and after drying and the weight of the sample that went through the sieve and the weight of the sample that did not go through the sieve. These measurements are not normally required, so they only need to be performed if client requested.
12. Have a 2nd analyst review the ISM_DD_SI_SS batch to ensure all required ISM aliquots have been performed. Take the ISM_DD_SI_SS batch to 2nd level review.
13. Now the samples are ready to be ground by Ring and Puck.
14. As the samples are ground, add them to the ISM_DD_SI_PM_SS batch.
15. As you add samples to the grinding batch, watch the LSM window to ensure that all ISM_DD_SI_SS methods are at 2nd level review. If there are ISM_DD_SI_SS methods that are not at 2nd level review, perform ISM on the sample for the requested methods before grinding the sample.
16. Take the samples to 2nd level review.
17. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Steps for Samples logged for Ring & Puck ONLY. No ISM_DD_SI_SS methods logged.

1. Run the Dry/Sieve/Grind/ISM backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for ISM_DD_SI_SS for metals and ISM_DD_SI_PM_SS for explosives, you can easily see that the sample needs both preps.
2. Pull the samples from the walk-in cooler and take custody of the samples. Take note of what shelf the sample came from.
3. Batch the samples and print out labels. Then remove the samples from the batch to place them back on the backlog.
4. Lay the samples out on parchment or foil. Label each tray with the sample ID and the grinding method (Ring & Puck)
5. Document the date and time the samples were laid out to dry. Document if the samples were laid out on parchment or foil. Document that a label check was performed.
6. Set the samples to Scheduled in the backlog to show that they are laid out to dry.

7. Once the samples are dry enough to sieve, sieve the samples and document what sieve size on the Explosive Review Checklist.
8. Open the batch with a grinding LCS. As the samples are ground, add them back to the original ISM_DD_SI_PM_SS batch. There can only be 20 field samples in each batch,. Ring and puck batches can be open for up to 3 days.
9. As you add samples to the grinding batch, watch the LSM window to ensure that the samples do NOT require any non-ground aliquots.
10. Take the samples to 2nd level review.
11. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Steps for Samples logged for only ISM_DD_SI_SS, Dry_Grind, or Dry_Sample. No grinding methods logged.

1. Run the Dry/Sieve/Grind/ISM backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for ISM_DD_SI_SS for metals and ISM_DD_SI_PM_SS for explosives, you can easily see that the sample needs both preps.
2. Batch the samples under the pre-prep method logged. Do not put samples in the same batch that are logged for different pre-prep methods. Do not put samples in the same batch that require different sieve sizes.
3. Scan your samples into the batch. If your samples are logged in for more than one of these three methods, a window will appear called “Select Login Sample Methods”.
4. Select only the methods that have ISM_DD_SI_SS as the pre-prep.
    a. You can only batch ISM samples under a ISM_DD_SI_SS batch.
    b. You can batch “Dry_Grind” and “Dry Sample” samples under the same batch.

    If the LSM window shows methods with pre-preps of ISM_DD_SI_PM_SS or ISM_DD_SI_BM_SS, then stop and follow the instructions above under the header “Steps for Samples logged for both ISM_DD_SI_PM_SS and Ring & Puck.
5. Save the batch and print the benchsheet.
6. Print labels. Print one label for each method logged on each sample. Write on the label the analytical method.
7. Lay out the samples to dry. Place all of the labels on the sample tray for the sample.
8. Sieve the samples and take the required aliquots. Whenever possible, aliquot the samples directly in the digestion cup for metals, or microwave tube or beaker for organics and record the aliquot masses in the ISM worksheet in Appendix 4. Place the aliquots on the tray with the sample so a 2nd analyst can perform a label check.
9. The Notes field in the Worksheets tab can be used to document if there was rocks or vegetation that did not go thru the sieve. Write NCMs for any samples that contained rocks or vegetation that was removed from the sample.
10. In the Worksheet tab, you can record the weight of the sample before and after drying and the weight of the sample that went through the sieve and the weight of the sample that did not go through the sieve. These measurements are not normally required, so they only need to be performed if client requested.
11. Have a 2nd analyst review the batch to ensure all required aliquots have been performed. Take the batch to 2nd level review.
12. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Appendix 4

ISM Worksheet

G:/QA/Edit/FORMS/Organic Prep Forms/MASTER ISM Spreadsheet_Rev1

ISM BATCH:

Use this spreadsheet to document alquot weights when aliquotting into digestion or extraction vessels. If aliquoting into a temporary vessel, no need to document the exact weight because the sample aliquot will be transferred and weighed at the time of analysis.

Login	**Sample**	Method --->											
			(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)
		ALIQUOT 1											
		ALIQUOT 2											
		ALIQUOT 1											
		ALIQUOT 2											
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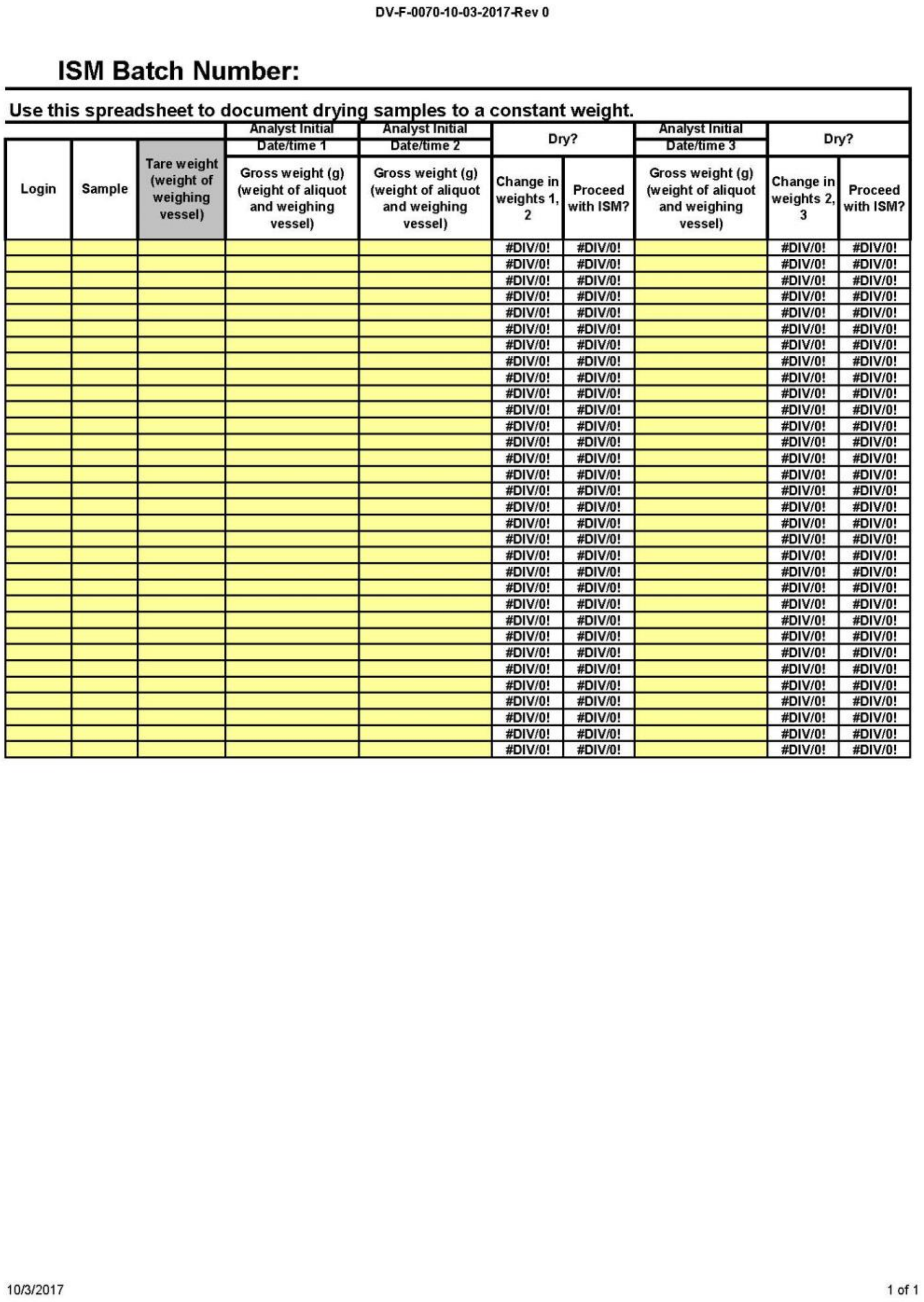
Appendix 5

ISM Constant Weight Worksheet

Located: \\tafs\Lab2\Denver\Admin\QA\Edit\FORMS\Organic Prep Forms



DV-F-0070-10-03-2017-Rev 0

ISM Batch Number:

Use this spreadsheet to document drying samples to a constant weight.

			Analyst Initial	Analyst Initial	Dry?		Analyst Initial	Dry?	
			Date/time 1	Date/time 2			Date/time 3		
Login	Sample	Tare weight (weight of weighing vessel)	Gross weight (g) (weight of aliquot and weighing vessel)	Gross weight (g) (weight of aliquot and weighing vessel)	Change in weights 1, 2	Proceed with ISM?	Gross weight (g) (weight of aliquot and weighing vessel)	Change in weights 2, 3	Proceed with ISM?
					#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
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10/3/2017

1 of 1

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

SOP Number: CA-551
Revision History
Cover Page
Page 1

TITLE: GRAIN SIZE ANALYSIS

Prepared By: Date: 10-1-15

Approved By:

Department Manager: Date: 10-1-15

Operations Manager: Deborah J. Nadeau Date: 10.1.15

QA Officer: Leslie Dimond Date: 10.01.15

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Updated title of sections 1.4 + 5.0, Updated method references for NELAC + DOD Added information about hydrometer readings for sandy samples.	LAD	09/17	09/17
02	Sect. 2 - Updated method Summary, Sect. 4 - Added 1/4" Sieve, removed 3/4". Sect. 7 - Updated Sieve only analysis. Updated references and Logbook example	LAD	04/19	04/19

TITLE: **Grain Size Analysis**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-551-02,** titled **GRAIN SIZE ANALYSIS.**

Recipient: ______________________________ Date: ______________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-551-02,** titled **GRAIN SIZE ANALYSIS.**

Recipient: ______________________________ Date: ______________

TITLE: **Grain Size Analysis**

1.0 SCOPE AND APPLICATION

This SOP details the procedure used by Katahdin Analytical Services technical personnel for particle size analysis in soils. This method is applicable to ASTM D422.

1.1 Definitions

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in Grain Size Analysis. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in Grain Size Analysis to read and understand this SOP, adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, that their work is properly documented and to indicate periodic review of the associated logbooks

1.3 Safety

1.3.1 Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs (material safety data sheets) for all the materials used in this procedure.

1.3.2 Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Management Program for further details on pollution prevention techniques.

Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Hazardous Waste Plan and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

For Grain size with hydrometer, depending on total solids of a sample, a certain amount is soaked in a dispersing agent overnight. The sample is then split into two portions, the material retained on the #10 sieve and the material passing the #10 sieve. The material retained on the #10 sieve is dried overnight to a constant weight. The sample is then passed through a large size sieve stack. Material passing the #10 sieve may be subjected to hydrometer analysis. After wet washing the sample on a #200 sieve the sample retained is dried overnight, then passed through a small size sieve stack. The material retained on each sieve, large and small sieves are measured and recorded. All measurements, large and small sieves and hydrometer readings are used to determine the particle size distribution of the sample. If the analysis requires sieve only, the sample weight will be determined as with samples including hydrometer. The samples will then be soaked in DI overnight, than wet washed and baked overnight. They will then be sieved through large and small sieves.

3.0 INTERFERENCES

Not Applicable

4.0 APPARATUS AND MATERIAL

4.1 Sieves ASTM E-11 Specifications, Brand Advantech, of the following size(s):

4.1.1 3.0” (75.00 mm)

4.1.2 2.0” (50.00 mm)

4.1.3 1.5” (37.50 mm)

4.1.4 1.0” (25.00 mm)

4.1.5 3/4" (19.00 mm)

4.1.6 1/4 “ (6.3mm)

4.1.7 # 4 (4.75 mm)

4.1.8 #10 (2.00 mm)

4.1.9 #20 (850.0 um)

4.1.10 #40 (425 um)

4.1.11 #60 (250.0 um)

4.1.12 #80 (180 um)

4.1.13 #100 (150.0 um)

4.1.14 #200 (75.0 um)

4.2 Sedimentation Classico Cylinder(s) 1000 mL

4.3 Hydrometer: ASTM 151H Humboldt H-4242

4.4 Drying Oven with temperature range of 60-110°C

4.5 Stainless Steel Spatulas & Spoons

4.6 Metal & Bristle Brushes

4.7 Ro-Tap Sieve Shaker- Gilson Company

4.8 Timers- capable of counting up to 24hours

4.9 Balance, capable of weight measurement to 0.01 g

4.10 Mechanical Stirring Device and Dispersion Cup- Hamiliton Beach Humboldt

4.11 Thermometer: Accurate to 0.5°C

4.12 Mortar and Rubber Tipped Pestle

4.13 Glass beakers- 1000ml and 500ml

5.0 REAGENTS AND STANDARDS

5.1 Laboratory Grade Reagent Water

5.2 Sodium Hexametaphosphate:

5.3 **Sodium Hexametaphosphate Solution**: Add 120 g of sodium hexametaphosphate and 2940 g of reagent water to a 1-gallon plastic jug with cover. Mix the solution until it is homogeneous. Assign an expiration date of 30 days from the date made unless the parent reagent expires sooner in which case use the earliest expiration date. Store the prepared solution at ambient temperature.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Sediment/soil samples must be collected in a soil jar and must be maintained at 4°C (±2°C).

Store all extracts at 4°C (±2°C) in the dark in labeled Teflon-sealed containers. See SOP SD-902, "Sample Receipt and Internal Control," current revision, for storage areas and temperature maintenance procedures.

7.0 PROCEDURES

7.1 The following information must be recorded in the Grainsize logbook (all that are applicable).

- Start/End Date and Time
- Date/Time placement of samples in and out of oven
- Hydrometer(s) Serial Number
- Hydromter(s) Calibration Date
- Balance ID(s)
- Reagant ID
- Initial and final weights
- Analysts Initials
- Any comments regarding the sample extraction

Samples need to be “swiped” out when removing and “swiped” in when replacing samples in storage locations to maintain the internal chain of custody. Refer to Katahdin SOP, Sample Receipt and Internal Control, current revision, for the proper procedure for removal and return samples.

Fill out the sample preparation/extraction log with the necessary information before starting the extraction.

7.2 Equipment Calibration

Calibrate the balances being used each day prior to use. Record in the logbook designated for this purpose.

Calibrate or replace the hydrometers every five years

7.3 Total Solids Determination

Refer to SOP CA-717 “Total Solids/Total Volatile Solids Determination In Solid Matrices”

7.4 Sample Preparation

7.4.1 From the calculated percent total solids and the sample characterisitics for each sample the amount needed for the analysis can be determined using Table 1.

7.4.2 After determining the amount of sample to be used, place a 1000ml glass beaker on the balance and tare the balance. Mix the sample thoroughly with the stainless steel spatula. If the sample container is full to the extent that stirring the sample is impractical, try to remove the “best representative” aliquot from the jar based on color, particle size, moisture, etc. Discard any foreign objects such as sticks, leaves, and rocks.

7.4.3 Add 125ml sodium hexametaphosphate solution to each beaker containing sample. Stir and mix thoroughly, soak sample in solution for at least 16 hours.

7.4.4 Refer to Katahdin SOP CA-108, current revision, “Basic Laboratory Technique” for more information on subsampling.

7.5 Sample Partition

After sample and solution has soaked for a minimum of 16 hours, the sample slurry is rinsed into a dispersion cup using DI water. Fill the dispersion cup ½ full with DI water and place the cup on the blender to mix for one minute.

7.5.1 If the sample appears to have large gravel, sand, or organic material that does not appear to be amendable for using the blender notify the PM and proceed to the next step without blending.

7.5.2 After the sample slurry has been blended, pour sample through a #10 sieve with pan attached, so sample smaller than a #10 sieve is collected in pan. Transfer contents in pan to a 1000ml graduated cylinder and continue to rinse the dispersion cup through the #10 sieve until transfer is complete. After all sample in the pan is rinsed into the cylinder bring the volume of the cylinder to 1000ml using DI water. Cover the cylinder with a rubber stopper and equilibrate the sample to ambient temperature for the hydrometer analysis.

7.5.3 Weigh and label a medium aluminum pan, than transfer the contents of the material retained on the # 10 sieve to the pan. Place the aluminum pan in a drying oven set at 110 ± 5° C and dry the sample material for at least 16 hours or until constant weight set aside for sieve analysis.

7.6 Hydrometer

Prepare a hydrometer blank by adding 125ml sodium hexametaphosphate and bring to 1000 mL with DI water in a 1000 mL graduated cylinder. Be sure to take readings with a hydrometer and a thermometer while taking readings on actual hydrometer samples. This will provide us with the temperature and solution correction factors later in the procedure. Also prepare a hydrometer rinse bath, used to rinse the hydrometer between uses.

7.6.1 To shake the cylinder, rotate the flask up and down for one minute approximating at least 60 turns. One turn down and one turn up equals two turns.

7.6.2 To take a hydrometer reading, gently insert the hydrometer into the graduated cylinder and wait approximately 20 seconds. Read the hydrometer from the top of the meniscus to the nearest 0.0005. Enter the reading on the logbook. After each reading, clean the hydrometer by twisting and dropping the hydrometer into the hydrometer rinse bath.

7.6.3 Insert a temperature probe into the cylinder to the same depth used for the hydrometer reading. Read the temperature to the nearest 0.5°C and enter the temperature measurement on the logbook. Rinse the temperature probe in the hydrometer rinse bath.

7.6.4 Repeat the above process taking hydrometer readings every 2, 5, 15, 30, 60, 240 and 1440 minutes, proceed to small sieve analysis.

With samples that are mostly sand, the hydrometer reading can drop below the reading of the blank. When this occurs, we will apply the lowest hydrometer reading to the blank reading. We will include this in the technical narrative. The logic behind this issue is due to the high amount of sand, resulting in more density. As a result, less DI water is added when transferring the sample/hexametaphosphate solution to the 1000 mL cylinders. Since the blank has a higher DI water/hexametaphosphate ratio, it increases the reading.

7.7 Sieve Analysis for Large and Small Sieves

Look at the sample material in the aluminum pan and record a description of the non-soil material (such as- sticks, grass, wood, plastic), hardness of material and shape of material in the logbook.

Hardness qualifiers include hard, soft or brittle.
Shape qualifiers include well rounded, rounded, subrounded, subangular, and angular.

<u>Large Sieves</u>

7.7.1 Weigh the 3/4”, 1/4”, #4 and #10 sieves and enter the weight measurements in the logbook as the tare weight.

7.7.2 Stack the sieves then transfer the sample material from the aluminum dish to the sieve stack. If the sample material is less than 30 g, manually shake the sieve stack for 2 minutes. If the sample material is greater than 30 g, place the sieve stack into the Ro-tap machine and shake the sieve stack for 4 minutes. Weigh each sieve and record these measurements in the logbook.

<u>Small Sieves</u>

Completely transfer the sample from the graduated cylinder to a #200 wet wash sieve. Make sure the entire sample has been transferred to the #200 wet wash sieve by rinsing the graduated cylinder several time with DI water. Using DI water, wash the sample through the #200 sieve until the water runs clear then transfer the material retained on the sieve into a aluminum tin labeled with the sample’s LAB ID.

7.7.3 Place the beaker in the drying oven and dry at a temperature of 110ºC for at least 16 hours. After 16 hours, remove the beaker from the oven and allow it to cool.

7.7.4 Samples are sieved through the #20, #40, #60, #80, #100, and #200.

7.7.5 After samples have cooled, stack the sieves then transfer the sample material from the aluminum dish to the sieve stack. If the sample material is less than 30 g, manually shake the sieve stack for 2 minutes. If the sample material is greater than 30 g, place the sieve stack into the Ro-tap machine and shake the sieve stack for 4 minutes. Weigh each sieve and record these measurements in the logbook.

7.8 Sieve Only Analysis

7.8.1 Determine the total solids of the sample. Use the Percent Solid Table (Table 1) to determine the sample size to be used. If total solids are not available depending on sample matrix we make an educated guess as to how much sample will be used. Samples are then soaked in DI overnight.

7.8.2 After sample and solution has soaked for a minimum of 16 hours, the sample slurry is rinsed into a dispersion cup using DI water. Fill the dispersion cup ½ full with DI water and place the cup on the blender to mix for one minute.

7.8.3 If the sample appears to have large gravel, sand, or organic material that does not appear to be amendable for using the blender notify the PM and proceed to the next step without blending.

7.8.4 Samples are then wet-washed through the #200 Sieve until samples run clear.

7.8.5 Samples are then completely transferred to a metal tin labeled with appropriate sample ID, and dry at a temperature of 110ºC for at least 16 hours. After 16 hours, remove the tin from the oven and allow it to cool.

7.8.6 Gently mix the dried contents of the beaker with a rubber-tipped pestle to break any soil aggregates that may have formed during the drying stage.

7.8.7 For Large Sieve analysis follow 7.7.1-7.7.2

7.8.8 For Small Sieve analysis follow sections 7.7.2-7.7.3

7.9 Calculations

7.9.1 Sample Used (SU): total dry sample

SU =Total Sample Weight ((100-%Moisture)/100)*

HMCF = Hygroscopic moisture correction factor (we assume 1)

7.9.2 Sieve Analysis (Percent Finer = PF)

Large Sieves:

3 inch: PF = 100-100 (Sieve and Sample (3 inch) - Sieve (3 inch))/SU*

2 inch: PF = PF (3 inch) - 100(Sieve and Sample (2 inch) - Sieve (2 inch))/SU and so on through the #10 Sieve.*

Small Sieves:

#20: PF = PF(#10) - 100(mass passing #10/sample mass (Hyd))*(sieve and sample (#20) - sieve(#20))/sample used*

#40: PF = PF (#20) - 100(mass passing #10/sample mass (Hyd))*(sieve and sample (#40) - sieve (#40))/sample used and so on up through #10 sieve.*

7.9.3 Hydrometer Analysis

Particle size, Micron

1000*sqrt [930*viscosity/980*(SG-1))*(effective depth/time)]

Effective Depth, cm = 16.29-264.5*(actual Hydrometer reading - 1)
Time, minutes = Time of hydrometer reading from beginning of edimentation
Sqrt - square root
SG - Specific Gravity of soil (assuming a default SG)
Viscosity - is the resistance of a liquid to flow

Percent Finer (PF):

PF = Constant*(actual hydrometer reading - hydrometer correction factor - 1)

Constant = (100,000/W)*SG/(SG-1)
W = (Total sample used *sample used for hydrometer analysis*HMCF)/Amount of total sample passing #10 sieve
Hydrometer Correction = slope*sample temperature + Intercept
Slope = ((low temp. reading -1)-(high temp. reading -1)/(low temp. - high temp.))

Intercept = (low temp. reading -1) - (low temp. * slope)

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Not Applicable

9.0 METHOD PERFORMANCE

Not Applicable

10.0 APPLICABLE DOCUMENTS/REFERENCES

ASTM Standard D 422-63 (Re-approved 2007) “Standard Test Method for Particle-Size Analysis of Soils”, ASTM International, West Conshohocken, PA 2003, DOI: 10.1520/C0033-03, www.astm.org

Katahdin SOP SOP CA-717 “Total Solids/Total Volatile Solids Determination
In Solid Matrices”, current revision.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 2009.

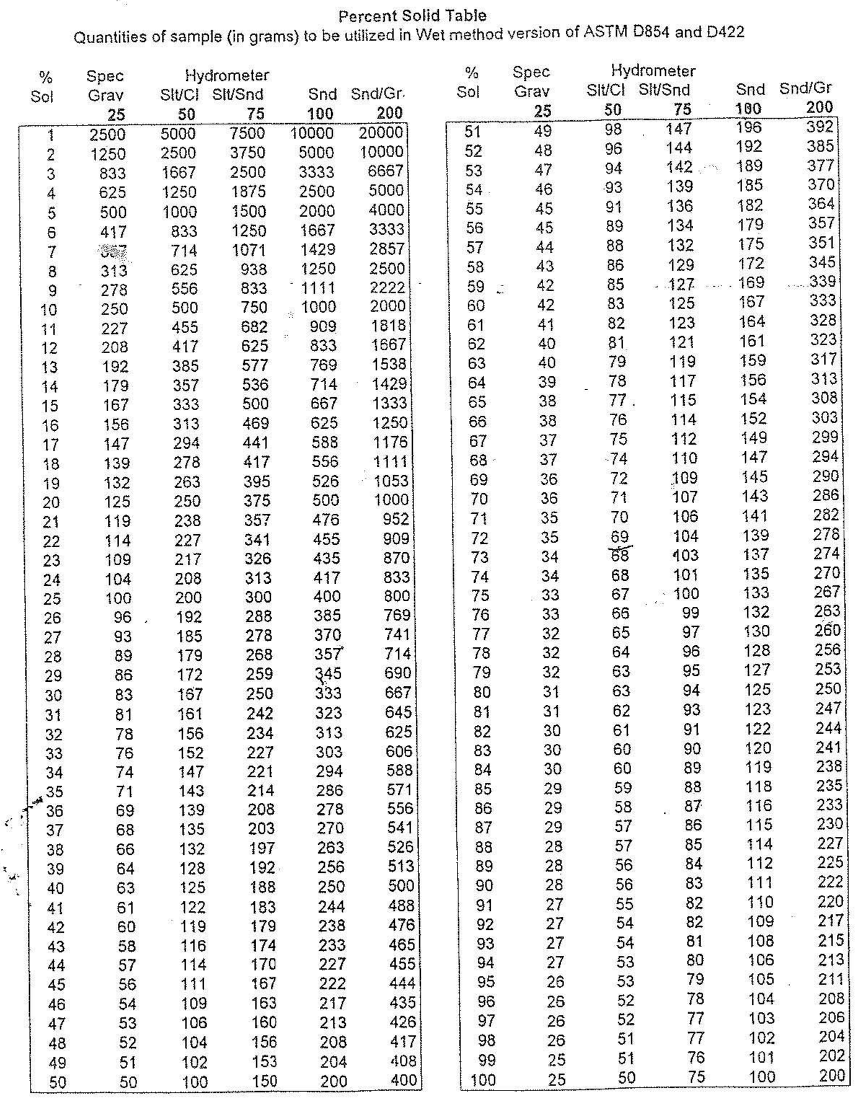
Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 5.1.1, 2018

LIST OF TABLES AND FIGURES

TITLE: **Grain Size Analysis**

TABLE 1

PERCENT SOLIDS TABLE FOR WEIGHT DETERMINATION



Percent Solid Table

Quantities of sample (in grams) to be utilized in Wet method version of ASTM D854 and D422

% Sol	Spec Grav	Hydrometer Slt/Cl	Hydrometer Slt/Snd	Snd	Snd/Gr
	25	50	75	100	200
1	2500	5000	7500	10000	20000
2	1250	2500	3750	5000	10000
3	833	1667	2500	3333	6667
4	625	1250	1875	2500	5000
5	500	1000	1500	2000	4000
6	417	833	1250	1667	3333
7	357	714	1071	1429	2857
8	313	625	938	1250	2500
9	278	556	833	1111	2222
10	250	500	750	1000	2000
11	227	455	682	909	1818
12	208	417	625	833	1667
13	192	385	577	769	1538
14	179	357	536	714	1429
15	167	333	500	667	1333
16	156	313	469	625	1250
17	147	294	441	588	1176
18	139	278	417	556	1111
19	132	263	395	526	1053
20	125	250	375	500	1000
21	119	238	357	476	952
22	114	227	341	455	909
23	109	217	326	435	870
24	104	208	313	417	833
25	100	200	300	400	800
26	96	192	288	385	769
27	93	185	278	370	741
28	89	179	268	357	714
29	86	172	259	345	690
30	83	167	250	333	667
31	81	161	242	323	645
32	78	156	234	313	625
33	76	152	227	303	606
34	74	147	221	294	588
35	71	143	214	286	571
36	69	139	208	278	556
37	68	135	203	270	541
38	66	132	197	263	526
39	64	128	192	256	513
40	63	125	188	250	500
41	61	122	183	244	488
42	60	119	179	238	476
43	58	116	174	233	465
44	57	114	170	227	455
45	56	111	167	222	444
46	54	109	163	217	435
47	53	106	160	213	426
48	52	104	156	208	417
49	51	102	153	204	408
50	50	100	150	200	400
51	49	98	147	196	392
52	48	96	144	192	385
53	47	94	142	189	377
54	46	93	139	185	370
55	45	91	136	182	364
56	45	89	134	179	357
57	44	88	132	175	351
58	43	86	129	172	345
59	42	85	127	169	339
60	42	83	125	167	333
61	41	82	123	164	328
62	40	81	121	161	323
63	40	79	119	159	317
64	39	78	117	156	313
65	38	77	115	154	308
66	38	76	114	152	303
67	37	75	112	149	299
68	37	74	110	147	294
69	36	72	109	145	290
70	36	71	107	143	286
71	35	70	106	141	282
72	35	69	104	139	278
73	34	68	103	137	274
74	34	68	101	135	270
75	33	67	100	133	267
76	33	66	99	132	263
77	32	65	97	130	260
78	32	64	96	128	256
79	32	63	95	127	253
80	31	63	94	125	250
81	31	62	93	123	247
82	30	61	91	122	244
83	30	60	90	120	241
84	30	60	89	119	238
85	29	59	88	118	235
86	29	58	87	116	233
87	29	57	86	115	230
88	28	57	85	114	227
89	28	56	84	112	225
90	28	56	83	111	222
91	27	55	82	110	220
92	27	54	82	109	217
93	27	54	81	108	215
94	27	53	80	106	213
95	26	53	79	105	211
96	26	52	78	104	208
97	26	52	77	103	206
98	26	51	77	102	204
99	25	51	76	101	202
100	25	50	75	100	200

TABLE 2

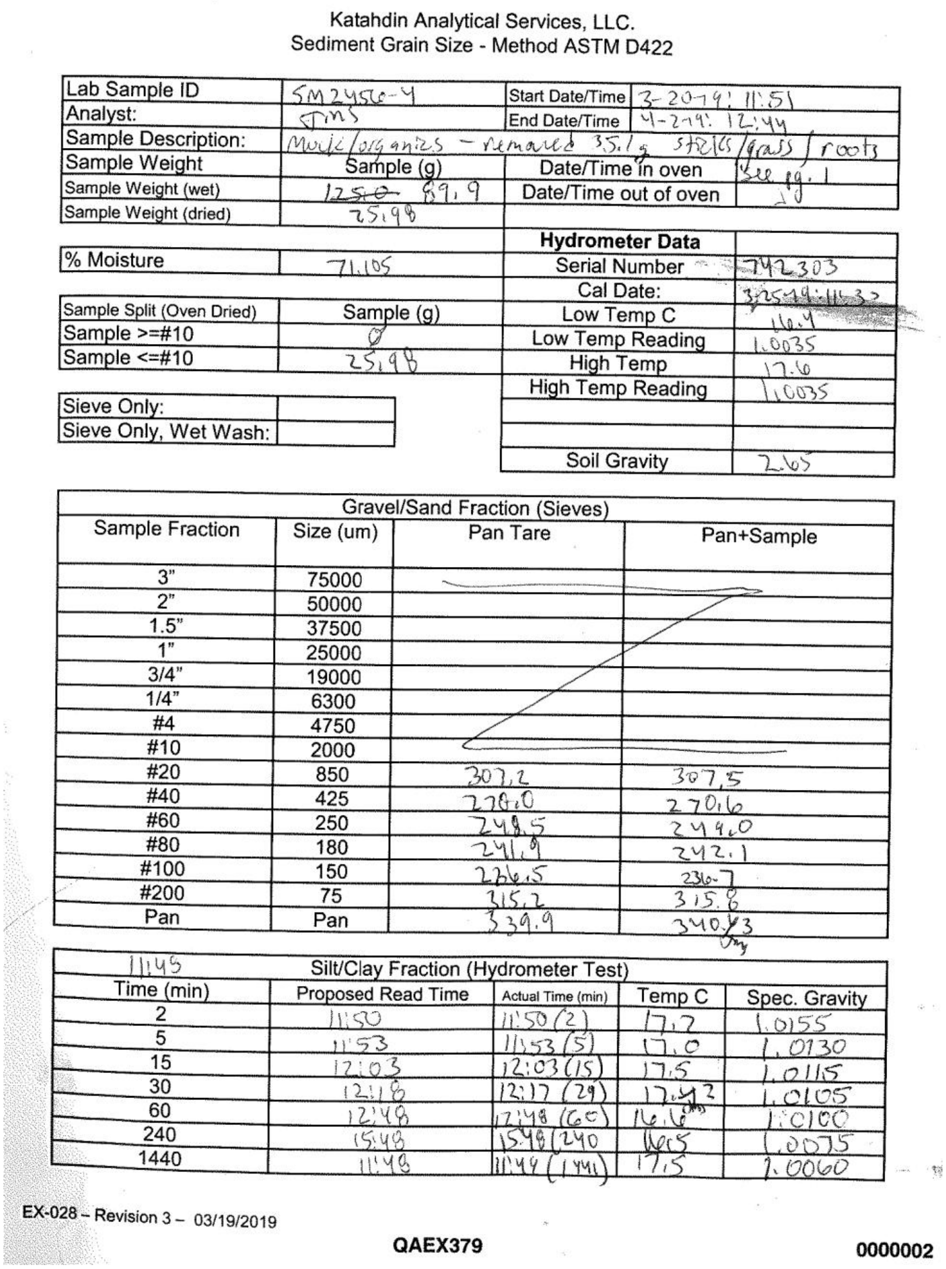
SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-551-02	METHOD ASTM D 422-63
Procedures		
Apparatus/Materials		
Reagents		
Sample Preservation and handling		
QC – Accuracy/ Precision		

TITLE: **Grain Size Analysis**

FIGURE 1

EXAMPLE OF LOGBOOK PAGE



Katahdin Analytical Services, LLC.
Sediment Grain Size - Method ASTM D422

Lab Sample ID	SM2456-4	Start Date/Time	3-20-19: 11:51
Analyst:	JMS	End Date/Time	4-2-19: 12:44
Sample Description:	Mulch/organics – removed 35.1g sticks/grass/roots		
Sample Weight	Sample (g)	Date/Time in oven	See pg. 1
Sample Weight (wet)	~~125.0~~ 89.9	Date/Time out of oven	
Sample Weight (dried)	25.98		

% Moisture	71.105

Sample Split (Oven Dried)	Sample (g)
Sample >=#10	0
Sample <=#10	25.98

Sieve Only:	
Sieve Only, Wet Wash:	

Hydrometer Data	
Serial Number	742303
Cal Date:	3-25-19: 11:32
Low Temp C	16.4
Low Temp Reading	1.0035
High Temp	17.6
High Temp Reading	1.0035
Soil Gravity	2.65

Gravel/Sand Fraction (Sieves)

Sample Fraction	Size (um)	Pan Tare	Pan+Sample
3"	75000		
2"	50000		
1.5"	37500		
1"	25000		
3/4"	19000		
1/4"	6300		
#4	4750		
#10	2000		
#20	850	307.2	307.5
#40	425	270.0	270.6
#60	250	248.5	249.0
#80	180	241.9	242.1
#100	150	236.5	236.7
#200	75	315.2	315.8
Pan	Pan	339.9	340.~~4~~3

11:45 Silt/Clay Fraction (Hydrometer Test)

Time (min)	Proposed Read Time	Actual Time (min)	Temp C	Spec. Gravity
2	11:50	11:50 (2)	17.2	1.0155
5	11:53	11:53 (5)	17.0	1.0130
15	12:03	12:03 (15)	17.5	1.0115
30	12:18	12:17 (29)	17.~~4~~2	1.0105
60	12:48	12:48 (60)	16.6	1.0100
240	15:48	15:48 (240	16.5	1.0075
1440	11:48	11:44 (1441)	17.5	1.0060

EX-028 – Revision 3 – 03/19/2019

QAEX379

0000002

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KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: CA-777
Revision History
Cover Page
Page 1

TITLE: TITRIMETRIC DETERMINATION OF ORGANIC CARBON USING THE WALKLEY-BLACK METHOD

Prepared By: George Brewer Date: 05/22/13

Approved By:

Department Manager: George Brewer Date: 05/22/13

Operations Manager: Deborah J. Nadeau Date: 5-22-13

QA Officer: Leslie Dimond Date: 05.22.13

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date

---

TITLE: **TITRIMETRIC DETERMINATION OF ORGANIC CARBON USING THE WALKLEY-BLACK METHOD**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-777-00**, titled **TITRIMETRIC DETERMINATION OF ORGANIC CARBON USING THE WALKLEY-BLACK METHOD**

Recipient: ______________________________ Date: ______________

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-777-00**, titled **TITRIMETRIC DETERMINATION OF ORGANIC CARBON USING THE WALKLEY-BLACK METHOD**

Recipient: ______________________________ Date: ______________

TITLE: TITRIMETRIC DETERMINATION OF ORGANIC CARBON USING THE WALKLEY-BLACK METHOD

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedure and requirements followed by Katahdin Analytical Services, Inc. for the titrimetric determination of organic carbon. This method is applicable to the measurement of carbon in soils and sediments in accordance with the method of Walkley and Black. The minimum reporting limit for this method is 0.1% on a dry weight basis.

1.1 Definitions

Laboratory Duplicate – a second aliquot of a sample that is analyzed the same way as the original sample in order to determine the precision of the method.

LCS - Laboratory Control Sample - A standard or solid reference material of known value that has been brought through the sample preparation an analysis process. The LCS is used to assess the accuracy of the method.

MB – Method Blank - Reagent water that has been brought through the sample preparation and analysis process. The MB is used to assess contamination.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the MDL.

MDL - Method Detection Limit - The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the titrimetric analysis of organic carbon by the Walkley-Black method. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, “Personnel Training & Documentation of Capability,” current revision.

It is the responsibility of all Katahdin technical personnel involved in titrimetric analysis of organic carbon by the Walkley-Black method to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the department manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and follow appropriate procedures such as: wearing safety glasses and gloves when working with chemicals or near an instrument; not taking food or drink into the laboratory; and knowing the location and use of all safety equipment.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

Any residual basic waste generated from the preparation of reactive organic carbon in this analysis is placed in satellite “G” or pyridine waste. The acidic waste after titration is put in satellite “A” or acid waste.

Other wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Environmental Health and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

An aliquot of a soil sample is oven-dried, ground, and sieved prior to analysis. Organic carbon in the sample is oxidized with a measured excess of potassium dichromate in the presence of sulfuric acid. Dichromate ion reacts with organic carbon as follows:

$$2Cr_2O_7^{2-} + 3C^0 + 16H^+ \rightarrow 4Cr^{3+} + 3CO_2 + 8H_2O$$

Excess dichromate ion is then back-titrated with ferrous iron. Ferrous iron reacts with dichromate as follows:

$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

The endpoint of the titration is indicated by the formation of a red-brown complex between excess ferrous iron and o-phenanthroline using ferroin indicator.

3.0 INTERFERENCES

3.1 High chloride concentrations will give a positive error.

3.2 Ferrous iron in the sample will give a positive error. Drying the sample prior to analysis in the presence of air oxidizes ferrous iron to ferric iron.

3.3 The method will not measure element organic carbon, such as soot carbon or charcoal.

4.0 APPARATUS AND MATERIALS

4.1. Buret, 50 mL, graduated to 0.1 mL (Class A)

4.2. Stir plate

4.3. Buret stand and holder

4.4. Mortar and pestle, porcelain or glass

4.5. Brass sieve, 0.5 mm

4.6. Top loading balance readable to 0.001 g

4.7. Stir bar and retriever

4.8. 500 mL Erlenmeyer flask

4.9. Adjustable automatic pipets or volumetric pipets-10mL, 1 mL

4.10. Volumetric flasks, Type A

5.0 REAGENTS

5.1 Laboratory Grade Reagent Water: organic carbon-free water.

5.2 Potassium dichromate ($K_2Cr_2O_7$) solution, 1N: Dry ACS reagent grade potassium dichromate in an oven at 103°C – 105°C overnight, and store in a dessicator until use. Dissolve 49.04 g of potassium dichromate in water in a 1000 mL volumetric flask, and bring to a final volume of 1000 mL. Store in a HDPE bottle. Prepare fresh every 6 months.

5.3 Sulfuric acid, concentrate, ACS reagent grade

5.4 Ferroin indicator, purchased.

5.5 Potassium hydrogen phthalate or KHP, acidimetric standard, ACS reagent grade, oven dried at 103^{o}C – 105^o.

5.6 Organic carbon standard, 10000 mg/L: Dissolve 2.128 g oven-dried KHP in reagent water in a 100 mL volumetric flask. Dilute to volume and store in a glass amber bottle at 4 +/- 2^{o}C for up to 6 months.

5.7 Ferrous sulfate heptahydrate ($FeSO_4\bullet 7H_2O$) titrant: In a 1000 mL volumetric flask, dissolve 140 g ACS reagent grade $FeSO_4\bullet 7H_2O$ in approximately 500 mL reagent grade water. Add 15 mL of concentrated sulfuric acid. Cool and dilute to volume with reagent grade water.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

6.1 Samples should be taken in glass or plastic bottles, and stored at 4 +/- 2^{o}C until analysis.

6.2 Samples must be analyzed within 28 days from sample collection.

7.0 PROCEDURES

7.1 SAMPLE PREPARATION

7.1.1 Samples are dried at 103^o C – 105^o C prior to analysis. Sufficient sample should be prepared to provide a 10 g aliquot for analysis.

7.1.2 Dried samples are ground using a mortar and pestle to as fine a powder as possible.

7.1.3 The ground sample is passed through a 0.5 mm brass sieve, and the sieved sample is subsampled for analysis.

7.2 STANDARDIZATION OF FERROUS SULFATE TITRANT

7.2.1 Using a volumetric pipet, add 10.0 mL of 1N potassium dichromate solution to a 500 mL Erlenmeyer flask.

7.2.2 Using a bottle-top dispenser, carefully add 20 mL of concentrated H_2SO_4 to the flask. Perform this operation in a fume hood. Swirl the flask to mix the reagents and allow to cool in the fume hood for 30 minutes.

7.2.3 Using a graduated plastic measuring cup, add 200 mL of reagent water to the reagents in the flask and swirl to mix.

7.2.4 Add 5 to 10 drops of ferroin indicator to the flask and place a Teflon stir bar to the flask. Stir the mixture continuously on a stir plate while titrating with the ferrous sulfate titrant. The mixture will turn olive green, then deep green, and then green-blue as the endpoint is approached. When the end point is near, add titrant dropwise until the color turns reddish-brown at the endpoint. This color change is very sharp.

7.2.5 Record the volume of titrant used to the nearest 0.05 mL.

7.2.6 Calculate the normality of the ferrous sulfate titrant using the following equation:

Ferrous Sulfate Normality = 10 / (mL of titrant)

7.2.7 If the titrant normality is not 0.500 +/- 0.05N, remake the titrant and the potassium dichromate solution and retitrate

7.3 SAMPLE ANALYSIS

7.3.1 Weigh an aliquot of dried, sieved sample and add to a 500 mL Erlenmeyer flask. Add a stir bar to the flask. The sample aliquot may weigh up to 10 g and should contain 10 to 25 mg of organic carbon.

7.3.2 Using a volumetric pipet, add 10.0 mL of 1N potassium dichromate solution to a 500 mL Erlenmeyer flask.

7.3.3 Using a bottle-top dispenser, carefully add 20 mL of concentrated H_2SO_4 to the flask. Perform this operation in a fume hood. Swirl the flask to mix the reagents and place on a stir plate and stir for one minute to thoroughly mix the sample and reagents. Allow to cool in the fume hood for 30 minutes.

7.3.4 Using a graduated plastic measuring cup, add 200 mL of reagent water to the flask and swirl to mix. If the suspension is very turbid and the titration endpoint will be difficult to discern, quantitatively filter the suspension through a 1.2 uM glass fiber filter using a vacuum filtration apparatus. Rinse the apparatus and filter pad with a small amount of reagent water (10 – 20 mL) to ensure that the filtration is quantitative. The small amount of added water will make no difference in the titration.

7.3.5 Add 5 to 10 drops of ferroin indicator to the flask and place a Teflon stir bar to the flask. Stir the mixture continuously on a stir plate while titrating with the ferrous sulfate titrant until the endpoint is reached. Record the volume of titrant used to the nearest 0.05 mL.

7.3.6 If all of the dichromate ion has been consumed in the sample preparation (i.e. if the sample contains organic carbon in excess of the amount of dichromate added), the sample will turn reddish-brown as soon as the first drops of titrant are added. In this case, or if less than 4.0 mL of titrant are used in the titration, reanalyze the sample using a smaller sample aliquot.

7.3.7 Calculate the amount of organic carbon in the sample according to the following equation:

$$\text{Organic Carbon, Wt. \%} = \frac{[10-(\text{Normality of } FeSO_4 \text{ x mL of } FeSO_4)](0.003)(100)(1.3)}{\text{grams of dry soil}}$$

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, remaining sample volume and client and project specific Data Quality Objectives. The Department Manager, Operations Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 Prepare and analyze a Laboratory Control Sample (LCS) in each analytical batch of 20 or fewer samples. The LCS is prepared by adding 1.0 mL of 10000 mg/L TOC standard (Section 5.6) to 1.0 grams of blank sand in a 500 mL Erlenmeyer flask.

The expected TOC concentration of the LCS is 1.0%, Acceptance criteria for the titrimetric LCS is 80-120% recovery If LCS is out-of-criteria, reanalyze prior to beginning the titrations of the samples. If the LCS remains out, check the standardization of the ferrous sulfate titrant. Reprepare the associated reagents and standards and repeat the LCS.

8.2 Prepare and analyze a Method Blank in each analytical batch of 20 or fewer samples. The Method Blank consists of 10 g of blank sand. Acceptance criteria for the method blank is an organic carbon concentration less than or equal to the PQL (0.1% by weight).

8.3 Analyze one sample in duplicate for every 10 or fewer samples. Acceptance criteria for the laboratory duplicate is a relative percent difference of 20% or less if the sample concentration is at least three times the PQL.

8.4 Prepare and analyze one matrix spike sample in each analytical batch of 20 or fewer samples. Matrix spikes are prepared by adding 0.5 mL of 10000 mg/L TOC standard (Section 5.6) to a dry sample aliquot in a 500 mL Erlenmeyer flask prior to sample preparation and analysis. Acceptance criteria for the titrimetric matrix spike are 75-125% recovery. If matrix spike recovery or duplicate RPD is out of criteria narrate or flag appropriately.

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantitation (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.
MDLs are filed with the Organic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revisions of USEPA Method 376.1 and SW846 Method 9034 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Walkley, A. and I.A. Black. 1934. “An Examination of Degtjareff Method for Determining Soil Organic Matter and a Proposed Modification of the Chromic Acid Titration Method”. Soil Science 37:29-37.

Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, US EPA SW-846, 3rd Edition, Method 9034, Rev. 0, December, 1996.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Current Version.

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

List of Figures and Tables

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Titrimetric Determination of Organic Carbon (Walkley-Black)	Method blank	One per prep batch of 20 or fewer samples	No analyte detected >PQL	(1) Investigate source of contamination (2) Report all sample results <PQL. (3) Report sample results >10X the blank result and flag results with a “B”. (4) Reanalyze all other samples associated with the failing blank where possible or flag results with “B”
	LCS	One per prep batch of 20 or fewer samples	80% - 120% Recovery	(1) If the LCS fails repeat LCS determination (2) Reprepare affected reagent or standard and repeat LCS
	Matrix Spike	One for every set of 20 or fewer samples	75% - 125% Recovery	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. Low recovery may be due to acid-insoluble organic carbons.
	Sample Duplicate	One sample duplicate per ten samples	(1) RPD $\leq$20 for sample results greater than 3 times the PQl (2) For sample results less than three times the PQL, the RPD between sample and duplicate should be < 100%.	(1) If RPD is outside criteria report original result with notation or narration.
	Demonstration of analyst proficiency – 4 replicates of LCS	Once per analyst per year	P&A meet method criteria	Repeat P&A study
	MDL study and/or LOD/LOQ Verifications	Refer to KAS SOP QA-806, “Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications”, current revision.		

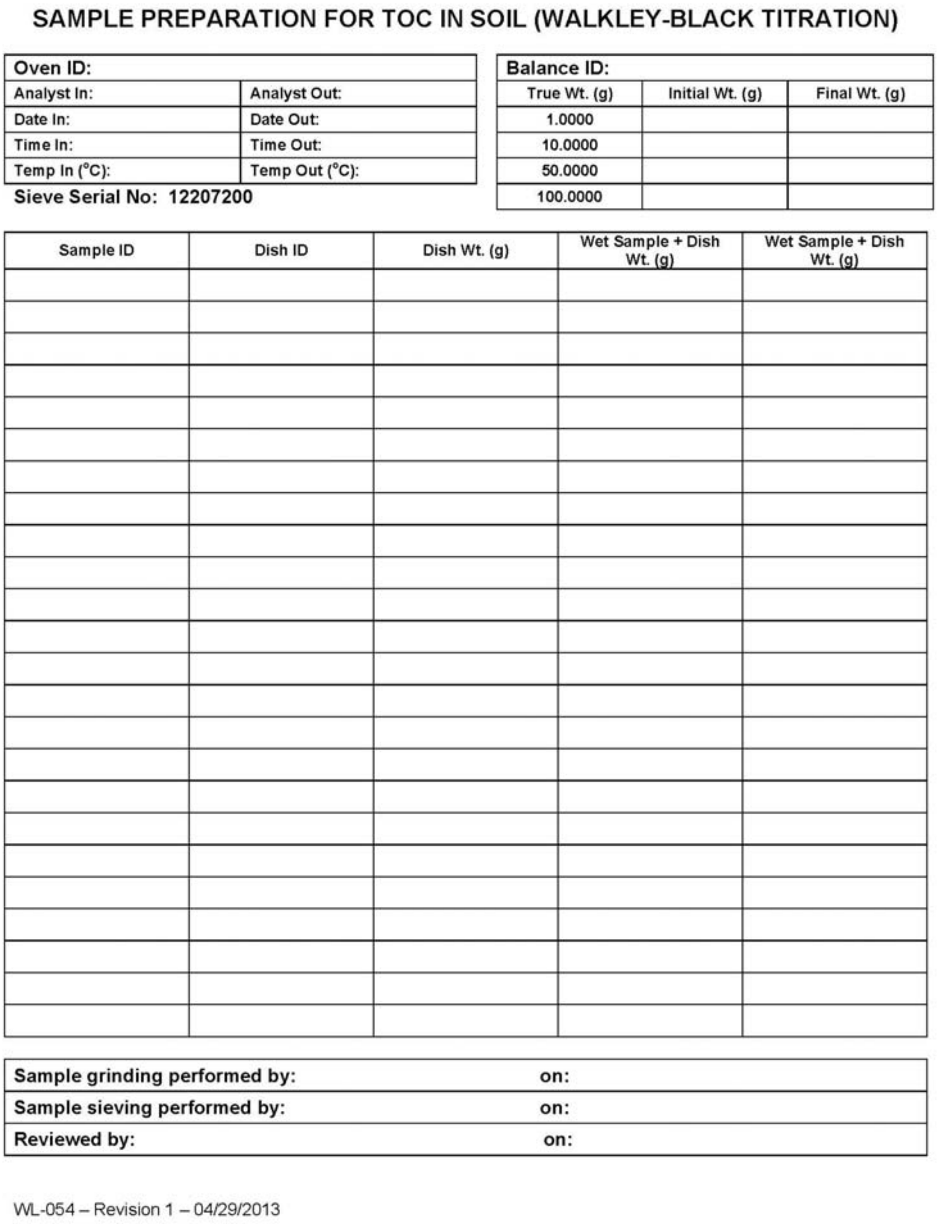
TABLE 2

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-777-00	Walkley Black Method
Apparatus/Materials		
Reagents		
Sample preservation/ handling		
Procedures		
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL		

FIGURE 1

EXAMPLE OF SAMPLE PREPARATION LOGBOOK PAGE



SAMPLE PREPARATION FOR TOC IN SOIL (WALKLEY-BLACK TITRATION)

Oven ID:	
Analyst In:	Analyst Out:
Date In:	Date Out:
Time In:	Time Out:
Temp In (°C):	Temp Out (°C):

Sieve Serial No: 12207200

Balance ID:		
True Wt. (g)	Initial Wt. (g)	Final Wt. (g)
1.0000		
10.0000		
50.0000		
100.0000		

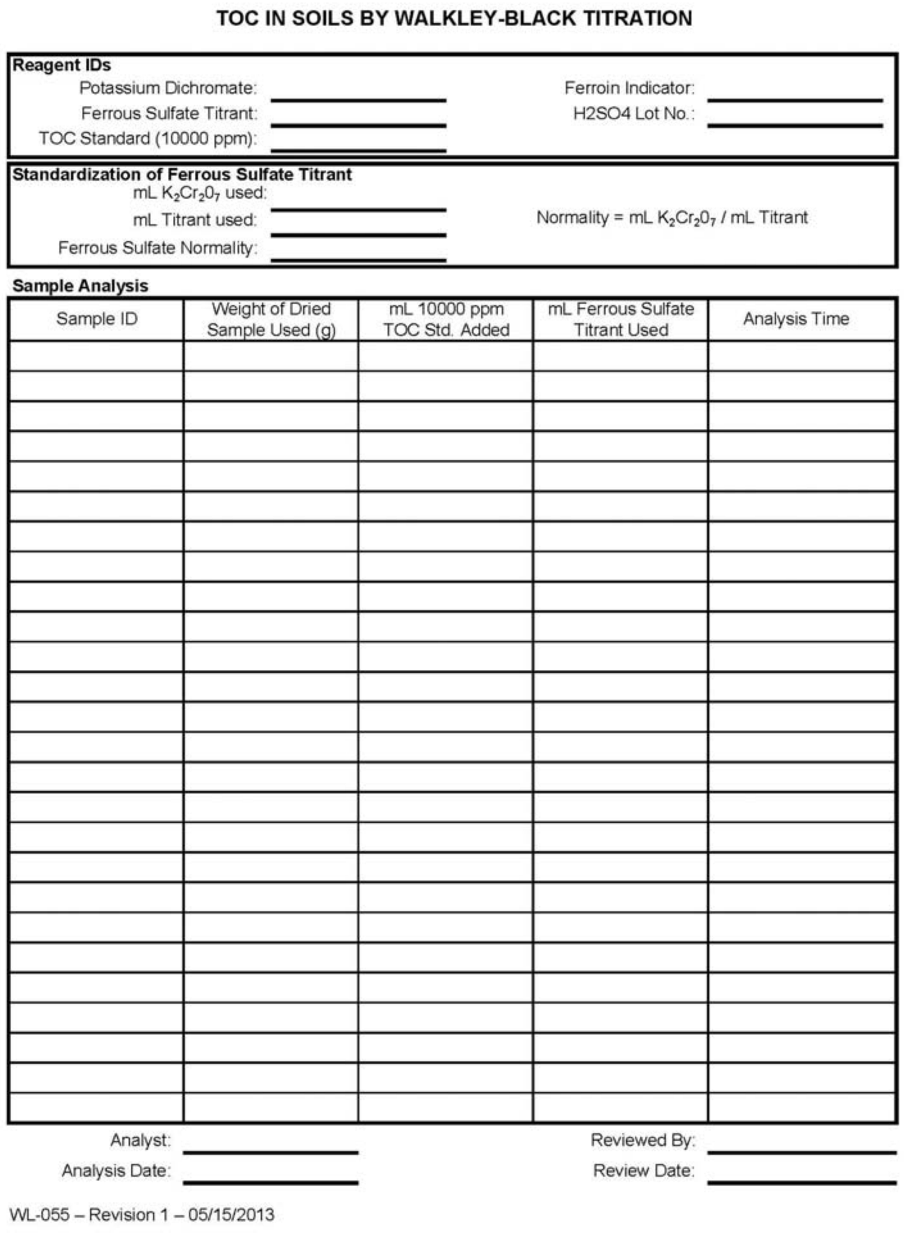
Sample ID	Dish ID	Dish Wt. (g)	Wet Sample + Dish Wt. (g)	Wet Sample + Dish Wt. (g)

Sample grinding performed by:	**on:**
Sample sieving performed by:	**on:**
Reviewed by:	**on:**

WL-054 – Revision 1 – 04/29/2013

FIGURE 2

EXAMPLE OF SAMPLE ANALYSIS LOGBOOK PAGE



TOC IN SOILS BY WALKLEY-BLACK TITRATION

Reagent IDs

Potassium Dichromate: ____________
Ferrous Sulfate Titrant: ____________
TOC Standard (10000 ppm): ____________
Ferroin Indicator: ____________
H2SO4 Lot No.: ____________

Standardization of Ferrous Sulfate Titrant

mL $K_2Cr_20_7$ used: ____________
mL Titrant used: ____________
Ferrous Sulfate Normality: ____________

Normality = mL $K_2Cr_20_7$ / mL Titrant

Sample Analysis

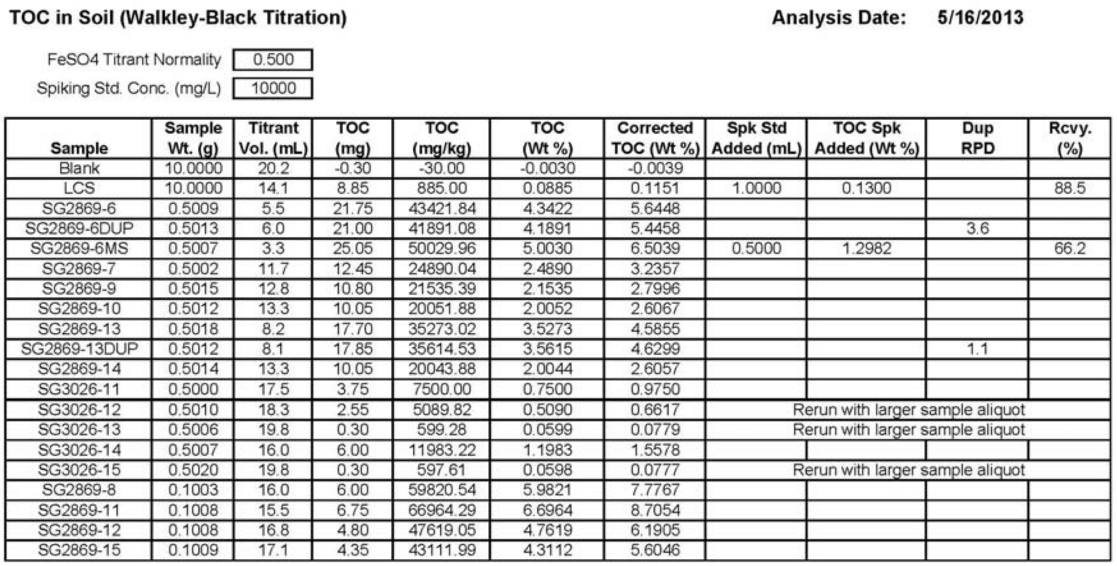
Sample ID	Weight of Dried Sample Used (g)	mL 10000 ppm TOC Std. Added	mL Ferrous Sulfate Titrant Used	Analysis Time

Analyst: ____________
Analysis Date: ____________
Reviewed By: ____________
Review Date: ____________

WL-055 – Revision 1 – 05/15/2013

FIGURE 3

EXAMPLE OF CALCULATION SPREADSHEET



TOC in Soil (Walkley-Black Titration) **Analysis Date: 5/16/2013**

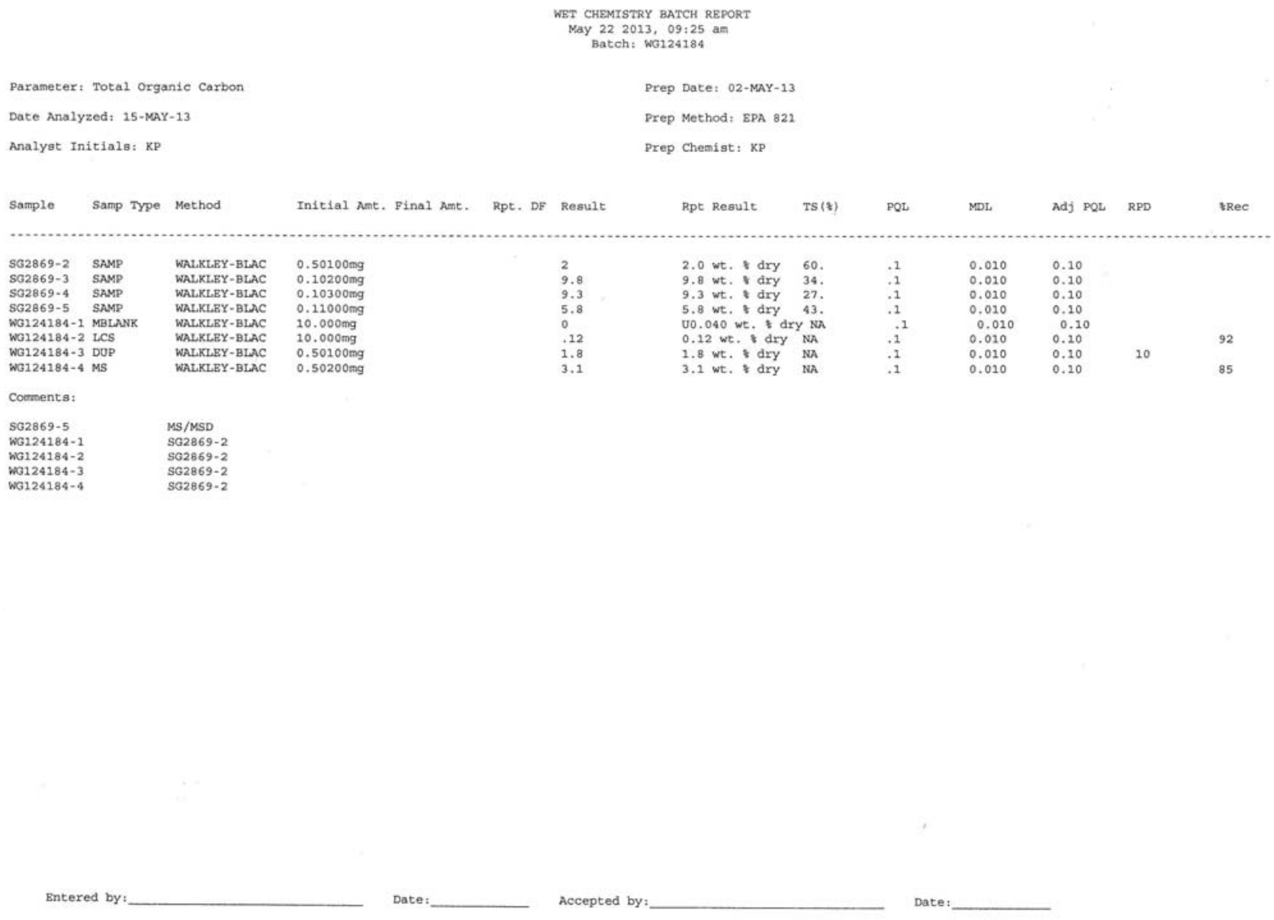
FeSO4 Titrant Normality: 0.500
Spiking Std. Conc. (mg/L): 10000

Sample	Sample Wt. (g)	Titrant Vol. (mL)	TOC (mg)	TOC (mg/kg)	TOC (Wt %)	Corrected TOC (Wt %)	Spk Std Added (mL)	TOC Spk Added (Wt %)	Dup RPD	Rcvy. (%)
Blank	10.0000	20.2	-0.30	-30.00	-0.0030	-0.0039				
LCS	10.0000	14.1	8.85	885.00	0.0885	0.1151	1.0000	0.1300		88.5
SG2869-6	0.5009	5.5	21.75	43421.84	4.3422	5.6448				
SG2869-6DUP	0.5013	6.0	21.00	41891.08	4.1891	5.4458			3.6	
SG2869-6MS	0.5007	3.3	25.05	50029.96	5.0030	6.5039	0.5000	1.2982		66.2
SG2869-7	0.5002	11.7	12.45	24890.04	2.4890	3.2357				
SG2869-9	0.5015	12.8	10.80	21535.39	2.1535	2.7996				
SG2869-10	0.5012	13.3	10.05	20051.88	2.0052	2.6067				
SG2869-13	0.5018	8.2	17.70	35273.02	3.5273	4.5855				
SG2869-13DUP	0.5012	8.1	17.85	35614.53	3.5615	4.6299			1.1	
SG2869-14	0.5014	13.3	10.05	20043.88	2.0044	2.6057				
SG3026-11	0.5000	17.5	3.75	7500.00	0.7500	0.9750				
SG3026-12	0.5010	18.3	2.55	5089.82	0.5090	0.6617	Rerun with larger sample aliquot			
SG3026-13	0.5006	19.8	0.30	599.28	0.0599	0.0779	Rerun with larger sample aliquot			
SG3026-14	0.5007	16.0	6.00	11983.22	1.1983	1.5578				
SG3026-15	0.5020	19.8	0.30	597.61	0.0598	0.0777	Rerun with larger sample aliquot			
SG2869-8	0.1003	16.0	6.00	59820.54	5.9821	7.7767				
SG2869-11	0.1008	15.5	6.75	66964.29	6.6964	8.7054				
SG2869-12	0.1008	16.8	4.80	47619.05	4.7619	6.1905				
SG2869-15	0.1009	17.1	4.35	43111.99	4.3112	5.6046				

TITLE: TITRIMETRIC DETERMINATION OF ORGANIC CARBON USING THE WALKLEY-BLACK METHOD

FIGURE 4

EXAMPLE OF BATCH SHEET



```
                                              WET CHEMISTRY BATCH REPORT
                                                May 22 2013, 09:25 am
                                                   Batch: WG124184

Parameter: Total Organic Carbon                                    Prep Date: 02-MAY-13

Date Analyzed: 15-MAY-13                                           Prep Method: EPA 821

Analyst Initials: KP                                               Prep Chemist: KP


Sample      Samp Type  Method         Initial Amt. Final Amt.  Rpt. DF  Result          Rpt Result       TS(%)       PQL        MDL        Adj PQL  RPD         %Rec
------------------------------------------------------------------------------------------------------------------------------------------------------------------------

SG2869-2    SAMP       WALKLEY-BLAC   0.50100mg                         2               2.0 wt. % dry    60.         .1         0.010      0.10
SG2869-3    SAMP       WALKLEY-BLAC   0.10200mg                         9.8             9.8 wt. % dry    34.         .1         0.010      0.10
SG2869-4    SAMP       WALKLEY-BLAC   0.10300mg                         9.3             9.3 wt. % dry    27.         .1         0.010      0.10
SG2869-5    SAMP       WALKLEY-BLAC   0.11000mg                         5.8             5.8 wt. % dry    43.         .1         0.010      0.10
WG124184-1 MBLANK      WALKLEY-BLAC   10.000mg                          0               U0.040 wt. % dry NA           .1         0.010      0.10
WG124184-2 LCS         WALKLEY-BLAC   10.000mg                          .12             0.12 wt. % dry   NA          .1         0.010      0.10                   92
WG124184-3 DUP         WALKLEY-BLAC   0.50100mg                         1.8             1.8 wt. % dry    NA          .1         0.010      0.10     10
WG124184-4 MS          WALKLEY-BLAC   0.50200mg                         3.1             3.1 wt. % dry    NA          .1         0.010      0.10                   85

Comments:

SG2869-5            MS/MSD
WG124184-1          SG2869-2
WG124184-2          SG2869-2
WG124184-3          SG2869-2
WG124184-4          SG2869-2




     Entered by:______________________   Date:__________   Accepted by:______________________   Date:__________
```

ADDENDUM

SOP NO CHANGE FORM

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Kerri Pawlina

Review Date: 8/29/13

SOP Number: CA777

SOP Title: TOC Walkley Black

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: Brewer

Date: 11/18/13

QAO Signature: Leslie Dimond

Date: 11.18.13

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Zachary B. Smith

Review Date: 05 - February - 2015

SOP Number: CA - 777

SOP Title: Titrimetric Determination of Organic Carbon using the Walkley - Black Method

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: A. Brewer

Date: 08/20/15

QAO Signature: Leslie Dimond

Date: 08.20.15

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Zach Fuller

Review Date: 2-7-17

SOP Number: CA-777-00

SOP Title: Titrimetric Determination of Organic Carbon using the Walkley-Black Method

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature:

Date: 03/08/17

QAO Signature: Leslie Dimond

Date: 03.13.17

KATAHDIN ANALYTICAL SERVICES
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Zach Fuller

Review Date: 2/27/19

SOP Number: CA-777-00

SOP Title: TOC Walkley Black

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature:

Date: 03/15/19

QAO Signature: Leslie Dimond

Date: 04.17.19

LOQ Check - Recovery Limits

Method	Matrix	CAS #	Analytes	lt_code	Rec. Low	Rec. High	Units
6010	Soil	7429-90-5	Al	LLCSREC	90	110	%
6010	Soil	7440-70-2	Ca	LLCSREC	90	110	%
6010	Soil	7439-89-6	Fe	LLCSREC	90	126	%
6010	Soil	7440-09-7	K	LLCSREC	90	114	%
6010	Soil	7439-95-4	Mg	LLCSREC	88	115	%
6010	Soil	7440-23-5	Na	LLCSREC	45	179	%
6020	Soil	7440-22-4	Ag	LLCSREC	90	110	%
6020	Soil	7440-38-2	As	LLCSREC	90	110	%
6020	Soil	7440-39-3	Ba	LLCSREC	87	121	%
6020	Soil	7440-41-7	Be	LLCSREC	20	180	%
6020	Soil	7440-43-9	Cd	LLCSREC	82	120	%
6020	Soil	7440-48-4	Co	LLCSREC	87	110	%
6020	Soil	7440-47-3	Cr	LLCSREC	77	116	%
6020	Soil	7440-50-8	Cu	LLCSREC	90	110	%
6020	Soil	7439-96-5	Mn	LLCSREC	90	110	%
6020	Soil	7439-98-7	Mo	LLCSREC	90	113	%
6020	Soil	7440-02-0	Ni	LLCSREC	90	110	%
6020	Soil	7439-92-1	Pb	LLCSREC	90	110	%
6020	Soil	7440-36-0	Sb	LLCSREC	88	113	%
6020	Soil	7782-49-2	Se	LLCSREC	86	131	%
6020	Soil	7440-28-0	Tl	LLCSREC	90	117	%
6020	Soil	7440-62-2	V	LLCSREC	89	110	%
6020	Soil	7440-66-6	Zn	LLCSREC	90	110	%
7471	Soil	7439-97-6	Hg	LLCSREC	49	143	%
8082	Soil	12674-11-2	PCB-1016	LLCSREC	28	132	%
8082	Soil	11104-28-2	PCB-1221	LLCSREC	16	130	%
8082	Soil	11141-16-5	PCB-1232	LLCSREC	10	130	%
8082	Soil	53469-21-9	PCB-1242	LLCSREC	10	130	%
8082	Soil	12672-29-6	PCB-1248	LLCSREC	13	130	%
8082	Soil	11097-69-1	PCB-1254	LLCSREC	25	130	%
8082	Soil	11096-82-5	PCB-1260	LLCSREC	31	130	%
8082	Soil	37324-23-5	PCB-1262	LLCSREC	10	130	%
8082	Soil	11100-14-4	PCB-1268	LLCSREC	22	130	%
8260B	Soil	71-43-2	Benzene	LLCSREC	80	120	%
8260B	Soil	100-41-4	Ethylbenzene	LLCSREC	80	122	%
8260B	Soil	179601-23-1	m-Xylene & p-Xylene	LLCSREC	79	124	%
8260B	Soil	95-47-6	o-Xylene	LLCSREC	80	125	%
8260B	Soil	108-88-3	Toluene	LLCSREC	80	120	%
8260B	Soil	1330-20-7	Xylenes, Total	LLCSREC	50	150	%
8270D SIM	Soil	90-12-0	1-Methylnaphthalene	LLCSREC	46	120	%
8270D SIM	Soil	91-57-6	2-Methylnaphthalene	LLCSREC	30	120	%
8270D SIM	Soil	83-32-9	Acenaphthene	LLCSREC	35	120	%
8270D SIM	Soil	208-96-8	Acenaphthylene	LLCSREC	32	120	%
8270D SIM	Soil	120-12-7	Anthracene	LLCSREC	35	120	%
8270D SIM	Soil	56-55-3	Benzo[a]anthracene	LLCSREC	36	120	%
8270D SIM	Soil	50-32-8	Benzo[a]pyrene	LLCSREC	20	123	%
8270D SIM	Soil	205-99-2	Benzo[b]fluoranthene	LLCSREC	20	133	%
8270D SIM	Soil	191-24-2	Benzo[g,h,i]perylene	LLCSREC	20	124	%
8270D SIM	Soil	207-08-9	Benzo[k]fluoranthene	LLCSREC	32	125	%
8270D SIM	Soil	218-01-9	Chrysene	LLCSREC	34	120	%
8270D SIM	Soil	53-70-3	Dibenz(a,h)anthracene	LLCSREC	20	131	%
8270D SIM	Soil	206-44-0	Fluoranthene	LLCSREC	44	123	%
8270D SIM	Soil	86-73-7	Fluorene	LLCSREC	44	120	%
8270D SIM	Soil	193-39-5	Indeno[1,2,3-cd]pyrene	LLCSREC	20	126	%

LOQ Check - Recovery Limits

Method	Matrix	CAS #	Analytes	lt_code	Rec. Low	Rec. High	Units
8270D SIM	Soil	91-20-3	Naphthalene	LLCSREC	44	120	%
8270D SIM	Soil	85-01-8	Phenanthrene	LLCSREC	42	120	%
8270D SIM	Soil	129-00-0	Pyrene	LLCSREC	43	120	%
8330B	Soil	99-35-4	1,3,5-Trinitrobenzene	LLCSREC	72	153	%
8330B	Soil	99-65-0	1,3-Dinitrobenzene	LLCSREC	80	135	%
8330B	Soil	118-96-7	2,4,6-Trinitrotoluene	LLCSREC	80	129	%
8330B	Soil	121-14-2	2,4-Dinitrotoluene	LLCSREC	80	132	%
8330B	Soil	606-20-2	2,6-Dinitrotoluene	LLCSREC	77	145	%
8330B	Soil	35572-78-2	2-Amino-4,6-dinitrotoluene	LLCSREC	80	134	%
8330B	Soil	618-87-1	3,5-Dinitroaniline	LLCSREC	50	150	%
8330B	Soil	19406-51-0	4-Amino-2,6-dinitrotoluene	LLCSREC	77	131	%
8330B	Soil	2691-41-0	HMX	LLCSREC	80	137	%
8330B	Soil	99-08-1	m-Nitrotoluene	LLCSREC	72	128	%
8330B	Soil	98-95-3	Nitrobenzene	LLCSREC	80	126	%
8330B	Soil	55-63-0	Nitroglycerin	LLCSREC	61	160	%
8330B	Soil	88-72-2	o-Nitrotoluene	LLCSREC	80	144	%
8330B	Soil	78-11-5	PETN	LLCSREC	78	160	%
8330B	Soil	99-99-0	p-Nitrotoluene	LLCSREC	68	130	%
8330B	Soil	121-82-4	RDX	LLCSREC	80	134	%
8330B	Soil	479-45-8	Tetryl	LLCSREC	58	154	%

Appendix H

Field Standard Operating Procedures

Contents:

Standard Operating Procedure No. 001
for
Sample Labels

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
November 2018

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 001	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	29 November 2018	Systematic review and update	Dan Hinckley Sheena Styger Sanita Corum	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the use of sample labels. Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. An example label is provided below. Other formats with similar levels of detail are acceptable. Some project software including Scribe (U.S. Environmental Protection Agency (EPA)-associated projects) and FUDSchem (U.S. Army Corps of Engineers-associated projects) can generate pre-prepared labels thus minimizing efforts in the field.

NOTE: It is important to review with the Project/Program Manager to determine if client or project-specific modifications to this SOP are required. For example, if using EPA laboratories, case numbers may be assigned in lieu of having site or project names on the label.

PROJECT NAME _____________ PROJECT NUM. ___________
SAMPLE LOCATION/SITE ID ____________________________
DATE: ____/____/____ TIME: _____:_____
ANALYTES: METALS VOC EXPLOSIVES ORGANICS OTHER
FILTERED: [NO] [YES]
PRESERVATIVE: [NONE] [HNO_3] [OTHER ______]
SAMPLER: ____________________

2. MATERIALS

The following materials may be required:

- Sample label
- Indelible marker.

3. PROCEDURE

The following sections describe how to use the sample labeling system.

3.1 LABEL INFORMATION

As each sample is collected/selected, fill out a sample label. Enter the following information on each label:

- Project name (do not include if there is a project or client-specific requirement to exclude)
- Project Number (or Case Number, as applicable)
- Location/site identification—enter the media type (i.e., well number, surface water, soil, etc.) sampling number, and other pertinent information concerning where the sample was taken
- Date of sample collection
- Time of sample collection
- Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with laboratory *prior to start of work)*
- Whether filtered or unfiltered (water samples only)
- Preservatives (water samples only)
- Number of containers for the sample (e.g., 1 of 2, 2 of 2).

3.2 ROUTINE CHECK

Double-check the label information to make sure it is correct. Detach the label, remove the backing, and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

3.3 RECORD INFORMATION

Record the sample number and designated sampling point in the field logbook, along with the following sample information:

- Time of sample collection (each logbook page should be dated)
- Location of the sample
- Organic vapor meter or photoionization meter readings for the sample (when appropriate)
- Any unusual or pertinent observations (oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, etc.)
- Number of containers required for each sample

- Whether the sample is a quality assurance sample (split, duplicate, matrix spike/matrix spike duplicate, or blank).

3.3.1 Logbook Entry

A typical logbook entry might look like this:

- 7:35 a.m. Sample No. MW-3. Photoionization Detector = 35 parts per million.
- Petroleum odor present. Sample designated MW-3-001.

NOTE: Duplicate samples may be given a unique sample designation rather than the actual sample number with an added prefix or suffix. This will prevent any indication to the laboratory that this is a duplicate sample thus making it “blind” to the laboratory. This fictitious sample number must be listed in the logbook along with the actual location of the sample.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

If “blind” field duplicate samples have been called for, then no indication of which samples are duplicates is to be provided to the laboratory.

6. REFERENCES

Not applicable.

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Standard Operating Procedure No. 002
for
Chain-of-Custody Form

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
November 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 002	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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CONTENTS

Page

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	29 November 2018	Systematic review and update	Dan Hinckley, Sheena Styger, Sanita Corum	Matthew Bowman

1. SCOPE AND APPLICATION

A chain-of-custody record (attached) is used as physical evidence of sample custody and as a permanent record for each sample collected. A chain-of-custody record documents the exchange and transportation of samples from the field to the laboratory. The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for use of the chain-of-custody form. Three example forms are provided as Figures SOP002-1 (EA's standard electronic chain-of-custody form), SOP002-2 (EA's Toxicology Laboratory chain-of-custody form), and SOP002-3 (U.S. Environmental Protection Agency [EPA] Scribe chain-of-custody form). Other formats with similar levels of detail are acceptable.

Most EPA projects utilize sampling and chain-of-custody instructions as documented in EPA's Samplers Guide (2014), which includes the use of Scribe, an in-house software program used to establish computer records of all environmental data and includes generation of chain-of-custodies. Using Scribe requires training, and the software and guidance can be found at the following link: https://response.epa.gov/site/site_profile.aspx?site_id=ScribeGIS. Training on Scribe is necessary and can be obtained through the Scribe weblink.

All new U.S. Army Corps of Engineers projects require the use of Formerly Used Defense Sites chemistry database (FUDSchem), which can be found at the following link: http://fudschem.com/public/framework/bannerhtml.aspx?dsn=systm&idhtml=10642&themesuffix=default&banner=banner_fudschem.jpg. This software will generate chain-of-custody forms specific to the sampling session. As with Scribe, FUDSchem training is necessary.

It is essential that chain-of-custody forms be completed properly, and that sample relinquishment be signed and dated appropriately. Laboratories use chain-of-custodies as their statement of work and, if it is not correct, the samples will not be analyzed appropriately. Sample custody documentation assures that the particular samples have been in secure locations, and that none of them have been tampered with, thus assuring appropriate results.

2. MATERIALS

The following materials may be required: chain-of-custody form and indelible ink pen.

3. PROCEDURE

- Give the site name and project name/number.
- Enter the sample identification code.
- Indicate the sampling dates for all samples.
- List the sampling times (military format) for all samples.

- Enter the total number of containers per cooler.
- List the analyses/container volume.
- Obtain the signature of sample team leader.
- State the carrier service and airbill number, analytical laboratory, and custody seal numbers (if applicable).
- Sign, date, and time the "relinquished by" section. Be sure the carrier signs and enters dates and time of acceptance of the samples.
- Upon completion of the form, retain a copy or portable document format, and affix the laboratory copy to the inside of the sample cooler in a zip-seal bag to protect from moisture, to be sent to the designated laboratory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency (EPA). 2014. Sampler's Guide, Contract Laboratory Program Guidance for Field Samplers. EPA/540/R014/013, Directive 92400.2-147. October.

Figures

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Figure SOP002-1 EA Chain-of-Custody Form

Company Name:	Project Manager or Contact: Phone:	Parameters/Method Numbers for Analysis	Chain-of-Custody Record EA Laboratories 231 Schilling Circle Hunt Valley, MD 21031 Telephone: (410) 584-7000
Project No. Dept.: Task:	Project Name:		
Sample Storage Location:	P.O. No.:		**Report Deliverables:** **1 2 3 4 D E** **EDD: Yes/No** **DUE TO CLIENT:** __________
Page of	**Report No.:**		

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
				XXXXXXXXXXXXXXXXXXX																**LPM**:
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
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Company Name:	Project Manager or Contact: Phone:	Parameters/Method Numbers for Analysis	Chain-of-Custody Record EA Laboratories 231 Schilling Circle Hunt Valley, MD 21031 Telephone: (410) 584-7000
Project No. Dept.: Task:	Project Name:		
Sample Storage Location:	P.O. No.:		**Report Deliverables:** **1 2 3 4 D E** **EDD: Yes/No** **DUE TO CLIENT:** _________
Page of	**Report No.:**		

Date	Time	Water	Soil	Sample Identification 19 Characters	**No. of Containers**														**EA Labs Accession Number**	Remarks
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																
				XXXXXXXXXXXXXXXXXXX																

Samples by: (Signature)	Date/Time |	Relinquished by: (Signature)	Date/Time |	Received by: (Signature)	Date/Time |
Relinquished by: (Signature)	Date/Time |	Received by Laboratory: (Signature)	Date/Time |	Airbill Number:	Sample Shipped by: (Circle) Fed Ex. Puro. UPS Hand Carried Other:

Cooler Temp. _______C pH: ___ Yes ___ No Comments: Custody Seals Intact ___ Yes ___ No

NOTE: Please indicate method number for analyses requested. This will help clarify any questions with laboratory techniques.

Figure SOP002-2 EA Toxicology Laboratory Chain-of-Custody Form

Client:

Project Manager:

Phone:

Project Contact:

Phone:

Project Name:

Project#:

Page 1 of 1

Sample Collected		Matrix		SAMPLE IDENTIFICATION	No. of Containers																							
Date	Time	Sediment	Water																									

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time

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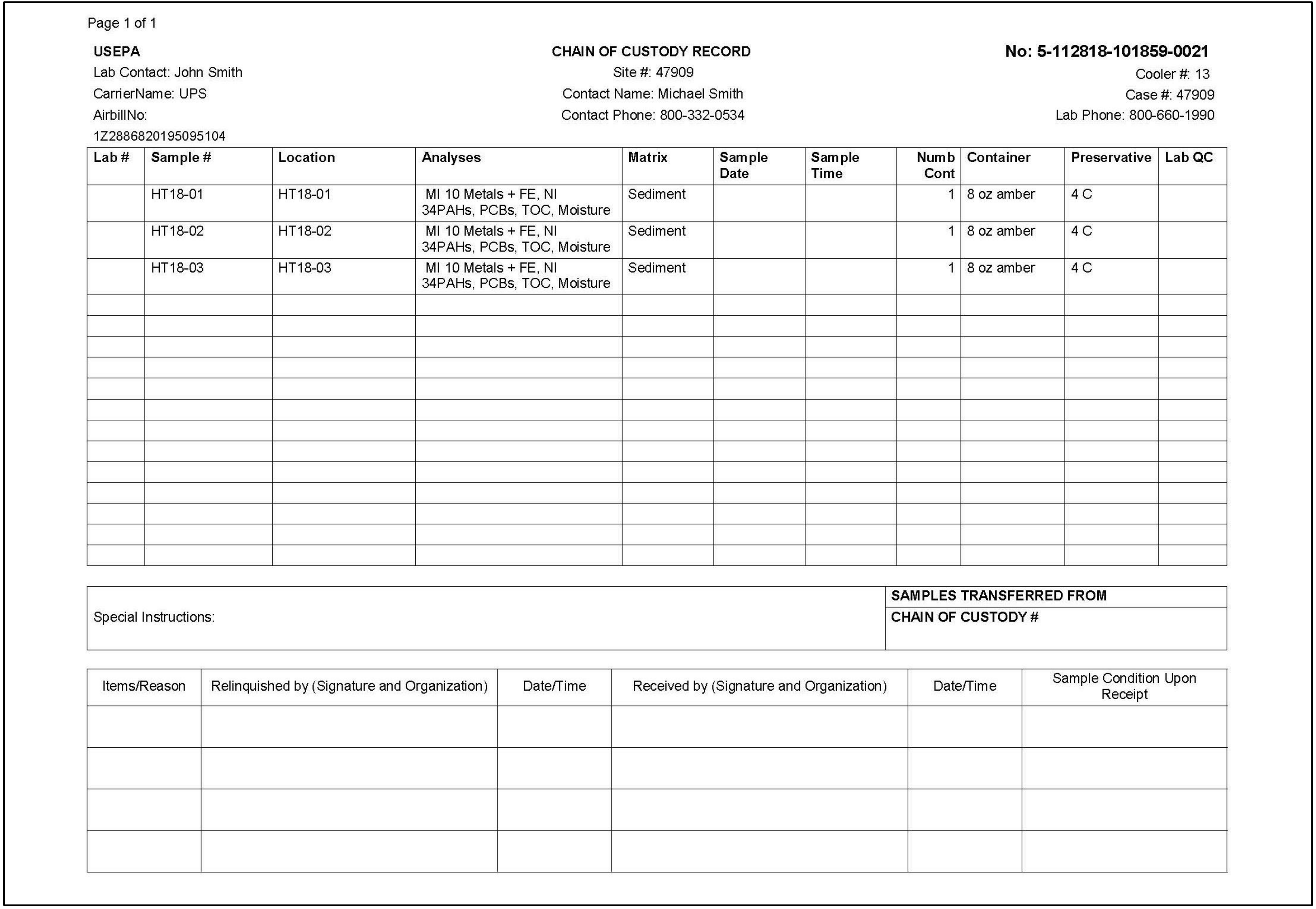
Figure SOP002-3 EPA Scribe Chain-of-Custody Form



Page 1 of 1

USEPA
Lab Contact: John Smith
CarrierName: UPS
AirbillNo:
1Z2886820195095104

CHAIN OF CUSTODY RECORD
Site #: 47909
Contact Name: Michael Smith
Contact Phone: 800-332-0534

No: 5-112818-101859-0021
Cooler #: 13
Case #: 47909
Lab Phone: 800-660-1990

Lab #	Sample #	Location	Analyses	Matrix	Sample Date	Sample Time	Numb Cont	Container	Preservative	Lab QC
	HT18-01	HT18-01	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	
	HT18-02	HT18-02	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	
	HT18-03	HT18-03	MI 10 Metals + FE, NI 34PAHs, PCBs, TOC, Moisture	Sediment			1	8 oz amber	4 C	

Special Instructions:	**SAMPLES TRANSFERRED FROM** **CHAIN OF CUSTODY #**

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt

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Standard Operating Procedure No. 003
for
Subsurface Utility Clearance

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
July 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 003	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	6/28/2018	Systematic review and update	Matt Bowman	Pete Garger

1. SCOPE AND APPLICATION

1.1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to prevent injury to workers and damage to subsurface structures (including tanks, pipe lines, water lines, gas lines, electrical service, etc.) during ground disturbance activities (including drilling, augering, sampling, use of direct-push technologies, excavation, trenching, concrete coring or removal, fence post installation, grading, or other similar subsurface operations).

1.2 LIMITATIONS

The procedures set forth in this document are general guidance, but may not be entirely applicable to particular sites based on the site-specific considerations. The Project Manager is responsible for making a site-specific evaluation of each site to determine how subsurface utility clearance procedures should be utilized or modified. If safety or other site-specific considerations require a modified or different procedure, the Project Manager should review the modified procedure with the Business Unit Director, Profit Center Manager, or Senior Technical Reviewer. Evaluation support of modified procedures may be provided by the Corporate Health and Safety Director or the Lead Construction Quality Engineer.

Special considerations may be required for utility location activities at complex or challenging project sites (underwater utilities, hazardous waste sites, etc.). Additional subsurface utility clearance procedures should be added as appropriate for difficult sites. When health and safety risks to workers or potential utility damage cannot be effectively managed through utility location, clearance, and protection measures, the Project Manager must consider the modification of ground disturbance activities (e.g., establishing a safe offset from high risk utilities). In these cases, detailed coordination with the client and/or regulatory staff is likely required.

1.3 SCOPE

This SOP provides minimum guidance for subsurface utility clearance activities, which must be followed prior to and during ground disturbance activities at EA project sites. Even after completing the subsurface utility clearance activities required in this SOP, all ground disturbance activities should proceed with due caution.

Deviations from this SOP may be provided on an exception basis for specific situations, such as underground storage tank systems removals, verified aboveground/overhead services/lines, undeveloped land/idle facilities, shallow groundwater conditions, soil stability, or well construction quality assurance/quality control concerns, etc.

EA or its subcontractors are responsible for, and shall ensure that, all ground disturbance activities are completed safely, without incident, and in accordance with applicable federal, state, and local regulations.

This SOP shall not override any site-specific or consultant/contractor procedures that are more stringent or provide a greater degree of safety or protection of health or the environment.

2. PROCEDURES

The EA Project Manager or his/her designee must complete the Subsurface Utility Clearance Checklist (Attachment A) in conjunction with the following procedures. The checklist must be completed before initiating any ground disturbance activities. The completed checklist must be submitted to the appropriate team individuals, subcontractors, and/or the client and included in the project files.

2.1 SAFETY

A Health and Safety Plan must be available onsite and followed by all contractors and subcontractors.

Work areas should be defined and secured with safety cones, safety tape, construction fence, other barriers, or signs as appropriate.

Site work permits must be obtained as required by site procedures. Based on site conditions or classification, the use of intrinsically-safe equipment may be required.

To ensure the safety of all onsite personnel and subsurface structure integrity, consideration should be given to de-energizing and locking out selected site utilities or temporarily shutting down a portion of or the entire facility.

2.2 SUBSURFACE UTILITY LOCATION ACTIVITIES

To gather all relevant information about potential subsurface structures prior to ground disturbance activities, the project team should pursue multiple lines of evidence on the type, location, depth, size, material of construction, and status (active/abandoned) of all utilities within and near the area planned for ground disturbance activities. A minimum of three lines of evidence should be obtained and documented; however, additional lines of evidences should be secured when possible. Lines of evidence may include the following:

- Historical Site Information
- Public Utility Mark-Out (One Call – 811)
- Private Utility Mark-Out
- Site Inspection
- Client/Facility Interviews and Coordination.

2.2.1 Historical Site Information

The most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) should be obtained, as available.

NOTE: As-built drawings may not accurately depict the locations and depths of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

EA should obtain any other site information such as easements, right-of-ways, historical plot plans, fire insurance plans, tank (dip) charts, previous site investigations, soil surveys, boring logs, and aerial photographs, etc. as relevant to the planned ground disturbance activities. Where applicable, EA should also contact contract personnel who may have historical site knowledge.

2.2.2 Public and Private Utility Mark-Outs

EA must ensure that a thorough mark-out at the site is completed to locate electrical, gas, telephone, water, sewer, low voltage electric lines, product delivery pipelines, fiber optic, and all other subsurface utilities/services.

- Where available, public utility companies must be contacted to identify subsurface utilities. (This can be accomplished through the One-Call system in most instances.) Attachment B provides a brochure for the 811 Utility Locate Call Center.

- In addition, where available and warranted by site conditions, a private utility/pipeline mark-out company should be contracted to perform an electronic subsurface survey to identify the presence of suspected hazardous or critical subsurface utilities and structures. In some cases, this is necessary to confirm public utility mark-outs in the vicinity of planned ground disturbance activities.

EA will review all available site plan subsurface information with the private mark-out company to assist in locating utilities and other subsurface structures.

NOTE: Mark-outs may not accurately depict the exact locations of improvements and subsurface structures and should, therefore, not be **solely** relied upon.

Where possible, EA personnel are encouraged to be onsite at the time of subsurface mark-outs. This is to ensure accuracy and understanding of subsurface utility structures identified and provides an opportunity to exchange information with mark-out company personnel regarding planned work activities.

Subsurface utility structures should be marked throughout the entire work area(s) with adequate materials (e.g., site conditions may require paint and tape/flags). Ground disturbance activities must be started within 30 days of mark-out, unless local ordinances specify a shorter time period.

If activities are not started within required time period or markings have faded, mark-outs must be redone.

EA personnel will record time and date of mark-out request and list all companies contacted by the service and confirmation number. This information should be available for review onsite and checked off after visual confirmation of markings.

2.2.3 Site Inspection

To compare the site plan to actual conditions based on information gathered in other lines of evidence, a site inspection should be performed to identify potential signs of subsurface utilities. These signs may include:

- Signage identifying subsurface utilities
- Asphalt patching or paving scars
- Pull boxes, junction boxes, valve box covers, or manhole covers
- Sewer drains and clean-out traps
- Meters and light poles
- Piping or conduit on the walls or roofs of buildings
- Linear ground depressions
- Markings from previous utility mark-out efforts
- Other utilities including fire hydrants, on/below grade electrical transformers, splice cages, sprinkler systems, steam lines (including insulated tanks that may indicate steam lines), and cathodic protection on lines/tanks.

EA will document all findings and update the site plan with this information. In some regions, it may be more effective and efficient to conduct the site inspection at the same time the contractor performing the ground disturbance activity is mobilized to the site. The site inspection may include others as determined by the consultant/contractor and the Project Manager.

2.2.4 Client/Facility Interviews and Coordination

Knowledgeable client and facility staff familiar with site utilities should be interviewed to obtain information and documentation on potential subsurface utility locations, depth, etc. Results of these interviews should be documented and included with the Subsurface Utility Clearance Checklist. On third party sites, close coordination with the site owner's representatives for mark-outs, review of as-builts, and other information reviews should be conducted prior to any ground disturbance work. Project Managers are encouraged to provide updated as-built information to the client.

EA will review the selected ground disturbance locations with the client. EA will not proceed with the subsurface activities until the plan has been discussed with the client. During execution of the project, if subsurface activities are required outside of the area previously approved by the client, EA will submit these changes to the client for approval prior to execution.

2.2.5 Ground Disturbance Activity Sequence

When practical, EA will plan ground disturbance activities starting at the point farthest from the location of suspected underground improvements. This is done to determine the natural subsurface conditions and to allow EA site personnel to recognize fill conditions.

Experience has shown that the following warning signs may indicate the presence of a subsurface structure:

- Warning tape (typically indicative of underground services).
- Pea gravel/sand/non-indigenous material (typically indicative of tanks or lines).
- Red concrete (typically indicative of electrical duct banks).
- The abrupt absence of soil recovery in a hand auger. This could indicate pea gravel or sand that has spilled out of the auger. This may not be indicative in areas where native soil conditions typically result in poor hand auger recoveries.
- Any unexpected departure from the native soil or backfill conditions as established by prior onsite digging.

If any of these conditions is encountered by EA site personnel, digging should stop and the client should be contacted.

3. UTILITY PROTECTION MEASURES DURING GROUND DISTURBANCE ACTIVITIES

After mobilization, but prior to the primary ground disturbance activities, the physical location of subsurface utilities should be cleared and verified whenever possible and practical. The clearance method used to clear and verify the subsurface utilities should be compatible with the inherent associated risk given the type of facility/property, subsurface utility material of construction, utility depth, soil stratigraphy, and the location of the ground disturbance activity, such that required delineation is obtained. It should be noted that in areas where there is paving, sufficient paving should be removed to allow clear visibility of the subsurface conditions during clearance activities. The following is a list of potential clearance methods that may be used on a job site:

- Vacuum digging
- Probing
- Hand digging
- Hand augering
- Post-hole digging.

EA personnel will evaluate the potential for electrical shock or fire/explosion for each subsurface disturbance project and will evaluate as necessary the use of non-conductive or non-sparking tools (i.e., fiberglass hand shovels, and thick electrically insulating rubber grips on hand augers or probes). The potential need for the use of non-conductive materials, electrical safety insulated gloves, and footwear will also be evaluated on a case-by-case basis.

For drilling, direct-push technology, fence post installation, or other borehole installation, the area to be delineated will exceed the diameter of the largest tool to be advanced and sufficiently allow for visual inspection of any obstructions encountered.

3.1 SUBSURFACE CLEARANCE PROCEDURES FOR TRENCHING/ EXCAVATION ACTIVITIES

For trenching and excavation activities, appropriate subsurface clearance methods should be conducted along the length and width of the excavation at a frequency sufficient to ensure adequate precautions have been applied to the entire work area. The frequency and density of investigations will be based on site knowledge, potential hazards, and risks of the work area to surrounding locations.

Whenever subsurface structures are exposed, EA will cease work and mark the area (e.g., flags, stakes, cross bracing) to ensure the integrity of these exposed structures is maintained during subsequent trenching/excavation/backfilling.

During ground disturbance activities, EA and its subcontractors should consider the use of spotters to monitor the excavation for signs of subsurface utilities (pipes, conduits, cables, bedding material, warning tape, tracing wire, soil material changes, etc.) to provide early warning in the event unknown subsurface utilities are encountered. The decision to use spotters should be based on the risk of encountering unknown subsurface utilities, utility hazards associated potential unknown utilities that could be encountered (electrical, natural gas, etc.), and the physical and environmental hazards to have a spotter in proximity to the excavation. Spotters, if used, should be briefed on the potential physical and utility hazards that may be present at the site and the signs of subsurface utilities that they should be monitoring for during ground disturbance activities.

Uniform color codes for marking of underground facilities are provided in Attachment C.

Attachment A

Subsurface Utility Clearance Checklist

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SUBSURFACE UTILITY CLEARANCE CHECKLIST

Site Identification: ______________________

Project Consultant/Contractor: ______________________

Section 1: Safety, Preparation Tasks, and Mark-Outs

Activity	Yes	No	N/A	Comments including Justification if Response Is No or Not Applicable
Health and Safety Plan is available and all contractors and subcontractors are familiar with it.				
All applicable local, state, and federal permits have been obtained.				
Site access/permission has been secured.				
Most recent as-built drawings and/or site plans (including underground storage tank, product, and vent lines) obtained.				
Reviewed site information to identify subsurface structures relevant to planned site activities (easements, rights-of-way, historical plot plans, fire insurance plans, tank dip charts, previous site investigations, soil surveys, boring logs, aerial photographs, etc.).				
Utility mark-outs have been performed by public utility company(s). Mark-outs clear/visible.				
Subsurface structure mark-outs performed by private mark-out company. Mark-outs clear/visible.				
Additional Activities: Were dig locations reviewed with site representative?				

Section 2: Initial Site Visit and Selecting Ground Disturbance Locations

Activity	Yes	No	N/A	Comments, including Justification if Response Is No or Not Applicable
Location of all aboveground indicators of subsurface utilities/services that may be leading to or from buildings within the planned work area has been identified.				
Location of utility mark-outs by all utility companies previously contacted has been identified within required time period.				
Location of all subsurface structure mark-outs by private mark-out company has been identified within required time period.				
Location of area lights/signs and associated subsurface lines identified.				
Location of all phones and associated subsurface lines identified.				
Location of all drains and associated interconnecting lines identified.				
Location of all electrical junction boxes and associated interconnecting lines identified				
Location of all natural gas meters or connections and all interconnecting lines identified				

Completed by: ______________________
Name

Signature: ______________________ ____________
Company Date

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Attachment B

811 Utility Locate Brochure

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ALWAYS CALL BEFORE YOU DIG

One free, easy call gets your utility lines marked AND helps protect you from injury and expense.

Know what's below. Always call 811 before you dig. Visit call811.com for more information.

811®
Know what's below.
Call before you dig.

INSERT
CALL CENTER
LOGO HERE

U.S. Department
of Transportation

The Associated General Contractors of America
Building Your Quality of Life

JOHN DEERE

TRAVELERS

Common Ground Alliance

811®
Know what's below.
Call before you dig.

Q: WHAT IS 811?

A: 811 is a new federally-mandated N-11 number designated by the FCC to consolidate all local "Call Before You Dig" numbers and help save lives by minimizing damages to underground utilities. One easy phone call to 811 quickly and easily begins the process of getting underground utility lines marked. Local One Call Center personnel will then notify affected utility companies, who will continue to mark underground lines for free.

Q: WHY SHOULD I CALL 811 BEFORE EVERY DIG?

A: Calling 811 will help save lives and protect infrastructure. Knowing where underground utility lines are buried before each digging project begins helps protect you from injury, expense and penalties. The depth of utility lines varies and there may be multiple utility lines in the same area. Even simple digging projects can damage utility lines and can disrupt vital services to an entire neighborhood, harm diggers, and potentially result in expensive fines and repair costs. Marked lines show diggers the approximate location of underground lines and help prevent undesired consequences.

Q: I'M JUST A HOMEOWNER, NOT A CONTRACTOR—IS 811 FOR ME?

A: Calling 811 is for professional excavators and do-it-yourself homeowners. A recent national survey revealed that roughly half of Americans are "active diggers" who have done (or are planning to do) some type of digging project at home. Whether you are a professional excavator or an avid do-it-yourselfer, you need to call 811 before every dig every time.

Q: WHO IS PROMOTING AWARENESS OF 811?

A: The national 811 campaign is a project of The Common Ground Alliance (CGA), working with its 1,400 individual members, member organizations, sponsors and 811 campaign national launch partners. CGA is a member-driven association dedicated to ensuring public safety, environmental protection, and the integrity of services by promoting effective damage prevention practices. In recent years, the association has established itself as the leading organization in an effort to reduce damages to all underground facilities in North America through shared responsibility among all stakeholders.

Attachment C

Uniform Color Codes for Marking of Underground Facilities

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APWA UNIFORM COLOR CODE

WHITE - Proposed Excavation

PINK - Temporary Survey Markings

RED - Electric Power Lines, Cables, Conduit and Lighting Cables

YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials

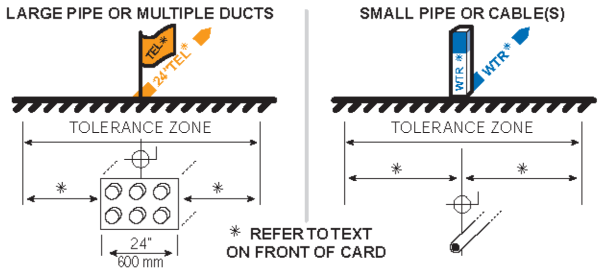
ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit

BLUE - Potable Water

PURPLE - Reclaimed Water, Irrigation and Slurry Lines

GREEN - Sewers and Drain Lines

TYPICAL MARKING



Customize with your center's phone and address information

GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS

The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

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Standard Operating Procedure No. 004
for
Sample Packing and Shipping

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031

Revision 1
September 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 004	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	25 September 2018	Systematic update and review	Cristina Radu, Amanda Kohn	Matthew Bowman

1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for the packing and shipping of environmental samples to the laboratory for analysis. Additional requirements are applicable when shipping samples under the U.S. Environmental Protection Agency's Superfund Contract Laboratory Program.

NOTE: Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated could require shipment as dangerous goods; procedures for shipping of such samples are not covered in this SOP.

2. MATERIALS

The following materials may be required:

- Clear tape
- Custody seals
- Ice
- Packing material
- Plastic garbage bags
- Sample documentation
- Waterproof coolers (hard plastic)
- Zip-seal plastic bags.

3. PROCEDURE

Refer to SOP Numbers (Nos.) 001, 002, 016, and 039 as applicable.

Samples will be placed in clean, bubble-wrap lined sample coolers with double-bagged ice immediately after collection to ensure proper preservation. Most sample analyses require that the sample material is maintained at 2-6 degrees Celsius (°C). It is also important to ensure that sample containers are maintained at all times at the temperature required by the analytical method used to analyze the sample media; as such, samples should be retained in a chilled cooler during the inventory, quality control, and packaging process.

Check cap tightness and wipe down outside of each sample container. Verify that information on sample labels is correct and matches chain-of-custody forms. Ensure that both waterproof labels and indelible ink are used to label sample containers. Clear tape should be placed completely over the label. Wrap breakable sample containers in bubble wrap. Enclose each sample in a clear zip-seal plastic bag.

Prepare cooler for shipping. Empty any water that has accumulated in coolers from melting ice. Securely seal all valves and/or drain holes in the shipping container, both inside and out, with duct tape to prevent leakage in the event of sample container breakage or melting ice. Place several layers of bubble wrap on top of absorbent material and line the cooler sidewalls with bubble wrap. Line cooler with open garbage bag.

Prepare sample containers for shipping as follows:

- ***Glass Containers***—Wrap each glass sample container in bubble wrap or closed cell foam sheets. It is acceptable to package up to three 40-milliliter vials in one bubble wrap bag that is usually provided by the analytical laboratory. Enclose sample containers in a clear zip-seal plastic bag.

- ***Polyethylene Containers***—Place sample containers in clear zip-seal bags.

- ***Zip-Seal Bags***—Double-bag the samples to ensure that moisture will not reach the label.

Place all the sample containers upright inside garbage bag. Do not stack glass containers or lay them on their sides. Add additional bubble wrap between and around sample containers as needed to ensure containers do not shift during transport. If a second garbage bag was used, tie the (inner) garbage bag to isolate samples.

Double bag and seal loose, fresh ice to prevent melting ice from soaking the packing material. Fill gallon-size or larger zip-seal bags with fresh ice about two-thirds full and squeeze excess air out of the bags before sealing. Turn bag upside down and place in a second zip-seal bag, also removing excess air. Prepare sufficient bags to cover sample containers and ensure that the proper temperature (2-6° C) is maintained during transport.

Place ice on top of sample containers. Ensure that packing material does not insulate samples from ice. Do not use loose ice in sample coolers. Do not use bagged ice as packing material between or around sample bottles. Tie the garbage bag ensuring that the cooler lid will close securely.

Place a temperature blank into the cooler. The temperature blank consists of a plastic bottle containing either potable or deionized water. Temperature blanks are typically provided by the analytical laboratory. If temperature blanks are not provided, field staff must add a clean container filled with deionized water; ensure the cap is tight and container is labeled before placing in cooler.

If aqueous volatile organic analyte samples are being submitted, ensure a trip blank sample set is placed in each cooler containing volatile organic analyte samples. Trip blanks are used to check for contamination of volatile organic compound samples during handling, storage, and shipment from field to laboratory. The trip blanks consist of volatile organic analyte vials filled with deionized water and are typically provided by the analytical laboratory. Ensure that the trip blank samples and analyses are included on the chain-of-custody record.

Make copies of sample documentation (chain-of-custody forms or other field records) and retain in field files for record. Enclose the original field documentation forms in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation.

Seal coolers with signed and dated custody seals such that if the coolers were opened, the custody seals would be broken. Place clear tape over the custody seals to prevent damage to the seals.

Tape the cooler shut with packing tape over the hinges and custody seals. Tape should be wrapped around the cooler a minimum of five times. Ship all samples via overnight delivery on the same day they are collected if possible. Project-specific shipping requirements (e.g., Saturday delivery, communication with the receiving laboratory, etc.) should be discussed with the sample manager or project manager during project planning.

After samples are packaged within shipping containers, place shipping labels clearly on the outside of the container; clearly mark the number of containers in the shipment on the shipping label. Mark each cooler as “1 of 2,” “2 of 2,” etc.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

The project manager and field team leader are responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample meets or is suspected to meet the definition of “dangerous goods” per the Dangerous Goods Regulation of the International Air Transport Association, then that sample must be handled according to the instructions given for that material. Dangerous goods must be prepared for shipping only by personnel trained and certified by International Air Transport Association in dangerous goods shipment.

6. REFERENCES

Not applicable.

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Standard Operating Procedure No. 005
for
Field Decontamination

Prepared by

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Revision 2
September 2018

PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-*specific* variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 005	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

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DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
1	25 September 2018	Systematic update and review	Cristina Radu, Amanda Kohn	Matthew Bowman

1. SCOPE AND APPLICATION

All personnel or equipment involved in intrusive sampling, or that enter a hazardous waste site, must be thoroughly decontaminated prior to leaving the site to minimize the spread of contamination and prevent adverse health effects. This Standard Operating Procedure (SOP) describes the normal decontamination of sampling equipment and site personnel. Specific projects and programs may have additional decontamination requirements. Refer to the planning document(s) for additional site-specific requirements.

As a good practice, sampling at a site should be conducted moving from least to most impacted locations to minimize the potential for cross-contamination. It is advisable to use disposable tools and personal protective equipment to the extent possible such that decontamination is not necessary. If disposable equipment cannot be used, all attempts will be made to minimize the need for decontamination by using dedicated equipment when practical.

1.1 MATERIALS

The following materials may be required:

0.01 normal (N) hydrochloric acid	Non-phosphate laboratory detergent (Liquinox)
0.10 N nitric acid	Plastic garbage bags
Aluminum foil or clean plastic sheeting	Plastic sheeting, buckets, etc. to collect washwater and rinsates
Approved water (deionized, potable, etc.)	Pressure sprayer, spray bottles, brushes, laboratory wipes, disposable cloth (shop towel or similar)
High performance liquid chromatography (HPLC)-grade water[a]	Reagent grade alcohol[b]

a. For the purpose of this SOP, HPLC-grade water is considered equivalent to “deionized ultra-filtered water,” “reagent-grade distilled water,” and “deionized organic-free water.” The end product is water that is pure with no spurious ions or organics to contaminate the sample. The method of generation is left to the individual contractor.
b. For the purpose of this SOP, the term “reagent grade alcohol” refers to either pesticide grade isopropanol or reagent grade methanol.

1.2 PROCEDURE

All reusable (non-dedicated) equipment that contacts or could potentially contact environmental samples shall be decontaminated prior to use at a site, between sampling locations, and at the completion of sampling events before leaving the site. Decontamination procedures are conducted in the Contaminant Reduction Zone, which may or may not be contiguous to the Exclusion Zone. The Contaminant Reduction Zone should be located on a level, preferably paved surface, either in an area upwind of the investigation/sampling area or in an area believed to be free of surface contamination. Care must be employed when moving contaminated tools and equipment to the Contaminant Reduction Zone to prevent the spread of contamination.

Specially designated and properly built decontamination pads may be built at a centralized location to accommodate larger pieces of equipment. The pads are built such that any water produced during the decontamination process can be contained and pumped into investigative-derived waste holding containers (i.e., frac tank, 55-gallon drum, etc.) for waste profiling and disposal.

For other field equipment, the Contaminant Reduction Zone may be a mobile decontamination station set up in the vicinity of the Exclusion Zone or sampling location. Plastic sheeting will be used to create a clean surface for the sampling and decontamination equipment to be placed upon.

1.2.1 Sample Bottles

At the completion of each sampling activity, the exterior surfaces of the sample bottles must be decontaminated as follows:

- Ensure the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

1.2.2 Personnel Decontamination

Review the Health and Safety Plan for the appropriate decontamination of site personnel and reusable personal protective equipment, such as protective suits used at highly contaminated sites, respirators, safety boots, safety glasses, etc. Decontamination will be conducted in a designated Contaminant Reduction Zone as per the Health and Safety Plan and the general decontamination procedures outlined further in this SOP.

1.2.3 Non-Dedicated Equipment

Reasonable attempts will be made to minimize the need for decontamination by using dedicated equipment when practical.

All reusable (non-dedicated) equipment that contacts or could potentially contact environmental samples shall be decontaminated prior to use at a site, between sampling locations, and at the completion of sampling events before leaving the site. Decontamination shall be conducted at a central decontamination station (i.e., decontamination pad) or at the sampling location.

Decontamination stations should be located on a level, preferably paved surface, either in an area upwind of the investigation area or in an area believed to be free of surface contamination. Plastic sheeting will be used to create a clean surface for the sampling and decontamination equipment to be placed upon.

Used decontamination solutions will be disposed of properly according to the site-specific Health and Safety Plan or applicable planning documents.

1.2.3.1 Field Monitoring and Testing Equipment

Water quality meters and temperature, pH, conductivity, redox, and dissolved oxygen probes will be cleaned per the manufacturer's instructions. If no such specifications exist, remove gross contamination and triple rinse probe with HPLC-grade water. If downhole probes are used, wipe the wetted portion of the cable with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination and rinse with approved water.

Electronic water level indicators, weighted tapes, measuring tapes transducers, level loggers, etc. will be decontaminated after each use as follows:

- Wipe the wetted or contaminated portion of the tape or cable and the probe with a clean laboratory wipe or disposable cloth (shop towel or similar) that has been soaked with non-phosphate laboratory detergent solution to remove gross contamination. Rinse cloth in the solution and continue wiping until tape or cable is clean.

- Wipe with a second wipe or cloth or rinse with HPLC-grade water to remove soap residue.

- Dry tape with a third cloth (or laboratory wipe) and rewind into case or on spool, or re-coil tape.

Other field monitoring or measuring equipment such as beakers and graduated cylinders used to measure flow rates; flow-through cells used for monitoring water quality parameters; piezometers used to determine water levels; packers, mechanical slug device, and downhole equipment used during aquifer (hydraulic) testing; etc. will be decontaminated by washing with a non-phosphate laboratory detergent solution, followed by approved water and HPLC-grade water rinse.

1.2.3.2 Bladder Pumps

Non-dedicated bladder pumps with disposable bladders will be decontaminated as follows:

- Disconnect tubing from pump.

- Completely disassemble the pump, being careful to note the initial position of and retain any springs and loose ball checks.

- Discard the pump bladder.

- Clean all parts in the same manner as provided in Section 1.2.3.1.

- Install a new Teflon® bladder and reassemble pump.

- Store pump in a clean, dedicated polyvinyl chloride, polytetrafluorethylene (PTFE), or low density polyethylene (for perfluorooctanesulfonic acid/per- and polyfluoroalkyl substances sampling) storage container.

1.2.3.3 Grundfos Redi-Flow® or Similar Submersible Pumps

Non-dedicated Grundfos Redi-Flow® and similar pumps will be disassembled and decontaminated per the manufacturer's instructions on an as-needed basis (i.e., where high concentrations and an elevated risk of cross-contamination exist). Due to the challenges associated with pump decontamination, if possible, consider designating one pump for sampling in highly contaminated areas and a second pump for sampling non-impacted areas or areas with lower contaminant concentrations. In most cases, the pumps will be decontaminated following the procedures below.

The pump and support cable/electrical wires that come in contact with water will be decontaminated via pumping as detailed below. To avoid electrical shock, always disconnect power from the pump when handling the pump body during decontamination procedures.

- Disconnect sample tubing from pump.

- Decontaminate the wetted portion of the cable/electrical wires by washing with non-phosphate laboratory detergent solution, followed by approved water and HPLC-grade water rinse. Coil cable/electrical wires on spools or clean plastic sheeting.

- Scrub the exterior of the pump to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate detergent (steam cleaning may be substituted for detergent scrub).

- Transfer pump to rinse bucket filled with approved water. Rinse by pumping no less than nine volumes or a minimum of 5 minutes of approved water.

- Rinse pump exterior with reagent grade alcohol.

- Rinse pump exterior with HPLC-grade water.

- Rinse pump exterior with 0.10 N nitric acid solution

- Rinse pump exterior with HPLC-grade water.

- Allow pump to air dry.

- Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.

- Prior to reusing pump, rinse exterior again with HPLC-grade water.

1.2.3.4 Other Liquid Sampling Equipment

Other sampling equipment used to collect surface water, groundwater, non-aqueous phase liquid (NAPL), or other liquid samples includes but is not limited to PTFE double-check valve bailers, dip samplers (whether bucket, long-handled, or short-handled), discrete interval stainless-steel samplers, ball check valves and foot valves, and labware (i.e., beakers, graduated cylinders, vials, and other containers that are used to hold samples for field measurements/screening and water chemistry). This equipment will be decontaminated after each use as follows:

- Discard all ropes, tubing, etc. used in sampling in a properly marked sealable container, or as directed by the Health and Safety Plan. NOTE: No tubing is to be used in conjunction with a bailer in collecting samples.

- Wash sampling equipment with non-phosphate laboratory detergent and approved water solution using appropriate brush(es), laboratory wipes, or disposable cloth (shop towel or similar) to remove gross (visible) contamination.

- Rinse with approved water.

- Rinse with reagent grade alcohol.

- Rinse with HPLC-grade water.

- Rinse with 0.10 N nitric acid solution using a spray bottle. This rinse may be eliminated if inorganic compounds such as metals are not being sampled/are not a contaminant of concern.

- Rinse with HPLC-grade water.

- Allow equipment to air dry. If sampling equipment has just been used for purging and is being decontaminated prior to sampling, do not air dry. Double rinse with HPLC-grade water and proceed to collect samples.

- Wrap equipment in aluminum foil or clean plastic sheeting, or store in a clean, dedicated polyvinyl chloride or PTFE storage container.

- Rinse equipment with HPLC-grade water immediately prior to re-use.

1.2.3.5 Solid Materials Samplers

Solid materials samplers include soil and sediment sampling probes, augers, trowels, shovels, sludge samplers, and other sampling equipment (e.g., core tubes, grab samples, core catchers, core liners, scoops, spoons, etc.), which will be decontaminated as follows:

- Scrub the sampler to remove gross (visible) contamination, using appropriate brush(es), approved water, and non-phosphate laboratory detergent (steam cleaning may be substituted for detergent scrub).

- Rinse off detergent with approved water.

- Rinse sampler with reagent grade alcohol.

- Rinse sampler with HPLC-grade water.

- For non-metallic samplers only, rinse sampler with 0.10 N nitric acid solution.

- For non-metallic samplers only, rinse sampler with HPLC-grade water.

- Allow sampler to air dry.

- Wrap sampler in aluminum foil or clean plastic sheeting, or store in a new zip-seal bag (size permitting) or clean, dedicated polyvinyl chloride or PTFE storage container.

- Rinse sampler with HPLC-grade water immediately prior to re-use.

For larger sediment sampling equipment, if sediment can be collected from the interior of a sampling device and away from potentially contaminated surfaces of the sampler, a site water rinse may be sufficient between stations. A site water rinse may also be sufficient for vessel surfaces between sample locations. However, all tools and equipment coming into contact with the sample should be decontaminated in accordance with the procedures above. Washwater from decontamination activities should be collected and disposed of properly.

1.2.3.6 Other Sampling and Measurement Probes

Soil (or sediment) gas sampling probes will be decontaminated as solids sampling devices.

1.2.3.7 Drilling Rigs, Sediment Sampling Vessels, and Other Heavy Equipment

All drilling rigs, sediment sampling vessels, and associated equipment such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out) will be decontaminated prior to site entry after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed prior to site entry when there is a likelihood that contamination has accumulated on tires and as spatter or dust on the way from one site to the next.

- Place contaminated equipment in an enclosure (i.e., existing wash pad, decontamination pad, etc.) designed to contain all decontamination residues (water, sludge, etc.).

- Steam clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) have been removed.

- Water used will be taken from an approved source.

- Containerize decontamination fluids in 55-gallon drums; sample; characterize; and, based on sample results, dispose of all decontamination residues properly.

Other heavy equipment includes use of backhoes, excavators, skid steers, etc. If heavy equipment is utilized during field activities (i.e., a backhoe for test pitting), the bucket should not come in contact with soil to be sampled. If the bucket contacts the soil to be sampled, then it should be decontaminated between sample locations, following the same procedures as listed above for a drill rig.

1.2.3.8 Ice Chests and Reusable Shipping Containers

Scrub exterior/interior with approved brush and Liquinox detergent. Rinse off detergent with approved water. Let air dry and properly store until re-use.

NOTE: If container/ice chest is severely contaminated, clean as thoroughly as possible, render unusable, and properly dispose of.

2. PRECAUTIONS

Segregate all waste streams as specified in the sampling documents and store investigation-derived waste properly. Dispose of all washwater, rinse water, rinsates, and other sampling wastes (tubing, plastic sheeting, etc.) in properly marked, sealable containers, or as directed by the Health and Safety Plan or applicable planning documents.

Once a piece of equipment has been decontaminated, be careful to keep it in such condition until needed.

3. REFERENCES

Site-specific Health and Safety Plan and/or applicable planning documents.

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Standard Operating Procedure No. 015
for
Document Control System

Prepared by

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Hunt Valley, Maryland 21031

Revision 0
December 2014

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for identifying and storing a complete set of documents relating to project tasks. Each document will receive a unique identification number comprised of elements describing the document.

2. MATERIALS

Not applicable.

3. PROCEDURE

Each project-related document will be given to the Document Control Officer. The Document Control Officer will record information for each document on a Document Control Sheet which will be retained as a backup record. The information from each Document Control Sheet will be maintained in a computer database.

The individual Document Control Number will be entered on the Document Log Sheet and will be written on the document.

The storage location for each document will be recorded on the Document Control Log Sheet and the documents will be stored in the recorded location.

The database file will be backed up on a regular basis to prevent accidental loss of the data.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

None.

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Standard Operating Procedure No. 016
for
Surface Water, Groundwater, and Soil/Sediment Field Logbooks

Prepared by

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Revision 0
December 2014

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to delineate protocols for recording surface water, groundwater, soil/sediment sampling information, instrument calibration data, and data from hydrologic testing in the field logbooks. Acceptable field logbooks are: bound, unprinted books such as a surveyor’s field book, or a federal supply service No. 7530-00-222-3525 record book (or equivalent); or they may be company-proprietary, pre-printed forms bound into a field logbook. Example forms are provided herein. Alternate, equivalent forms are acceptable.

2. MATERIALS

The following material may be required: applicable field logbook and indelible ink pen.

3. PROCEDURE

Information pertinent to soil/sediment, groundwater, or surface water sampling will be recorded in the appropriate logbook. Each page/form of the logbook will be consecutively numbered. Entries will be made in indelible ink. Corrections will consist of line-out deletions that are initialed and dated. If using carbon paper or self-duplicating forms, before entering data in logbook, insert a sheet protector between form sets to isolate first blank form from remaining forms.

3.1 SOIL/SEDIMENT LOGBOOK (Requires Figures SOP016-1 and SOP016-3)

3.1.1 Field Parameter Form (Items on Figures SOP016-1 and SOP016-2)

1. HIGH CONCENTRATION EXPECTED?: Answer “Yes” or “No.”

2. HIGH HAZARD?: Answer “Yes” or “No.”

3. SITE: Record the complete name of the site.

4. AREA: Record the area designation of the sample site.

5. INST CODE: Record the 2-letter installation code appropriate for the installation or site. Correct abbreviations can be found on Pages 3-6 of the IRDMS User’s Guide for chemical data entry.

6. FILE NAME: Record “CSO” for a soil sample or “CSE” for a sediment sample.

7. SITE TYPE: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User’s Guide for chemical data entry. This entry must match the Site Type on the map file form.

8. SITE ID: Record a code up to 10 characters or numbers which is unique to the site.

9. FIELD SAMPLE NUMBER: Record a code specific for the sample.

10. DATE: Enter the date the sample was taken.

11. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken.

12. AM PM: Circle "AM" or "PM" to designate morning or afternoon (12-hour clock).

13. SAMPLE PROG: Record "GQA" (Groundwater Quality Assessment) or other appropriate sample program.

14. DEPTH (TOP): Record the total depth sampled.

15. DEPTH INTERVAL: Record the intervals at which the plug will be sampled.

16. UNITS: Record the units of depth (feet, meters)

17. SAMPLE MEASUREMENTS: Check the appropriate sampling method.

18. CHK: Check off each container released to a laboratory.

19. ANALYSIS: Record the type of analysis to be performed on each sample container.

20. SAMPLE CONTAINER: Record the sample container type and size.

21. NO.: Record the number of containers.

22. REMARKS: Record any remarks about the sample

23. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers.

24. SITE DESCRIPTION: Describe the location where the sample was collected.

25. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System.

26. COLOR: Record the color of the sample as determined from standard Munsell Color Charts.

27. ODOR: Record the odor of the sample or "none." See SOP No. 001 Section 5.

28. PID (HNu): Record the measured PID (HNu) values.

29. UNUSUAL FEATURES: Record anything unusual about the site or sample.

30. WEATHER/TEMPERATURE: Record the weather and temperature.

31. SAMPLER: Record your name.

3.1.2 Map File Form (Figure SOP016-3)

1. The map file logbook form will be located on the reverse of the field parameter logbook form, or on an adjoining page of the field logbook (if level book is used).

2. SITE ID: Record the Site ID from the field parameter form.

3. POINTER: Record the field sample number for the sample being pointed to.

4. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks.

5. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks.

6. MAP REFERENCE: Record which U.S. Geological Survey Quad Map references the site.

7. COORDINATE DEFINITION: Write the compass directions the X- and Y-Coordinates of the map run.

8. COORDINATE SYSTEM: Write “UTM” (Universal Transverse Mercator).

9. SOURCE: Record the 1-digit code representing the Map Reference.

10. ACCURACY: Give units (e.g., write “1-M” for 1 meter).

11. X-COORDINATE: Record the X-Coordinate of the sample site location.

12. Y-COORDINATE: Record the Y-Coordinate of the sample site location.

13. UNITS: Record the unit’s map sections are measured in.

14. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey.

15. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference.

16. ACCURACY: Record the accuracy of the map or survey providing the topographical information.

17. ELEVATION: Record the elevation of the sampling site.

18. UNITS: Write the units in which the elevation is recorded.

19. SAMPLER: Write your name.

3.2 SURFACE WATER LOGBOOK (Requires Figures SOP016-2 and SOP016-3)

3.2.1 Field Parameter Form (Items Unique to Figure SOP016-3)

1. CAL REF: Record the calibration reference for the pH meter.

2. pH: Record the pH of the sample.

3. TEMP: Record the temperature of the sample in degrees Celsius.

4. COND: Record the conductivity of the water.

5. For all other sections, see Section 3.2.1.

3.3 GROUNDWATER SAMPLING LOGBOOK (Requires Figures SOP016-2, SOP016-3, and SOP016-4)

3.3.1 Field Parameter Form (Items on Figure SOP016-4)

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on Pages 18-21 of the IRDMS User's Guide for chemical data entry.

2. SAMPLE NO.: Record the reference number of the sample.

3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks.

4. X-COORD and Y-COORD: Record the survey coordinates for the sampling site.

5. ELEV: Record the elevation where the sample was taken.

6. UNITS: Record the units the elevation was recorded in.

7. DATE: Record the date in the form MM/DD/YY.

8. TIME: Record the time, including a designation of AM or PM.

9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit).

10. WELL DEPTH: Record the depth of the well in feet and inches.

11. CASING HT.: Record the height of the casing in feet and inches.

12. WATER DEPTH: Record the depth (underground) of the water in feet and inches.

13. WELL DIAMETER: Record the diameter of the well in inches.

14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches.

15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter.

16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations, to determine one equivalent volume (EV):

1 EV = Volume in casing + volume in saturated sand pack. Or to restate:

$$1\ \text{EV} = (BR_w^2h_w + 0.30B(R_s^2-R_w^2)h_s) * (0.0043)$$

where

R_s = Radius of sandpack in inches
R_w = Radius of well casing in inches
h_s = Height of sandpack in inches
h_w = Water depth in inches

0.0043 = gal/in.^{3}
and filter pack porosity is assumed as 30 percent

— OR —

Volume in casing = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_c^2)(W_h)

where

R_c = Radius of casing in inches
W_h = Water column height in feet

Vol. in sandpack = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_b^2 - R_c^2)(W_h)(0.30)

(if W_h is less than the length of the sandpack),

— PLUS —

Vol. in sandpack = (0.0043 gal/in.^{3})(B)(12 in./ft)(R_b^2 - R_c^2)(S_h)(0.30)

(if W_h is greater than the length of the sandpack).

where
R_b = Radius of the borehole
S_h = Length of the sandpack.

Show this calculation in the comments section.

17. VOLUME OF BAILER OR PUMP RATE: Record bailer volume or pump rate.

18. TOTAL NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers required to remove 3 equivalent volumes (EV) of water from the well or the total purge time and volume as applicable.

19. WELL WENT DRY? Write "YES" OR "NO."

20. NUMBER OF BAILERS OR PUMP TIME: Record the number of bailers or pump time which made the well go dry.

21. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry.

22. RECOVERY TIME: Record the time required for the well to refill.

23. PURGE AGAIN?: Answer "YES" or "NO."

24. TOTAL VOL. REMOVED: Record the total volume of water (in gal) removed from the well.

25. CAL REF.: Record the calibration reference for the pH meter.

26. TIME: Record time started (INITIAL T[0]), 2 times DURING the sampling and the time sampling ended (FINAL).

27. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling and at the end of sampling (FINAL).

28. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

29. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

30. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

31. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

32. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling and at the end of sampling (FINAL).

33. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace prior to sampling.

34. NAPL: Record the presence and thickness of any non-aqueous phase liquids (light or dense)

35. COMMENTS: Record any pertinent information not already covered in the form.

36. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (Maintained as a separate logbook, or incorporated into sampling logbooks)

3.4.1 Items on Figure SOP016-5

1. Record time and date of calibration. Note whether 12- or 24-hour clock was used.

2. Record calibration standard reference number.

3. Record meter I.D. number

4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line.

5. Record value of reference standard (as required).

6. COMMENTS: Record any pertinent information not already covered on form.

7. SIGNATURE: Sign form.

3.5 GROUNDWATER HYDROLOGY TESTS LOGBOOK (Must include Figures SOP016-6 and SOP016-7 and/or SOP016-8, OR SOP016-9 or SOP016-10)

3.5.1 Field Permeability Test Data Sheet (Items on Figures SOP016-6)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

4. PROJECT NO.: Record the contractor assigned project number or the contract number.

5. LOCATION: Specific location

6. CLIENT: Agency or company with the contract under which the work is being performed.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

9. TEST TYPE: Short description of the type of test to be performed.

10. RISING/FALLING HEAD WITH SLUG: Check if the test involved the insertion/removal of and inert object.

11. RISING/FALLING HEAD WITHOUT SLUG: Check if the test involved the addition/removal of a quantity of water.

12. START DATE: Date on which the test was begun.

13. CLOCK TIME: Time each datum (depth to groundwater level) is collected. Note whether 12- or 24-hour clock was used.

14. ELAPSED TIME: Time since the last datum was collected.

15. DEPTH TO GWL (ft): Depth to the top of the groundwater table (Groundwater Level) as measured by manual methods.

16. REC. (ft): Water level as reported by transducer/datalogger (this is the depth of water above the transducer.

17. TIME: Time the discharge rate check was begun (addition or removal of water method). Note whether 12- or 24-hour clock was used.

18. FLOW METER (Addition or removal of water method): The amount of water added or removed as registered by the flowmeter, in gal of liters.

19. DISCHARGE RATE: Flowmeter reading divided by time interval (gal/min or liters/min).

20. SIGNATURE: The person completing this form must sign the form at the end of the test.

21. DATE: Date the form was signed.

3.5.2 Groundwater Levels – Single Well (Items on Figure SOP016-7)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

Well Data

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: Remedial investigation wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATE: Date of each water level reading
16. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.
17. ELAPSED TIME: Time since test was begun.
18. DEPTH TO WATER: Measured depth to the groundwater table.
19. WATER ELEVATION: Elevation of the top of the groundwater table (use datum listed above).
20. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).
21. TAPE NO.: The unique identification number of the traceable standard tape used to calibrate the measuring device.
22. WELL STATUS: Condition of the well at the time of measuring (see abbreviation key at the bottom of the data sheet).
23. REMARKS: Any additional pertinent comments not specifically required above.
24. INITIALS: Initials of person completing this data entry.
25. ABBREVIATION KEYS: Self explanatory.
26. SIGNATURE: The person completing this form must sign the form at the end of the test.
27. DATE: Date the form was signed.

3.5.3 Groundwater Levels – Single Well (Items on Figure SOP016-8)

1. CONTRACTOR: Organization performing the test.
2. SEQ. #: Enter page number of this set of forms (page # of #).
3. PROJECT NO.: Record the contractor assigned project number or the contract number.
4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.
5. PROJECT NAME: Record the name assigned by the contractor’s organization to the project.
6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

WELL DATA

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

15. DATALOGGER: This section is record of pertinent datalogger information.

16. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

17. MODEL: Enter the model number of the datalogger.

18. S/N: Enter the serial number of this datalogger.

19. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

20. TRANSDUCER: This section is a listing of pertinent information about the transducer used.

21. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

22. MODEL: Enter the model number of the transducer.

23. S/N: Enter the serial number of this transducer.

24. INPUT/UNITS: What are the units this transducer uses?

25. RANGE: Record the pressure or depth range over which this transducer is certified.

CALIBRATION

26. PRESSURE RATING: This is taken from the manufacturer’s specifications for a given transducer. (Usually in psi, or kpa).

27. “SUBMERGENCE = ___ (V) / (MV)”: Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

28. VOLUME WATER ADDED/REMOVED: (Applicable if inert object insertion/removal method was not employed.) Record the volume of water added to or removed from the well.

29. DISCHARGE RATE: If z (above) is filled, enter the rate at which this water was added or removed.

30. INITIAL WATER LEVEL (ft): Enter the water level in the well at the beginning of the test.

31. PRESSURE TRANSDUCER SUBMERGENCE: Record the depth to which the transducer is submerged at the beginning of the test and the depth to the transducer at the end if the test. All depths will be recorded to the nearest 0.01 ft.

32. TIME: Record the time the test is begun and ended. Note whether 12- or 24-hour clock was used.

33. OBSERVED CHANGES IN ADJACENT WELLS: Note any changes in water levels in nearby wells.

34. RESULTS RECORDED ON DISKETTE #: Tracking number of the diskette on which these data are archived.

35. DISKETTE FILE NAME: Name of the file(s).

36. SIGNATURE: The person completing this form must sign the form at the end of the test

37. DATE: Date the form was signed.

3.6 GROUNDWATER LEVELS – MULTIPLE WELLS (Items on Figure SOP016-9)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

5. LOCATION: Specific location.

6. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

7. CLIENT: Agency with the contract under which the work is being performed.

8. REMARKS: Any pertinent observations not specifically required above.

9. WELL: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

10. DATE: Date this measurement was made.

11. TIME: Time this measurement was made. Note whether 12- or 24-hour clock was used.

12. DEPTH TO WATER: Depth from MP to top of groundwater table.

13. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

14. MP ELEV.: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

15. MEAS. METH.: Method used to measure the water level in the well (see abbreviation key at the bottom of the data sheet).

16. REMARKS/MP: Describe the location and nature of the measuring point.

17. INITIALS: Initials of the person completing this form.

18. ABBREVIATION KEYS: Self explanatory.

19. SIGNATURE: The person completing this form must sign the form at the end of the test.

20. DATE: Date the form was signed.

3.7 GROUNDWATER LEVELS – DATALOGGERS (Items on Figure SOP016-10)

1. CONTRACTOR: Organization performing the test.

2. SEQ. #: Enter page number of this set of forms (page # of #).

3. PROJECT NO.: Record the contractor assigned project number or the contract number.

4. WELL #: Record the well number as it appears on the well completion tag, affixed to the protector casing or well completion records.

5. PROJECT NAME: Record the name assigned by the contractor's organization to the project.

6. LOCATION: Specific location.

7. FIELD PARTY CHIEF: Printed name of the person responsible for this particular field test.

8. CLIENT: Agency with the contract under which the work is being performed.

WELL DATA

9. STICKUP: Enter the length of well casing extending above the average ground surface at the base of the protective casing.

10. MEASURED UP(+)/DOWN(-) FROM: Describe the starting point for the previous measurement.

11. MP ELEVATION: Enter the elevation of the measuring point here. NOTE: This datum may require reference to tables and/or maps and may be added after completing the day's field work.

12. DATUM = MSL OR: Is the datum for the previous elevation Mean Sea Level? If not, what? Also tell whether it was derived from a map elevation (write "MAP") or survey data (write "SURVEY").

13. MEASURING POINT DESCRIPTION: Describe the point used as the origin for all down-hole (water table) measurements. NOTE: All Rhode Island wells are required to have a permanently marked reference (measuring) point (refer to SOP No. 019, Section 3.4).

14. REMARKS: Record any pertinent observations about the site/well conditions not specifically required in the preceding.

DATALOGGER (This section is a record of pertinent datalogger information)

15. MANUFACTURER: Record the manufacturer/brand name as stated on the datalogger.

16. MODEL: Enter the model number of the datalogger.

17. S/N: Enter the serial number of this datalogger.

18. TAG PROGRAMMED IN LOGGER: What is the identifier used in the datalogger's program to indicate that this unit was used to record a given data set?

TRANSDUCER (This section is a listing of pertinent information about the transducer used)

19. MANUFACTURER: Record the manufacturer/brand name as stated on the transducer.

20. MODEL: Enter the model number of the transducer.

21. S/N: Enter the serial number of this transducer.

22. INPUT/UNITS: What are the units this transducer uses?

23. RANGE: Record the pressure or depth range over which this transducer is certified.

CALIBRATION

24. PRESSURE RATING: This is taken from the manufacturer's specifications for a given transducer (usually in psi, or kpa).

25. "SUBMERGENCE = ___ (V) / (MV)": Record the voltage returned by the transducer at a given depth of submergence. Indicate whether the reading is in volts (v), or millivolts (mv).

26. DATE: Date of each water level reading

27. TIME: Time of each water level reading. Note whether 12- or 24-hour clock was used.

28. LOGGING TIME INTERVAL: Time since test was begun.

29. WL FEET BELOW MP: Measured depth to the groundwater table from measuring point.

30. SUBMERGENCE: Depth of water above the transducer.

31. MEAS.METHOD: What device/method was used to measure the water level.

32. TAPE NO.: Record the tape identification number.

33. TRANSDUCER MOVED?: Was the transducer moved since the last water level reading?

34. REMARKS: Any pertinent remarks not otherwise specified.

35. INITIALS:

DATA TRANSFER TO DISKETTE:

36. DATE: Date data were archived onto diskette.

37. TIME: Time stamp the computer assigns the data file.

38. FILE NAME: Name assigned the data file.

39. SOFTWARE USED FOR TRANSFER: Any special software, or computer operating system used to write the files to diskette. NOTE: If a “shareware” archiver which compresses files was used, and the archived file is not self-extracting, a copy of the unarchive program should be copied onto the diskette also.

40. OUTPUT FORMAT: What is the format of the output file? (DOS, UNIX, Binary, Compressed?)

41. INITIALS: Initials of the person who copied the data to diskette.

42. ABBREVIATION KEY: Self-explanatory.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

None.

6. REFERENCES

U.S. Environmental Protection Agency. 1984. User’s Guide to the Contract Laboratory Program. July.

FIGURE SOP016-1
FIELD PARAMETER LOGBOOK
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

INSTALLATION/SITE ________________________________ AREA ___________________

INST CODE FILE NAME ____

SITE TYPE SITE ID
FIELD SAMPLE NUMBER

DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.

DEPTH (TOP) DEPTH INTERVAL UNIT _____________

SAMPLING METHOD:

SPLIT SPOON AUGER SHELBY TUBE SCOOP OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS
SITE DESCRIPTION:____
SAMPLE FORM ______________________ COLOR _____________ ODOR _____________
PID (HNu) _______________________ UNUSUAL FEATURES _______________________
____
WEATHER/TEMPERATURE
SAMPLER

HIGH CONCENTRATION EXPECTED? HIGH HAZARD?

FIGURE SOP016-2
FIELD PARAMETER LOGBOOK
GROUNDWATER AND SURFACE WATER SAMPLES

INSTALLATION/SITE AREA
INST CODE FILE NAME SITE TYPE
SITE ID FIELD SAMPLE NUMBER
DATE (MM/DD/YY) / / TIME AM PM SAMPLE PROG.
DEPTH (TOP) DEPTH INTERVAL UNITS

SAMPLING MEASUREMENTS

CAL REF.	pH	TEMPERATURE C	CONDUCTIVITY	OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION
SAMPLING METHOD
SAMPLE FORM COLOR ODOR
PID (HNu)
UNUSUAL FEATURES
WEATHER/TEMPERATURE _________________________ SAMPLER _________________

FIGURE SOP016-3
MAP FILE LOGBOOK

SITE ID POINTER ____________________
DESCRIPTION/MEASUREMENTS
SKETCH/DIMENSIONS:

MAP REFERENCE
COORDINATE DEFINITION (X is Y is)
COORDINATE SYSTEM SOURCE ACCURACY
X-COORDINATE Y-COORDINATE UNITS
ELEVATION REFERENCE
ELEVATION SOURCE ACCURACY ELEVATION
UNITS

SAMPLER

FIGURE SOP016-4
MAP FILE AND PURGING LOGBOOK GROUNDWATER SAMPLES

WELL COORD. OR ID SAMPLE NO.______________
WELL/SITE
DESCRIPTION____
____
X-COORD. Y-COORD. _______________ ELEV. UNITS
DATE ____/____/____ TIME AIR TEMP.

WELL DEPTH _________ ft _________ in. CASING HT. _________ ft _______ in.
WATER DEPTH __________ ft _________ in. WELL DIAMETER __________ in.
WATER COLUMN HEIGHT _________ ft _________ in. SANDPACK DIAM. ________ in.
EQUIVALENT VOLUME OF STANDING WATER ____________ (gal) (L)
VOLUME OF BAILER ___________ (gal) (L) or PUMP RATE ___________ (gpm) (lpm)
TOTAL NO. OF BAILERS (5 EV)___________ or PUMP TIME ___________ MIN.
WELL WENT DRY? [Yes] [No] NUM. OF BAILERS ________ or PUMP TIME______MIN
VOL. REMOVED __________ (gal) (L) RECOVERY TIME __________ MIN
PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED __________ (gal) (L)

Date and Time	Quantity Removed	Time Required	pH	Cond	Temp	ORD	Turb	DO	Character of water (color/ clarity/odor/partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS:____
____
____
____

____
SIGNATURE

FIGURE SOP016-5
FIELD CALIBRATION: pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, OXIDATION-REDUCTION POTENTIAL, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	DATE:
TIME:	TIME:

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ______________________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID _________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID ________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER			

FIGURE SOP016-5 *(continued)*

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO: _______________

METER ID ____________________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS:____
____
____
____

____
SIGNATURE

FIGURE SOP016-6
FIELD PERMEABILITY TEST DATA SHEET

Contractor: **Seq. #** /

Project Name:	Project #:
Location:	Client:
Party Chief:	Contractor:
Observation Well:	
Test Type: Rising/Falling Head w/Slug	Rising/Falling Head w/out Slug

Start Date:								Discharge Rate		
Clock Time	Elapsed Time (min)	Depth to GWL (ft)	Rec (ft)	Clock Time	Elapsed Time	Depth to GWL (ft)	Rec (ft)	Time	Flow Meter	Discharge Rate

Signature: ____ **Date:** ______________________

FIGURE SOP016-7
GROUNDWATER LEVELS – SINGLE WELL

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:
Well No.: Site: Area:
Site: Area:
Area:

up (+)/down (-) from: Datum = MSL or:
Datum = MSL or:

Measuring Point Description:

Datalogger:
Manufacturer: Model: S/N:
Tag No. Programmed in Logger:

Transducer: Manufacturer: Model: S/N:
Input/Units: Range:

Calibration:
Pressure Rating:
0 ft submergence = (v) / (mv) ft submergence = (v) / (mv)

Volume Water Added/Removed:
Discharge Rate:
Initial Water Level (ft):

Pressure Transducer Submergence
Initial (ft): Final(ft): Time:Start: End:
Observed Changes in Adjacent Wells:

Results Recorded on Diskette #:
Diskette File Name:

Signature: ____ **Date:** ______________________

FIGURE SOP016-8
GROUNDWATER LEVELS – MULTIPLE WELLS

Contractor: **Seq. #** /

Project No.:
Project Name:
Field Party Chief:

WELL DATA:

Stickup: (ft)
MP Elevation:

Measuring Point Description:
Remarks:
Well No.:
Site: Area: up (+)/down (-) from:
up (+)/down (-) from:
up (+)/down (-) from:
Datum = MSL or:

Date	Time	Elapsed Time	Depth to Water	Water Elevation	Meas. Meth.	Tape No.	Well Status	Remarks	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

Signature: ________________________________ **Date:** ____________________

FIGURE SOP016-8 *(continued)*

Contractor: **Seq. #** /

Project No.:
Project Name: Location:
Field Party Chief: Client:

Well	Date	Time	Depth to Water	Stickup	MP Elev.	Meas. Meth.	Tape No.	Remarks/MP	Initials

Measurement Method:
A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:
D = Dry
F = Flowing
P = Pumping
RP = Recently pumped
NP = Nearby well pumping
NRP = Nearby well recently
X = Obstructed

FIGURE SOP016-9
GROUNDWATER LEVELS DATALOGGERS

Contractor

Project No.: **Well No.:**

Project Name: **Site:**

Field Party Chief: **Area:**

WELL DATA: Stickup: **(ft)** **up (+)/down (-) from:**

MP Elevation: **Datum = MSL or:**

Measuring Point Description:

Remarks:

Datalogger:

Manufacturer: Model: S/N:

Tag No. Programmed in Logger:

Transducer: Manufacturer: Model: S/N:

Input/Units: Range:

Calibration: Pressure Rating:

0 ft submergence = (v) / (mv) ft submergence = (v)

Logging	Date	Time	Logging Time Interval	WL, ft Below MP	Submergence (logger reading)	Meas. Method	Tape No.	Well Status	Transducer Moved	Remarks	Initials
Start											
Stop											
Start											
Stop											

Data Transfer to Disk

Date	Time	File Name	Software Used for Transfer	Output Format	Initials

Measurement Method:

A = Airline
C = Chalk and tape
E = Electric tape
T = Tape with popper
X = Other (describe in remarks)

Well Status:

D = Dry
F = Flowing
P = Pumping
RP = Recently
NP = Nearby well pumping
NRP = Nearby well recently pumped
X = Obstructed

Signature **Date**

Standard Operating Procedure No. 021
for
Sediment Sampling

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
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Hunt Valley, Maryland 21031

Revision: 2
March 2019

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PROJECT-SPECIFIC VARIANCE FORM

This form is to be completed to indicate if there are any client-, project-, or site-specific variances to this Standard Operating Procedure (SOP) (**also check Box A**), or if this SOP is being used with no changes (**only check Box B**).

☐ **A. Variances required; cite section(s) of the SOP to which there is a variance**

☐ **B. No variances**

SOP No. 021	
SOP Section	**Variance**

Project Manager (Name)

Project Manager (Signature) Date

CONTENTS

DOCUMENT REVISION HISTORY

ORIGINAL (MASTER) DOCUMENT REVISION HISTORY				
Revision Number	**Revision Date**	**Revision Summary**	**Revised By**	**Reviewed By**
2	28 March 2019	Systematic review and update	Caryn Kiehl-Simpson Peggy Derrick	Matthew Bowman

1. SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) delineates protocols for sampling sediments from streams, rivers, ditches, lakes, ponds, lagoons, and marine and estuarine systems.

EA recognizes that other protocols have been developed that meet the criteria of quality and reproducibility. Clients may have their own sediment sampling protocols, which may contain methodologies and procedures that address unique or unusual site-specific conditions or may be in response to local regulatory agency requirements. In such cases, EA will compare its and the client's protocols. The goal is to provide the client with the most quality; therefore, if the client's protocols provide as much or more quality assurance than EA's protocols for the particular site or project, EA will adopt those particular protocols and this SOP will be superseded in those respects. If EA is required to implement the client's protocols in lieu of EA's protocols, EA will make the client formally aware of any concerns regarding differences in protocols that might affect data quality and will document such concerns in the project file.

2. PROCEDURES

The water content of sediment varies. Sediments range from soft to dense and fine to rocky. A variety of equipment may be necessary to obtain representative samples, even at a single site. Factors to consider in selecting the appropriate sampling equipment include sample location (edge or middle of the waterbody), depth of water and sediment, grain size, water velocity, and analytes of interest.

3. GENERAL PROCEDURES

1. All samples must be handled in a manner that satisfies the project Quality Assurance Project Plan, SOPs, and data quality objectives. Prior to a field effort, verify general sample requirements such as sample numbers, volume requirements, holding times, sample preservation requirements, and duplicate and other quality assurance/quality control sample requirements. Verify general sampling logistics such as site access, access to temporary and secure field storage, designated sample transport procedures, laboratory shipping address(es), and points of contact.

2. Comply with the Health and Safety Plan specifications for proper personal protective equipment (steel-toed boots, safety glasses, hard hats, splash shields, and Tyvek as appropriate and designated in the site-specific Health and Safety Plan). Wear chemically-protective gloves when collecting samples appropriate for the potential constituents to be sampled. Complete review of emergency plans and equipment. If sampling from a boat or near waterbodies with depths of 4 feet or more, the sampling team will wear life jackets. Review and comply with SOP Number (No.) 035 Small Boat Operations, if applicable.

3. Verify local One Call service has been contacted prior to sampling activities and proper utility clearance has been obtained. Verify site access, dockage, other required communications (e.g., U.S. Coast Guard, local authorities, etc.) have been secured.

4. Review specific responsibilities of each field team member and conduct daily safety briefings as specified by the site-specific Safety and Health Plan.

5. Confirm sampling equipment and supplies are adequate for the field effort. In addition to the sampling equipment and vessel requirements, verify that support equipment including, but not limited to, spatulas, scoops, spoons, pans, buckets, bowls, gloves, measuring implements, plastic sheeting, data forms, and logbooks are available. Appropriate sample storage and transport equipment may include a refrigeration unit, ice chests, dry ice or ice, insulation or other stabilization material to protect sample containers, custody seals, sampling containers, and shipping paperwork. Confirm decontamination supplies and equipment are sufficient for the duration of the field effort.

6. Collect samples first from areas suspected of being the least contaminated to minimize the risk of cross-contamination.

7. If surface water and sediment samples are to be collected at the same location or co-located (if both are required in the project-specific Sampling and Analysis Plan), collect the surface water sample first (refer to SOP No. 007 for surface water sampling). Sediment sampling usually results in disturbance of the sediments, which may influence the analytical results of the surface water samples.

8. Water quality measurements may be required at the same locations as the surface water and/or sediment sample locations. Collect the water quality measurements before the collection of surface water or sediment samples (refer to SOP No. 043 for water quality measurement collection).

9. Minimize the potential for sediment disturbance prior to sampling. Care should be taken when wading into a waterbody and/or during vessel operations prior to sampling. These activities can disturb the sediment. Move slowly and cautiously, approach the sample location from downstream. If flow is not strong enough to move entrained particles away from the sample location, wait for the sediment to resettle before sampling.

10. Collecting samples directly into sample containers is not recommended. Sediment samples should be placed in Teflon®, stainless steel, or glass trays, pans, or bowls for sample preparation and processing.

11. Use the proper equipment and material construction for the analytes of interest. For example, for volatile organic compound analysis, the sampling material in direct contact with the sediment or surface water must consist of Teflon, polyethylene, or stainless steel.

12. Refer to EA SOP No. 005 (Field Decontamination) for proper decontamination methods before and after sampling and between samples.

13. Collect samples for volatile organic compound analysis and acid volatile sulfide analysis first. Do not mix such samples before placing them in the sample containers. For composite volatile organic compound and acid volatile sulfide samples, place equal aliquots of each subsample in the sample container with no headspace. To maintain sample integrity, exposure to oxygen/air should be limited to the extent possible.

14. Sediment that will be analyzed for other constituents should be prepared as follows:

    - Place the sediment in a mixing container.
    - Divide the sediment into equal quarters by volume.
    - Mix each quarter separately and thoroughly.
    - Combine the quarters and mix thoroughly.
    - For composite samples, mix each subsample as described above. Place equal aliquots of each subsample in a mixing container and follow the procedure described above.
    - Sediment preparation activities should be performed where the potential of contamination from external sources (e.g., running engines) can be minimized or eliminated.

15. Mark the sampling location on a site map. Record sampling location coordinates with a Global Positioning System unit, photograph (optional, recommended), describe each location, and place a numbered stake above the visible high water mark on the bank closest to the sampling location (if appropriate). The photographs and description must be adequate to allow the sampling station to be relocated at a future date.

16. Dispose of investigation-derived wastes according to applicable rules and regulations.

4. CORERS

A corer provides a vertical profile of the sediment that may be useful in tracing historical contaminant trends, geological characterization and dating, and characterizing the depth of impacts at a site. Because displacement is minimal, a corer is particularly useful for maintaining the integrity of the vertical sediment profile. Core samplers are also useful when it is important to maintain an oxygen-free environment as they limit oxygen exchange with the air more effectively than grab samplers. Corers can be constructed out of a variety of materials.

4.1 EQUIPMENT

The following list of equipment may be needed during the collection of sediment core samples. Depending upon the actual collection method used and the analyses that will be conducted in the samples, not all equipment on the list may be used.

- Probing equipment for pre-sampling testing for utilities
- Sampling vessel, floating platform (properly equipped and sized barge or boat), and waders and plan for collecting samples by hand (may significantly limit sample depth)
- Winch
- Crane, boom arm or A-frame
- Sediment core sampler (Vibracore, piston tube, Wildco tube sampler, etc.)
- Core liners, core catchers, liner caps, etc.
- Saw, knife, and cutters to open or split core liners
- Sampling vessel
- Propulsion method for sampling vessel or floating platform
- Containers, buckets, and tubs
- Small trays
- Calibration bucket
- Wash box
- Glassware
- Logbook
- Labels
- Coolers
- Spoons
- Water filters
- Gloves for sampling
- Gloves for other sampling activities such as cutting, equipment handling, etc.

- Measuring device
- Decontamination chemicals and de-ionized water.

4.2 PROCEDURE

4.2.1 Manual Sampling

When sampling manually, a polyvinyl chloride pipe (commonly 2-inch in diameter) with a Teflon or polyethylene liner (as an example) can be lowered into the sediment; a well cap can be used to form an airtight seal and negative pressure as the pipe is withdrawn.

1. Ensure that the corer and (optional) liner and other sampling equipment are properly cleaned.
2. Position downstream of the sample location.
3. Force the corer into the sediment with a smooth continuous motion. Rotate (not rock) the corer if necessary to penetrate the sediment.
4. Twist the corer to detach the sample; then withdraw the corer in a single smooth motion. If the corer does not have a nosepiece, place a cap on the bottom to keep the sediment in place.
5. Remove the top of the corer and decant the water in a slow controlled manner (into appropriate sample containers for surface water analysis, if required).
6. Remove the nosepiece or cap and begin sample description, logging, and processing per the work planning documents.
7. Decontaminate the sediment coring apparatus as described in SOP No. 005 or work planning documents.
8. Repeat the process at an offset location until sufficient sample quantity has been recovered. Additional cores may need to be obtained if the core recovery is insufficient to achieve the required volume. Verify recovery limits are in accordance with work planning documents and data quality objectives.
9. Process the core samples as described in work planning documents.

4.2.2 Sampling from a Vessel

1. Select a sediment core sampler (Vibracore, piston tube, Wildco tube sampler, etc.) suitable for the bottom conditions, water depth expected, water velocity, the volume of material needed, and the planned/targeted depth of sampling.

2. Select sediment coring tools of sufficient diameter and length to obtain the needed sample volume and depth of penetration. Depending on the volume of sediment needed, multiple sediment cores may be required. To the extent possible, predetermine the number of cores required to avoid having to return to a location for additional cores/sample volume.

3. Set up the sediment coring tool and install the core liner tube, drive head, drive shoe, and/or core catcher, piston, and piston line, as appropriate for the specific sampler chosen and the proposed depth of sample/penetration.

4. Securely attach the core sampler to a winch with cable or line of sufficient length and strength to accommodate the weight of the sampler and sample (Vibracore) or other sampler (piston tube or Wildco tube sampler) to sufficient pipe to reach the maximum proposed sample depth.

5. A measurement system should be in place capable of documenting the depth to the sediment surface, depth of penetration, and depth of recovery. Location coordinates should be collected at each sample location (if a vessel navigation system will be used to collect the location coordinates, an offset may be required between the antenna and the sampler deployment location).

6. Slowly lower the sampler through the moon pool or over the side until the sampler reaches the water/sediment interface. The sampler may be lowered using a crane or on a winch cable and A-frame or other mechanical mechanism capable of carry/control the weight of the sampler. The crane, A-frame, or boom arm must have enough clearance to accommodate the length of the sample and sampling apparatus and enough strength to safely accommodate the weight of the sample and sampling apparatus. Note the depth to the top of sediment.

7. Advance the sediment core sampler into the sediment to the proposed depth or refusal, whichever comes first. Vibracore samplers will be advanced by the vibrating head. Vibracore samplers will continue to be attached to the winch line and the rate of descent will be controlled during penetration into the sediment. Piston tube or Wildco tube samplers will be advanced manually. If necessary, a piston tube or Wildco tube sampler may be advanced by tapping the top of the pipe with a rubber mallet. These samplers are intended for soft sediment and will not tolerate heavy abuse from pounding in an attempt to penetrate through debris, shell beds, or consolidated material.

8. Slowly retrieve the sediment coring tool. As soon as possible, cap the bottom of the sample tube to prevent loss of sample. Secure the sampling apparatus.

9. Remove the sediment core liner from the sampling apparatus.

10. Allow the core to drain or siphon water, taking care not to disturb the surface of the sediment. At the first sign of sediment in the drained water sample, cease draining and tie or cap the sample liner to ensure that the surficial layer remains intact in the sample.

11. Cut off any empty core liner to eliminate headspace. Measure core recovery. Acceptable core recoveries may be specified in the work planning documents. Typically, recoveries of 70 or 80 percent are favorable for results interpretation and data evaluations. Lesser recoveries may not sufficiently represent the sediment column. The data quality objectives of a specific project will dictate the selected recoveries. If the sampler meets refusal above the proposed depth, offset the initial location and make up to the required number of attempts. Work planning documents should specify the maximum number of attempts to be made to obtain a core with sufficient recovery. If sufficient recovery cannot be obtained, other drilling and sampling methods and/or location abandonment may be appropriate.

12. If sufficient recovery was obtained in the interval penetrated, process the core and obtain samples from that interval.

13. Write the location identification and orientation (up arrow) on the outside of the core tube with a permanent marker. Write the location identification, date, and time of collection on the core tube cap.

14. The location (Global Positioning System coordinates), collection date and time, penetration depth, recovery depth, and identification for each core should be recorded in the field logbook.

15. Transport sediment cores to the onshore processing area throughout the day, if possible. Data quality objectives and work planning documents may require that core tubes be maintained in a vertical orientation. When possible, transport sediment cores to shore after each location or at an interval that will maintain the integrity of the samples. Cores should be stored under refrigeration or iced on the sampling vessel to maintain sample integrity.

16. Decontaminate the sediment coring apparatus as described in SOP No. 005 or work planning documents.

17. Repeat the process at an offset location until sufficient sample quantity has been recovered. Additional cores may be needed if the core recovery is insufficient to achieve the required volume. Debris and obstructions are possible that may prevent the full penetration and recovery of all of the advanced cores. Observation of debris, obstructions, or hard bottom conditions that preclude advancement of the sampler should be documented in the field logbook.

18. Water quality measurements may be required at each coring location or locations specified in the project work plan. The measurements should be conducted on the same day as the core collection, and prior to the core collection, if possible.

19. Verify that all field measurements and documentation are complete prior to moving off location.

20. Process the core samples as described in work planning documents.

5. SCOOPS AND SPOONS

When sampling at the margins of a waterbody or in shallow water, scoops and spoons may be the most appropriate sampling equipment. For sample collection several feet from shore or in deeper water, the scoop or spoon may be attached to a pole or conduit. Equipment will be a subset of that described above in Section 4.1.

- Stand downstream of the sample location.

- Collect the sample slowly and gradually to minimize disturbing the fine particles.

- Decant the water slowly to minimize the loss of fine particles.

- Transfer the sediment to sample containers or mixing trays, as appropriate.

- Process the samples as indicated by the project work plan.

- Verify that all field measurements and documentation are complete prior to moving off location.

6. DREDGES

Three types of dredges are most frequently used: Peterson, Ponar, and Eckman. Many other dredge types are available; their applicability will depend upon site-specific factors. Equipment will be a subset of that described above in Section 4.1.

6.1 PETERSON, VAN VEEN, AND PONAR DREDGES

These dredges are suitable for hard, rocky substrates, deep waterbodies, and streams with fast currents. Ponars have top screens and side plates to prevent sample loss during retrieval.

- Open the jaws and place the cross bar into the proper notch.

- Lower the dredge to the bottom in a controlled manner, making sure it settles flat.

- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.

- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval through incomplete closure due to rocks, shells, or other debris; penetration at an angle; or tilting during retrieval. The sampler should not be overfilled such that the sediment surface is touching the top of the sampler. Overlying water should be present indicating minimal leakage; this water should be siphoned off, not decanted, prior to sample processing. The sediment water interface should be intact with no signs of washout or channeling.

- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

- Verify that all field measurements and documentation are complete prior to moving off location.

6.2 ECKMAN DREDGE

The Eckman dredge works best in soft substrates in waterbodies with slow or no flow.

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.

- Lower the dredge to the bottom in a controlled manner, making sure it settles flat.

- Holding the line taut, send down the message to close the jaws.

- Pull the dredge to the surface. Make sure the jaws are closed and that no sample was lost during retrieval through incomplete closure due to rocks, shells, or other debris; penetration at an angle; or tilting during retrieval. The sampler should not be overfilled such that the sediment surface is touching the top of the sampler. Overlying water should be present indicating minimal leakage; this water should be siphoned off, not decanted, prior to sample processing. The sediment water interface should be intact with no signs of washout or channeling.

- Open the jaws and transfer the sediment to sample containers or to a mixing tray.

- Verify that all field measurements and documentation are complete prior to moving off location.

7. REFERENCES

Not applicable.

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Standard Operating Procedure No. 025
for
Soil Sampling

Prepared by

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1. SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure is to delineate protocols for sampling surface and subsurface soils. Soil samples give an indication of the area and depth of site contamination, so a representative sample is very important.

2. MATERIALS

The following materials may be required:

Bucket auger or push tube sampler	Split-spoon, Shelby tube, or core barrel sampler
Drill rig and associated equipment	Stainless steel bowl
Personal protective equipment as required by the Health and Safety Plan	Stainless steel spoon, trowel, knife, spatula (as needed)

3. PROCEDURE

3.1 SUBSURFACE SAMPLES

Don personal protective equipment. Collect split-spoon, core barrel, or Shelby Tube samples during drilling. Upon opening sampler, or extruding sample, immediately screen soil for volatile organic compounds using either a photoionization detector or flame ionization detector. If sampling for volatile organic compounds, determining the area of highest concentration, use a stainless steel knife, trowel, or laboratory spatula to peel and sample this area. Log the sample in the Field Logbook while it is still in the sampler. Peel and transfer the remaining sample in a decontaminated stainless steel bowl. Mix thoroughly with a decontaminated stainless steel spoon or trowel. Place the sample into the required number of sample jars. Preserve samples as required. Discard any remaining sample into the drums being used for collection of cuttings. Decon sampling implements. All borings will be abandoned.

NOTE: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same, except that two split-spoon samples will be mixed together. The Field Logbook should clearly state that the samples have been composited, which samples were composited, and why the compositing was done.

Samples taken for geotechnical analysis will be undisturbed samples, collected using a thin-walled (Shelby tube) sampler.

3.2 SURFICIAL SOIL SAMPLES

Don personal protective equipment. Remove vegetative mat. Collect a sample from under the vegetative mat with a stainless steel trowel, push tube sampler, or bucket auger. If a representative sample is desired over the depth of a shallow hole or if several shallow samples are to be taken to represent an area, composite as follows:

- As each sample is collected, place a standard volume in a stainless steel bowl.
- After all samples from each hole or area are in the bucket, homogenize the sample thoroughly with a decontaminated stainless steel spoon or spatula.

If no compositing is to occur, place sample directly into the sample jars. Place the leftover soil in the auger borings and holes left by sampling. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas. Samples for volatile organic compounds will not be composited. A separate sample will be taken from a central location of the area being composited and transferred directly from the sampler to the sample container. Preserve samples as required. Decon sampling implements.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Refer to the Health and Safety Plan.

Soil samples will not include vegetative matter, rocks, or pebbles, unless the latter are part of the overall soil matrix.

6. REFERENCES

ASTM International. Method D1586-84, Penetration Test and Split-Barrel Sampling of Soils.

———. Method D1587-83, Thin Walled Sampling of Soils.

Department of the Army, Office of the Chief of Engineers. 1972. Engineer Manual 1110-2-1907 Soil Sampling. 31 March.

Standard Operating Procedure No. 057
for
Multi-Incremental Sampling

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1. INTRODUCTION

1.1 SCOPE AND APPLICATION

Multi-incremental (MI) sampling (sometimes designated by the acronym MIS), originally utilized by the mining industry, was initially proposed for environmental sampling at explosives-related sites (U.S. Environmental Protection Agency Solid Waste 846 Method 8330B, Appendix A Collecting and Processing of Representative Samples for Energetic Residues in Solid Matrices from Military Training Ranges [2006]). MI sampling is particularly effective at such sites because explosives residue is found in surface soil as opposed to at depth, and the potentially impacted areas are relatively easy to delineate because the area of the firing ranges is, in most cases, well defined.

Although MI sampling was initially implemented for the assessment of impacts from explosives, there has been recent movement to extend the list of acceptable contaminants to include metals, semivolatile organic compounds, and even volatile organic compounds (State of Alaska Department of Environmental Conservation [2009] and State of Hawai'i Department of Health [2009]). However, the adequacy of MI sampling is evaluated on a case-by case basis at the time the planning documents are prepared to ensure that the resulting analytical data are appropriate to make the decisions required by the project. This evaluation process considers:

1. Planning elements based on the decisions to be made for each potentially complete pathway (based on the conceptual site model), including contaminants distribution, hot spot size, future land use scenarios, contaminant fate and transport, etc.

2. Sample preparation procedures to be employed by the analytical laboratory (limitations and impacts on the analytical data due to the various preparation methods that can be employed)

3. Data evaluation requirements (i.e., the data needing to meet a certain level of confidence). In addition to technical considerations, stakeholders' input is also folded into the planning stages. Consequently, specific field requirements may be outlined in the planning documents for the sampling program implementation to supplement this Standard Operating Procedure (SOP).

This SOP focuses on the actual collection of MI samples, not project planning or data evaluation to follow, and assumes that successful project planning and scoping have been performed, documented, and agreed to by all stakeholders. Because Sampling Units (SUs) are defined so that the mean concentration value obtained is relevant to an explicitly articulated end use of the data, it is imperative that any changes to the SUs or sampling strategy deemed necessary by actual field conditions unanticipated at the time the sampling plan was designed should be made by the project technical lead rather than by field personnel. This way, field deviations from the approved plan during sample collection will not negatively impact the adequacy of the data for the planned purpose.

1.2 GLOSSARY OF TERMS

1.2.1 Sampling Units

An SU (sometimes termed Decision Unit [DU]) is the area and depth of soil (the sampled population) to be characterized by the average concentration of the MI sample. A DU may contain several SUs that are sampled using MI techniques or may consist of just one SU. SUs are restricted to actual source zones and must incorporate only areas that are similar as far as impact (i.e., not to "dilute" contamination) as well as future use. SUs/DUs selected based on future land use scenarios may be called Exposure Units. SUs must be delineated so that the mean analyte concentrations obtained are directly relevant to well defined project objectives. They are the smallest volume of soil for which a concentration value will be obtained, and the basic unit about which a decision or conclusion based on an analytical result can be made.

1.2.2 Decision Units

A DU is a specific area (or volume of soil) about which a decision is to be made. In the ideal and most direct case, the DU and SU are the same volume of soil. As noted above, a DU may be composed of a single SU, or may include multiple SUs, if the DU is very large in size. The important thing is that the entire area of a DU is consistent as far as contamination distribution and future use/exposure scenario, just like an SU. Either all or a percent of the SUs composing the DU may be sampled in an MI fashion, the number of SUs sampled depending on the confidence of the data that are extended from the SUs to the DU.

1.2.3 Grid Cell

A grid cell is a sub-division of the SU. SUs are divided into uniform-size grid cells, and one increment is collected from each cell, from the same relative location within each grid cell. The shape of the cells is not specified—the only criterion for cell shape selection is that the cells should be of equal size (they can be triangular, square, rectangular, etc.) so the increments collected from each cell are equally weighted over the SU.

1.3 GENERAL CONCEPTS

The use of standard discrete samples to characterize soil contamination has two significant sources of error:

1. Field sampling error is at least 10 times greater than analytical (laboratory-associated) error.

2. A source of analytical error was found to be that in sample processing and sub-sampling (a single subsample from the 4- or 8-ounce soil jar is taken at the laboratory).

Depending on the areal and vertical contaminant distribution profile, MI sampling and processing are designed to minimize these sources of error, resulting in an average concentration that is a much more precise and accurate estimate for the SU.

It is also important to note that the horizon characterized by MI sampling is usually superficial, although MI can be implemented at greater depth, this resulting in much higher associated sampling costs.

The purpose of this SOP is to delineate protocols for the application of MI field sampling of surface soil. The procedure, which can be adapted to allow for MI sampling in other environments, i.e., in an excavation trench, has been adapted from U.S. Army Corps of Engineers sampling guidance (2009).

2. EQUIPMENT AND MATERIALS

The following equipment and materials may be required:

- Spray paint[1], pin flags, or rope to mark either grid corners or outline the sampling grid

- Incremental sampling tool (i.e., the MI tool developed by the Cold Regions Research and Engineering Laboratory or alternative[2] coring device); stainless steel spoons or scoops may be used but only in conjunction with scales, so that aliquots of equal mass are collected from each location

- Clean Zip-lock® bags, 5-gallon plastic containers, or other appropriate large container for placing the increments; the size of the container should be adequate to hold the sample volume, which is approximately 1-2 kilograms

- If MI sampling is used for volatile organic compound analysis, the increments of equal mass are collected with tools such as En Core® sampler and placed in a container obtained from the analytical laboratory that is partially filled with methanol

- Coolers and ice for cold storage of samples after collection

- Field logbook and pen with waterproof black ink for field documentation

- Global Positioning System instrument or other survey equipment to document locations of DU or SUs

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[1] Avoid if spray paint is likely to affect MI sample quality.

[2] A source for the MI sampling tool shown in this SOP is Ike Loukos, LES Engineering, Inc. Telephone No. 301-471-3393, email i.loukos@att.net.

- Personal protective equipment should be worn during sample collection as required by the Health and Safety Plan for the project.

3. MULTI-INCREMENTAL SAMPLING PROCEDURE

Increments of soil will be collected within each cell of the SU. Increments should be approximately of the same weight. For surface soil sampling, a coring tool may be used to facilitate the rapid collection of uniform, representative increments from a consistent depth interval. This way, equal volumes are collected for each increment and equal mass is obtained under the assumption that the density of the sampled medium is uniform across the cell of the SU. The size of the coring tool will be selected based on the volume of the increments, which is in turn calculated based on number and depth of the increments and the fact that an adequate total sample mass is typically 1-2 kilograms dry weight (to overcome effects of compositional heterogeneity due to the inherent particulate nature of soil and sediment). It is not necessary to determine by the Global Positioning System location of every increment collected, as long as the SU has been properly identified and the relative position of the increment location within each cell is recorded.

The SU or DU will be demarcated in the field using pin flags, spray paint, or rope and fixed with a Global Positioning System. Increments will be selected as defined in the sampling plan.

Prior to MI sampling activities, the field team will don the personal protective equipment. The increments will be collected from the depth specified in the planning documents (usually up to 6 inches deep) using a coring tool or other method that ensures equal volume is collected for each increment. Unless specified in the sampling plan, the vegetative mat will be included in the sampled interval. Of note is that some plans may require only sampling native soil; the horizontal limits of sampling will be dependent on past disposal practices and the decision to be made. If used, the stainless-steel sampler will be pushed into the soil until the sampler is full and will not penetrate further. The sampler is then removed carefully, and the soil is pushed out of the sampler with the lever on the side of the instrument (see photos below).

Place the sample (increment or aliquot) directly into a large re-sealable bag, 5-gallon bucket, or alternative large container (note the above photos show placing the aliquot into a sampler's hand only for aliquot visualization purposes). Field experience has found that placing samples into a decontaminated 5-gallon bucket and then pouring the whole sample into a bag is a better process. The likelihood of spilling increases with the use of a bag alone because as the bag fills up it is harder to eject additional soil increments into the bag. The bucket is more stable and may prevent loss of fines. The holes left by sampling will be filled using surrounding soil or, if necessary, sand may be used to bring the subsurface sampling areas back to original grade. Soil samples should not include large rocks or pebbles unless they are part of the overall soil matrix. It is not necessary to decontaminate the sampling tool between the increments within a DU or SU.

If collecting an MI sample for volatile organic compound analysis, a wide-mouth glass container and methanol will be obtained from the analytical laboratory for sample aliquot preservation. The collection of the increments will be performed using EnCore™ or TerraCore™ sampling tools, meaning that a much smaller increment volume will be collected, resulting in a smaller total sample volume. The field team will place the 5- to 15-milligram increments into the glass container and care should be taken to follow the health and safety precautions associated with methanol handling. To prevent loss of methanol through volatilization, the sample container will be kept closed as much as feasible and only opened to place sample aliquots within the container.

Prior to the collection of replicate samples or MI samples from another SU or DU, the sampling tool will be decontaminated according to requirements set forth in EA SOP No. 005 – Field Decontamination. The replicate samples from the same SU/DU will be collected following a different path, as shown in Figure SOP No. 057-1. The specific relative location of the replicate increments within each SU cell will be established in a random manner to eliminate potential bias. To select the relative increment location for a replicate increment in a cell, the cell may be divided in turn into sub-grids and a sub-cell may be selected by randomly generating a number on a calculator. Another selection method is performed by rolling a dice for a 6 × 6 sub-grid in the SU cell; the first die would indicate the row and the second die the column of this sub-grid.

The large re-sealable bag containing the total sample volume will be labeled with indelible ink and then double-bagged. The samples will be bubble-wrapped and taped for shipping and placed into iced coolers for transport under chain-of-custody protocol to the analytical laboratory. The field procedures will follow the requirements set forth in EA SOP No. 002 – Chain-of-Custody Form and EA SOP No. 004 – Sample Packing and Shipping. Copies of the chain-of-custody forms and shipping documents will be retained in the project file. Field activities will be documented according to logbook procedures specified in EA SOP No. 016 – Surface Water, Groundwater, and Soil/Sediment Field Logbooks.

4. MAINTENANCE

Not applicable.

5. PRECAUTIONS

Safety precautions documented in the Site Health and Safety Plan will be followed. If sampling procedures are to occur in areas where unexploded ordnance is known or potentially exist, the area will not be entered until unexploded ordnance support is provided. If, at any time, an unsafe condition is identified, stop work immediately until the unsafe condition is mitigated. If sampling for volatile organic compound analysis, follow precautions associated with handling methanol. Also, because much larger quantities of methanol are employed for MI sampling, follow all requirements associated with transportation of these samples. In most cases, these samples are driven to the analytical laboratory rather than shipped via air, which constitutes a limitation in using this method at sites not located in close proximity of a laboratory.

6. REFERENCES

State of Alaska Department of Environmental Conservation. 2009. *Draft Guidance on Multi Increment Soil Sampling.* Division of Spill Prevention and Response Contaminated Sites Program. March.

State of Hawai'i Department of Health. 2009. *Technical Guidance Manual for the Implementation of the Hawai'i State Contingency Plan Interim Final.* Office of Hazard Evaluation and Emergency Response. June.

U.S. Army Corps of Engineers. 2009. Interim Guidance 09-02, *Implementation of Incremental Sampling of Soil for the Military Munitions Response Program.* 20 July.

U.S. Environmental Protection Agency. 2006. *SW-846 Method 8330B, Appendix A Collecting and Processing of Representative Samples for Energetic Residues in Solid Matrices from Military Training Ranges.*

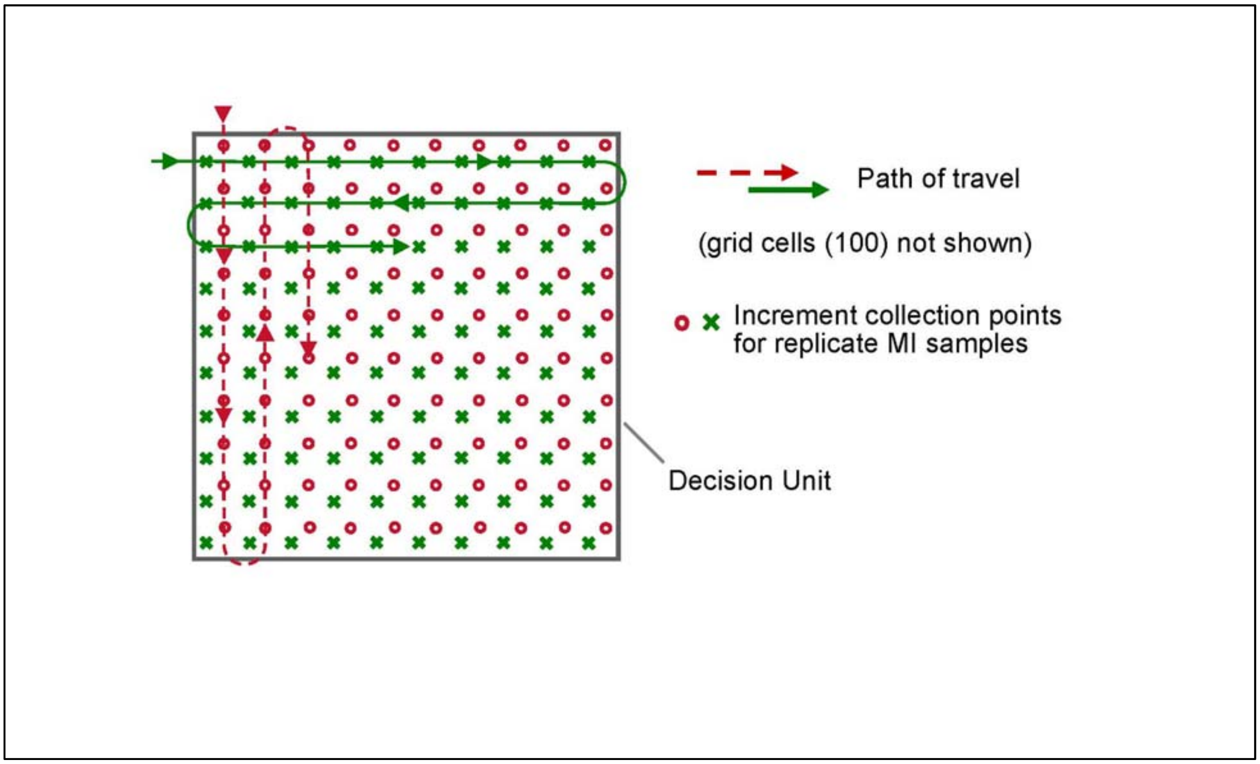

Figure SOP057-1. Example incremental sampling in a Decision Unit.

Standard Operating Procedure No. 059
for
Field Logbook

Prepared by

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1. SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording field survey and sampling information in the Field Logbook.

2. MATERIALS

The following materials may be required:

- Field Logbook (Teledyne 415 Level Book, or equivalent)[1]
- Indelible ink pen (e.g., Sharpie®).

3. PROCEDURE

All information pertinent to a field survey or sampling effort will be recorded in a bound logbook. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink, and all corrections will consist of line-out deletions that are initialed and dated. The person making the correction will provide a brief explanation for the change. Entries are factual only. No personal opinions should be entered.

There should be no blank lines on a page. A single blank line or a partial blank line (i.e., at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an “X” drawn across it. The bottom of each page must be signed and dated by the field personnel entering the information.

At a minimum, entries in the Field Logbook will include but not be limited to the following:

- Date.
- Project number and project name.
- Name and address of field contact.
- Identification of sample crew members.
- Documentation should include model numbers of equipment used (e.g., drilling rigs) and calibration (if applicable). Each day’s entry should begin with time onsite, who is onsite (including observers other than the sampling crew), brief description of what work will be performed that day and how, and the weather.

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[1] Pre-printed, bound forms are approved as well. See SOP No. 016 for recommended content and format.

- If samples are being taken in or near tidal waters, the time of high and low tide for the site should be determined from local gauges or tables and recorded.

- References such as maps of the sampling site.

- Times of key daily milestones should be entered (e.g., time borings began, times personnel arrived and left site, times subcontractors arrived and left site, etc.). Time should be recorded in the left-hand margin on the page in military time.

- Sample-specific information:

  — Unique, sequential field sample number

  — Purpose of sampling

  — Location, description, and log of photographs of each sampling point

  — Details of the sample site (e.g., elevation of the casing, casing diameter and depth, integrity of the casing, etc.)

  — Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters and absorbing reagents)

  — Type of media of sample (e.g., groundwater, surface water, soil, sediment, and product)

  — Suspected waste composition

  — Number and volume of sample taken

  — Sampling methodology, including distinction between grab and composite sample

  — Sample preservation

  — Date and time of collection

  — Collector’s sample identification number(s)

  — Sample shipment (e.g., name of the laboratory and cartage agent: Federal Express, United Parcel Service, etc.)

  — Field observations (e.g., oily sheen on groundwater sample, incidental odors, soil color, grain size, plasticity, moisture content, layering, Unified Soil Classification System classification, etc.)

- Any field measurements made (e.g., pH, conductivity, explosivity, water depth, organic vapor analyzer readings, etc.)

- Signature and date by the personnel responsible for observations

- Decontamination procedures.

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a Field Logbook. However, records should contain sufficient information so that someone can reconstruct the sampling activity without relying on the sampler's memory. Further, the project work plan or field sampling plan should be reviewed to identify additional specific information or requirements that should be included in the Field Logbook.

The Project Manager will keep a master list of all Field Logbooks assigned to the Sampling Team Leaders. One Field Logbook kept by the Project Manager will be a master site log of daily activities and will contain the list of Field Logbooks assigned to Sampling Team Leaders.

Project name and number should be clearly marked on the outside cover using indelible ink. If more than one Field Logbook exists for the project, then the number of the Field Logbook should also be clearly marked on the outside cover.

4. MAINTENANCE

At the end of the field sampling effort, the Field Logbook should be scanned and filed in the electronic file for the project and maintained according to the EA Records Retention Policy or contract requirements.

5. PRECAUTIONS

None.

6. REFERENCES

EA Engineering, Science, and Technology, Inc., PBC. 2014. Standard Operating Procedure No. 016 for Surface Water, Groundwater, and Soil/Sediment Field Logbooks. December.

U.S. Environmental Protection Agency. 1980. *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80.

———. 1990. *Sampler's Guide to the Contract Laboratory Program*. EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C. December.

———. 1991. *User's Guide to the Contract Laboratory Program*. EPA/540/O-91/002, Directive 9240.0-01D. Office of Emergency and Remedial Response. January.

Appendix I

Field Forms

Contents:

- Instrument Calibration Checklist
- Daily Field Report Form
- Daily Quality Control Report
- Preparatory Phase Checklist
- Initial Phase Checklist
- Final/Pre-Final Inspection Checklist
- Quality Control Surveillance Report
- Deficiency Management Record
- Non-Conformance Report
- Correction Action Request
- Quality Control Health and Safety Checklist
- Soil Boring Log

INSTRUMENT CALIBRATION CHECKLIST

Project Name/Number:

Date: ________________

Complete daily. Answer each question by checking the appropriate column (yes, no, or N/A). If "no" is checked, provide an explanation on the form.

	Yes	**No**	**N/A**
Instrument Calibration			
1. Were all field instruments calibrated properly under comparable temperatures as it will be used in the field and in accordance with QAPP worksheet #22 and manufacturer's instructions?	☐	☐	☐
2. Were calibration checks performed during/at the end of each day as necessary to ensure equipment is staying within calibration range during a full day of sampling?	☐	☐	☐
3. Were water quality probes rinsed and stored at room temperature when not in use?	☐	☐	☐

List instruments used at the site:

The sampler shall sign this checklist upon completion of all items on the checklist.

Sampler's Signature: ___________________________

Date: _____________________

Date: _____________________

DAILY FIELD REPORT

Day:

Date:

Temperature: (F)	(am)	(pm)
Wind Direction:	(am)	(pm)

Weather: (am)
(pm)

Project Name:

Contract No.

Arrive at site: (am)

Leave site: (pm)

HEALTH & SAFETY:

Are there any changes to the Health & Safety Plan? (If yes, list the deviation under items for concern)		Yes ( )	No ( )	
Are monitoring results at acceptable levels?	Soil	Yes ( )	n/a ( )	* No ( )
	Waters	Yes ( )	n/a ( )	* No ( )
	Air	Yes ( )	n/a ( )	* No ( )

- *If No, provide comments*

OTHER ITEMS:

Site Sketch Attached:	Yes ( )	No ( )
Photos Taken:	Yes ( )	No ( )

DESCRIPTION OF DAILY WORK PERFORMED:

DAILY FIELD REPORT Day: Date:

ENVIRONMENTAL SAMPLING

Contractor Sample ID **Description**

CONTRACTOR/SUBCONTRACTOR EQUIPMENT AND PERSONNEL ON SITE:

EA personnel:

(Name of Subcontractor) personnel:

(Name of contractor) equipment:

(*Indicates active equipment)

Other Subcontractors:

VISITORS TO SITE:

PROJECT SCHEDULE ISSUES:

PROJECT BUDGET ISSUES:

ITEMS OF CONCERN:

COMMENTS:

ATTACHMENT(S) TO THIS REPORT:

SITE REPRESENTATIVE:

Name:

DAILY QUALITY CONTROL REPORT

Date: ____/____/____ Contract #: ____________ **Task Order #:** ___________
Site/Location: ___________________________________
Weather: __________________ Temperature: ______ Rainfall: ________

1. Preparatory Inspection: ____
____
____
Results: ____

2. QC Audits Performed *

a. Operations: ____
____
____
Results: ____

b. Safety: ____
____
____
Results: ____

b. Administrative: ____
____
____
Results: ____

d. Equipment: ____
____
____
____
Results: ____
____

Note: * A formal surveillance needs to be completed at a minimum of once weekly for each task that is performed during that week.

Daily Quality Control Report Cont'd:

3. QC Performed (Grids)

Number of Grids QC'd: __________ Results: ______ # Pass ______ # Fail _________

Comments: ____

____

____

____

4. Follow-Up Inspections and Results

Section(s): ____

____

____

Results: ____

5. Instructions Received: ____

____

____

____

____

Remarks: ____

____

____

____

QC Signature: ____________________________________ **Date:** ____/____/____

Printed Name: ____________________________________

+CQC DAILY FORM – 　　DATE:

CONTRACT NUMBER AND NAME OF CONTRACTOR: 　　**DESCRIPTION AND LOCATION OF THE WORK:**

WEATHER CLASSIFICATION:

CLASS A	No interruptions of any kind from weather conditions occurring this or previous shifts.
CLASS B	Weather occurred during this shift that caused a complete stoppage of all work.
CLASS C	Weather occurred during this shift that caused a partial stoppage of work.
CLASS D	Weather overhead excellent or suitable during shift. Work stopped due to results of previous adverse weather.
CLASS E	Weather overhead excellent or suitable during shift but work partially stopped due to previous adverse manner.
OTHER	Explain.

CLASSIFICATION:

CLASS:

TEMPERATURE:

MAX: 　MIN:

PRECIPITATION:

INCHES

CONTRACTOR/SUBCONTRACTORS AND AREA OF RESPONSIBILITY FOR WORK PERFORMED TODAY: (*Attach list of items of equipment either idle or working as appropriate*)

1)

2)

3)

4)

1. **WORK PERFORMED TODAY:** (*Indicate location and description of work performed)*

2. **TYPE AND RESULTS OF INSPECTION:** (*Indicate whether: P = Preparatory, I = Initial, or F = Follow-up and include satisfactory work completed or deficiencies with action to be taken.)*

3. **TESTS REQUIRED BY PLANS AND/OR SPECIFICATIONS PERFORMED AND RESULTS OF TESTS:**

4. **VERBAL INSTRUCTIONS RECEIVED:** (*List any instructions given by Government personnel on construction deficiencies, retesting required, etc., with action to be taken.)*

5. **REMARKS:** (*Cover any conflicts in plans, specifications, or instructions: acceptability of incoming materials; offsite*

surveillance activities; progress of work, delays, causes, and extent thereof; days of no work with reasons for same. Note if a Preparatory or Initial Phase Meeting was held, and attach a copy of the checklist.)

5. a. **REQUESTS FOR INFORMATION**: (*Note that there is an RFI attached to this daily report, assign a control number, and attach a sheet to this report which fully describes the RFI, and recommends a solution if applicable*.)

☐ RFI Attached; Control Number =

5. b. **ENVIRONMENTAL QUALITY CONTROL**

Environmental Quality Control Requirements are in place and have been checked? ☐ Yes ☐ Not Applicable

Have any endangered species been encountered? ☐ Yes ☐ No

(If Yes, attach required reports in accordance with Section ENVIRONMENTAL PROTECTION!)

5. c. **VISITORS TO THE SITE:** *(List the name of all official visitors to the site and who they represent i.e., State DEP, OSHA)*

1)

2)

3)

4)

6. **SAFETY**: (*Include all infractions of the accident prevention plan; COE Safety and Health Requirements Manual, EM 385-1-1; or instructions from Government QA personnel.* ***Describe corrective actions taken.***)

Safety meeting held today? ☐ Yes, ☐ No (If Yes, state the subject and report number of personnel in attendance)

Safety meeting subject:

Number of Contractor personnel attending =

Number of Subcontractor personnel attending =

Name of Reporting QC Inspector/s:

____

Signature and Date:________________________________ Date: ______________

CONTRACTOR's CERTIFICATION: I certify that the above report is complete and correct and that all material and equipment used, work performed, and tests conducted during this reporting period were in compliance with the contract except as noted above.

____

Contractor's QC Manager/Authorized Representative

PREPARATORY PHASE CHECKLIST

Date: _________________

Contract No.: ___________________ Spec. Sect. & Para.: ______________

Title: ___________________ Drawing No.: ___________________

MAJOR DEFINABLE SEGMENT OF WORK: ___________________________________

A. PERSONNEL PRESENT

Name	Position	Company
1.		
2.		
3.		
4.		
(List additional personnel on attached sheet)		

B. HAS EACH SPEC. PARAGRAPH AND DRAWING AND SHOP DRAWING DETAIL BEEN STUDIED

Yes _____ No _____

C. TRANSMITTALS INVOLVED: Yes _____ No _____

Number and Item	Code	Contractor/Government Approval
1.		
2.		
3.		
4.		
5.		
6.		

C-I. Have all items involved been approved? Yes _____ No _____
If No, list items:

D. ARE ALL MATERIALS ON HAND? Yes _____ No _____

D-I. Have all materials been checked for contract compliance against approved shop drawings?
Yes _____ No _____

D-II. Items not on hand or not in accordance with transmittals:

1.
2.
3.
4.

E. TESTS REQUIRED IN ACCORDANCE WITH CONTRACT REQUIREMENTS

Test	**Paragraph**
1.	
2.	
3.	

F. ACCIDENT PREVENTION PRE-PLANNING – HAZARD CONTROL MEASURES

F-I. Applicable Outlines (attach completed copies):

1.
2.
3.
4.

F-II. Operational Equipment Checklists:

Attached for:
1.
2.
3.

On File for:
1.
2.
3.

G. HAVE PROCEDURES FOR ACCOMPLISHING WORK BEEN REVIEWED WITH APPROPRIATE PEOPLE?
Yes _____ No _____

H. HAS ALL PRELIMINARY WORK BEEN ACCOMPLISHED IN ACCORDANCE WITH CONTRACT REQUIREMENTS AND IS THIS SEGMENT OF WORK READY TO START?
Yes _____ No _____

H-I. Explain any problems:

Quality Control Representative

INITIAL PHASE CHECKLIST

Date: ______________________

Contract No.: _________________ Spec. Sect. & Para.: _________________

Description and Location of Work Inspected: ______________________________________

REFERENCE CONTRACT DRAWINGS

A. PERSONNEL PRESENT

Name	Position	Company
1.		
2.		
3.		
4.		
5.		
6.		

B. MATERIALS BEING USED ARE IN STRICT COMPLIANCE WITH THE CONTRACT PLANS AND SPECIFICATIONS
Yes _____ No _____

If not, explain:

C. PROCEDURES AND/OR WORK METHODS WITNESSED ARE IN STRICT COMPLIANCE WITH THE REQUIREMENT OF THE CONTRACT SPECIFICATIONS
Yes _____ No _____

If not, explain:

D. WORKMANSHIP IS ACCEPTABLE Yes _____ No _____

State areas where improvement is needed:

E. SAFETY VIOLATIONS AND CORRECTIVE ACTION TAKEN

Quality Control Representative

DEFICIENCY MANAGEMENT RECORD

CONTRACT NO.: __________________ PROJECT: ___________________________ CONTRACTOR: EA

Date	Deficiency	No. Category	Deficiency Description	Discipline	Corrected Date	CQC Initials	QA Initials

Category: 1 = Urgent, 2 = Significant, 3 = Requires Written Letter of Non-Compliance.

Receipt Acknowledged:		Signature QC Staff:		Date:	

FINAL/PRE-FINAL INSPECTION CHECKLIST

1. Contract: _________________
2. Contractor: _______________
3. Project: __________________
4. Date of (Final) (Pre-Final) Inspection: ________________
5. Names and Positions of all Participants:

   ___________________ , CQC Manager

   ___________________ , Government's QA Representative

6. Topics Reviewed:

	Yes	No	N/A	Initials
a. All submittals received and approved?				
b. All payroll received?				
c. All measured quantities have been correctly measured in the field?				
d. Are all parties in agreement with final measured quantities?				
e. Are all change orders finalized? If “no,” the date set for final negotiations is ___________.				
f. Is warranty received and correct?				
g. (Final) (Pre-Final) log received?				
h. As-built drawings received?				
i. Is work per plans and specifications?				
j. Is performance rating complete?				
k. Is safety rating complete?				
l. Was project turned over to beneficial occupant (keys, utilities, manuals, acceptance)?				
m. Final inspection date set for _________.				

ACTIVITY ________________ ANALYZED BY/DATE ____________________ REVIEWED BY/DATE ____________________

Principal Steps	Potential Hazards	Recommended Controls

Equipment to be Used	Inspection Requirements	Training Requirements

QUALITY CONTROL SURVEILLANCE REPORT	Report Number:
Project Name:	Contract No:
Client:	Project Manager:

1 - Activity

☐ Project Management
☐ Intrusive Investigation
☐ Surface Sweep
☐ Geophysical Data Collection
☐ Geophysical Data Processing
☐ Anomaly Reacquisition
☐ Data Management
☐ Demolition
☐ Scrap Processing
☐ Brush Cutting/Clearing
☐ UXO Avoidance

☐ MC Sampling:____________________________________

☐ Other:____________________________________

2 - Phase

☐ Preparatory	☐ Initial	☐ Follow up

3 – Attendees/Organization at Inspection

4 – Observed Condition/Activities and Comments:

5 – Results of Surveillance

☐ Acceptable	☐ Unacceptable	Deficiency #: NCR #:

Conducted By:	Signature:	Date:

6 – Project Manager or Representative Review:

☐ Concur ☐ Non-Concur	Signature:	Date:

7 - Distribution

☐ PM ☐ Field Task Manager ☐ SUXOS ☐ UXOQCS/SO ☐ Other:

DEFICIENCY MANAGEMENT RECORD

CONTRACT NO.: ____________ PROJECT: ____________ CONTRACTOR: EA____________

Date	Deficiency	No. Category	Deficiency Description	Discipline	Corrected Date	CQC Initials	QA Initials

Category: 1 = Urgent, 2 = Significant, 3 = Requires Written Letter of Non-Compliance.

Receipt Acknowledged:		Signature QC Staff:		Date:	

Non-Conformance Report

Project **Original to EA Corporate QC Manager**	**NCR No.**	**Date**		
Item: **Work Plan Reference** **Requirement**				
Non-conformance				
Issued by **Name**	**Title**	**Organization**		
Date				
Disposition	**Accept**	**Reject**		
Disposition Approvals				
UXOQCS	**Date:**	**FCR Required?**	**Yes**	**No**
Project Manager	**Date:**	**Distribution**		
Remarks				

CORRECTIVE ACTION REQUEST

(1) PAGE 1 OF 2

(2) CAR#	(3) Priority: High ☐ Normal ☐	(4) Date Prepared:

Part A: Notice of Deficiency

(5) Project:	
(6) Project Mgr:	(7) QC Mgr/Staff:
(8) Construction Mgr:	(9) MRS Manager:
(10) Issued to (Individual & Organization)	
(11) Requirement & Reference	
(12) Problem Description & Location: (13) CAP Required? Yes ☐ No ☐ (14) Response Due:	
(15) Issued by (Printed Name & Title) Signature: Date:	(16) Management Concurrence:

Part B Corrective Action

(17) Proposed Corrective Action/Action Taken	
(18) Part B Completed By (Name & Title) Date	(19) QC Concurrence

Part C

(20) CAR Verification and Close Out: (Check only one & and Explain Stipulations, If any)

☐ Approved for Closure without Stipulations

☐ Approved for Closure with following stipulations

Comments/Stipulations:

(21) Closed by (Printed name and Title)

Signature: Date:

CORRECTIVE ACTION REQUEST (CAR) INSTRUCTION SHEET

(1) QC Manager: Verify that the total number of pages includes all attachments.

(2) QC Manager: Fill in CAR number from CAR log.

(3) CQC System Manager: Fill in appropriate priority category. High priority indicates resolution of deficiency requires expediting corrective action plan and correction of deficient conditions noted in the CAR and extraordinary resources may be required due to the deficiencies impact on continuing operations. Normal priority indicates that the deficiency resolution process may be accomplished without further impacting continuing operations.

(4) CAR Requestor: Fill in date CAR is initiated.

(5) CAR Requestor: Identify project name, number, CTO, and WAD.

(6) CAR Requestor: Identify Project Manager

(7) CAR Requestor: Identify CQC System Manager.

(8) CAR Requestor: Identify project organization, group, or discrete work environment where deficiency was first discovered.

(9) CAR Requestor: Identify line manager responsible for work unit where deficiency was discovered.

(10) QC Manager: Identify responsible manager designated to resolve deficiency (this may not be work unit manager).

(11) CAR Requestor: Identify source of requirement violated in contract, work planning document, procedure, instruction, etc; use exact reference to page and, when applicable, paragraph.

(12) CAR Requestor: Identify problem as it relates to requirement previously stated. Identify location of work activities impacted by deficiency.

(13) QC Manager: Identify if Corrective Action Plan (CAP) is required. CAP is typically required where one or more of the following conditions apply: CAR priority is High; deficiency requires a rigorous corrective action planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent future recurrence.

(14) QC Manager: Identify date by which proposed corrective action is due to QC for concurrence.

(15) QC Manager: Sign and date CAR and forward to responsible manager identified in (10) above.

(16) Responsible Manager: Initial to acknowledge receipt of CAR.

(17) Responsible Manager: Complete corrective action plan and identify date of correction. Typical corrective action response will include statement regarding how the condition occurred, what the extent of the problem is (if not readily apparent by the problem description statement in [12]), methods to be used to correct the condition, and actions to be taken to prevent the condition from recurring. If a CAP is required, refer to CAP only in this section.

(18) Responsible Manager: Sign and date corrective action response.

(19) QC Manager: Initial to identify concurrence with corrective action response from responsible manager.

(20) QC Manager: Check appropriate block to identify if corrective action process is complete so that CAR may be closed. Add close-out comments relevant to block checked.

(21) QC Manager: Indicate document closeout by signing and dating.

CORRECTIVE ACTION REQUEST

(1) PAGE 1 OF 2

Part A: To be completed by Project Manager or Designee

(1)Project:

(2) Project Mgr: (3) QC Mgr/Staff:

(4) CAR No (s)and date (s) Issued

(5) Deficiency Description and Location

(6) Planned actions	(7) Assigned Responsibility	(8) Completion Due Date

(9) Project Manager Signature: Date:

Part B To be completed by QCS System Manger or Designee

(10) CAP Reviewed by Date

(11) Reviewer Comments

(12) CAP Disposition: (check only one and explain Stipulations, if any.

☐ Approved without stipulations

☐ Approved with stipulations

☐ Approved delayed, further planning required

Comments:

(13) QC Manager Signature Date

QUALITY CONTROL
HEALTH AND SAFETY CHECKLIST

Date:	
Project Name/Number:	
Site:	
Personnel Observed and Locations:	

Answer each question by checking the appropriate column (yes, no, or N/A). If "no" is checked, provide an explanation on the form.

Preparatory	**Yes**	**No**	**N/A**
1. Has the Accident Prevention Plan (APP)/Site Safety and Health and Plan (SSHP) been reviewed and approved?	☐	☐	☐
2. Did new employees receive Safety Indoctrination Training?	☐	☐	☐
3. Was a test of cellular phone coverage across the entire work area conducted prior to mobilization?	☐	☐	☐
4. Was the medical facility contacted prior to field work to inform them of project activities, schedule, type of work, and anticipated potential injury types?	☐	☐	☐
5. Were the local fire and police departments contacted prior to field work to inform them of project activities?	☐	☐	☐
6. Did all employees attend a pre-entry briefing?	☐	☐	☐
7. Has all monitoring equipment been purchased/rented and calibrated?	☐	☐	☐

Initial	**Yes**	**No**	**N/A**
8. Are work zones properly and adequately designated?	☐	☐	☐
9. Is required personal protective equipment available and correctly used, maintained, and stored?	☐	☐	☐
10. Is the following emergency equipment located onsite:	☐	☐	☐
• Fire extinguisher?	☐	☐	☐
• Eye wash?	☐	☐	☐
• Communications (phone)?	☐	☐	☐
• First aid kit?	☐	☐	☐

11. Is the buddy system in use?	☐	☐	☐
12. Are personnel refraining from drinking, chewing, smoking, taking medications, or other hand-to-mouth contact while working in the exclusion zone?	☐	☐	☐
13. Was the initial safety inspection completed?	☐	☐	☐
14. Was a random employee asked if he/she know site hazard and emergency procedures?	☐	☐	☐

Follow-Up	**Yes**	**No**	**N/A**
15. Are daily safety inspections being completed?	☐	☐	☐
16. Are safety deficiencies being tracked and corrective actions being applied to the site?	☐	☐	☐
17. Is monitoring equipment being calibrated on a daily basis?	☐	☐	☐
18. Are any mishaps being properly investigated and reported?	☐	☐	☐
19. Are personnel refraining from drinking, chewing, smoking, taking medications, or other hand-to-mouth contact while working in the exclusion zone?	☐	☐	☐
20. Is site sanitation and housekeeping being maintained on a daily basis?	☐	☐	☐
21. Is the site organized to avoid tripping hazards and spreading contamination?	☐	☐	☐
22. Is the chemical inventory being updated as needed?	☐	☐	☐

Documentation	**Yes**	**No**	**N/A**
23. Is the Accident Prevention Plan (APP)/Site Safety and Health and Plan (SSHP) on the site?	☐	☐	☐
24. Has the APP/SSHP and associated AHAs been reviewed, dated, and signed within the last year?	☐	☐	☐
25. Are the tasks being completed reflected in the APP/SSHP and associated AHAs?	☐	☐	☐
26. Is there a written acknowledgement that all employees have been briefed on and read the APP/SSHP (signature sheet)?	☐	☐	☐
27. Are the following training records current and available:			
• 40-hour HAZWOPER?	☐	☐	☐
• 24 Hours Supervised Field experience?	☐	☐	☐
• 8-hour HAZWOPER Annual Refresher?	☐	☐	☐
• CPR/First Aid (minimum two people onsite)?	☐	☐	☐

• 8-Hour Hazardous Waste Site Supervisor?	☐	☐	☐
• Initial Site Health and Safety Briefing?	☐	☐	☐
28. Are emergency maps maintained in site support vehicles?	☐	☐	☐
29. Are documents current and available that indicate personnel are medically fit to work and wear the required personal protective equipment (if required)?	☐	☐	☐

The Quality Control Inspector shall sign this checklist upon completion of all items on the checklist.

Quality Control Inspector Signature Date

FIELD BORING LOG FORM

EA Engineering, P.C.
EA Science and Technology

LOG OF SOIL BORING

Coordinates:
Surface Elevation: ______________
Casing Below Surface: ______________
Reference Elevation: ______________
Reference Description: ______________

Job. No.	Client:	Location:
Drilling Method:		Soil Boring Number:
Sampling Method:		Sheet 1 of

					Drilling	
Water Lev.					Start	Finish
Time						

Blow Counts (140-lb)	Feet Drvn/Ft. Recvrd	Well Diagram	PID (ppm) HNu	Depth in Feet		Surface Conditions: Weather: Temperature:
				0		
				1		
				2		
				3		
				4		
				5		
				6		
				7		
				8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		
				16		
				17		
				18		
				19		
				20		

Logged by: ______________ Date: ______________

Drilling Contractor: ______________ Driller: ______________

WELL SPECIFICATIONS:

Diam. of casing: ________ Screen Interval: ________ Sand pack: ________ Grout: ________
BOH: ________ Riser Interval: ________ Bentonite: ________ Cover: ________

SOIL SAMPLE COLLECTED YES / **NO**
Samples Collected for VOC SVOC Duplicate MS/MSD

Sample Depth:_________feet Sample Time:_______________________ Sample Date:_____