QUALITY ASSURANCE PROJECT PLAN

DURHAM WATERLINE CONSTRUCTION:
Water Line and Water Tank Testing Only

Durham Meadows Superfund Site
Durham, Connecticut
Contract Number:
W912WJ9C0002

REVISION 4

July 2019

INTRODUCTION

This Quality Assurance Project Plan (QAPP) addresses the sampling and analytical requirements associated with field testing associated with water line and water tank installation/disinfection only.

Ludlow Construction will develop an QAPP addendum to this QAPP to address the areas of construction that will take place in with known contaminated soils and water. The addendum will also cover procedures for when contaminated soils or water are found in areas that are unknown to have contaminated items, especially during trenching activities. A QAPP outlining procedures to mitigate contaminated soils and contaminated water will be developed, submitted and approved prior to any work beginning in areas that are known to contain contaminated soils and water.

LCC is generating this document under USACE Contract #W912WJ19C0002. Consistent with the requirements of the Contract Documents, Volume 1 of the Specifications (the Specifications), this document meets the requirements and format of *EPA Guidance for Quality Assurance Project Plans (QA/G-5), EPA Requirements for Quality Assurance Project Plans (QA/R-5),* and the *Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs* (UFP-QAPP; Final Version 1, March 2015). The UFP-QAPP Optimized Worksheets were used.

The goal of the investigation addressed by this document is to generate data of sufficient quality and quantity to demonstrate that the water utilities provided conform to the water quality requirements as stated in the Specifications

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APPENDICES

QAPP Worksheet #1 & 2: Title and Approval Page
(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

1. Project Identifying Information
    a. Site name/project name: Durham Meadows Superfund Site / Waterline Remedial Action
    b. Site location/number: Durham, Connecticut
    c. Contract/Work assignment number USACE Contract No. W912WJ18B0016

2. Lead Organization
    a. Lead Organization Project Manager

    _____

    Name: Michael Pio Date
    Title: LCC Project Manager

    b. Lead Organization Quality Manager

    _____

    Name: Thomas Wilson Date
    Title: LCC Quality Manager

3. USACE Task Order Manager

    _____

    Name: Carl Niemitz Date
    Title: CENAE Task Order Manager

4. Federal Regulatory Agency (name/title/signature/date)

    _____

    Name: Ed Hathaway Date
    Title: EPA Task Order Manager

5. State Regulatory Agency (name/title/signature/date):

    _____

    Name: Jing Chen Date
    Title: CT DEEP Project Manager

6. Other Stakeholders (as needed):

List plans and reports from previous investigations relevant to this project:

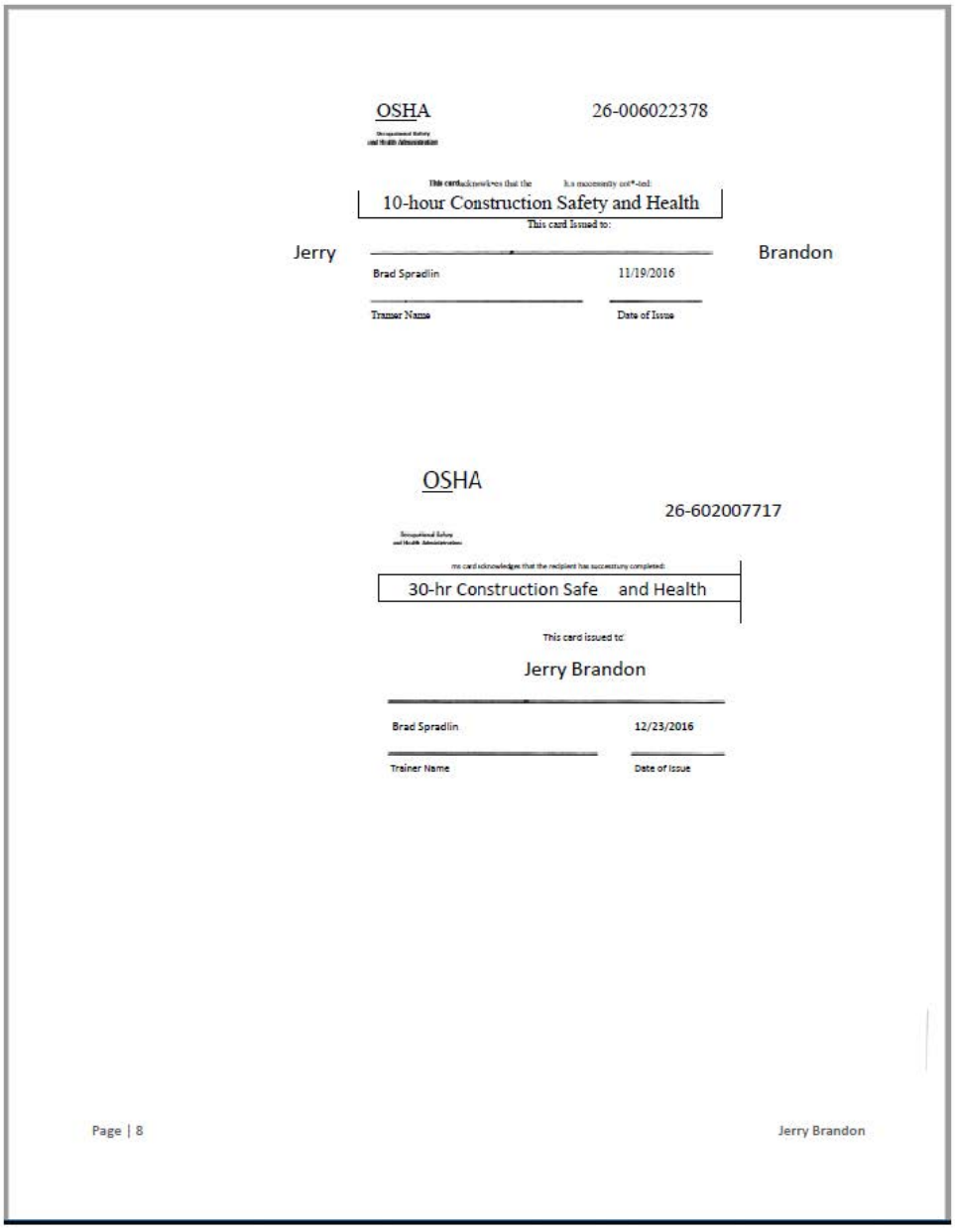
The Contract Documents, including:
Specifications – Volume 1 Durham Waterline
Specifications – Volume 2 Durham Waterline
Plans – Durham Meadows Waterline
Durham Basis of Design Report, April 25, 2018

Key Personnel Resume					
(a)	Name and Title:	Jerry Brandon, QCM			
(b)	Assignment:	Quality Control Manager			
(c)	Firm:				
(d)	Years With Firm:		With other Firms:	30	
(e)	Education:	1970–1972 ARKANSAS A&M College MONTICELLO, AR • Construction Management Certification • High School Diploma • Quality Control School for Contractors (USACE Certification) Mod- 12/13/2016 • U S Army Wireman School (Certification) 1965 • U S Army Airborne School (Certification) 1966			
(f)	Active Registration:	• CPR & First Aid Certificate Mod- 11/5/2016 • OSHA 10 Certificate Re Certified 11/19/2016 • OSHA 30 Certificate RE Certified 12/23/2016 • USAFB Certification on Safety, Contractor Safety, DOD Assurance • Safe Driving Certification.			
(g)	Specific Experience and Qualifications Relevant to this Project:				
	Relevant Project Experience: QCM: Jan 2005 – Present				
	Project Title: DAP Construction Management – Phoenix, AZ **Time on Project:** 1 Year **Position Description:** QCM/SUP - Served as QCM/SUP on USAFB project. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. This Contract included working hand in hand with Entergy, the electrical supplier for electric on the Little Rock Air Force Base, located in Jacksonville, Arkansas. Entergy is changing the Electrical feeds from overhead power poles to underground service installing new transformers for the underground service to the base. DAP Const Management is responsible for the secondary off the transformers to inside the buildings. The Project was completed in a timely manner on under budget. The Pre-Final and Final Inspection found no deficiencies and the BOD was issued.			Similar Scope Similar Hazards Government

	Project Title: Comanche National Construction – Oklahoma City, OK **Time on Project:** 1 Year **Position Description:** QCM/SSHO - Served as QCM/SSHO on this project. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. Project included repair and addition to the existing Ranger building for the USACE out of the Little Rock District in Conway, Arkansas.	Similar Scope Similar Hazards Government
	Project Title: MW Services – Temecula, CA **Time on Project:** 3 Years **Position Description:** QCM/SUP - Served as QCM/SUP on these projects. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. Projects were for USAFB Saber. Projects included renovations as well as new construction for base facilities and infrastructure.	Similar Scope Similar Hazards Government
	Project Title: 19th Civil Engineering Squadron - LRAFB **Time on Project:** 3 Years **Position Description:** QCM - Served as QCM on Little Rock Air Force Base project. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. Represented the Civil Engineer Commander in support of base development for construction programs, validated site issues and meet with key customers and coordinating officials to resolve problems to succeed in customer satisfaction and provided customer guidance and training on all systems and equipment installed on the many Government Projects. Projects included civil works for base facilities as well as interior and exterior upgrades to existing support structures	Similar Scope Similar Hazards Government

	Project Title: B&D Construction/Consultants – Odin, IN **Time on Project:** 1 Year **Position Description:** QCM/SSHO - Served as QCM/SSHO on this project. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. Project included abatement of existing asbestos tile and piping insulation along with removal and replacement of existing walls for new pipe and wall layouts on Grissom AFB.	Similar Scope Military
	Project Title: EMR-INC – St. Louis, MO **Time on Project:** 1 Year **Position Description:** QCM - Served as QCM on base project. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. Tasks included removal and replacement of the existing water lines throughout the base. Hydro excavation and underground boring. Project also included the removal and replacement of new fire hydrants as well as replacing the fire lines into the buildings.	Similar Scope Military
	Project Title: Pangea Group – St. Louis, MO **Time on Project:** 1 Year **Position Description:** QCM - Served as QCM on hanger project. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. USAFB HANGER 224 Project, located at the Little Rock Air Force Base in Jacksonville, AR. Project included the demolition of the mezzanine area and the offices between Hanger 224 North and Hanger 224 South. Also included upgrades to emergency lighting, HVAC equipment as well as interior/exterior finishes and roofing for office areas.	Similar Scope Military

	Project Title: Tillage Construction, LLC – Baton Rouge, LA **Time on Project:** 1 Year **Position Description:** QCM - Served as QCM on HVAC project. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. Project included installation a new HVAC System (Chiller and Cooling Tower) while removing the old HCAV System (Chiller and old Cooling tower). Also responsible for the installation of all the new pumps and piping. The work included the installation of 13 new Switch Gears along with 13 new Transfer Switches. Underground Electric was installed approximately 1000' underground to the new equipment.	Similar Scope Utilities
	Project Title: SLG Contractors, INC – Grand Prairie, TX **Time on Project:** 2 Years **Position Description:** QCM - Served as QCM on JOC projects. Responsibilities included, but were not limited to: Reviewing all submittals, plans and specifications and ensuring that all worked performed met specification requirements. Processing of RFI's. Composing and final review of the Quality Control, Environmental Protection, Accident Prevention, Solid Waste Management, Construction Site, and Demolition Plans. Approving monthly subcontractor billing percentages and processing company billing to USACE. Updating the project schedule and project manager reports monthly. Conducting weekly QC meeting with subcontractors and government. Performing multiple daily site inspections and documenting findings in daily contractor quality control report. Project included three different locations including Pine Bluff Arsenal and LRAFB. Scope included installation of explosive proof film on base structures as well as upgrades to welcome mat on the flight line of LRAFB.	Similar Scope Military JOC Saber Contractor



OSHA

26-006022378

This card acknowledges that the recipient has successfully completed:

10-hour Construction Safety and Health

This card Issued to:

Jerry Brandon

Brad Spradlin — Trainer Name

11/19/2016 — Date of Issue

OSHA

26-602007717

This card acknowledges that the recipient has successfully completed:

30-hr Construction Safe and Health

This card issued to:

Jerry Brandon

Brad Spradlin — Trainer Name

12/23/2016 — Date of Issue

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Jerry Brandon

U.S. ARMY CORPS OF ENGINEERS

USACE LEARNING CENTER
HUNTSVILLE, ALABAMA

NAVFAC

CERTIFICATE

JERRY BRANDON

SWT-33-17-0043

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

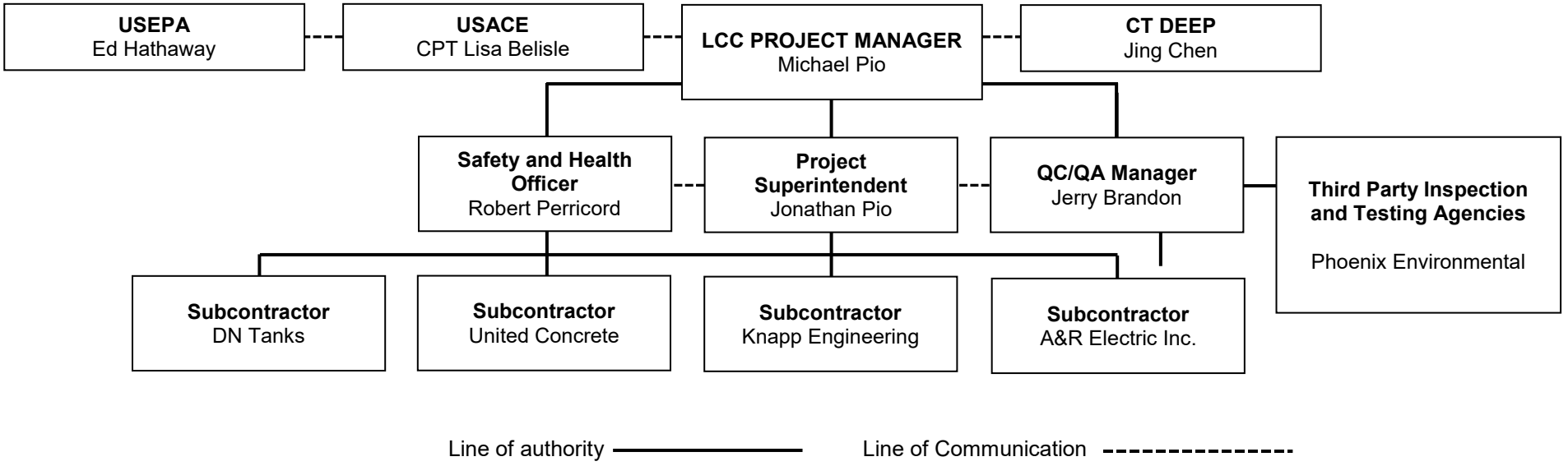
Tulsa, Ok	Dec 13-14, 2016	Tulsa District	Barry L. Pyles
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager

Barry L. Pyles	barry.pyles@usace.army.mil	918-669-7039	Barry L. Pyles
Facilitator/Instructor	Email	Telephone	Facilitator/Instructor Signature

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE
CQM-C Recertification online course: https://www.myuln.net

Jeffrey D. Dziedzic
Chief, USACE Learning Center
Jeffrey D. Dziedzic

QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution
(UFP-QAPP Manual Section 2.3 and 2.4)
(EPA 2106-G-05 Section 2.2.3 and 2.2.4)



QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet
(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)

ORGANIZATION: Ludlow Construction Company

Name [1]	Project Title/Role	Telephone Number	Email Address	Specialized Training/Certifications[1]	Signature/Date
Michael Pio	Project Manager	(413) 583-2522	mpio@ludlowconstuction.com	no special training requirements or certifications are required, please include a statement to that effect.	
Jonathan Pio	Project Superintendent	(413) 313-2428	jonpio@ludlowconstruction.com	no special training requirements or certifications are required, please include a statement to that effect.	
Jerry Brandon	Quality Assurance/Quality Control Manager				

ORGANIZATION: Phoenix Environmental

Name	Project Title/Role	Telephone Number	Email Address	Specialized Training/Certifications	Signature/Date
Gregory Lawrence		860-645-1102		no special training requirements or certifications are required, please include a statement to that effect.	

[1] See description of Specialized Training below.

ORGANIZATION: DN Tanks

Name	Project Title/Role	Telephone Number	Email Address	Specialized Training/Certifications	Signature/Date
Edwin Mejia	Project Manager	781-224-5132	Edwin.mejia@dntanks.com	no special training requirements or certifications are required, please include a statement to that effect.	

ORGANIZATION: United Concrete

Name	Project Title/Role	Telephone Number	Email Address	Specialized Training/Certifications	Signature/Date
Stephen Consiglio	Project Manager	203-269-3119	sconsiglio@unitedconcrete.com	no special training requirements or certifications are required, please include a statement to that effect.	

ORGANIZATION: Knapp Engineering

Name	Project Title/Role	Telephone Number	Email Address	Specialized Training/Certifications	Signature/Date
Gregg Knapp	Project Manager	203-758-3503		no special training requirements or certifications are required, please include a statement to that effect.	

ORGANIZATION: A&R Electric

Name	Project Title/Role	Telephone Number	Email Address	Specialized Training/Certifications	Signature/Date
Americo Gloria	Project Manager	203-368-3912		no special training requirements or certifications are required, please include a statement to that effect.	

Special Training Requirements/Certification

No special training requirements or certifications required at this time. If special training or certifications become required, the QAPP will be amended.

QAPP Worksheet #6: Communication Pathways
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Regulatory agency interface	USACE Project Manager (PM) LCC PM	Steve Dunbar Michael Pio	 413-583-2522	The USACE PM will receive updates, including monthly progress reports, from the LCC PM.
Field progress reports	LCC Project Superintendent (PS)	Johnathan Pio	413-3132-428	Daily updates from LCC PS and sampling personnel will communicate relevant information to the LCC PM.
Stop work due to safety issues	USACE Project Engineer LCC PM LCC PS LCC Safety and Health Officer (SHO) All Field Staff	CPT Lisa Belisle Michael Pio Johnathan Pio Forest Brown	 413-583-2522 413-3132-428	LCC PS, PM or HSO, or USACE PM may stop work in response to any situation that adversely affects health and safety of the staff. The issue and proposed corrective action will be documented with planned timing for implementation. The stop work order will be submitted to the USACE PM by e-mail or phone call within 24 hours. The LCC PM will notify the LCC PS via phone call or e-mail when the stop work order is lifted.
QAPP changes prior to field work	USACE Project Engineer LCC PM	CPT Lisa Belisle Michael Pio	 413-583-2522	USACE PM will communicate changes required to the QAPP with the LCC PM by e-mail or phone. Changes will be formally documented and incorporated into the QAPP as addenda.
QAPP changes during project execution	USACE Project Engineer LCC PM LCC PS	CPT Lisa Belisle Michael Pio Johnathan Pio	 413-583-2522 413-3132-428	The LCC PS will report any required changes to the QAPP to the LCC PM. The LCC PM will inform the USACE PM by phone or e-mail. The USACE PM will approve all changes; the LCC PM will then notify the LCC PS. Changes will be formally documented and incorporated into the QAPP as addenda.
Field corrective actions	LCC PM LCC PS	Michael Pio Johnathan Pio	413-583-2522 413-3132-428	Daily updates from LCC PS and sampling personnel will communicate relevant information to the LCC PM.
Sample receipt variances	LCC PM Laboratory	Michael Pio Phoenix Environmental	413-583-2522 (860) 645-1102	E-mail notification of sample receipt, sample condition and chain-of-custody review will be sent from the Lab Representative to the LCC PM.

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Laboratory quality control variances	LCC PM Laboratory	Michael Pio Kathleen Cressia	413-583-2522 (860) 645-1102	All quality assurance/quality control (QC) issues will be reported by the Laboratory PM to the LCC PM as part of the Case narrative. If significant problems are identified by the laboratory or the project team that impact the immediate usability of the data (i.e., the data are rejected or the data quality objectives [DQOs] are not met), the LCC PM will notify the USACE PM within 24 hours or the next business day.
Data verification issues, e.g., incomplete records	LCC PM LCC PS Laboratory	Michael Pio Johnathan Pio Phoenix Environmental	413-583-2522 413-3132-428 860-645-1102	If significant problems are identified by the laboratory or the project team that impact the usability of the data (i.e., incorrect sample identification or insufficient field QC), the LCC PM will notify the LCC PS and the USACE PM within 24 hours or the next business day.

QAPP Worksheet #9: Project Planning Session Summary
(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(EPA 2106-G-05 Section 2.2.5)

The work will simply be conducted in accordance with the specifications as written and no further discussion occurred. If further discussions become required a panning session summary will be added to the QAPP utilizing the chart below.

Date of first planning session:

Location:

Purpose:

Action Items:

Participants:

Name	Organization	Title/Role	Email/Phone

QAPP Worksheet #10: Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)

The Durham Meadows Superfund Site is located in the town of Durham, Connecticut, and includes an area of groundwater contamination generally centered on Main Street. The Site includes historic Main Street in Durham center, and contains industrial and residential properties. It is generally bounded by Talcott Lane to the north; Brick Lane, Ball Brook and Allyn Brook to the East; wetlands west of Maple Avenue to the west; and, based on recent sampling, the intersections of Maple Avenue and Fowler Avenue with Main Street to the south.

The Site is centered around the Durham Manufacturing Company (DMC), a currently operating manufacturing facility located at 201 Main Street (the "DMC Study Area"), and the former location of Merriam Manufacturing Company, Inc. (MMC) at 281 Main Street. The Merriam Manufacturing Company Study Area, or "MMC Study Area," includes the property on which the MMC plant was formerly located at 281 Main Street, and the abutting residential property at 275 Main Street.

Both companies manufactured metal cabinets, boxes, and other items. The companies' past disposal of wastewater in lagoons or sludge drying beds, spills at both facilities, and inadequate drum storage practices at MMC, among other things, contributed to the contamination at each facility and in the overall area of groundwater surrounding both facilities (the "Site-wide Groundwater Study Area"). Contamination from volatile organic compounds (VOCs) has been detected in soil and groundwater on both industrial properties, as well as in residential drinking water wells surrounding the MMC and DMC facilities. As of September 2017, there were 54 locations where GAC filtration units and/or bottled water are necessary due to groundwater contamination. Regular monitoring occurs at 28 additional locations, where filtration and/or bottled water are not yet needed.

The Record of Decision for the Site was issued on September 30, 2005. For the Site-wide Groundwater Study Area, the remedy includes a connection to the city of Middletown's Water Distribution System to distribute an alternative source of public water to all residences currently affected by groundwater contamination and a buffer zone of residences located near the contaminated area. The city of Middletown is located north of the town of Durham. These alternatives address current and future risk to human health from ingestion of contaminated groundwater.

Under this alternative, the existing Middletown Water Distribution System will be extended from the city of Middletown south along Route 17 to residences within the Study Area providing potable water to all impacted residents and eliminate current and future risk to human health from ingestion of groundwater. This alternative will provide a permanent source of drinking water to all residences currently affected by groundwater contamination and a buffer zone of residences located near the contaminated area. This alternative, combined with institutional controls on existing groundwater use, will prevent exposure to contaminated groundwater.

The design of the alternative water supply was developed by AECOM under contract to the USEPA. The design was put out to bid in June of 2018 by the USACE, and the construction contract was awarded to LCC in December 2018 under Contract 19C0002 Durham Meadow Construct Waterline.

QAPP Worksheet #9: Project Planning Session Summary

Work of this Contract shall include, but not limited to, the following major items:

- Construction of a new 0.8 million gallon pre-stressed concrete water storage tank, access roadway, site improvements, and appurtenances off Talcott Ridge Drive in the City of Middletown.
- TTHM Treatment at the Cherry Hill Tank.
- Modifications at the Long Hill Pump Station in the City of Middletown, including SCADA and control improvements, chlorine booster, and VFD controls.
- Talcott Ridge Booster Station
- Pressure reducing valve and meter vaults
- Installation of approximately 31,200 linear feet water main (20-inch to 6-inch diameter) and appurtenances in Town of Durham and CTDOT roadways, including but not limited to:
  (1) South Main Street (Route 17) in Middletown from Talcott Ridge Drive to the town line with Durham,
  (2) Main Street (Route 17) in Durham from the town line to Mill Pond Lane,
  (3) Talcott Lane in Durham,
  (4) Maple Avenue in Durham from Talcott Lane south to the Allyn Brook crossing and from the south point of the crossing near John's Way to connect to the existing water main,
  (5) Wallingford Road from Main Street west past Maple Avenue to near No. 47 Wallingford Road,
  (6) Maiden Lane from Main Street to the intersection with Pickett Lane,
  (7) Pickett Lane; and
  (8) Main Street service extensions (limited lengths) at; Royal Oak Drive, Littleton Lane, Parson Lane, Winsome Road, Middlefield Road, Haddam Quarter Road, Maiden Lane and Pickett Lane.
- Installation of approximately 500 linear feet of 12-inch water main and appurtenances on Town of Durham property west of Maple Avenue and crossing Allyn Brook.
- Installation of approximately 206 water service connections (from corporation to curb stops) of which approximately 115 will be installed into the building structure to establish a new water supply. Components of approximately 114 existing private water supply systems to be abandoned include existing wells and appurtenances, including pressure tanks and water treatment devices to be removed, as specified, including property restoration. Six supply wells shall be converted to monitoring wells.
- Construction of a booster pump station on South Main Street, including site improvements and appurtenances, in Middletown on the northern portion of the CT DOT property across from the intersection of Talcott Ridge Road.
- Construction of a water meter station, including site improvements and appurtenances, in the City of Middletown on City-owned property.

QAPP Worksheet #11: Project/Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

This sampling program is designed to produce field and analytical data to be used to meet the requirements of the State of Connecticut, the City of Middletown, and the Town of Durham during water main and tank testing.

LCC has contracted Phoenix Environmental Laboratories. Inc. 587 Eat Middle Turnpike, PO BOX 370 Manchester, CT 06040 to provide analytical services for water quality testing of the water line and tank. Consistent with the May 16, 2019, EPA clarifications concerning comments to the initial LCC QAPP dated March 21, 2019; the laboratory is currently certified to test drinking water for the analyses required by the Environmental Laboratory Certification Program of the Connecticut Department of Public Health. A copy of the current certification is provided in Appendix A.

QAPP Worksheet #12: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Refer to Appendix C for Phoenix Environmental Laboratories SOPs for water testing. Please see appendix D for LCC's SOP for D-1 waterline disinfection and D-3 Water Tank Disinfection.

Matrix: Water
Analytical Group or Method: Total Coliform Bacteria
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	Field Sample	0 or absent

Refer to Appendix C: Lab SOPs

QAPP Worksheet #12: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix: Water
Analytical Group or Method: Heterotrophic Plate Count (HPC)
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	Field Sample	< 100 organisms/mL

Refer to Appendix C: Lab SOPs

QAPP Worksheet #13: Secondary Data Uses and Limitations

Matrix: Water
Analytical Group or Method: Total Chlorine Residual
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	DPD drop dilution method kit per AWWA C651, Appendix A.1.	<= 4 mg/L

Refer to Appendix C: Lab SOPs

QAPP Worksheet #13: Secondary Data Uses and Limitations

Matrix: Water
Analytical Group or Method: Free Chlorine Residual
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	DPD drop dilution method kit per AWWA C651, Appendix A.1.	<= 4 mg/L

Refer to Appendix C: Lab SOPs

QAPP Worksheet #13: Secondary Data Uses and Limitations

Matrix: Water
Analytical Group or Method: Color
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	Field Sample Visual Test & PH test	< 15 CU

Refer to Appendix C: Lab SOPs

QAPP Worksheet #13: Secondary Data Uses and Limitations

Matrix: Water
Analytical Group or Method: Turbidity
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	Field Sample, turbidimeter	< 5 NTU

Refer to Appendix C: Lab SOPs

QAPP Worksheet #13: Secondary Data Uses and Limitations

Matrix: Water
Analytical Group or Method: Odor
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	Field sample, ((sample Volume + pure water volume to remove odor)/ sample volume=ton)	< 3

Source: United States Environmental Protection Agency National Secondary Drinking Water Regulations (NSDWR's)

Refer to Appendix C: Lab SOPs

QAPP Worksheet #13: Secondary Data Uses and Limitations

Matrix: Water
Analytical Group or Method: pH
Concentration Level: NA

Data Quality Indicator (DQI)	QC sample or measurement performance activity	Measurement Performance Criteria
	Field Sample;	range 6.5 – 8.5

Source: United States Environmental Protection Agency National Secondary Drinking Water Regulations (NSDWR's)

Refer to Appendix C: Lab SOPs

QAPP Worksheet #13: Secondary Data Uses and Limitations
(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements For Evaluating Existing Data)

Note there is no secondary data that applies to the water tank and water line testing

Data type	Source	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use

QAPP Worksheet #14&16: Project Tasks & Schedule
(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

Scheduling of testing analysis is unknown at this time. It is dependent on the pipe being installed.

Results will be submitted to USACE prior to work progressing on those sections

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date

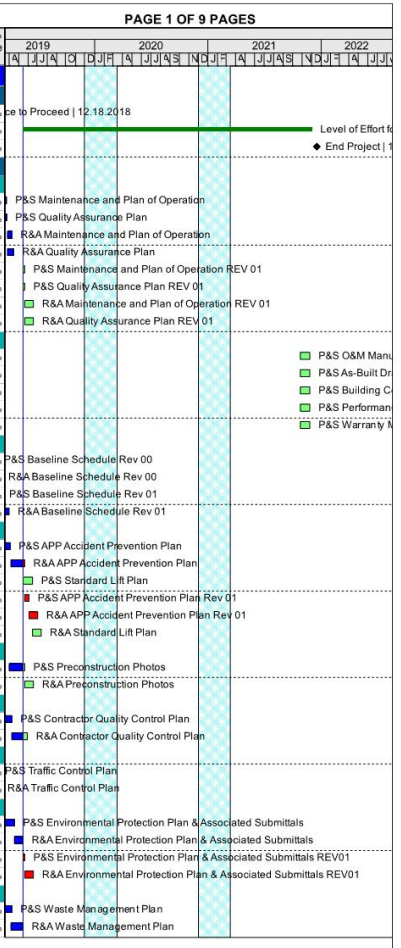
Schedule Abbreviation Key	
P&S	Procure and Submit
R&A	Review and Approve
Sta	Station Points along a survey. (Measured in 100' Increments)
WL	Water Line
HMA	Hot Mix Applied

QAPP Worksheet #14&16: Project Tasks & Schedule

QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 1 OF 9 PAGES**

Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
DD4.19.18 Durham Meadows Waterline - UP02 Recovery										
Milestones										
A1000	Notice to Proceed | 12.18.2018	0		18-Dec-18 A		16-May-19		Cure, Milestone, & Submittal - 7D/Wk	0	100%
A7650	Level of Effort for Cost Loading	576	0	15-Feb-19 A	30-Nov-21	01-Apr-19	30-Nov-21	Out of Roadway Work - Days	434	0%
A1020	End Project | 12.17.2021	0	0		17-Dec-21*		17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	0	0%
Submittals & Procurement										
01 11 00 - Preconstruction Submittals										
A7740	P&S Maintenance and Plan of Operation	30		20-Feb-19 A	25-Mar-19 A	31-May-19	31-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A7760	P&S Quality Assurance Plan	30		04-Mar-19 A	25-Mar-19 A	31-May-19	31-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A7750	R&A Maintenance and Plan of Operation	30		26-Mar-19 A	08-Apr-19 A	31-May-19	31-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A7770	R&A Quality Assurance Plan	30		26-Mar-19 A	15-Apr-19 A	31-May-19	31-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A7850	P&S Maintenance and Plan of Operation REV 01	5	15	16-May-19	20-May-19	31-May-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	5	0%
A7870	P&S Quality Assurance Plan REV 01	5	15	16-May-19	20-May-19	31-May-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	5	0%
A7860	R&A Maintenance and Plan of Operation REV 01	30	15	21-May-19	19-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A7880	R&A Quality Assurance Plan REV 01	30	15	21-May-19	19-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
01 11 00 - Closeout Submittals										
A7780	P&S O&M Manuals	30	22	26-Oct-21	25-Nov-21	18-Nov-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A7790	P&S As-Built Drawings	30	22	26-Oct-21	25-Nov-21	18-Nov-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A7800	P&S Building Commissioning Plan	30	22	26-Oct-21	25-Nov-21	18-Nov-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A7810	P&S Performance Verification Testing	30	22	26-Oct-21	25-Nov-21	18-Nov-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A7820	P&S Warranty Management Plan	30	22	26-Oct-21	25-Nov-21	18-Nov-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
01 32 01 - Project Schedule										
A3310	P&S Baseline Schedule Rev 00	30		01-Jan-19 A	15-Feb-19 A	26-Oct-21	26-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3320	R&A Baseline Schedule Rev 00	30		15-Feb-19 A	01-Mar-19 A	26-Oct-21	26-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3330	P&S Baseline Schedule Rev 01	15		01-Mar-19 A	05-Mar-19 A	26-Oct-21	26-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3340	R&A Baseline Schedule Rev 01	30		05-Mar-19 A	01-Apr-19 A	26-Oct-21	26-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	0	100%
01 35 26 - Governmental Safety Requirements										
A3350	P&S APP Accident Prevention Plan	30		12-Feb-19 A	05-Apr-19 A	17-May-19	17-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3360	R&A APP Accident Prevention Plan	30	1	06-Apr-19 A	20-May-19	17-May-19	21-May-19	Cure, Milestone, & Submittal - 7D/Wk	5	50%
A3370	P&S Standard Lift Plan	30	99	16-May-19	14-Jun-19	23-Aug-19	21-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A7830	P&S APP Accident Prevention Plan Rev 01	14	1	21-May-19	03-Jun-19	22-May-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	14	0%
A7840	R&A APP Accident Prevention Plan Rev 01	30	1	04-Jun-19	03-Jul-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3380	R&A Standard Lift Plan	30	99	15-Jun-19	14-Jul-19	22-Sep-19	21-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
01 39 00 - Pre- and Post- Construction Surveys										
A3390	P&S Preconstruction Photos	30	15	01-Apr-19 A	20-May-19	31-May-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	5	75%
A3400	R&A Preconstruction Photos	30	15	21-May-19	19-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
01 45 00 - Quality Control										
A3410	P&S Contractor Quality Control Plan	30		12-Feb-19 A	10-Apr-19 A	20-Jun-19	20-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3420	R&A Contractor Quality Control Plan	30	35	11-Apr-19 A	30-May-19	20-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	15	50%
01 50 00 - Temporary Construction Facilities and Controls										
A3430	P&S Traffic Control Plan	30		04-Feb-19 A	19-Feb-19 A	05-Jul-19	05-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3440	R&A Traffic Control Plan	30		20-Feb-19 A	26-Feb-19 A	05-Jul-19	05-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
01 57 20 - Environmental Protection										
A3450	P&S Environmental Protection Plan & Associated Submittals	30		20-Feb-19 A	18-Apr-19 A	16-May-19	16-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3460	R&A Environmental Protection Plan & Associated Submittals	30		19-Apr-19 A	16-May-19 A	16-May-19	16-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A8010	P&S Environmental Protection Plan & Associated Submittals REV01	5	0	16-May-19	20-May-19	16-May-19	20-May-19	Cure, Milestone, & Submittal - 7D/Wk	5	0%
A8020	R&A Environmental Protection Plan & Associated Submittals REV01	30	0	21-May-19	19-Jun-19	21-May-19	19-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
01 74 19 - Construction and Demolition Waste Management										
A3470	P&S Waste Management Plan	30		12-Feb-19 A	08-Apr-19 A	30-Aug-19	30-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3480	R&A Waste Management Plan	30		08-Apr-19 A	16-May-19 A	30-Aug-19	30-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%



Data Date 16-May-19
Run Date 17-May-19 09:19

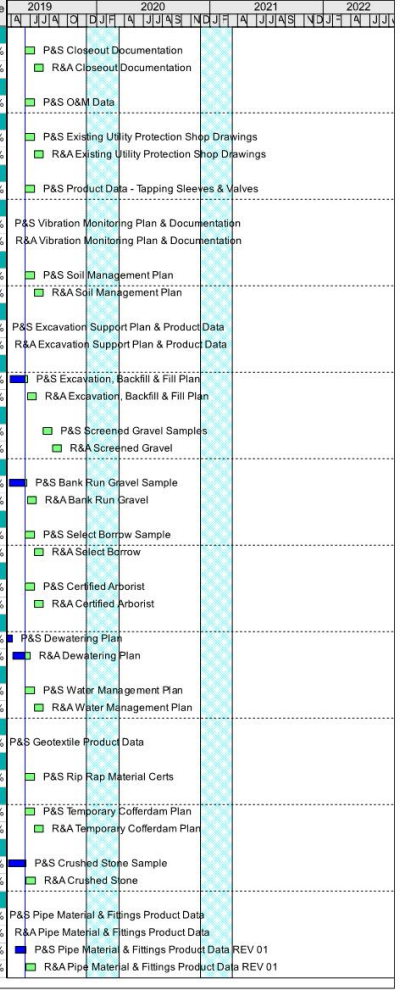
Ludlow Construction Co.
19 Carmelina's Circle | Ludlow, MA 01056
DD4.19.18 Durham Meadows Waterline - UP02 Recovery

Actual Work | Milestone
Remaining Work | Remaining Level of Eff...
Critical Remaining Work

QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 2 OF 9 PAGES**

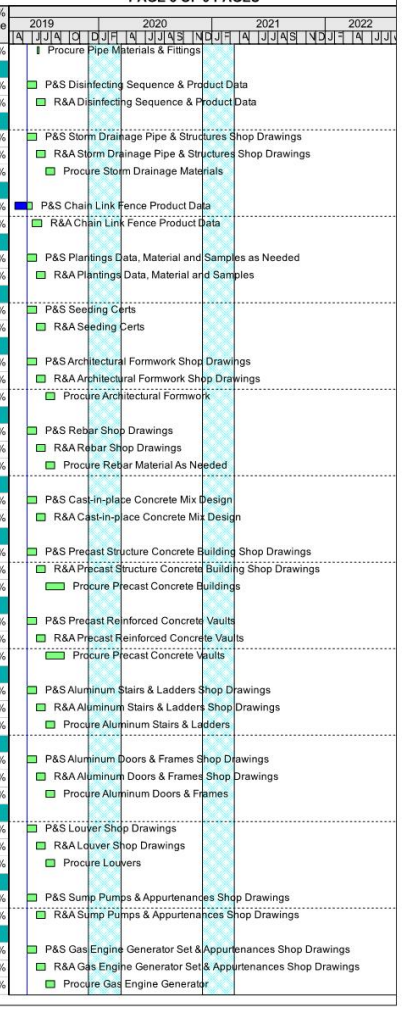
Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
01 78 00 - Closeout Submittals										
A3490	P&S Closeout Documentation	30	887	16-May-19	14-Jun-19	19-Oct-21	17-Nov-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3500	R&A Closeout Documentation	30	887	15-Jun-19	14-Jul-19	18-Nov-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
01 78 23 - Operation and Maintenance Data										
A3510	P&S O&M Data	30	917	16-May-19	14-Jun-19	18-Nov-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02012 - Protecting Existing Underground Utilities										
A3520	P&S Existing Utility Protection Shop Drawings	30	28	16-May-19	14-Jun-19	13-Jun-19	12-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3530	R&A Existing Utility Protection Shop Drawings	30	28	15-Jun-19	14-Jul-19	13-Jul-19	11-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02013 - Connection to Existing Buried Pipelines										
A3540	P&S Product Data - Tapping Sleeves & Valves	30	20	16-May-19	14-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02018 - Vibration Monitoring										
A3550	P&S Vibration Monitoring Plan & Documentation	30		04-Mar-19 A	14-Mar-19 A	27-Jun-19	27-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3560	R&A Vibration Monitoring Plan & Documentation	30		15-Mar-19 A	18-Mar-19 A	27-Jun-19	27-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
02053 - Excavated Material Management Plan										
A3570	P&S Soil Management Plan	30	813	16-May-19	14-Jun-19	06-Aug-21	04-Sep-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3580	R&A Soil Management Plan	30	813	15-Jun-19	14-Jul-19	05-Sep-21	04-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02160 - Excavation Support System										
A3590	P&S Excavation Support Plan & Product Data	30		25-Feb-19 A	08-Mar-19 A	05-Jul-19	05-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3600	R&A Excavation Support Plan & Product Data	30		09-Mar-19 A	14-Mar-19 A	05-Jul-19	05-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
02210 - Earth Excavation, Backfill, Fill and Grading										
A3610	P&S Excavation, Backfill & Fill Plan	30	12	29-Mar-19 A	23-May-19	28-May-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	8	0%
A3620	R&A Excavation, Backfill & Fill Plan	30	12	24-May-19	22-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02223 - Screened Gravel										
A3630	P&S Screened Gravel Samples	30	204	13-Jul-19	11-Aug-19	02-Feb-20	02-Mar-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3640	R&A Screened Gravel	30	204	12-Aug-19	10-Sep-19	03-Mar-20	01-Apr-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02224 - Bank Run or Crushed Gravel										
A3650	P&S Bank Run Gravel Sample	30	13	28-Mar-19 A	22-May-19	29-May-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	7	0%
A3660	R&A Bank Run Gravel	30	13	23-May-19	21-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02225 - Select Borrow										
A3670	P&S Select Borrow Sample	30	46	16-May-19	14-Jun-19	01-Jul-19	30-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3680	R&A Select Borrow	30	46	15-Jun-19	14-Jul-19	31-Jul-19	29-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02230 - Site Clearing										
A3690	P&S Certified Arborist	30	31	16-May-19	14-Jun-19	16-Jun-19	15-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3700	R&A Certified Arborist	30	31	15-Jun-19	14-Jul-19	16-Jul-19	14-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02240 - Dewatering										
A3710	P&S Dewatering Plan	30		18-Mar-19 A	05-Apr-19 A	19-Jun-19	19-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3720	R&A Dewatering Plan	30	34	06-Apr-19 A	31-May-19	19-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	16	50%
02241 - Construction Water Management										
A3730	P&S Water Management Plan	30	338	16-May-19	14-Jun-19	18-Apr-20	17-May-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3740	R&A Water Management Plan	30	338	15-Jun-19	14-Jul-19	18-May-20	16-Jun-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02273 - Geotextile Fabric										
A3750	P&S Geotextile Product Data	30		25-Feb-19 A	28-Feb-19 A	24-Sep-19	24-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
02371 - Riprap										
A3760	P&S Rip Rap Material Certs	30	109	16-May-19	14-Jun-19	02-Sep-19	01-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02400 - Temporary Cofferdam										
A3770	P&S Temporary Cofferdam Plan	30	94	16-May-19	14-Jun-19	18-Aug-19	16-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3780	R&A Temporary Cofferdam Plan	30	94	15-Jun-19	14-Jul-19	17-Sep-19	16-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02435 - Crushed Stone										
A3790	P&S Crushed Stone Sample	30	16	25-Mar-19 A	19-May-19	01-Jun-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	4	0%
A3800	R&A Crushed Stone	30	16	20-May-19	18-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02510 - Water Utilities										
A3810	P&S Pipe Material & Fittings Product Data	30		04-Feb-19 A	26-Feb-19 A	27-May-19	27-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A3820	R&A Pipe Material & Fittings Product Data	30		27-Feb-19 A	14-Mar-19 A	27-May-19	27-May-19	Cure, Milestone, & Submittal - 7D/Wk	0	100%
A7890	P&S Pipe Material & Fittings Product Data REV 01	5	11	15-Apr-19 A	19-May-19	27-May-19	30-May-19	Cure, Milestone, & Submittal - 7D/Wk	4	0%
A7900	R&A Pipe Material & Fittings Product Data REV 01	30	11	20-May-19	18-Jun-19	31-May-19	29-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%



QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 3 OF 9 PAGES**

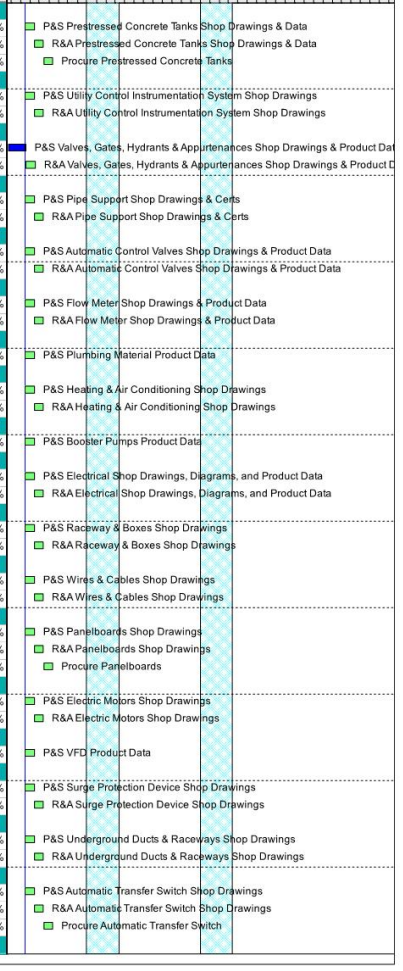
Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
A4520	Procure Pipe Materials & Fittings	5	11	19-Jun-19	23-Jun-19	30-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	5	0%
02515 - Disinfecting Water Utility Distribution Systems										
A3830	P&S Disinfecting Sequence & Product Data	30	752	16-May-19	14-Jun-19	06-Jun-21	05-Jul-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3840	R&A Disinfecting Sequence & Product Data	30	752	15-Jun-19	14-Jul-19	06-Jul-21	04-Aug-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02630 - Storm Drainage Utilities										
A3850	P&S Storm Drainage Pipe & Structures Shop Drawings	30	41	16-May-19	14-Jun-19	26-Jun-19	25-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3860	R&A Storm Drainage Pipe & Structures Shop Drawings	30	41	15-Jun-19	14-Jul-19	26-Jul-19	24-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4530	Procure Storm Drainage Materials	30	41	15-Jul-19	13-Aug-19	25-Aug-19	23-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02820 - Chain Link Fences & Gates										
A3870	P&S Chain Link Fence Product Data	30	281	08-Apr-19 A	02-Jun-19	21-Feb-20	09-Mar-20	Cure, Milestone, & Submittal - 7D/Wk	18	50%
A3880	R&A Chain Link Fence Product Data	30	281	03-Jun-19	02-Jul-19	10-Mar-20	08-Apr-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02900 - Planting										
A3890	P&S Plantings Data, Material and Samples as Needed	30	826	16-May-19	14-Jun-19	19-Aug-21	17-Sep-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3900	R&A Plantings Data, Material and Samples	30	826	15-Jun-19	14-Jul-19	18-Sep-21	17-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
02922 - Hydroseeding										
A3910	P&S Seeding Certs	30	813	16-May-19	14-Jun-19	06-Aug-21	04-Sep-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3920	R&A Seeding Certs	30	813	15-Jun-19	14-Jul-19	05-Sep-21	04-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	30	0%
03100 - Concrete Formwork										
A3930	P&S Architectural Formwork Shop Drawings	30	251	16-May-19	14-Jun-19	22-Jan-20	20-Feb-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3940	R&A Architectural Formwork Shop Drawings	30	251	15-Jun-19	14-Jul-19	21-Feb-20	21-Mar-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4540	Procure Architectural Formwork	30	251	15-Jul-19	13-Aug-19	22-Mar-20	20-Apr-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
03200 - Concrete Reinforcement										
A3950	P&S Rebar Shop Drawings	30	251	16-May-19	14-Jun-19	22-Jan-20	20-Feb-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3960	R&A Rebar Shop Drawings	30	251	15-Jun-19	14-Jul-19	21-Feb-20	21-Mar-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4550	Procure Rebar Material As Needed	30	251	15-Jul-19	13-Aug-19	22-Mar-20	20-Apr-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
03300 - Cast-In-Place Concrete										
A3970	P&S Cast-in-place Concrete Mix Design	30	281	16-May-19	14-Jun-19	21-Feb-20	21-Mar-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A3980	R&A Cast-in-place Concrete Mix Design	30	281	15-Jun-19	14-Jul-19	22-Mar-20	20-Apr-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
03410 - Precast Structural Concrete Building										
A3990	P&S Precast Structure Concrete Building Shop Drawings	30	34	16-May-19	14-Jun-19	19-Jun-19	18-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4000	R&A Precast Structure Concrete Building Shop Drawings	30	34	15-Jun-19	14-Jul-19	19-Jul-19	17-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4560	Procure Precast Concrete Buildings	60	34	15-Jul-19	12-Sep-19	18-Aug-19	16-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	60	0%
03420 - Precast Reinforced Concrete Vaults										
A4010	P&S Precast Reinforced Concrete Vaults	30	34	16-May-19	14-Jun-19	19-Jun-19	18-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4020	R&A Precast Reinforced Concrete Vaults	30	34	15-Jun-19	14-Jul-19	19-Jul-19	17-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4570	Procure Precast Concrete Vaults	60	34	15-Jul-19	12-Sep-19	18-Aug-19	16-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	60	0%
05515 - Aluminum Stairs and Ladders										
A4030	P&S Aluminum Stairs & Ladders Shop Drawings	30	69	16-May-19	14-Jun-19	24-Jul-19	22-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4040	R&A Aluminum Stairs & Ladders Shop Drawings	30	69	15-Jun-19	14-Jul-19	23-Aug-19	21-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4580	Procure Aluminum Stairs & Ladders	30	69	15-Jul-19	13-Aug-19	22-Sep-19	21-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
08111 - Flush Panel Aluminum Doors and Frames										
A4050	P&S Aluminum Doors & Frames Shop Drawings	30	69	16-May-19	14-Jun-19	24-Jul-19	22-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4060	R&A Aluminum Doors & Frames Shop Drawings	30	69	15-Jun-19	14-Jul-19	23-Aug-19	21-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4590	Procure Aluminum Doors & Frames	30	69	15-Jul-19	13-Aug-19	22-Sep-19	21-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
10200 - Louvers										
A4070	P&S Louver Shop Drawings	30	69	16-May-19	14-Jun-19	24-Jul-19	22-Aug-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4080	R&A Louver Shop Drawings	30	69	15-Jun-19	14-Jul-19	23-Aug-19	21-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4600	Procure Louvers	30	69	15-Jul-19	13-Aug-19	22-Sep-19	21-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
11316 - Sump Pumps and Appurtenances										
A4090	P&S Sump Pumps & Appurtenances Shop Drawings	30	108	16-May-19	14-Jun-19	01-Sep-19	30-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4100	R&A Sump Pumps & Appurtenances Shop Drawings	30	108	15-Jun-19	14-Jul-19	01-Oct-19	30-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
11397 - Gas Engine Generator Set and Appurtenances										
A4110	P&S Gas Engine Generator Set & Appurtenances Shop Drawings	30	86	16-May-19	14-Jun-19	10-Aug-19	08-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4120	R&A Gas Engine Generator Set & Appurtenances Shop Drawings	30	86	15-Jun-19	14-Jul-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4610	Procure Gas Engine Generator	30	86	15-Jul-19	13-Aug-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%



QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 4 OF 9 PAGES**

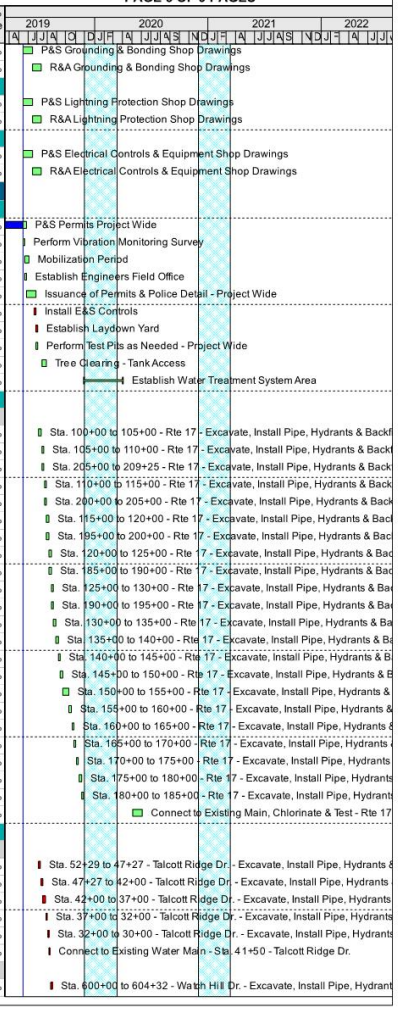
Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
13225 - Prestressed Concrete Tanks										
A4130	P&S Prestressed Concrete Tanks Shop Drawings & Data	30	275	16-May-19	14-Jun-19	15-Feb-20	15-Mar-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4140	R&A Prestressed Concrete Tanks Shop Drawings & Data	30	275	15-Jun-19	14-Jul-19	16-Mar-20	14-Apr-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4620	Procure Prestressed Concrete Tanks	30	275	15-Jul-19	13-Aug-19	15-Apr-20	14-May-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
13300 - Utility Control Instrumentation System										
A4150	P&S Utility Control Instrumentation System Shop Drawings	30	360	16-May-19	14-Jun-19	10-May-20	08-Jun-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4160	R&A Utility Control Instrumentation System Shop Drawings	30	360	15-Jun-19	14-Jul-19	09-Jun-20	08-Jul-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
15101 - Valves, Gates, Hydrants, and Appurtenances										
A4170	P&S Valves, Gates, Hydrants & Appurtenances Shop Drawings & Product Data	30	16	25-Mar-19 A	19-May-19	01-Jun-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	4	0%
A4180	R&A Valves, Gates, Hydrants & Appurtenances Shop Drawings & Product Data	30	16	20-May-19	18-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
15105 - Pipe Supports for Process Piping										
A4190	P&S Pipe Support Shop Drawings & Certs	30	400	16-May-19	14-Jun-19	19-Jun-20	18-Jul-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4200	R&A Pipe Support Shop Drawings & Certs	30	400	15-Jun-19	14-Jul-19	19-Jul-20	17-Aug-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
15112 - Self-Contained Automatic Control Valves and Appurtenances										
A4210	P&S Automatic Control Valves Shop Drawings & Product Data	30	360	16-May-19	14-Jun-19	10-May-20	08-Jun-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4220	R&A Automatic Control Valves Shop Drawings & Product Data	30	360	15-Jun-19	14-Jul-19	09-Jun-20	08-Jul-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
15115 - Flow Meter										
A4230	P&S Flow Meter Shop Drawings & Product Data	30	360	16-May-19	14-Jun-19	10-May-20	08-Jun-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4240	R&A Flow Meter Shop Drawings & Product Data	30	360	15-Jun-19	14-Jul-19	09-Jun-20	08-Jul-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
15400 - Plumbing Systems										
A4250	P&S Plumbing Material Product Data	30	376	16-May-19	14-Jun-19	26-May-20	24-Jun-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
15806 - Heating, Ventilating, and Air Conditioning										
A4260	P&S Heating & Air Conditioning Shop Drawings	30	116	16-May-19	14-Jun-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4270	R&A Heating & Air Conditioning Shop Drawings	30	116	15-Jun-19	14-Jul-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
15809 - Water Booster Pumps and Appurtenances										
A4280	P&S Booster Pumps Product Data	30	312	16-May-19	14-Jun-19	23-Mar-20	21-Apr-20	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16050 - Electrical Work - General										
A4290	P&S Electrical Shop Drawings, Diagrams, and Product Data	30	116	16-May-19	14-Jun-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4300	R&A Electrical Shop Drawings, Diagrams, and Product Data	30	116	15-Jun-19	14-Jul-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16110 - Raceway and Boxes for Electrical Systems										
A4310	P&S Raceway & Boxes Shop Drawings	30	116	16-May-19	14-Jun-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4320	R&A Raceway & Boxes Shop Drawings	30	116	15-Jun-19	14-Jul-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16120 - Electric Wires & Cables										
A4330	P&S Wires & Cables Shop Drawings	30	116	16-May-19	14-Jun-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4340	R&A Wires & Cables Shop Drawings	30	116	15-Jun-19	14-Jul-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16160 - Panelboards										
A4350	P&S Panelboards Shop Drawings	30	86	16-May-19	14-Jun-19	10-Aug-19	08-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4360	R&A Panelboards Shop Drawings	30	86	15-Jun-19	14-Jul-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4630	Procure Panelboards	30	86	15-Jul-19	13-Aug-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16220 - Electric Motors										
A4370	P&S Electric Motors Shop Drawings	30	116	16-May-19	14-Jun-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4380	R&A Electric Motors Shop Drawings	30	116	15-Jun-19	14-Jul-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16260 - Low Voltage Variable Frequency Drive Unit										
A4390	P&S VFD Product Data	30	136	16-May-19	14-Jun-19	29-Sep-19	28-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16400 - Surge Protection Devices										
A4400	P&S Surge Protection Device Shop Drawings	30	102	16-May-19	14-Jun-19	26-Aug-19	24-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4410	R&A Surge Protection Device Shop Drawings	30	102	15-Jun-19	14-Jul-19	25-Sep-19	24-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16402 - Underground Ducts and Raceways for Electrical Systems										
A4420	P&S Underground Ducts & Raceways Shop Drawings	30	106	16-May-19	14-Jun-19	30-Aug-19	28-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4430	R&A Underground Ducts & Raceways Shop Drawings	30	106	15-Jun-19	14-Jul-19	29-Sep-19	28-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16415 - Automatic Transfer Switches										
A4440	P&S Automatic Transfer Switch Shop Drawings	30	86	16-May-19	14-Jun-19	10-Aug-19	08-Sep-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4450	R&A Automatic Transfer Switch Shop Drawings	30	86	15-Jun-19	14-Jul-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4640	Procure Automatic Transfer Switch	30	86	15-Jul-19	13-Aug-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16450 - Grounding and Bonding for Electrical Systems										



QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 5 OF 9 PAGES**

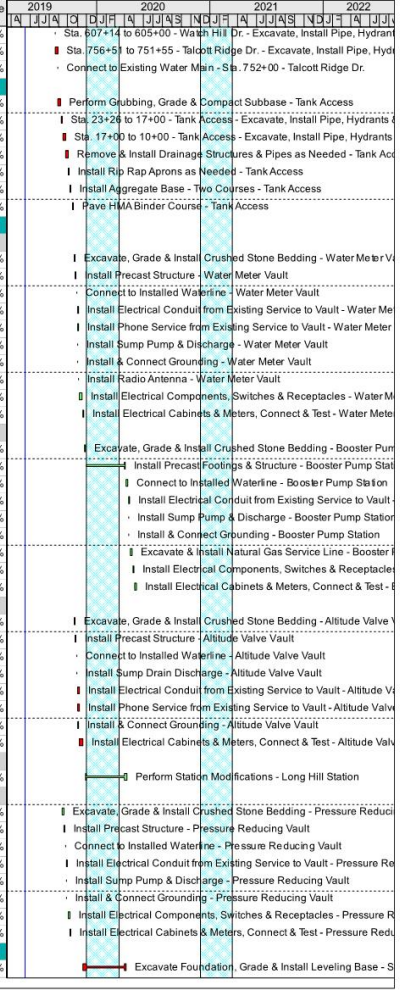
Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
A4460	P&S Grounding & Bonding Shop Drawings	30	112	16-May-19	14-Jun-19	05-Sep-19	04-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4470	R&A Grounding & Bonding Shop Drawings	30	112	15-Jun-19	14-Jul-19	05-Oct-19	03-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16601 - Lightning Protection										
A4480	P&S Lightning Protection Shop Drawings	30	112	16-May-19	14-Jun-19	05-Sep-19	04-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4490	R&A Lightning Protection Shop Drawings	30	112	15-Jun-19	14-Jul-19	05-Oct-19	03-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
16900 - Electrical Controls and Miscellaneous Electrical Equipment										
A4500	P&S Electrical Controls & Equipment Shop Drawings	30	116	16-May-19	14-Jun-19	09-Sep-19	08-Oct-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A4510	R&A Electrical Controls & Equipment Shop Drawings	30	116	15-Jun-19	14-Jul-19	09-Oct-19	07-Nov-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
Construction										
Start-up										
A7720	P&S Permits Project Wide	30	9	18-Feb-19 A	26-May-19	25-May-19	04-Jun-19	Cure, Milestone, & Submittal - 7D/Wk	11	80%
A4680	Perform Vibration Monitoring Survey	5	28	16-May-19	22-May-19	27-Jun-19	03-Jul-19	Out of Roadway Work - Days	5	0%
A1120	Mobilization Period	10	15	21-May-19	04-Jun-19	13-Jun-19	26-Jun-19	Out of Roadway Work - Days	10	0%
A4650	Establish Engineers Field Office	5	15	21-May-19	28-May-19	13-Jun-19	19-Jun-19	Out of Roadway Work - Days	5	0%
A7730	Issuance of Permits & Police Detail - Project Wide	30	9	27-May-19	25-Jun-19	05-Jun-19	04-Jul-19	Cure, Milestone, & Submittal - 7D/Wk	30	0%
A1140	Install E&S Controls	5	0	20-Jun-19	26-Jun-19	20-Jun-19	26-Jun-19	Out of Roadway Work - Days	5	0%
A1160	Establish Laydown Yard	5	0	27-Jun-19	03-Jul-19	27-Jun-19	03-Jul-19	Out of Roadway Work - Days	5	0%
A4660	Perform Test Pits as Needed - Project Wide	3	2	27-Jun-19	01-Jul-19	01-Jul-19	03-Jul-19	Out of Roadway Work - Days	3	0%
A5280	Tree Clearing - Tank Access	10	21	15-Jul-19	29-Jul-19	15-Aug-19	29-Aug-19	Out of Roadway Work - Days	10	0%
A7550	Establish Water Treatment System Area	5	52	27-Nov-19	03-Apr-20	18-Jun-20	24-Jun-20	Out of Roadway Work - Days	5	0%
Route 17 South Main Street										
Rte 17 - Sta 100+00 to 209+25										
A4670	Sta. 100+00 to 105+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	6	2	05-Jul-19	13-Jul-19	09-Jul-19	18-Jul-19	In Roadway Work - Nights	6	0%
A4700	Sta. 105+00 to 110+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	16-Jul-19	23-Jul-19	18-Jul-19	25-Jul-19	In Roadway Work - Nights	5	0%
A5100	Sta. 205+00 to 209+25 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	52	16-Jul-19	23-Jul-19	16-Oct-19	23-Oct-19	In Roadway Work - Nights	5	0%
A4720	Sta. 110+00 to 115+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	23-Jul-19	30-Jul-19	25-Jul-19	01-Aug-19	In Roadway Work - Nights	5	0%
A5080	Sta. 200+00 to 205+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	52	23-Jul-19	30-Jul-19	23-Oct-19	30-Oct-19	In Roadway Work - Nights	5	0%
A4740	Sta. 115+00 to 120+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	30-Jul-19	08-Aug-19	01-Aug-19	10-Aug-19	In Roadway Work - Nights	5	0%
A5060	Sta. 195+00 to 200+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	52	30-Jul-19	08-Aug-19	30-Oct-19	06-Nov-19	In Roadway Work - Nights	5	0%
A4760	Sta. 120+00 to 125+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	08-Aug-19	15-Aug-19	10-Aug-19	17-Aug-19	In Roadway Work - Nights	5	0%
A5020	Sta. 185+00 to 190+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	52	08-Aug-19	15-Aug-19	06-Nov-19	15-Nov-19	In Roadway Work - Nights	5	0%
A4780	Sta. 125+00 to 130+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	15-Aug-19	22-Aug-19	17-Aug-19	24-Aug-19	In Roadway Work - Nights	5	0%
A5040	Sta. 190+00 to 195+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	52	15-Aug-19	22-Aug-19	15-Nov-19	22-Nov-19	In Roadway Work - Nights	5	0%
A4800	Sta. 130+00 to 135+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	22-Aug-19	29-Aug-19	24-Aug-19	31-Aug-19	In Roadway Work - Nights	5	0%
A4820	Sta. 135+00 to 140+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	29-Aug-19	06-Sep-19	31-Aug-19	10-Sep-19	In Roadway Work - Nights	5	0%
A4840	Sta. 140+00 to 145+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	06-Sep-19	13-Sep-19	10-Sep-19	17-Sep-19	In Roadway Work - Nights	5	0%
A4860	Sta. 145+00 to 150+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	13-Sep-19	20-Sep-19	17-Sep-19	08-Oct-19	In Roadway Work - Nights	5	0%
A4880	Sta. 150+00 to 155+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	20-Sep-19	11-Oct-19	08-Oct-19	16-Oct-19	In Roadway Work - Nights	5	0%
A4900	Sta. 155+00 to 160+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	11-Oct-19	19-Oct-19	16-Oct-19	23-Oct-19	In Roadway Work - Nights	5	0%
A4920	Sta. 160+00 to 165+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	21-Oct-19	26-Oct-19	23-Oct-19	30-Oct-19	In Roadway Work - Nights	5	0%
A4940	Sta. 165+00 to 170+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	28-Oct-19	02-Nov-19	30-Oct-19	06-Nov-19	In Roadway Work - Nights	5	0%
A4960	Sta. 170+00 to 175+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	04-Nov-19	09-Nov-19	06-Nov-19	15-Nov-19	In Roadway Work - Nights	5	0%
A4980	Sta. 175+00 to 180+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	13-Nov-19	20-Nov-19	15-Nov-19	22-Nov-19	In Roadway Work - Nights	5	0%
A5000	Sta. 180+00 to 185+00 - Rte 17 - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	2	20-Nov-19	27-Nov-19	22-Nov-19	02-Apr-20	In Roadway Work - Nights	5	0%
A7540	Connect to Existing Main, Chlorinate & Test - Rte 17 - 16" WL	20	14	04-May-20	03-Jun-20	27-May-20	24-Jun-20	Out of Roadway Work - Days	20	0%
Talcott Ridge Dr. & Watch Hill Dr.										
Talcott Ridge Dr. - 16" Waterline										
A5120	Sta. 52+29 to 47+27 - Talcott Ridge Dr. - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	0	05-Jul-19	11-Jul-19	05-Jul-19	11-Jul-19	In Roadway Work - Days	5	0%
A5140	Sta. 47+27 to 42+00 - Talcott Ridge Dr. - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	0	12-Jul-19	18-Jul-19	12-Jul-19	18-Jul-19	In Roadway Work - Days	5	0%
A5160	Sta. 42+00 to 37+00 - Talcott Ridge Dr. - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	0	19-Jul-19	26-Jul-19	19-Jul-19	26-Jul-19	In Roadway Work - Days	5	0%
A5180	Sta. 37+00 to 32+00 - Talcott Ridge Dr. - Excavate, Install Pipe, Hydrants & Backfill - 16" WL	5	0	29-Jul-19	02-Aug-19	29-Jul-19	02-Aug-19	In Roadway Work - Days	5	0%
A5200	Sta. 32+00 to 30+00 - Talcott Ridge Dr. - Excavate, Install Pipe, Hydrants & Backfill - 20" WL	3	0	05-Aug-19	07-Aug-19	05-Aug-19	07-Aug-19	In Roadway Work - Days	3	0%
A7520	Connect to Existing Water Main - Sta. 41+50 - Talcott Ridge Dr.	2	0	08-Aug-19	09-Aug-19	08-Aug-19	09-Aug-19	Out of Roadway Work - Days	2	0%
Talcott Ridge Dr. & Watch Hill Dr. - 8" Waterline										
A5260	Sta. 600+00 to 604+32 - Watch Hill Dr. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	0	12-Aug-19	19-Aug-19	12-Aug-19	19-Aug-19	In Roadway Work - Days	5	0%



QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 6 OF 9 PAGES**

Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
A5240	Sta. 607+14 to 605+00 - Watch Hill Dr. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	2	0	20-Aug-19	21-Aug-19	20-Aug-19	21-Aug-19	In Roadway Work - Days	2	0%
A5220	Sta. 756+51 to 751+55 - Talcott Ridge Dr. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	0	22-Aug-19	28-Aug-19	22-Aug-19	28-Aug-19	In Roadway Work - Days	5	0%
A7530	Connect to Existing Water Main - Sta. 752+00 - Talcott Ridge Dr.	1	0	29-Aug-19	29-Aug-19	29-Aug-19	29-Aug-19	Out of Roadway Work - Days	1	0%
Tank Access Driveway										
A5290	Perform Grubbing, Grade & Compact Subbase - Tank Access	5	0	30-Aug-19	06-Sep-19	30-Aug-19	06-Sep-19	Out of Roadway Work - Days	5	0%
A5300	Sta. 23+26 to 17+00 - Tank Access - Excavate, Install Pipe, Hydrants & Backfill - 20" WL	5	0	09-Sep-19	13-Sep-19	09-Sep-19	13-Sep-19	Out of Roadway Work - Days	5	0%
A5320	Sta. 17+00 to 10+00 - Tank Access - Excavate, Install Pipe, Hydrants & Backfill - 20" WL	5	0	16-Sep-19	23-Sep-19	16-Sep-19	23-Sep-19	Out of Roadway Work - Days	5	0%
A5350	Remove & Install Drainage Structures & Pipes as Needed - Tank Access	5	0	24-Sep-19	01-Oct-19	24-Sep-19	01-Oct-19	Out of Roadway Work - Days	5	0%
A5360	Install Rip Rap Aprons as Needed - Tank Access	3	0	02-Oct-19	04-Oct-19	02-Oct-19	04-Oct-19	Out of Roadway Work - Days	3	0%
A5340	Install Aggregate Base - Two Courses - Tank Access	5	0	07-Oct-19	11-Oct-19	07-Oct-19	11-Oct-19	Out of Roadway Work - Days	5	0%
A5370	Pave HMA Binder Course - Tank Access	3	0	15-Oct-19	18-Oct-19	15-Oct-19	18-Oct-19	Out of Roadway Work - Days	3	0%
Vaults & Stations										
Water Meter Vault										
A6150	Excavate, Grade & Install Crushed Stone Bedding - Water Meter Vault	3	14	21-Oct-19	24-Oct-19	14-Nov-19	18-Nov-19	Out of Roadway Work - Days	3	0%
A6160	Install Precast Structure - Water Meter Vault	2	14	25-Oct-19	28-Oct-19	19-Nov-19	20-Nov-19	Out of Roadway Work - Days	2	0%
A6170	Connect to Installed Waterline - Water Meter Vault	3	14	29-Oct-19	31-Oct-19	21-Nov-19	25-Nov-19	Out of Roadway Work - Days	3	0%
A6190	Install Electrical Conduit from Existing Service to Vault - Water Meter Vault	3	14	01-Nov-19	05-Nov-19	26-Nov-19	29-Nov-19	Out of Roadway Work - Days	3	0%
A6200	Install Phone Service from Existing Service to Vault - Water Meter Vault	3	19	01-Nov-19	05-Nov-19	03-Apr-20	07-Apr-20	Out of Roadway Work - Days	3	0%
A6180	Install Sump Pump & Discharge - Water Meter Vault	1	21	01-Nov-19	01-Nov-19	07-Apr-20	07-Apr-20	Out of Roadway Work - Days	1	0%
A6230	Install & Connect Grounding - Water Meter Vault	1	20	01-Nov-19	01-Nov-19	06-Apr-20	06-Apr-20	Out of Roadway Work - Days	1	0%
A6320	Install Radio Antenna - Water Meter Vault	1	20	04-Nov-19	04-Nov-19	07-Apr-20	07-Apr-20	Out of Roadway Work - Days	1	0%
A6330	Install Electrical Components, Switches & Receptacles - Water Meter Vault	5	14	07-Nov-19	15-Nov-19	01-Apr-20	07-Apr-20	Out of Roadway Work - Days	5	0%
A6210	Install Electrical Cabinets & Meters, Connect & Test - Water Meter Vault	5	14	18-Nov-19	22-Nov-19	09-Apr-20	16-Apr-20	Out of Roadway Work - Days	5	0%
Booster Pump Station										
A6440	Excavate, Grade & Install Crushed Stone Bedding - Booster Pump Station	3	14	25-Nov-19	27-Nov-19	17-Apr-20	21-Apr-20	Out of Roadway Work - Days	3	0%
A6450	Install Precast Footings & Structure - Booster Pump Station	4	14	29-Nov-19	03-Apr-20	22-Apr-20	27-Apr-20	Out of Roadway Work - Days	4	0%
A6460	Connect to Installed Waterline - Booster Pump Station	4	14	06-Apr-20	10-Apr-20	28-Apr-20	01-May-20	Out of Roadway Work - Days	4	0%
A6470	Install Electrical Conduit from Existing Service to Vault - Booster Pump Station	4	14	13-Apr-20	17-Apr-20	04-May-20	08-May-20	Out of Roadway Work - Days	4	0%
A6480	Install Sump Pump & Discharge - Booster Pump Station	2	42	13-Apr-20	14-Apr-20	17-Jun-20	18-Jun-20	Out of Roadway Work - Days	2	0%
A6490	Install & Connect Grounding - Booster Pump Station	2	42	13-Apr-20	14-Apr-20	17-Jun-20	18-Jun-20	Out of Roadway Work - Days	2	0%
A7510	Excavate & Install Natural Gas Service Line - Booster Pump Station	5	14	20-Apr-20	24-Apr-20	11-May-20	18-May-20	Out of Roadway Work - Days	5	0%
A6510	Install Electrical Components, Switches & Receptacles - Booster Pump Station	5	14	27-Apr-20	01-May-20	19-May-20	26-May-20	Out of Roadway Work - Days	5	0%
A6520	Install Electrical Cabinets & Meters, Connect & Test - Booster Pump Station	4	30	04-May-20	08-May-20	19-Jun-20	24-Jun-20	Out of Roadway Work - Days	4	0%
Altitude Valve Vault										
A6070	Excavate, Grade & Install Crushed Stone Bedding - Altitude Valve Vault	3	0	21-Oct-19	24-Oct-19	21-Oct-19	24-Oct-19	Out of Roadway Work - Days	3	0%
A6080	Install Precast Structure - Altitude Valve Vault	2	0	25-Oct-19	28-Oct-19	25-Oct-19	28-Oct-19	Out of Roadway Work - Days	2	0%
A6090	Connect to Installed Waterline - Altitude Valve Vault	2	0	29-Oct-19	30-Oct-19	29-Oct-19	30-Oct-19	Out of Roadway Work - Days	2	0%
A6140	Install Sump Drain Discharge - Altitude Valve Vault	1	0	31-Oct-19	31-Oct-19	31-Oct-19	31-Oct-19	Out of Roadway Work - Days	1	0%
A6110	Install Electrical Conduit from Existing Service to Vault - Altitude Valve Vault	4	0	01-Nov-19	07-Nov-19	01-Nov-19	07-Nov-19	Out of Roadway Work - Days	4	0%
A6120	Install Phone Service from Existing Service to Vault - Altitude Valve Vault	4	0	01-Nov-19	07-Nov-19	01-Nov-19	07-Nov-19	Out of Roadway Work - Days	4	0%
A6220	Install & Connect Grounding - Altitude Valve Vault	3	1	01-Nov-19	05-Nov-19	04-Nov-19	07-Nov-19	Out of Roadway Work - Days	3	0%
A6130	Install Electrical Cabinets & Meters, Connect & Test - Altitude Valve Vault	5	0	08-Nov-19	18-Nov-19	08-Nov-19	18-Nov-19	Out of Roadway Work - Days	5	0%
Long Hill Station Modifications										
A6540	Perform Station Modifications - Long Hill Station	8	276	27-Nov-19	09-Apr-20	05-Oct-21	20-Oct-21	Out of Roadway Work - Days	8	0%
Pressure Reducing Valve Vault										
A6340	Excavate, Grade & Install Crushed Stone Bedding - Pressure Reducing Vault	3	20	13-Sep-19	17-Sep-19	17-Oct-19	21-Oct-19	Out of Roadway Work - Days	3	0%
A6350	Install Precast Structure - Pressure Reducing Vault	2	20	19-Sep-19	20-Sep-19	22-Oct-19	24-Oct-19	Out of Roadway Work - Days	2	0%
A6360	Connect to Installed Waterline - Pressure Reducing Vault	2	20	23-Sep-19	24-Sep-19	25-Oct-19	28-Oct-19	Out of Roadway Work - Days	2	0%
A6370	Install Electrical Conduit from Existing Service to Vault - Pressure Reducing Vault	3	20	26-Sep-19	30-Sep-19	29-Oct-19	31-Oct-19	Out of Roadway Work - Days	3	0%
A6390	Install Sump Pump & Discharge - Pressure Reducing Vault	2	26	26-Sep-19	27-Sep-19	07-Nov-19	08-Nov-19	Out of Roadway Work - Days	2	0%
A6400	Install & Connect Grounding - Pressure Reducing Vault	1	27	26-Sep-19	26-Sep-19	08-Nov-19	08-Nov-19	Out of Roadway Work - Days	1	0%
A6420	Install Electrical Components, Switches & Receptacles - Pressure Reducing Vault	5	20	01-Oct-19	07-Oct-19	01-Nov-19	08-Nov-19	Out of Roadway Work - Days	5	0%
A6430	Install Electrical Cabinets & Meters, Connect & Test - Pressure Reducing Vault	4	20	08-Oct-19	11-Oct-19	12-Nov-19	18-Nov-19	Out of Roadway Work - Days	4	0%
Cherry Hill Storage Tank										
A7240	Excavate Foundation, Grade & Install Leveling Base - Storage Tank	12	0	19-Nov-19	06-Apr-20	19-Nov-19	06-Apr-20	Out of Roadway Work - Days	12	0%



QAPP Worksheet #14&16: Project Tasks & Schedule

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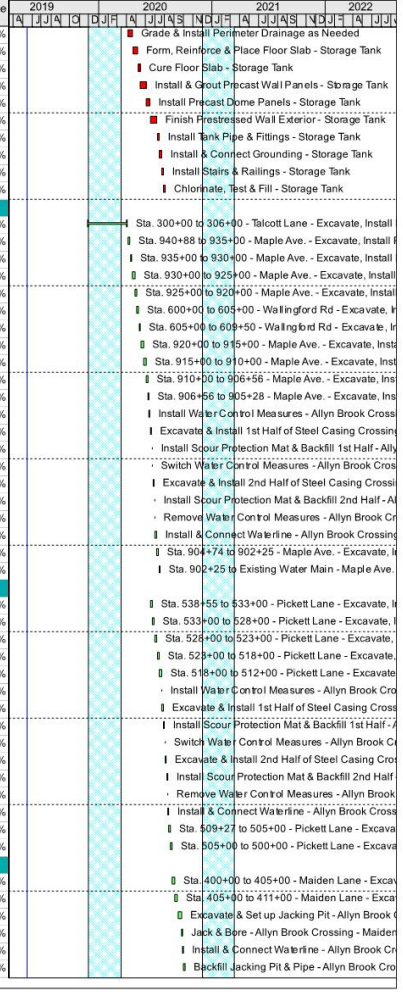
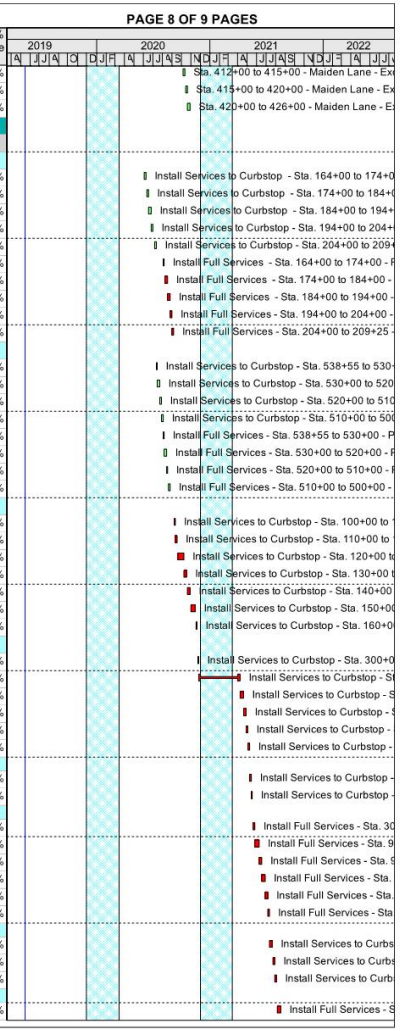
Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
A7320	Grade & Install Perimeter Drainage as Needed	8	0	07-Apr-20	20-Apr-20	07-Apr-20	20-Apr-20	Out of Roadway Work - Days	8	0%
A7250	Form, Reinforce & Place Floor Slab - Storage Tank	12	0	21-Apr-20	07-May-20	21-Apr-20	07-May-20	Out of Roadway Work - Days	12	0%
A7260	Cure Floor Slab - Storage Tank	7	0	08-May-20	14-May-20	08-May-20	14-May-20	Cure, Milestone, & Submittal - 7D/Wk	7	0%
A7270	Install & Grout Precast Wall Panels - Storage Tank	12	0	15-May-20	02-Jun-20	15-May-20	02-Jun-20	Out of Roadway Work - Days	12	0%
A7300	Install Precast Dome Panels - Storage Tank	8	0	03-Jun-20	15-Jun-20	03-Jun-20	15-Jun-20	Out of Roadway Work - Days	8	0%
A7280	Finish Prestressed Wall Exterior - Storage Tank	15	0	16-Jun-20	07-Jul-20	16-Jun-20	07-Jul-20	Out of Roadway Work - Days	15	0%
A7290	Install Tank Pipe & Fittings - Storage Tank	5	0	09-Jul-20	15-Jul-20	09-Jul-20	15-Jul-20	Out of Roadway Work - Days	5	0%
A7420	Install & Connect Grounding - Storage Tank	5	0	16-Jul-20	22-Jul-20	16-Jul-20	22-Jul-20	Out of Roadway Work - Days	5	0%
A7310	Install Stairs & Railings - Storage Tank	5	0	23-Jul-20	29-Jul-20	23-Jul-20	29-Jul-20	Out of Roadway Work - Days	5	0%
A7330	Chlorinate, Test & Fill - Storage Tank	3	0	30-Jul-20	03-Aug-20	30-Jul-20	03-Aug-20	Out of Roadway Work - Days	3	0%
Maple Avenue, Talcott Lane, Wallingford Rd. - Line Installation										
A5730	Sta. 300+00 to 306+00 - Talcott Lane - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	3	27-Nov-19	03-Apr-20	02-Apr-20	09-Apr-20	In Roadway Work - Days	5	0%
A5400	Sta. 940+88 to 935+00 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	4	3	06-Apr-20	10-Apr-20	10-Apr-20	15-Apr-20	In Roadway Work - Days	4	0%
A5420	Sta. 935+00 to 930+00 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	3	13-Apr-20	17-Apr-20	16-Apr-20	23-Apr-20	In Roadway Work - Days	5	0%
A5440	Sta. 930+00 to 925+00 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	3	20-Apr-20	27-Apr-20	24-Apr-20	30-Apr-20	In Roadway Work - Days	5	0%
A5460	Sta. 925+00 to 920+00 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	3	28-Apr-20	04-May-20	01-May-20	08-May-20	In Roadway Work - Days	5	0%
A5750	Sta. 600+00 to 605+00 - Wallingford Rd - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	4	04-May-20	09-May-20	08-May-20	15-May-20	In Roadway Work - Nights	5	0%
A5770	Sta. 605+00 to 609+50 - Wallingford Rd - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	4	11-May-20	16-May-20	15-May-20	22-May-20	In Roadway Work - Nights	5	0%
A5480	Sta. 920+00 to 915+00 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	3	18-May-20	26-May-20	22-May-20	29-May-20	In Roadway Work - Days	5	0%
A5500	Sta. 915+00 to 910+00 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	5	3	27-May-20	02-Jun-20	01-Jun-20	05-Jun-20	In Roadway Work - Days	5	0%
A5520	Sta. 910+00 to 906+56 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	4	3	03-Jun-20	08-Jun-20	08-Jun-20	12-Jun-20	In Roadway Work - Days	4	0%
A5540	Sta. 906+56 to 905+28 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	2	3	09-Jun-20	11-Jun-20	15-Jun-20	16-Jun-20	Out of Roadway Work - Days	2	0%
A7160	Install Water Control Measures - Allyn Brook Crossing - Maple Ave	2	3	12-Jun-20	15-Jun-20	17-Jun-20	18-Jun-20	Out of Roadway Work - Days	2	0%
A7170	Excavate & Install 1st Half of Steel Casing Crossing - Allyn Brook Crossing - Maple Ave	4	80	16-Jun-20	19-Jun-20	19-Oct-20	23-Oct-20	Out of Roadway Work - Days	4	0%
A7180	Install Scour Protection Mat & Backfill 1st Half - Allyn Brook Crossing - Maple Ave	1	80	22-Jun-20	22-Jun-20	26-Oct-20	26-Oct-20	Out of Roadway Work - Days	1	0%
A7190	Switch Water Control Measures - Allyn Brook Crossing - Maple Ave	1	80	23-Jun-20	23-Jun-20	27-Oct-20	27-Oct-20	Out of Roadway Work - Days	1	0%
A7200	Excavate & Install 2nd Half of Steel Casing Crossing - Allyn Brook Crossing - Maple Ave	4	80	24-Jun-20	29-Jun-20	28-Oct-20	02-Nov-20	Out of Roadway Work - Days	4	0%
A7210	Install Scour Protection Mat & Backfill 2nd Half - Allyn Brook Crossing - Maple Ave	1	80	30-Jun-20	30-Jun-20	03-Nov-20	03-Nov-20	Out of Roadway Work - Days	1	0%
A7220	Remove Water Control Measures - Allyn Brook Crossing - Maple Ave	1	80	01-Jul-20	01-Jul-20	04-Nov-20	04-Nov-20	Out of Roadway Work - Days	1	0%
A7230	Install & Connect Waterline - Allyn Brook Crossing - Maple Ave	2	80	02-Jul-20	06-Jul-20	05-Nov-20	06-Nov-20	Out of Roadway Work - Days	2	0%
A5560	Sta. 904+74 to 902+25 - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8" WL	4	80	07-Jul-20	13-Jul-20	09-Nov-20	16-Nov-20	Out of Roadway Work - Days	4	0%
A5580	Sta. 902+25 to Existing Water Main - Maple Ave. - Excavate, Install Pipe, Hydrants & Backfill - 8"	3	73	14-Jul-20	17-Jul-20	17-Nov-20	20-Nov-20	In Roadway Work - Days	3	0%
Pickett Lane - Line Installation										
A5900	Sta. 538+55 to 533+00 - Pickett Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	3	16-Jun-20	22-Jun-20	19-Jun-20	25-Jun-20	Pickett Lane School Zone - Days	5	0%
A5920	Sta. 533+00 to 528+00 - Pickett Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	3	23-Jun-20	29-Jun-20	26-Jun-20	02-Jul-20	Pickett Lane School Zone - Days	5	0%
A5940	Sta. 528+00 to 523+00 - Pickett Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	3	30-Jun-20	07-Jul-20	06-Jul-20	10-Jul-20	Pickett Lane School Zone - Days	5	0%
A5960	Sta. 523+00 to 518+00 - Pickett Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	3	08-Jul-20	14-Jul-20	13-Jul-20	20-Jul-20	Pickett Lane School Zone - Days	5	0%
A5980	Sta. 518+00 to 512+00 - Pickett Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	3	16-Jul-20	22-Jul-20	21-Jul-20	27-Jul-20	Pickett Lane School Zone - Days	5	0%
A7000	Install Water Control Measures - Allyn Brook Crossing - Pickett Lane	1	3	23-Jul-20	23-Jul-20	28-Jul-20	28-Jul-20	Pickett Lane School Zone - Days	1	0%
A7010	Excavate & Install 1st Half of Steel Casing Crossing - Allyn Brook Crossing - Pickett Lane	4	3	24-Jul-20	29-Jul-20	29-Jul-20	03-Aug-20	Pickett Lane School Zone - Days	4	0%
A7050	Install Scour Protection Mat & Backfill 1st Half - Allyn Brook Crossing - Pickett Lane	2	3	30-Jul-20	31-Jul-20	04-Aug-20	05-Aug-20	Pickett Lane School Zone - Days	2	0%
A7020	Switch Water Control Measures - Allyn Brook Crossing - Pickett Lane	1	3	03-Aug-20	03-Aug-20	06-Aug-20	06-Aug-20	Pickett Lane School Zone - Days	1	0%
A7030	Excavate & Install 2nd Half of Steel Casing Crossing - Allyn Brook Crossing - Pickett Lane	4	3	04-Aug-20	07-Aug-20	07-Aug-20	12-Aug-20	Pickett Lane School Zone - Days	4	0%
A7060	Install Scour Protection Mat & Backfill 2nd Half - Allyn Brook Crossing - Pickett Lane	2	3	10-Aug-20	11-Aug-20	13-Aug-20	14-Aug-20	Pickett Lane School Zone - Days	2	0%
A7070	Remove Water Control Measures - Allyn Brook Crossing - Pickett Lane	1	3	12-Aug-20	12-Aug-20	17-Aug-20	17-Aug-20	Pickett Lane School Zone - Days	1	0%
A7040	Install & Connect Waterline - Allyn Brook Crossing - Pickett Lane	1	3	13-Aug-20	13-Aug-20	18-Aug-20	18-Aug-20	Pickett Lane School Zone - Days	1	0%
A6000	Sta. 509+27 to 505+00 - Pickett Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	4	3	14-Aug-20	19-Aug-20	19-Aug-20	24-Aug-20	Pickett Lane School Zone - Days	4	0%
A6020	Sta. 505+00 to 500+00 - Pickett Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	4	3	20-Aug-20	25-Aug-20	25-Aug-20	01-Sep-20	Pickett Lane School Zone - Days	4	0%
Maiden Lane - Line Installation										
A5790	Sta. 400+00 to 405+00 - Maiden Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	76	26-Aug-20	02-Sep-20	10-May-21	18-May-21	In Roadway Work - Days	5	0%
A5810	Sta. 405+00 to 411+00 - Maiden Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	6	76	03-Sep-20	11-Sep-20	18-May-21	26-May-21	In Roadway Work - Days	6	0%
A7090	Excavate & Set up Jacking Pit - Allyn Brook Crossing - Maiden Lane	8	83	14-Sep-20	24-Sep-20	26-May-21	08-Jun-21	Out of Roadway Work - Days	8	0%
A7100	Jack & Bore - Allyn Brook Crossing - Maiden Lane	2	83	25-Sep-20	28-Sep-20	08-Jun-21	11-Jun-21	Out of Roadway Work - Days	2	0%
A7150	Install & Connect Waterline - Allyn Brook Crossing - Maiden Lane	2	83	29-Sep-20	30-Sep-20	11-Jun-21	15-Jun-21	Out of Roadway Work - Days	2	0%
A7130	Backfill Jacking Pit & Pipe - Allyn Brook Crossing - Maiden Lane	3	83	01-Oct-20	05-Oct-20	15-Jun-21	18-Jun-21	Out of Roadway Work - Days	3	0%



QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 8 OF 9 PAGES**

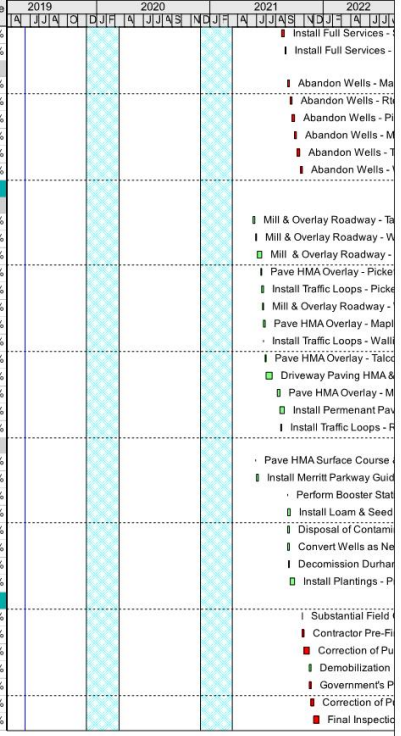
Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
A5830	Sta. 412+00 to 415+00 - Maiden Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	85	06-Oct-20	13-Oct-20	18-Jun-21	25-Jun-21	In Roadway Work - Days	5	0%
A5850	Sta. 415+00 to 420+00 - Maiden Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	5	85	14-Oct-20	20-Oct-20	25-Jun-21	02-Jul-21	In Roadway Work - Days	5	0%
A5870	Sta. 420+00 to 426+00 - Maiden Lane - Excavate, Install Pipe, Hydrants & Backfill - 12" WL	6	85	21-Oct-20	28-Oct-20	02-Jul-21	13-Jul-21	In Roadway Work - Days	6	0%
Service Installations										
Service Installations										
Route 17 - Services										
A7920	Install Services to Curbstop - Sta. 164+00 to 174+00 - Route 17	4	14	03-Jun-20	10-Jun-20	24-Jun-20	30-Jun-20	In Roadway Work - Nights	4	0%
A7930	Install Services to Curbstop - Sta. 174+00 to 184+00 - Route 17	5	14	10-Jun-20	17-Jun-20	30-Jun-20	10-Jul-20	In Roadway Work - Nights	5	0%
A7940	Install Services to Curbstop - Sta. 184+00 to 194+00 - Route 17	6	14	17-Jun-20	25-Jun-20	10-Jul-20	18-Jul-20	In Roadway Work - Nights	6	0%
A7950	Install Services to Curbstop - Sta. 194+00 to 204+00 - Route 17	5	14	25-Jun-20	02-Jul-20	20-Jul-20	25-Jul-20	In Roadway Work - Nights	5	0%
A7960	Install Services to Curbstop - Sta. 204+00 to 209+25 - Route 17	4	14	07-Jul-20	11-Jul-20	27-Jul-20	31-Jul-20	In Roadway Work - Nights	4	0%
A6560	Install Full Services - Sta. 164+00 to 174+00 - Route 17	4	0	03-Aug-20	07-Aug-20	03-Aug-20	07-Aug-20	In Roadway Work - Nights	4	0%
A6570	Install Full Services - Sta. 174+00 to 184+00 - Route 17	5	0	07-Aug-20	18-Aug-20	07-Aug-20	18-Aug-20	In Roadway Work - Nights	5	0%
A6580	Install Full Services - Sta. 184+00 to 194+00 - Route 17	5	0	18-Aug-20	25-Aug-20	18-Aug-20	25-Aug-20	In Roadway Work - Nights	5	0%
A6590	Install Full Services - Sta. 194+00 to 204+00 - Route 17	5	0	25-Aug-20	01-Sep-20	25-Aug-20	01-Sep-20	In Roadway Work - Nights	5	0%
A6600	Install Full Services - Sta. 204+00 to 209+25 - Route 17	4	0	01-Sep-20	05-Sep-20	01-Sep-20	05-Sep-20	In Roadway Work - Nights	4	0%
Pickett Lane - Services										
A7970	Install Services to Curbstop - Sta. 538+55 to 530+00 - Pickett Lane	2	13	13-Jul-20	14-Jul-20	31-Jul-20	03-Aug-20	Pickett Lane School Zone - Days	2	0%
A7980	Install Services to Curbstop - Sta. 530+00 to 520+00 - Pickett Lane	6	13	16-Jul-20	23-Jul-20	04-Aug-20	11-Aug-20	Pickett Lane School Zone - Days	6	0%
A7990	Install Services to Curbstop - Sta. 520+00 to 510+00 - Pickett Lane	3	15	24-Jul-20	28-Jul-20	14-Aug-20	18-Aug-20	Pickett Lane School Zone - Days	3	0%
A8000	Install Services to Curbstop - Sta. 510+00 to 500+00 - Pickett Lane	4	15	29-Jul-20	03-Aug-20	19-Aug-20	24-Aug-20	Pickett Lane School Zone - Days	4	0%
A6930	Install Full Services - Sta. 538+55 to 530+00 - Pickett Lane	2	4	04-Aug-20	05-Aug-20	10-Aug-20	11-Aug-20	Pickett Lane School Zone - Days	2	0%
A6940	Install Full Services - Sta. 530+00 to 520+00 - Pickett Lane	6	4	06-Aug-20	13-Aug-20	12-Aug-20	19-Aug-20	Pickett Lane School Zone - Days	6	0%
A6950	Install Full Services - Sta. 520+00 to 510+00 - Pickett Lane	3	4	14-Aug-20	18-Aug-20	20-Aug-20	24-Aug-20	Pickett Lane School Zone - Days	3	0%
A6960	Install Full Services - Sta. 510+00 to 500+00 - Pickett Lane	4	4	19-Aug-20	24-Aug-20	25-Aug-20	01-Sep-20	Pickett Lane School Zone - Days	4	0%
Route 17 - Services to Curbstop										
A6680	Install Services to Curbstop - Sta. 100+00 to 110+00 - Route 17	3	0	08-Sep-20	11-Sep-20	08-Sep-20	11-Sep-20	In Roadway Work - Nights	3	0%
A6690	Install Services to Curbstop - Sta. 110+00 to 120+00 - Route 17	5	0	11-Sep-20	18-Sep-20	11-Sep-20	18-Sep-20	In Roadway Work - Nights	5	0%
A6700	Install Services to Curbstop - Sta. 120+00 to 130+00 - Route 17	5	0	18-Sep-20	09-Oct-20	18-Sep-20	09-Oct-20	In Roadway Work - Nights	5	0%
A6710	Install Services to Curbstop - Sta. 130+00 to 140+00 - Route 17	5	0	09-Oct-20	17-Oct-20	09-Oct-20	17-Oct-20	In Roadway Work - Nights	5	0%
A6720	Install Services to Curbstop - Sta. 140+00 to 150+00 - Route 17	9	0	19-Oct-20	30-Oct-20	19-Oct-20	30-Oct-20	In Roadway Work - Nights	9	0%
A6730	Install Services to Curbstop - Sta. 150+00 to 160+00 - Route 17	9	0	30-Oct-20	14-Nov-20	30-Oct-20	14-Nov-20	In Roadway Work - Nights	9	0%
A6740	Install Services to Curbstop - Sta. 160+00 to 164+00 - Route 17	5	0	16-Nov-20	21-Nov-20	16-Nov-20	21-Nov-20	In Roadway Work - Nights	5	0%
Maple Avenue, Talcott Ln. & Wallingford Rd.- Curbstop										
A6750	Install Services to Curbstop - Sta. 300+00 to 306+00 - Talcott Lane	2	0	23-Nov-20	24-Nov-20	23-Nov-20	24-Nov-20	In Roadway Work - Days	2	0%
A6790	Install Services to Curbstop - Sta. 940+88 to 930+00 - Maple Ave	8	0	25-Nov-20	08-Apr-21	25-Nov-20	08-Apr-21	Out of Roadway Work - Days	8	0%
A6800	Install Services to Curbstop - Sta. 930+00 to 920+00 - Maple Ave	6	0	09-Apr-21	19-Apr-21	09-Apr-21	19-Apr-21	Out of Roadway Work - Days	6	0%
A6810	Install Services to Curbstop - Sta. 920+00 to 907+00 - Maple Ave	6	0	20-Apr-21	27-Apr-21	20-Apr-21	27-Apr-21	Out of Roadway Work - Days	6	0%
A6820	Install Services to Curbstop - Sta. 907+00 to 900+00 - Maple Ave	5	0	28-Apr-21	04-May-21	28-Apr-21	04-May-21	Out of Roadway Work - Days	5	0%
A6770	Install Services to Curbstop - Sta. 600+00 to 609+50 - Wallingford Rd.	4	0	04-May-21	08-May-21	04-May-21	08-May-21	In Roadway Work - Nights	4	0%
Talcott Ridge Dr. & Watch Hill Dr. - Curbstop										
A6970	Install Services to Curbstop - Sta. 52+00 to 42+00 - Talcott Ridge Dr.	3	0	10-May-21	13-May-21	10-May-21	14-May-21	Out of Roadway Work - Days	3	0%
A6980	Install Services to Curbstop - Sta. 42+00 to 30+00 - Talcott Ridge Dr.	3	0	14-May-21	18-May-21	14-May-21	19-May-21	Out of Roadway Work - Days	3	0%
Maple Avenue, Talcott Ln. & Wallingford Rd. - Building Services										
A6760	Install Full Services - Sta. 300+00 to 306+00 - Talcott Lane	4	0	19-May-21	24-May-21	19-May-21	25-May-21	Out of Roadway Work - Days	4	0%
A6830	Install Full Services - Sta. 940+88 to 930+00 - Maple Ave	9	0	25-May-21	07-Jun-21	25-May-21	08-Jun-21	Out of Roadway Work - Days	9	0%
A6840	Install Full Services - Sta. 930+00 to 920+00 - Maple Ave	7	0	08-Jun-21	17-Jun-21	08-Jun-21	18-Jun-21	Out of Roadway Work - Days	7	0%
A6850	Install Full Services - Sta. 920+00 to 907+00 - Maple Ave	7	0	18-Jun-21	28-Jun-21	18-Jun-21	29-Jun-21	Out of Roadway Work - Days	7	0%
A6860	Install Full Services - Sta. 907+00 to 900+00 - Maple Ave	5	0	29-Jun-21	06-Jul-21	29-Jun-21	07-Jul-21	Out of Roadway Work - Days	5	0%
A6780	Install Full Services - Sta. 600+00 to 609+50 - Wallingford Rd.	4	0	07-Jul-21	12-Jul-21	07-Jul-21	13-Jul-21	Out of Roadway Work - Days	4	0%
Maiden Lane - Curbstop										
A6870	Install Services to Curbstop - Sta. 400+00 to 410+00 - Maiden Lane	6	0	13-Jul-21	21-Jul-21	13-Jul-21	22-Jul-21	In Roadway Work - Days	6	0%
A6880	Install Services to Curbstop - Sta. 410+00 to 420+00 - Maiden Lane	5	0	22-Jul-21	28-Jul-21	22-Jul-21	29-Jul-21	In Roadway Work - Days	5	0%
A6890	Install Services to Curbstop - Sta. 420+00 to 426+00 - Maiden Lane	5	0	29-Jul-21	04-Aug-21	29-Jul-21	05-Aug-21	In Roadway Work - Days	5	0%
Maiden Lane - Services										
A6900	Install Full Services - Sta. 400+00 to 410+00 - Maiden Lane	8	0	05-Aug-21	17-Aug-21	05-Aug-21	19-Aug-21	Out of Roadway Work - Days	8	0%



QAPP Worksheet #14&16: Project Tasks & Schedule

DD4.19.18 Durham Meadows Waterline - UP02 Recovery | **Ludlow - All Activities** | **PAGE 9 OF 9 PAGES**

Activity ID	Activity Description	Orig. Dur.	Total Float	Early Start	Early Finish	Late Start	Late Finish	Calendar	Remaining Duration	Physical % Complete
A6910	Install Full Services - Sta. 410+00 to 420+00 - Maiden Lane	7	0	19-Aug-21	27-Aug-21	19-Aug-21	30-Aug-21	Out of Roadway Work - Days	7	0%
A6920	Install Full Services - Sta. 420+00 to 426+00 - Maiden Lane	5	0	30-Aug-21	03-Sep-21	30-Aug-21	07-Sep-21	Out of Roadway Work - Days	5	0%
Well Abandonments										
A7660	Abandon Wells - Maiden Lane	5	0	07-Sep-21	14-Sep-21	07-Sep-21	16-Sep-21	Out of Roadway Work - Days	5	0%
A7710	Abandon Wells - Rte 17	5	0	16-Sep-21	22-Sep-21	16-Sep-21	23-Sep-21	Out of Roadway Work - Days	5	0%
A7700	Abandon Wells - Pickett Lane	5	0	23-Sep-21	29-Sep-21	23-Sep-21	30-Sep-21	Out of Roadway Work - Days	5	0%
A7670	Abandon Wells - Maple Ave	5	0	30-Sep-21	06-Oct-21	30-Sep-21	08-Oct-21	Out of Roadway Work - Days	5	0%
A7680	Abandon Wells - Talcott Lane	5	0	08-Oct-21	18-Oct-21	08-Oct-21	19-Oct-21	Out of Roadway Work - Days	5	0%
A7690	Abandon Wells - Wallingford Rd.	5	0	19-Oct-21	25-Oct-21	19-Oct-21	26-Oct-21	Out of Roadway Work - Days	5	0%
Project Wide Finishes										
In Roadway Finishes										
A7390	Mill & Overlay Roadway - Talcott Ridge Dr.	6	52	19-May-21	26-May-21	05-Aug-21	13-Aug-21	In Roadway Work - Days	6	0%
A7400	Mill & Overlay Roadway - Watch Hill Dr.	3	52	27-May-21	01-Jun-21	16-Aug-21	18-Aug-21	In Roadway Work - Days	3	0%
A7380	Mill & Overlay Roadway - Route 17	12	52	01-Jun-21	18-Jun-21	19-Aug-21	04-Sep-21	In Roadway Work - Nights	12	0%
A7370	Pave HMA Overlay - Pickett Lane	4	47	14-Jun-21	17-Jun-21	20-Aug-21	25-Aug-21	Pickett Lane School Zone - Days	4	0%
A7580	Install Traffic Loops - Pickett Lane	2	47	18-Jun-21	21-Jun-21	26-Aug-21	31-Aug-21	Pickett Lane School Zone - Days	2	0%
A7410	Mill & Overlay Roadway - Wallingford Rd.	2	52	18-Jun-21	22-Jun-21	04-Sep-21	09-Sep-21	In Roadway Work - Nights	2	0%
A7340	Pave HMA Overlay - Maple Avenue	5	52	22-Jun-21	28-Jun-21	09-Sep-21	15-Sep-21	In Roadway Work - Days	5	0%
A7570	Install Traffic Loops - Wallingford Rd.	2	71	22-Jun-21	23-Jun-21	22-Oct-21	26-Oct-21	In Roadway Work - Days	2	0%
A7350	Pave HMA Overlay - Talcott Lane	3	52	29-Jun-21	01-Jul-21	16-Sep-21	04-Oct-21	In Roadway Work - Days	3	0%
A7500	Driveway Paving HMA & Aprons - Project Wide	10	55	02-Jul-21	19-Jul-21	08-Oct-21	26-Oct-21	In Roadway Work - Days	10	0%
A7360	Pave HMA Overlay - Maiden Lane	6	30	05-Aug-21	13-Aug-21	05-Oct-21	14-Oct-21	In Roadway Work - Days	6	0%
A7450	Install Permenant Pavement Markings - Project Wide	8	30	13-Aug-21	27-Aug-21	14-Oct-21	26-Oct-21	In Roadway Work - Nights	8	0%
A7460	Install Traffic Loops - Rte 17	4	33	16-Aug-21	19-Aug-21	20-Oct-21	26-Oct-21	In Roadway Work - Days	4	0%
Out of Roadway Finishes										
A5380	Pave HMA Surface Course & Curb - Tank Access	2	90	27-May-21	28-May-21	18-Oct-21	20-Oct-21	Out of Roadway Work - Days	2	0%
A5390	Install Merritt Parkway Guiderail System - Tank Access	4	90	01-Jun-21	04-Jun-21	20-Oct-21	26-Oct-21	Out of Roadway Work - Days	4	0%
A6530	Perform Booster Station Modifications - Durham Booster Station	2	26	07-Sep-21	09-Sep-21	20-Oct-21	22-Oct-21	Out of Roadway Work - Days	2	0%
A7440	Install Loam & Seed - Project Wide	6	18	07-Sep-21	16-Sep-21	05-Oct-21	15-Oct-21	Out of Roadway Work - Days	6	0%
A7490	Disposal of Contaminated Material as Needed - Project Wide	5	25	07-Sep-21	14-Sep-21	19-Oct-21	26-Oct-21	Out of Roadway Work - Days	5	0%
A7560	Convert Wells as Needed - Project Wide.	5	25	07-Sep-21	14-Sep-21	19-Oct-21	26-Oct-21	Out of Roadway Work - Days	5	0%
A7480	Decomission Durham Fairground Well - Durham Fairground	2	26	10-Sep-21	13-Sep-21	22-Oct-21	26-Oct-21	Out of Roadway Work - Days	2	0%
A7430	Install Plantings - Project Wide	10	18	17-Sep-21	30-Sep-21	18-Oct-21	29-Oct-21	Out of Roadway Work - Days	10	0%
Closeout										
A1060	Substantial Field Completion Request	1	0	26-Oct-21	26-Oct-21	26-Oct-21	26-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	1	0%
A1070	Contractor Pre-Final Inspection	5	0	26-Oct-21	31-Oct-21	27-Oct-21	31-Oct-21	Cure, Milestone, & Submittal - 7D/Wk	5	0%
A1090	Correction of Punch List from Contractors Pre-Final Inspection	10	0	01-Nov-21	16-Nov-21	01-Nov-21	16-Nov-21	In Roadway Work - Days	10	0%
A1080	Demobilization	5	4	17-Nov-21	23-Nov-21	23-Nov-21	30-Nov-21	Out of Roadway Work - Days	5	0%
A1100	Government's Pre-Final Inspection	5	0	17-Nov-21	21-Nov-21	17-Nov-21	21-Nov-21	Cure, Milestone, & Submittal - 7D/Wk	5	0%
A3180	Correction of Punchlist from Governments Pre-Final Inspection	5	0	22-Nov-21	30-Nov-21	22-Nov-21	30-Nov-21	In Roadway Work - Days	5	0%
A1110	Final Inspection	17	0	01-Dec-21	17-Dec-21	01-Dec-21	17-Dec-21	Cure, Milestone, & Submittal - 7D/Wk	17	0%



QAPP Worksheet #15: Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Phoenix Environmental Laboratories has selected methods that are sufficiently sensitive to meet project objectives.

Parameter	**Standard**
Total Coliform Bacteria	0 or absent
HPC	< 100 organisms/mL
Color	< 15 CU
Turbidity	< 5 NTU
Odor	< 2
PH	range 6.4 – 10

Lab reporting Limits

Parameter	**Limits**
Total Coliform Bacteria	0 or absent
HPC	0
Color	1 color units
Turbidity	0.20 NTU
Odor	1
PH	0.5 pH units

QAPP Worksheet #17: Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Sampling design for water quality sampling of the water main, as indicated in the Specifications, is dictated by the regulatory requirements for the Town of Durham, City of Middletown and the State of Connecticut.

Water quality testing for the waterline and water tank will be conducted according to the Durham Meadows Waterline Testing Plan. A draft version of the plan is included as Appendix B. Water main sections to be tested, the tests to be conducted and the objectives for the tests are presented in the Testing Plan.

LCC will conduct water line disinfection and taking water samples for water line disinfection. LCC will sent samples to Phoenix Environmental Laboratories. Phoenix Environmental Laboratories will be will responsible for testing samples and providing results and required analysis.

Per Section 13225 Prestressed Concrete Tanks, Section 3 – Execution, paragraph 3.10 Waterline Disinfection, sub paragraph B “City of Middletown Water and Sewer Department will collect all water quality samples with Contractor assistance and will perform all required water quality testing. Contractor shall provide at least 72 hours advance notice for scheduling testing. “

Consistent with the Specifications, construction water may be discharged at the location designated by the Contracting Officer. Construction water that has the potential to be encountered is water that may be encountered in excavations, groundwater, domestic water used for hydration, and/or pooled rainwater.

Matrix	Testing Frequency	Analysis	Data Use

QAPP Worksheet #18: Sampling Locations and Methods
(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.1 and 2.3.2)

Table 18-1: Water Quality Testing- Water Main

Sample Location	Stations	Sample ID	Matrix	Depth	Type	Analyte / Analytical Group	Sampling SOP	Comments
South Main Street	51+90 to 52+35 & 100+00 to 119+37	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Main Street at Royal Oak Drive	119+37 to 136+61	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Main Street at Parsons Lane	136+61 to 151+51	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Main Street at Haddam Quarter Road	151+51 to 166+32	Determined in field and	Water	n/a	n/a	Total Coliform Bacteria HPC	SOP-002	

QAPP Worksheet #17: Sampling Design and Rationale

Sample Location	Stations	Sample ID	Matrix	Depth	Type	Analyte / Analytical Group	Sampling SOP	Comments
		labeled per station number				Color Turbidity Odor PH		
Main Street	166+32 to 183+65	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Main Street at Pickett Lane	183+65 to 204+45	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Main Street at Mill Pond Lane	204+45 to 209+25	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Talcott Ridge Drive and Watch Hill Drive	35+74 to 51+90 600+00 to 604+31 605+00 to 607+12	Determined in field and	Water	n/a	n/a	Total Coliform Bacteria HPC	SOP-002	

QAPP Worksheet #17: Sampling Design and Rationale

Sample Location	Stations	Sample ID	Matrix	Depth	Type	Analyte / Analytical Group	Sampling SOP	Comments
		labeled per station number				Color Turbidity Odor PH		
Talcott Ridge Drive	31+84 to 35+74 30+00 to 31+84 10+79 to 23+26 10+30 to 10+79	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Maple Avenue	900+00 to 920+65	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Wallingford Road	600+00 to 606+87 606+87 to 609+46	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Maple Avenue	920+80 to 940+88	Determined in field and	Water	n/a	n/a	Total Coliform Bacteria HPC	SOP-002	

QAPP Worksheet #17: Sampling Design and Rationale

Sample Location	Stations	Sample ID	Matrix	Depth	Type	Analyte / Analytical Group	Sampling SOP	Comments
		labeled per station number				Color Turbidity Odor PH		
Talcott Lane	300+00 to 306+13	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Maiden Lane	400+00 to 410+47	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Maiden Lane	410+47 to 426+03	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Pickett Lane	500+00 to 509+21	Determined in field and	Water	n/a	n/a	Total Coliform Bacteria HPC	SOP-002	

QAPP Worksheet #17: Sampling Design and Rationale

Sample Location	Stations	Sample ID	Matrix	Depth	Type	Analyte / Analytical Group	Sampling SOP	Comments
		labeled per station number				Color Turbidity Odor PH		
Pickett Lane	509+21 to 530+90	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	
Pickett Lane	530+90 to 538+51	Determined in field and labeled per station number	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-002	

Notes:

QAPP Worksheet #17: Sampling Design and Rationale

Table 18-2: Water Quality Testing- Water Tank

Will be tested at a later date

Sample Location	Sample ID	Matrix	Depth	Type	Analyte / Analytical Group	Sampling SOP	Comments
Water Tank Out Flow	City of Middletown Coding	Water	n/a	n/a	Total Coliform Bacteria HPC Color Turbidity Odor PH	SOP-003	

Notes:

QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Table 19/30-1: Water Quality Testing- Water Main

Sample Delivery Method:

Matrix/Analyte/Analyte Group	Method/ SOP	Container(s) (number, size & type per sample)[1,2]	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround	Lab or Onsite	
Total Coliform Bacteria	SM 9223 / 407	Sterilized nonreactive borosilicate glass or plastic (e.g. Bacteria cup)	4ºC, sodium thiosulfate	NA	30 hours	5-7 business days	lab	
Heterotrophic Plate Count	SM 9215B / 406					5-7 business days	lab	
Total Chlorine Residual	SM4500 /	250 mL poly	Dark, ±5ºF of collection temperature	NA	15 minutes			This is a field parameter
Free Chlorine Residual	SM4500 /	250 mL poly	Dark, ±5ºF of collection temperature	NA	15 minutes			This is a field parameter
Color	SP 317	Erlenmeyers flasks, 500ml glass watch glass covers	No preservative stored at 4°C	n/a	48 hours	5-7 business days	lab	
Turbidity	SM 2130B / 306	950 mL poly	No preservative stored at 4°C	n/a	48 hours	5-7 business days	lab	
Odor	SM 2150B /317	Erlenmeyers flasks, 500ml glass watch glass covers	No preservative stored at 4°C	n/a	48 hours	5-7 business days	lab	
pH	SM4500 /	950 mL poly	Dark, ±5ºF of collection temperature	NA	15 minutes	Same day		This is a field parameter

QAPP Worksheet #17: Sampling Design and Rationale

Notes: pH and total/free chlorine are typically field parameters. They can do done in the laboratory but will be flagged as past hold time. Field samples will be tested by utilizing a pH testing strip

1) Containers and container size provided by the laboratory may vary. Sample for multiple analyses with the same preservation may be combined.

2) Containers for all samples and coolers shall be supplied by the laboratory. All sample containers shall be provided from an EPA approved supplier utilizing pre-cleaned containers.

QAPP Worksheet #17: Sampling Design and Rationale

Table 19/30-2: Water Quality Testing- Water Tank

Sample Delivery Method:

Matrix/Analyte/Analyte Group	Method/ SOP	Container(s) (number, size & type per sample)[1,2]	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround	Lab or Onsite
Total Coliform Bacteria	SM 9223 / SOP-001	Sterilized nonreactive borosilicate glass or plastic (e.g. Bacteria cup)	4ºC, sodium thiosulfate	NA	30 hours	5-7 business days	lab
Heterotrophic Plate Count	SM 9215B / SOP-001					5-7 business days	lab
Total Chlorine Residual	SM4500 / SOP-001	250 mL poly	Dark, ±5ºF of collection temperature	NA	15 minutes		This is a field parameter
Free Chlorine Residual	SM4500 / SOP-001	250 mL poly	Dark, ±5ºF of collection temperature	NA	15 minutes		This is a field parameter
Color	/ SOP-001					5-7 business days	lab
Turbidity	SM 2130B / SOP-001					5-7 business days	lab
Odor	SM 2150B / SOP-001					5-7 business days	lab
pH	SM4500 / SOP-001	950 mL poly	Dark, ±5ºF of collection temperature	NA	15 minutes		This is a field parameter

Notes: : pH and total/free chlorine are typically field parameters. They can do done in the laboratory, but will be flagged as past hold time

1) Containers and container size provided by the laboratory may vary. Sample for multiple analyses with the same preservation may be combined.
2) Containers for all samples and coolers shall be supplied by the laboratory. All sample containers shall be provided from an EPA approved supplier utilizing pre-cleaned containers.

QAPP Worksheet #17: Sampling Design and Rationale

QAPP Worksheet #20: Field QC Summary
(UFP-QAPP Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.5)

Collection of field quality control samples, type and frequency, will vary based on the requirements for each type of sample and analytical activity. For water quality testing of the water supply, collection of field QC samples will be as required by the City of Middletown and CT DPH.

Sample Area	Type	Frequency		QC
Piping Systems	Disinfection	Each Pipe System	2 consecutive satisfactory bacteriological samples	Samples taken for each system
Tank	Disinfection	Each Pipe System	2 consecutive satisfactory bacteriological samples	Samples taken for each system

QAPP Worksheet #21: Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

SOP # or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N*	QAPP Location	Comments*
SOP-001	City of Middletown Water and Sewer Department Disinfection of Water Storage Facilities	City of Middletown		no	Appendix B	
SOP-002	Standard Operating Procedure Testing and Disinfection of Water Mains	Ludlow Construction Inc.		no	Appendix D	

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.1.2.4)
(EPA 2106-G-05 Section 2.3.6)

Field Equipment	Activity	SOP Reference Or Description of Activity	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
Copper Tubing	Water line Testing	SOP-002	LCC	1st use, prior to testing	Clean, not bent	Replace
	Water Tank Testing	SOP-001	City Of Middletown	1st use, prior to testing	Clean, not bent	Replace
Gloves	Water line Testing	SOP-002	LCC	Prior to use	Complete, no holes, rips, correct size	Replace
	Water Tank Testing	SOP-001	City Of Middletown	Prior to use	Complete, no holes, rips, correct size	Replace
Sample Bottles	Water line Testing	SOP-002	LCC	Delivered; Prior to use, periodic inspections	Not leaking, not cracked, correct size, label, clean	replace
	Water Tank Testing	SOP-001	City Of Middletown	Delivered; Prior to use, periodic inspections	Not leaking, not cracked, correct size, label, clean	replace
Chlorine	Water line Testing	SOP-002	LCC	Prior to Use	Sealed, proper concentration	replace
	Water Tank Testing	SOP-001	City Of Middletown	Prior to Use	Sealed, proper concentration	replace

QAPP Worksheet #21: Field SOPs

Field Equipment	Activity	SOP Reference Or Description of Activity	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action

Notes:

QAPP Worksheet #23: Analytical SOPs
(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? Y/N
SOP-003a	Total Coliform in Drinking water by Colilert		Water		no
SOP-003b	Chromogenic Total Coliform/E. Coli Test by Most Probable Number		Water		no
SOP-003c	Heterotrophic Plate Count (HPC) formerly known as Standard Plate Count (SPC)		Water		no
SOP-003d	PC Titrator for Ph, Alkalinity, Conductivity & Turbidity		Water		no
SOP-003e	Threshold Odor.		Water		no
SOP-003e	Odor SOP		Water		no
SOP-003f	Measurement of volatile organic compounds by capillary column gas chromatography/mass spectrometry		Water		no
SOP-003g	Measurement of purgeable organic compounds in water by capillary column gas chromatography/mass spectrometry		Water		no
SOP-003h	Determination of 1,4-dioxane in water by solid phase extraction (spe) and gas chromatography/mass spectrometry (gc/ms) with selected Ion monitoring (sim)		Water		no
SOP-003i	Color		Water		no

QAPP Worksheet #23: Analytical SOPs

Notes:

QAPP Worksheet #24: Analytical Instrument Calibration
(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

There is currently no field equipment requiring calibration. The PH will be LCC will utilize Copper Tubing, Gloves, Sample Bottles, hypochlorite solution, and potable water to obtain samples.

Please refer to SOP-002a and SOP-002b for sampling and testing methods. Please refer to SOP-002e for testing equipment to be used.

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection (UFP-QAPP Manual Section 3.2.3) (EPA 2106-G-05 Section 2.3.6)

Refer to laboratory SOPs in Appendix C.

QAPP Worksheet #26 & 27: Sample Handling, Custody, and Disposal
(UFP-QAPP Manual Section 3.3)
(EPA 2106-G-05 Section 2.3.3)

Sampling Organization: Ludlow Construction Company

Laboratory: Phoenix Environmental Laboratories

Method of sample delivery (shipper/carrier): Ground courier and Overnight carrier (FedEx or UPS); or laboratory courier

Number of days from reporting until sample disposal:

Activity	Organization and title or position of person responsible for the activity	SOP reference
Water Line Testing	LCC Personnel	Appendix D SOP – 002A
Water Tank Testing	City of Middletown	Appendix D SOP – 002A

QAPP Worksheet #28: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Refer to laboratory SOPs in Appendix C.

QAPP Worksheet #29: Project Documents and Records
(UFP-QAPP Manual Section 3.5.1)
(EPA 2106-G-05 Section 2.2.8)

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage location/archival**
Consumables Documentation (e.g., LCC test results, Certificates of Analysis)	LCC QC	LCC RAC Lead Chemist	LCC Project files (electronic, LCC network)
Field logbook, data collection sheets	LCC Field Staff	LCC PS	LCC Project files (electronic, LCC network)
Photographs	LCC Field Staff	LCC PS	LCC Project files (electronic, LCC network)
Instrument calibration records	Lab Staff	LAB QCM	LCC Project files (electronic, LCC network)
Chain-of-Custody Forms / Airbills	LCC Field Staff	LCC QC	LCC Project files (electronic, LCC network)
Subcontractor Daily Reports	Subcontractor	LCC QC	LCC Project files (electronic, LCC network)
Deviations	LCC PS	LCC QC	LCC Project files (electronic, LCC network)
Nonconformances	LCC PS	LCC QC	LCC Project files (electronic, LCC network)
Corrective Action Reports	LCC PS	LCC PM/QA	LCC Project files (electronic, LCC network)
Project Assessments			
Record	**Generation**	**Verification**	**Storage location/archival**
Field Team Meeting minutes	LCC PS	None required	LCC Project files (electronic, LCC network)
Completed Safety, Health and Environment (SH&E) Management Site Visit form	LCC PS	LCC HSO Manager or designee	LCC Project files (electronic, LCC network)
Laboratory Records			
Record	**Generation**	**Verification**	**Storage location/archival**
Laboratory Data Report (PDF)	Laboratory	Laboratory Manager	LCC Project files (electronic, LCC network)
Electronic Data Deliverable (Microsoft Excel)	Laboratory	LCC Data Coordinator	LCC (electronic, LCC network)

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action
(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(EPA 2106-G-05 Section 2.4 and 2.5.5)

Assessment Response and Corrective Action

Assessment Type [1]	Frequency	Internal or External	Organization Performing Assessment	Person(s) responsible for performing assessment, title and organizational affiliation	Person(s) responsible for responding to assessment findings, title and organizational affiliation	Person(s) responsible for identifying and implementing corrective actions (CA), title and organizational affiliation	Person(s) responsible for monitoring effectiveness of CA, title and organizational affiliation
ID	Each Test	Internal	Phoenix Environmental Laboratories	Lab QA/QC	Assistant Lab Director	Assistant Lab Director	Lab QA/QC
Correct Analysis	Each Test	Internal	Phoenix Environmental Laboratories	Lab QA/QC	Assistant Lab Director		Lab QA/QC
Anomalous Result	Each Test	Internal	Phoenix Environmental Laboratories	Lab QA/QC	Assistant Lab Director		Lab QA/QC

[1] TSA = Technical Systems Audit

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action

Management Reports

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation, Title and Organizational Affiliation	Report Recipients, Title and Organizational Affiliation
Analytical	Each Test Conducted		QCM	Contracting Officer

QAPP Worksheet #34: Data Verification and Validation Inputs
(UFP-QAPP Manual Section 5.2.1 and Table 9)
(EPA 2106-G-05 Section 2.5.1)

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP		
2	The Specifications and Contract	X	X
3	Subcontract agreements		
4	Field SOPs	X	X
5	Laboratory SOPs	X	X
Field Report			
6	Chain of Custody	X	X
Analytical Data Package			
7	Cover sheet (laboratory identifying information)	X	X
8	Case narrative	X	X
9	Internal laboratory chain-of-custody	X	X
10	Sample receipt records	X	X
11	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	X	X
12	Communication records	X	X
13	Limit of detection/limit of quantification establishment and verification	X	X
14	Instrument calibration records	X	X
15	Definition of laboratory qualifiers	X	X
16	Sample results	X	X
17	QC sample results	X	X
18	Corrective action reports	X	X
19	Raw data	X	X
20	Electronic data deliverable	X	X

QAPP Worksheet #35: Data Verification Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Chain-of-custody forms	QAPP, field SOPs, laboratory SOPs	Verify the completeness of chain-of-custody records and entries for consistency with field records. Verify that custody forms are complete and correct, including sample IDs, preservation, analyses, dates, times, and signatures Check that appropriate methods and sample preservation have been recorded. Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify that all required signatures and dates are present. Check for transcription errors.	LCC Project Superintendent or designee (daily) Laboratory Sample Management (upon sample receipt) LCC QC/QA Manager
Laboratory Deliverable	QAPP	Verify that the laboratory deliverable contains all records specified in the QAPP. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the CoCs to verify that results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify that necessary signatures and dates are present.	Laboratory Project Manager (before release) LCC QC/QA Manager (upon receipt)
Audit Reports, Corrective Action Reports	QAPP	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	LCC Project Manager LCC QC/QA Manager

QAPP Worksheet #36 Data Validation Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Formal validation of analytical data is not required.

QAPP Worksheet #37: Data Usability Assessment
(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

An overall assessment of data usability is not required. Data review and verification are presented in Worksheet # 35.

References

- USACE Specifications W912WJ18B0016 Construct Waterline Durham Meadows, Durham, Connecticut
- AWWA C600-10 INSTALLATION OF DUCTILE-IRON MAINS AND THEIR APPURTENANCES
- United States Environmental Protection Agency: Quick Guide to Drinking Water
- Durham Meadows Waterline RD Disinfecting SOP
- Town of Middletown Water Storage Facilities SOP

QAPP Worksheet #37: Data Usability Assessment

Appendix A Laboratory Quality Management Manual and NELAC Certification

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL HEALTH SECTION

ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM
CERTIFIED ANALYTES REPORT FOR ALL MATRICES

Phoenix Environmental Laboratories, Inc.

587 EAST MIDDLE TURNPIKE
MANCHESTER, CT 06040

CT REGISTRATION NUMBER :	PH-0618
REGISTERED OWNER / AUTHORIZED AGENT :	Allan Caffyn
DIRECTOR :	Phyllis Shiller
CO DIRECTOR(S) :	Kathleen Cressia
PHONE :	(860) 645-1102
LABORATORY REGISTRATION EFFECTIVE DATE :	07/01/2018
LABORATORY REGISTRATION EXPIRATION DATE :	06/30/2020
LABORATORY STATUS :	APPROVED

APPROVED BY
SUZANNE BLANCAFLOR, MS, MPH
CHIEF, ENVIRONMENTAL HEALTH SECTION

REVIEWED BY 6/18/2018 2:36:23 PM
DERMOT JONES

ANY QUESTIONS CONCERNING THIS DOCUMENT SHOULD BE ADDRESSED TO THE ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM AT (860) 509-7389

QAPP Worksheet #37: Data Usability Assessment

DRINKING WATER (SDWA)

STATUS REPORTED ON 6/18/2018

ANALYTE NAME	
MICROBIOLOGY/BACTERIA	
E. COLI - COLILERT (SM9223 Enumeration & P/A)	
E. COLI - MF NUTRIENT AGAR + MUG (SM9222G)	ENTEROCOCCUS - ENTEROLERT
ENTEROCOCCUS - MF mEI Agar (EPA1600)	FECAL COLIFORM - MF m-FC (SM9222D)
HPC - POUR PLATE (SM9215B)	TOT COLIFORM - COLILERT (SM9223 Enumeration & P/A)
TOT. COLIFORM - MF mENDO (SM9222B)	
PHYSICALS	
COLOR	
CONDUCTIVITY	ODOR
pH	TEMPERATURE
TURBIDITY	
MINERALS	
ACIDITY	
ALKALINITY	CHLORIDE
CHLORINE, TOTAL & FREE RESIDUAL	FLUORIDE
HARDNESS, CALCIUM	HARDNESS, TOTAL
SULFATE	
NUTRIENTS	
AMMONIA	
NITRATE	NITRITE
O-PHOSPHATE	
METALS	
ALUMINUM	
ANTIMONY	ARSENIC
BARIUM	BERYLLIUM
BORON	CADMIUM
CALCIUM	CHROMIUM
COBALT	COPPER
IRON	LEAD
MAGNESIUM	MANGANESE
MERCURY	MOLYBDENUM
NICKEL	POTASSIUM
SELENIUM	SILVER
SODIUM	THALLIUM

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Phoenix Environmental Laboratories, Inc.

QAPP Worksheet #37: Data Usability Assessment

TIN	VANADIUM
ZINC	
RESIDUE	
TOTAL DISSOLVED SOLIDS	TOTAL RESIDUE (SOLIDS)
DEMANDS	
TOTAL ORGANIC CARBON	
MISCELLANEOUS	
CYANIDE (TOTAL)	
FOAMING AGENTS (MBAS)	
ORGANIC DISINFECTION BY-PRODUCTS	
BROMOACETIC ACID	
BROMOCHLOROACETIC ACID	CHLOROACETIC ACID
DIBROMOACETIC ACID	DICHLOROACETIC ACID
TRICHLOROACETIC ACID	
VOLATILE ORGANICS	
1,2-DIBROMO-3-CHLOROPROPANE 504.1 (DBCP) (SOC)	1,4-DIOXANE (522 SIM)
1,4-DIOXANE (Mod 8270)	ETHYLENE DIBROMIDE 504.1 (EDB) (SOC)
TOTAL TRIHALOMETHANES 524.2 (SOC)	VINYL CHLORIDE - 524.2
VOLATILE ORGANICS - 524.2 (SOCs)	
PESTICIDES/ PCB'S	
ALDRIN	CHLORDANE (TECHNICAL) (SOC)
DIELDRIN	ENDRIN (SOC)
HEPTACHLOR (SOC)	HEPTACHLOR EPOXIDE (SOC)
HEXACHLOROBENZENE (SOC)	HEXACHLOROCYCLOPENTADIENE (SOC)
LINDANE (BHC-GAMMA) (SOC)	METHOXYCHLOR (SOC)
METRIBUZIN	PCB's (Aroclors, Qualitative Only)
TOXAPHENE (SOC)	
HERBICIDES	
2,4,5-TP (SILVEX) (SOC)	
2,4-D (SOC)	DALAPON (SOC)
DICAMBA	DINOSEB (SOC)
DIQUAT (SOC)	GLYPHOSATE (SOC)
PARAQUAT	PENTACHLOROPHENOL (SOC)
PICLORAM (SOC)	
PHTHALATE ESTERS & ADIPATES	
BIS (2 - ETHYLHEXYL) ADIPATE - 525.3 (SOC)	
BIS (2 - ETHYLHEXYL) PHTHALATE - 525.3 (SOC)	
PAHS	
BENZO(a)PYRENE - 525.3 (SOC)	

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Phoenix Environmental Laboratories, Inc.

QAPP Worksheet #37: Data Usability Assessment

TRIAZINE PESTICIDES	
ALACHLOR (SOC)	ATRAZINE (SOC)
BUTACHLOR	METOLACHLOR
PROPACHLOR	SIMAZINE (SOC)
CARBAMATE PESTICIDES	
3 - HYDROXYCARBOFURAN	ALDICARB (SOC)
ALDICARB SULFONE (SOC)	ALDICARB SULFOXIDE (SOC)
CARBARYL	CARBOFURAN (SOC)
METHOMYL	OXAMYL (SOC)
RADIOCHEMICALS	
URANIUM - EPA 200.8	

QAPP Worksheet #37: Data Usability Assessment

NON-POTABLE WATER/ WASTEWATER (CWA)

STATUS REPORTED ON 6/18/2018

ANALYTE NAME	
MICROBIOLOGY/BACTERIA	
E. COLI - COLILERT (SM9223 Enumeration & P/A)	
E. COLI - MF NUTRIENT AGAR + MUG (SM9222G)	ENTEROCOCCUS - ENTEROLERT
ENTEROCOCCUS - MF mEI Agar (EPA1600)	FECAL COLIFORM - COLILERT-18 (Enumeration)
FECAL COLIFORM - MF m-FC (SM9222D)	FECAL STREPT - MF mEnterococcus Agar (SM9230C)
HPC - POUR PLATE (SM9215B)	TOT COLIFORM - COLILERT (SM9223 Enumeration & P/A)
TOT. COLIFORM - MF mENDO (SM9222B)	
PHYSICALS	
COLOR	
CONDUCTIVITY	ODOR
pH	TEMPERATURE
TURBIDITY	
MINERALS	
ACIDITY	
ALKALINITY	CHLORIDE
CHLORINE, TOTAL & FREE RESIDUAL	HARDNESS, CALCIUM
HARDNESS, TOTAL	SULFATE
SULFIDE	SULFITE
NUTRIENTS	
AMMONIA	
KJELDAHL NITROGEN	NITRATE
NITRITE	O-PHOSPHATE
TOTAL PHOSPHOROUS	
METALS	
ALUMINUM	ANTIMONY
ARSENIC	BARIUM
BERYLLIUM	BORON
CADMIUM	CALCIUM
CHROMIUM	CHROMIUM - Hexavalent
COBALT	COPPER
IRON	LEAD
MAGNESIUM	MANGANESE
MERCURY	MOLYBDENUM
NICKEL	POTASSIUM

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Phoenix Environmental Laboratories, Inc.

QAPP Worksheet #37: Data Usability Assessment

SELENIUM	SILVER
SODIUM	STRONTIUM
THALLIUM	TIN
TITANIUM	VANADIUM
ZINC	
RESIDUE	
TOTAL DISSOLVED SOLIDS	TOTAL RESIDUE (SOLIDS)
TOTAL SUSPENDED SOLIDS	TOTAL VOLATILE RESIDUE
DEMANDS	
BOD	
CARBONACEOUS BOD	COD
TOTAL ORGANIC CARBON	
MISCELLANEOUS	
CYANIDE (AMENABLE)	CYANIDE (TOTAL)
FOAMING AGENTS (MBAS)	FORMALDEHYDE
PHENOLICS	
INORGANIC DISINFECTION BY-PRODUCTS	
BROMIDE	
VOLATILE ORGANICS	
VOLATILE ORGANICS - 624.1	
PESTICIDES/ PCB'S	
ORGANOCHLORINE PESTICIDES - 608.3	
PCB IN OIL	PCBs - 608.3
TOXAPHENE	
SOLVENTS	
CT Extractable Petroleum Hydrocarbons (ETPH)	
MA Extractable Petroleum Hydrocarbons (EPH)	MA Volatile Petroleum Hydrocarbons (VPH)
OIL & GREASE	TPH (HEM/SGT)
HERBICIDES	
2,4,5-T	
2,4,5-TP (SILVEX)	2,4-D
2,4-DB	DALAPON
DICAMBA	
TRIAZINE PESTICIDES	
ALACHLOR	ATRAZINE
SIMAZINE	
RADIOCHEMICALS	
URANIUM	

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Phoenix Environmental Laboratories, Inc.

QAPP Worksheet #37: Data Usability Assessment

SEMIVOLATILES

SEMIVOLATILES - 625.1

QAPP Worksheet #37: Data Usability Assessment

RECREATIONAL WATER

STATUS REPORTED ON 6/18/2018

ANALYTE NAME
MICROBIOLOGY/BACTERIA
ENTEROCOCCUS - MF mEI Agar (EPA1600)

QAPP Worksheet #37: Data Usability Assessment

SOLID WASTE/SOIL (RCRA)

STATUS REPORTED ON 6/18/2018

ANALYTE NAME	
PHYSICALS	
pH	
MINERALS	
SULFIDE	
NUTRIENTS	
AMMONIA	KJELDAHL NITROGEN
TOTAL PHOSPHOROUS	
METALS	
ALUMINUM	
ANTIMONY	ARSENIC
BARIUM	BERYLLIUM
BORON	CADMIUM
CALCIUM	CHROMIUM
CHROMIUM - Hexavalent	COBALT
COPPER	IRON
LEAD	MAGNESIUM
MANGANESE	MERCURY
MOLYBDENUM	NICKEL
POTASSIUM	SELENIUM
SILVER	SODIUM
STRONTIUM	THALLIUM
TIN	TITANIUM
VANADIUM	ZINC
RESIDUE	
TOTAL RESIDUE (SOLIDS)	
TOTAL VOLATILE RESIDUE	
DEMANDS	
TOTAL ORGANIC CARBON	
MISCELLANEOUS	
CORROSIVITY	
CYANIDE (TOTAL)	IGNITABILITY
PHENOLICS	REACTIVITY
SPLP LEACH (1312)	TCLP LEACH (1311)

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Phoenix Environmental Laboratories, Inc.

QAPP Worksheet #37: Data Usability Assessment

PESTICIDES/ PCB'S	
CHLORDANE (TECHNICAL)	
ORGANOCHLORINE PESTICIDES (Single Response)	PCB IN OIL
POLYCHLORINATED BIPHENYLS	TOXAPHENE
SOLVENTS	
CT Extractable Petroleum Hydrocarbons (ETPH)	
MA Extractable Petroleum Hydrocarbons (EPH)	MA Volatile Petroleum Hydrocarbons (VPH)
OIL & GREASE	TOTAL ORGANIC HALIDES
TPH (HEM/SGT)	
HERBICIDES	
2,4,5-T	
2,4,5-TP (SILVEX)	2,4-D
DICAMBA	
TRIAZINE PESTICIDES	
ALACHLOR	
ATRAZINE	SIMAZINE
RCRA (SW-846) ORGANICS	
ACID EXTRACTABLES (PHENOLS) (SW 8270)	BENZIDINES (SW 8270)
CHLORINATED HYDROCARBONS (SW 8270)	HALOETHERS (SW 8270)
NITROAROMATICS & CYCLIC KETONES (SW 8270)	NITROSOAMINES (SW 8270)
PAH's (SW 8270)	PHTHALATES (SW 8270)
VOLATILE ORGANICS (SW 8260)	
RADIOCHEMICALS	
URANIUM	
ENVIRONMENTAL HEALTH & HOUSING	
LEAD (PAINT) IN SOIL	LEAD IN DUST WIPES
LEAD IN PAINT	

QAPP Worksheet #37: Data Usability Assessment

Report Profile:	Lab Name : Phoenix Environmental Laboratories, Inc.
	Test Name : *
	Matrix Name : *
	Matrix Selection = ALL OR SOME MATRICES SELECTED
	Certifications approved or provisional on 6/18/2018

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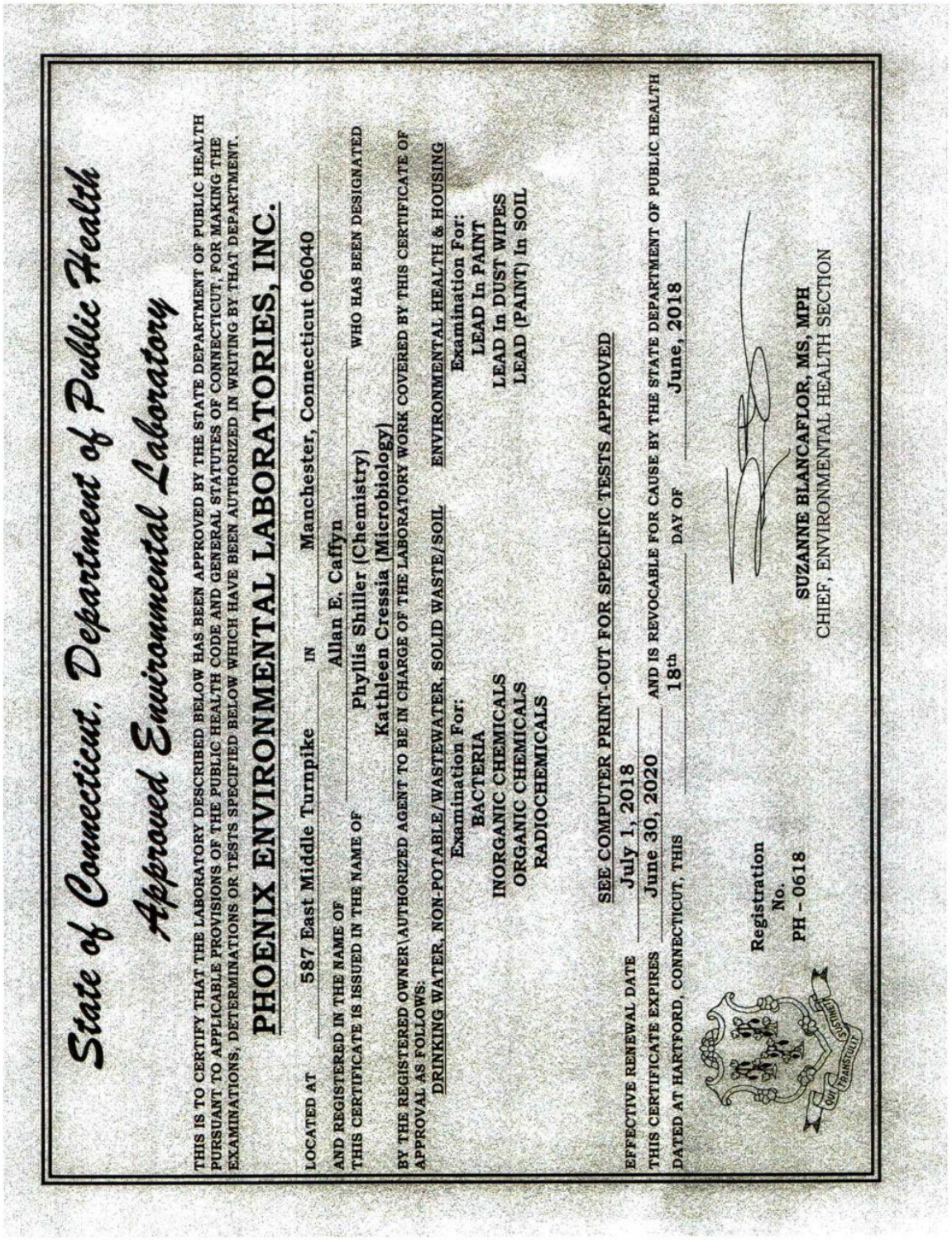
QAPP Worksheet #37: Data Usability Assessment

QAPP Worksheet #37: Data Usability Assessment



State of Connecticut, Department of Public Health
Approved Environmental Laboratory

THIS IS TO CERTIFY THAT THE LABORATORY DESCRIBED BELOW HAS BEEN APPROVED BY THE STATE DEPARTMENT OF PUBLIC HEALTH PURSUANT TO APPLICABLE PROVISIONS OF THE PUBLIC HEALTH CODE AND GENERAL STATUTES OF CONNECTICUT, FOR MAKING THE EXAMINATIONS, DETERMINATIONS OR TESTS SPECIFIED BELOW WHICH HAVE BEEN AUTHORIZED IN WRITING BY THAT DEPARTMENT.

PHOENIX ENVIRONMENTAL LABORATORIES, INC.

LOCATED AT 587 East Middle Turnpike IN Manchester, Connecticut 06040

AND REGISTERED IN THE NAME OF Allan E. Caffyn

THIS CERTIFICATE IS ISSUED IN THE NAME OF Phyllis Shiller (Chemistry) WHO HAS BEEN DESIGNATED
Kathleen Cressia (Microbiology)

BY THE REGISTERED OWNER\AUTHORIZED AGENT TO BE IN CHARGE OF THE LABORATORY WORK COVERED BY THIS CERTIFICATE OF APPROVAL AS FOLLOWS:

DRINKING WATER, NON-POTABLE/WASTEWATER, SOLID WASTE/SOIL
Examination For:
BACTERIA
INORGANIC CHEMICALS
ORGANIC CHEMICALS
RADIOCHEMICALS

ENVIRONMENTAL HEALTH & HOUSING
Examination For:
LEAD In PAINT
LEAD In DUST WIPES
LEAD (PAINT) In SOIL

SEE COMPUTER PRINT-OUT FOR SPECIFIC TESTS APPROVED

EFFECTIVE RENEWAL DATE July 1, 2018

THIS CERTIFICATE EXPIRES June 30, 2020 AND IS REVOCABLE FOR CAUSE BY THE STATE DEPARTMENT OF PUBLIC HEALTH

DATED AT HARTFORD, CONNECTICUT, THIS 18th DAY OF June, 2018

Registration No. PH - 0618

SUZANNE BLANCAFLOR, MS, MPH
CHIEF, ENVIRONMENTAL HEALTH SECTION

QAPP Worksheet #37: Data Usability Assessment

Appendix B SOP-001 Durham Meadows Waterline Testing Plan

Durham Meadows Waterline RD Disinfecting Water Distribution System

Section No. 02515-4
PART 3 - EXECUTION
3.01 PREPARATION:

A. Isolate new work being disinfected from system to avoid possibility of contaminating materials entering distribution system.
B. Water Storage Facilities:
    a. Remove debris and material not part of structural or operating facilities of tank.
    b. Clean using high pressure water jet or other equally effective means to remove dirt
C. and foreign material.
    a. Cleaning shall:
        i. Remove deposits of foreign nature.
        ii. Remove growths.
        iii. Broom walls, floor, and ceiling.
        iv. Avoid damage to structure.
        v. Avoid contamination by workers and equipment.
    b. Remove water, dirt, and foreign material and dispose.
    c. Water used in cleaning reservoir shall be wasted before adding chlorinating agent to reservoir.
D. Method of disinfection for water containment devices and piping systems shall conform to AWWA C651 and AWWA C652.

QAPP Worksheet #37: Data Usability Assessment

Town of Middletown Water Storage Facilities SOP

City of Middletown Water and Sewer Department
Disinfection of Water Storage Facilities

Tank shall be isolated from the distribution system. All valves shall be operated by Water and Sewer Department personnel.

The interior of the tank shall be inspected by Water and Sewer Department Personnel prior to any filling or disinfection. There shall be no debris, spills, or equipment in the tank. Special care should be taken to inspect the overflow and drain piping to be sure they are free of debris.

Water and Sewer Personnel shall operate valves to fill the tank. No one shall be inside the tank during filling operations. Water and Sewer Personnel shall be on site during all filing operations.

Water storage facilities shall be disinfected in accordance with latest revision of AWWA C-652. The City's preferred method is Chlorination Method 3 using sodium hypochlorite:

Method 3

1. The storage tank shall be filled to a level that equals 5% of its total volume.
2. The sodium hypochlorite should be added after the water level has reached 1 foot.
3. An adequate volume of sodium hypochlorite shall be added to ensure a chlorine concentration of 50 ppm when filled to 5% of the tank's total volume.
4. The tank manways and hatches shall be closed and sealed.
5. This chlorine solution shall be held in the tank for a minimum of 6 hours.
6. The storage tank shall then be filled to overflow level using potable water from the distribution system. The chlorine concentration should be equal to 2 ppm and held in the storage tank for a minimum of 24 hours.

Water quality sampling shall be conducted after the 24 hour disinfection period.

Once the sampling results have demonstrated that the storage tank meets water quality standards, Water and Sewer Department personnel may put the tank into service. The Water and Sewer Department will make the final determination of acceptance.

If the tank is not placed back into service within 24 hours of acceptance, additional testing may be required by this Department to be sure water quality has not deteriorated.

Contractors

1. Contractors shall submit a written plan for water storage tank disinfection for Department approval at least 10 days in advance of work.
2. No disinfection work may begin without prior approval from the Water and Sewer Department.
3. All disinfection work shall be coordinated with the Water and Sewer Department at least 72 hours in advance.

QAPP Worksheet #37: Data Usability Assessment

Water Main Service Specs

QAPP Worksheet #37: Data Usability Assessment

City of Middletown
WATER & SEWER DEPARTMENT
82 Berlin Street
Middletown, CT 06457
TEL: (860) 638-3500
FAX: (860) 343-8091

GENERAL REQUIREMENTS
WATER MAIN AND SERVICE INSTALLATION
JANUARY 2017

WATER MAINS: Cement lined ductile iron pipe, push on "Tyton" type joints and mechanical joints. Size varies, Class 52 (typical) per ANSI/AWWA C151/A21.51. Class 54 TR Flex type joints on Bridges and/or railroad crossings. Contact Water Department for exact information.

WATER SERVICES: A separate service is required for each building or structure on a lot.

Underground:
Type "K" copper tubing with compression joints. Sizing 1, 1½ and 2 inch. Provide Smith Blair Model #317 double strap, stainless steel service saddle for services 1-½ or 2 inch in size.

In House:
Type "K" copper tubing with flared joint connections to main shutoff valve. Shut off valve shall have a full port opening.

FIRE SERVICES: Same as water mains, minimum tap size by the Middletown Water Department is 6 inches.

VALVES: 6" to 12" resilient seal gate valves; (Clockwise, Open Right).

Mueller, Clow or Kennedy or approved equal.

16 inch and above butterfly valves; Mueller or Pratt.

Provide Valve Box Adaptor II by Adaptor, Inc. for all valve and gate boxes.

QAPP Worksheet #37: Data Usability Assessment

GENERAL REQUIREMENTS
WATER MAIN AND SERVICE INSTALLATION
CONTINUED

VALVES (CONT.):	Gate valve nut shall be 2 to 3-½ feet below finish grade. Provide Geneco 5VR-D gate valve nut extension as needed.
HYDRANTS:	Mueller Super Centurion 4-½ inch Barrel, 5-foot Bury Depth Typical. (Counter Clockwise, Open Left). Multiple extensions are not acceptable. Different bury depths or hydrant lateral offsets may be required to avoid multiple extensions or As Ordered by Engineer (A.O.B.E.). Grade adjustment are available in 6-Inch increments. Place a minimum of six cubic feet of ¾ inch crushed stone for hydrant bleed off below weep holes. Hydrants shall be factory painted John Deere Green on the bonnet and caps and John Deere Yellow for the remainder.
MINIMUM COVER:	The minimum cover for mains and services is 4-½ feet to top of pipe. Insulated piping or rigid insulation may be required at drainage structures or A.O.B.E.
SEPARATION:	The minimum horizontal separation distance shall be 10 feet from sanitary sewers and/or 18 inches vertical. It is preferred to have the water main above the sanitary sewer wherever possible. Maintain a minimum of five feet horizontal separation for all other utilities.
FITTINGS:	Cement lined ductile iron, mechanical joint, size and pressure rating compatible with adjoining pipe. No 90 degree bends allowed use two 45 degree bends instead.
RESTRAINTS:	A joint restraint harness or EBAA Megalug shall be installed at all fittings. Joint restraints are to be installed on a minimum of two pipe joints either side of the fittings (50 feet minimum each side). Thrust blocks, solid concrete blocks with oak wedges, are to be installed at all bends, tees, hydrants or A.O.B.E., against undisturbed earth. Poured thrust blocks shall be installed A.O.B.E.
HYDRANT BRANCHES:	Hydrant Branches shall be completely retained and blocked, or clamped and laced, A.O.B.E. Anchor tees are acceptable.
DEAD ENDS:	Shall be retained and blocked, or clamped and laced, A.O.B.E. (3 lengths or 50 feet minimum). A blow off shall be installed at the end with a curb stop or gate valve.

QAPP Worksheet #37: Data Usability Assessment

GENERAL REQUIREMENTS
WATER MAIN AND SERVICE INSTALLATION
CONTINUED

VALVE LAYOUT: Three way valving shall be required at all intersection tees and four way valving shall be required at all intersection crosses or A.O.B.E. Single valving on all hydrant branches and fire services. Location of valve shall be determined by the Engineer in the field.

PAVEMENT: Pavement removal and/or replacement shall be in accordance with the latest City of Middletown DPW standards.

TAPPING SLEEVES: Shall be Mueller Mechanical Joint Tapping Sleeve H-615 on all taps that are the same size as the main. Outlet flange gaskets shall be 1/8" thick Nitrile (Buna-N) and NSF 61 approved.

All other tapping arrangements use Smith Blair 622 of 625 Tapping Sleeves or approved equal. Outlet flanges shall be mechanical joint.

The contractor shall follow the manufacturer's recommendations regarding installation, including a 120 psi air test to be witnessed by the Water Department prior to performing the tap.

NEW WATER MAIN: The procedure for bringing a newly installed water main into service shall follow these steps: fill main, check chlorine residual, flush, check chlorine residual, collect a bacteria sample (Wednesdays only), and pressure test once bacterial sample passes.

DISINFECTION: The contractor may secure in place chlorine tablets during installation to obtain a minimum chlorine concentration of 25 ppm for a duration of 48-hours. Alternately, the contractor may continuously inject a chlorine solution or use granulated powder to acquire a minimum concentration of 50 ppm.

Granulated powder may be placed in the piping during installation or liquid chlorine can be injected through a corporation cock after installation until a concentration of 50 ppm is maintained for a minimum of 24-hours. The highly chlorinated wastewater shall be discharged to the sanitary sewer if possible or dechlorinated prior to discharge. This procedure must meet or exceed the AWWA Standard C 651.

QAPP Worksheet #37: Data Usability Assessment

GENERAL REQUIREMENTS
WATER MAIN AND SERVICE INSTALLATION
CONTINUED

FLUSHING: Discharge to sanitary sewer, if possible or to storm sewer utilizing best management practices including dechlorination, A.O.B.E. Contractor is responsible for all necessary appurtenances, flow monitoring and chemicals.

BACTERIA TEST: Per City Requirements. Samples can only be collected on Wednesdays.

PRESSURE TEST: A typical pressure test shall maintain a pressure of 200 psi for two hours. If the pressure drops below 200 psi than the resulting leakage must meet the minimum allowable per AWWA C 600.

TRENCH BACKFILL: Backfill to one foot above the water main shall be in accordance with the latest Water Department standards (see typical trench detail). The remainder of the trench backfill shall be in accordance with the latest City of Middletown DPW standards.

JOINT DEFLECTION: Unless otherwise approved, joint deflection for pipes sized 6 inches thru 12 inches inclusive shall be limited to 80% of the manufacturer's recommended maximum allowable deflection. Joint Deflection shall not exceed 4 degrees.

GRID SPACING: Grid spacing shall not exceed approximately 100 feet per inch of pipe diameter.

i.e.: 8 inch pipe 800 feet
12 inch pipe 1,200 feet

Grid spacing must be approved by the City of Middletown Water and Sewer Department.

VALVE SPACING: In addition to 3 or 4 way intersection valving, additional valve spacing shall generally not exceed grid spacing. Valve spacing must be approved by the City of Middletown Water and Sewer Department.

QAPP Worksheet #37: Data Usability Assessment

GENERAL REQUIREMENTS
WATER MAIN AND SERVICE INSTALLATION
CONTINUED

HYDRANT SPACING: Hydrant spacing shall generally not exceed the following:

Low Density	600 feet
High Density	300 feet

The City of Middletown Water Department and the Fire Marshall of the appropriate Fire District must approve hydrant spacing.

BACKFLOW PREVENTERS: Must be installed per the State of Connecticut Regulations. Submit plans/shop drawings for review and approval by Engineer.

BOOSTER PUMPS: Booster pumps shall be installed in the event that the second floor shower pressure is less than 40 psi.

PRESSURE REDUCERS: Pressure reducers shall be installed when the basement pressure exceeds 80 psi.

WATER METERS: All water meters shall be installed in an accessible location approximately two feet above the finished floor and no more than five feet from the shut off valve. The main shut off valve shall be within 8-inches of the service entrance. No taps or drain valves shall be located before the meter.

COUPLINGS/SLEEVES: Use a mechanical joint (M.J.) solid sleeve. If M.J. solid sleeve does not fit on non-standard cast iron pipe, then the contractor may request approval for a Smith Blair #442 cast coupling, minimum length shall be 12 inches.

MARKING TAPE: Provide detectable blue marking tape, six inches wide, located 12 inches above the water main or service.

ABANDONMENT: If water service is to be abandoned, the water service will be brought back to the corporation cock at the main. The gate valve, tee or tapping sleeve and gate valve shall be removed from the main and replace with ductile iron pipe and solid sleeves or A.O.B.E.

SUBMITTALS: Cut sheets for all materials to be used for construction must be submitted to the Water Department for review and approval two weeks prior to construction.

QAPP Worksheet #37: Data Usability Assessment

GENERAL REQUIREMENTS
WATER MAIN AND SERVICE INSTALLATION
CONTINUED

INFORMATION: All installations, building connections, valve operations, and test procedures must be cleared with the City of Middletown Water Department. Phone Number: 860-638-3500. Use the following extensions 860-638-XXXX:

Chief Engineer	3515
Assistant Chief Engineer	3517
Markouts/Inspections	3520
Backflow Prevention	3526
Distribution	3540

Provide the department with notification at least 48 hours prior to commencement of work. Any water main work requiring a shut down requires a minimum 10 day notification of those customers impacted by the shut down.

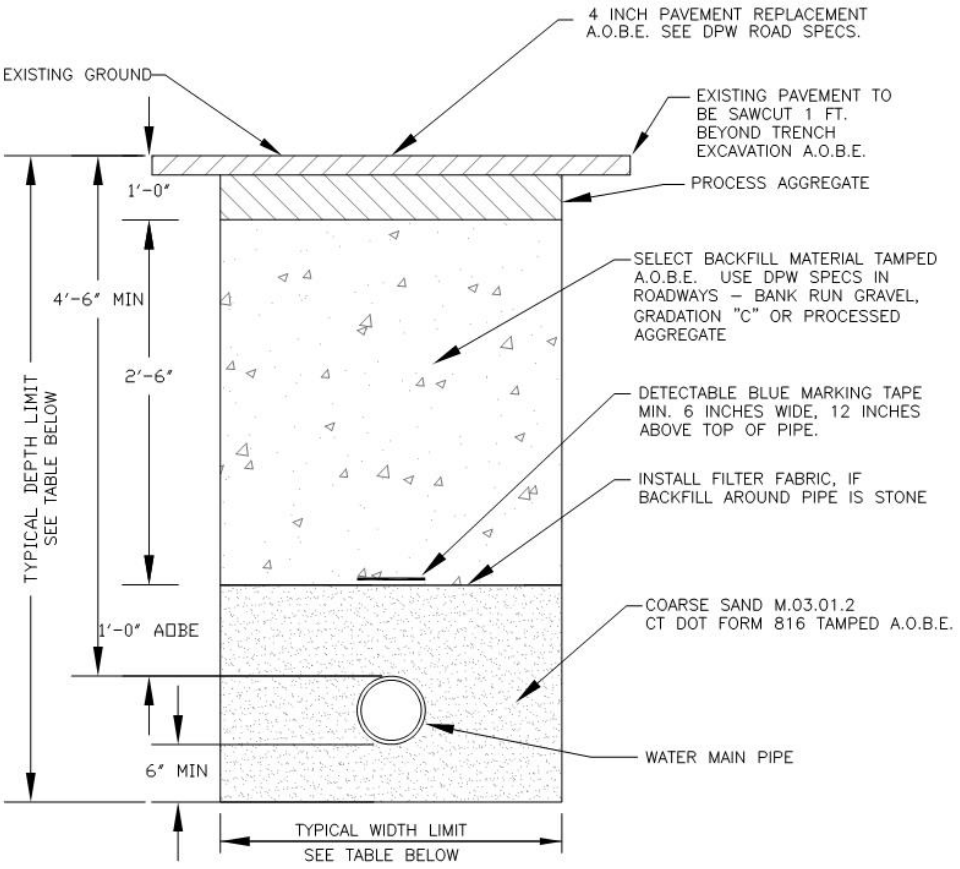
AS BUILT: Upon completion of work, 12 inch x 30 inch as-built drawings shall be furnished to the Water Department, for review and approval. Upon approval provide mylar prints and electronic copies in PDF and AutoCAD formats.

PUNCH LISTS: Prior to acceptance of a project the Department with generate a punch list with regard to the project. Two punch list inspections will be included. If more than two inspections are required to accept a project there is a fee that will be charged in accordance of City of Middletown Ordinances.

INSPECTIONS: If it is necessary to provide inspections during non working hours there will be an overtime charge to the contractor.

QAPP Worksheet #37: Data Usability Assessment

TYPICAL TRENCH CROSS-SECTION
(WATER OR FIRE SERVICE)
N.T.S.



TRENCH STANDARD LIMITS

PIPE SIZE	WIDTH	DEPTH
6"	3.0'	5.5'
8"	3.0'	5.6'
12"	3.0'	5.9'
16"	3.4'	6.2'
20"	3.9'	6.6'
24"	4.3'	6.9'

NOTE:

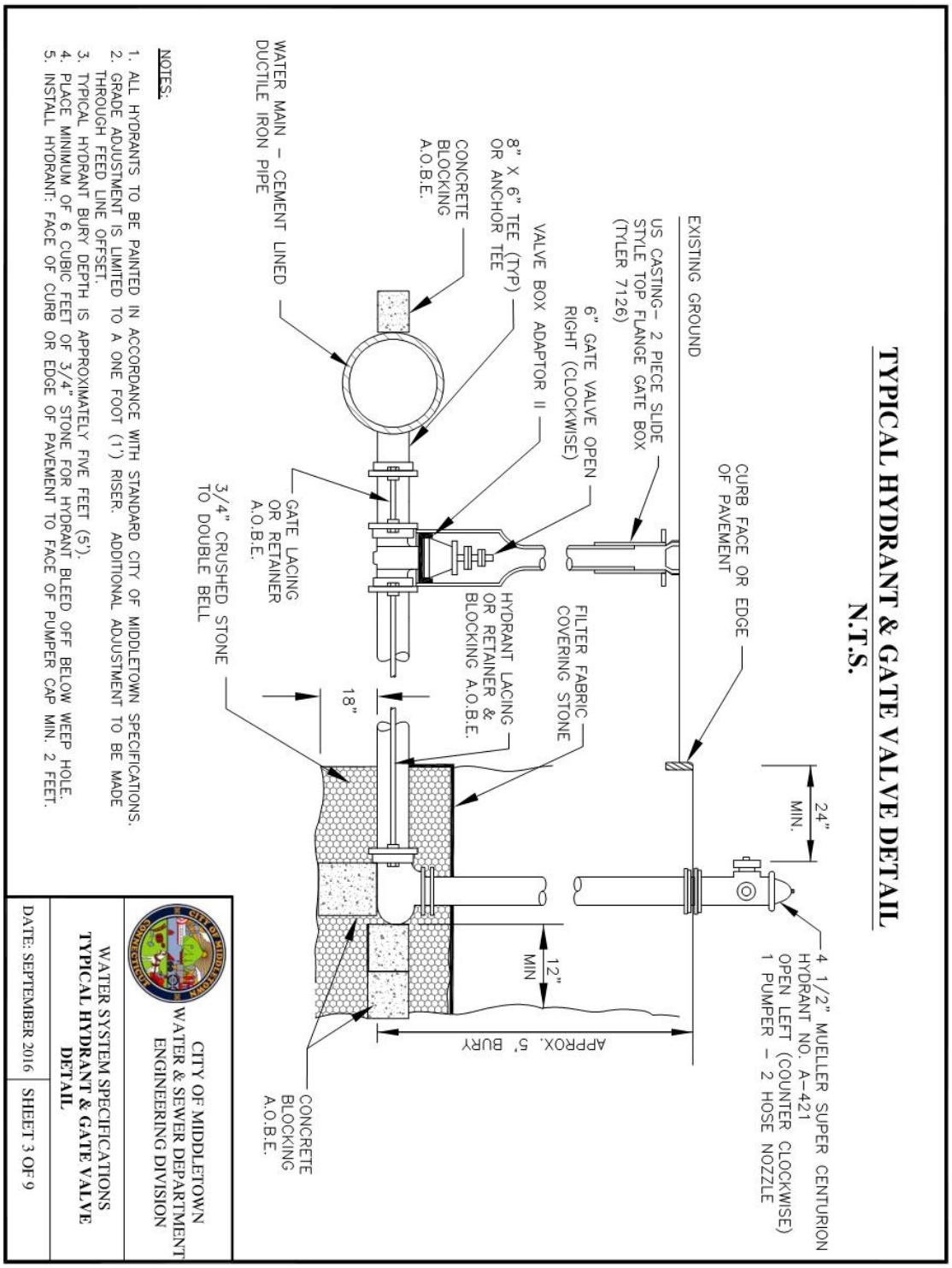
PROVIDE GATE VALVE NUT EXTENSION IF NUT IS DEEPER THAN THREE FEET BELOW FINAL GRADE. (AOBE). THE NUT EXTENSION SHALL BE A GENECO MAIN VALVE STEM EXTENSION PART NO. 5VR-D.

CITY OF MIDDLETOWN
WATER & SEWER DEPARTMENT
ENGINEERING DIVISION

WATER SYSTEM SPECIFICATIONS
TYPICAL TRENCH CROSS-SECTION

DATE: SEPTEMBER 2016 | SHEET 1 OF 9

QAPP Worksheet #37: Data Usability Assessment



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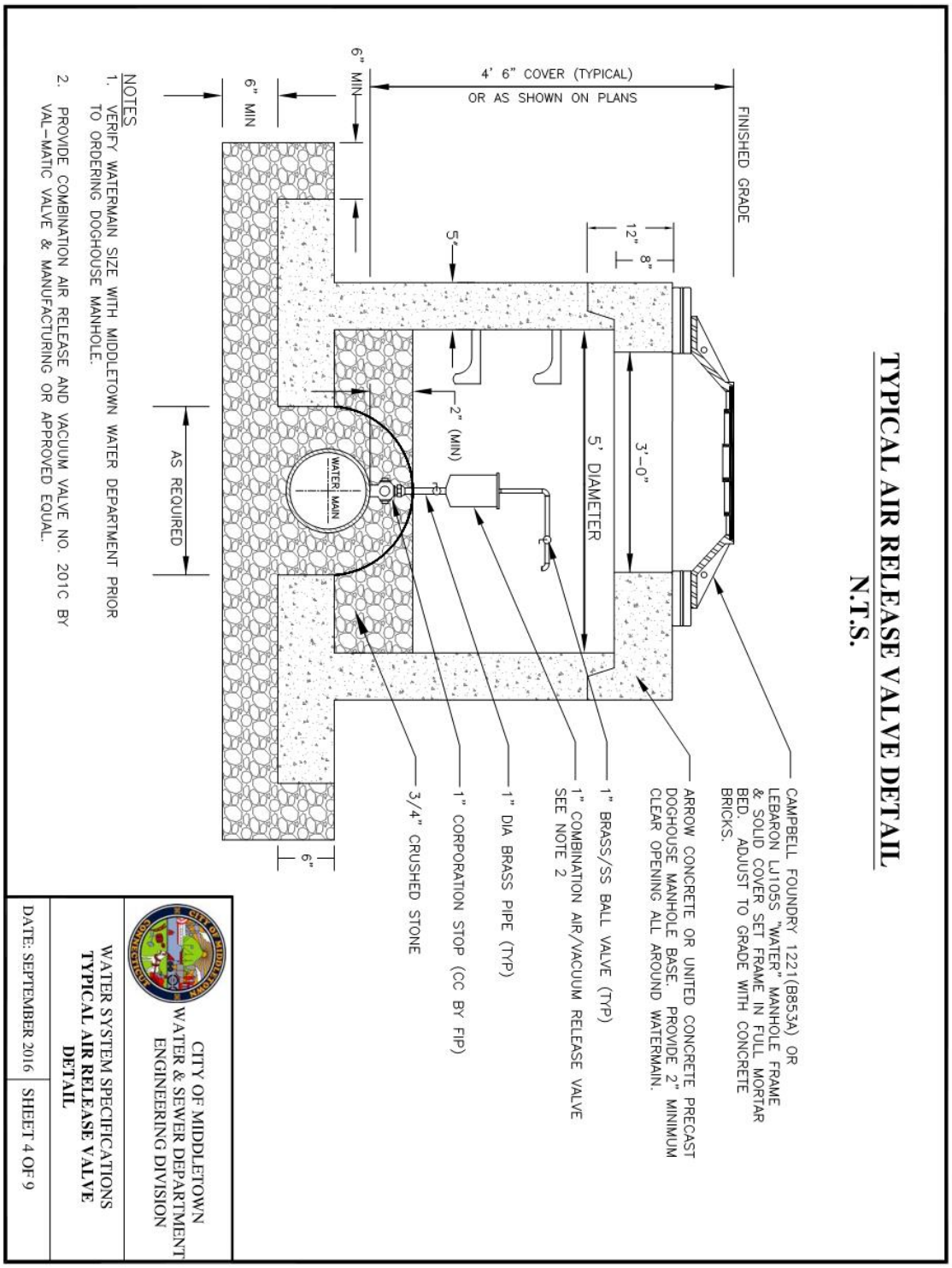

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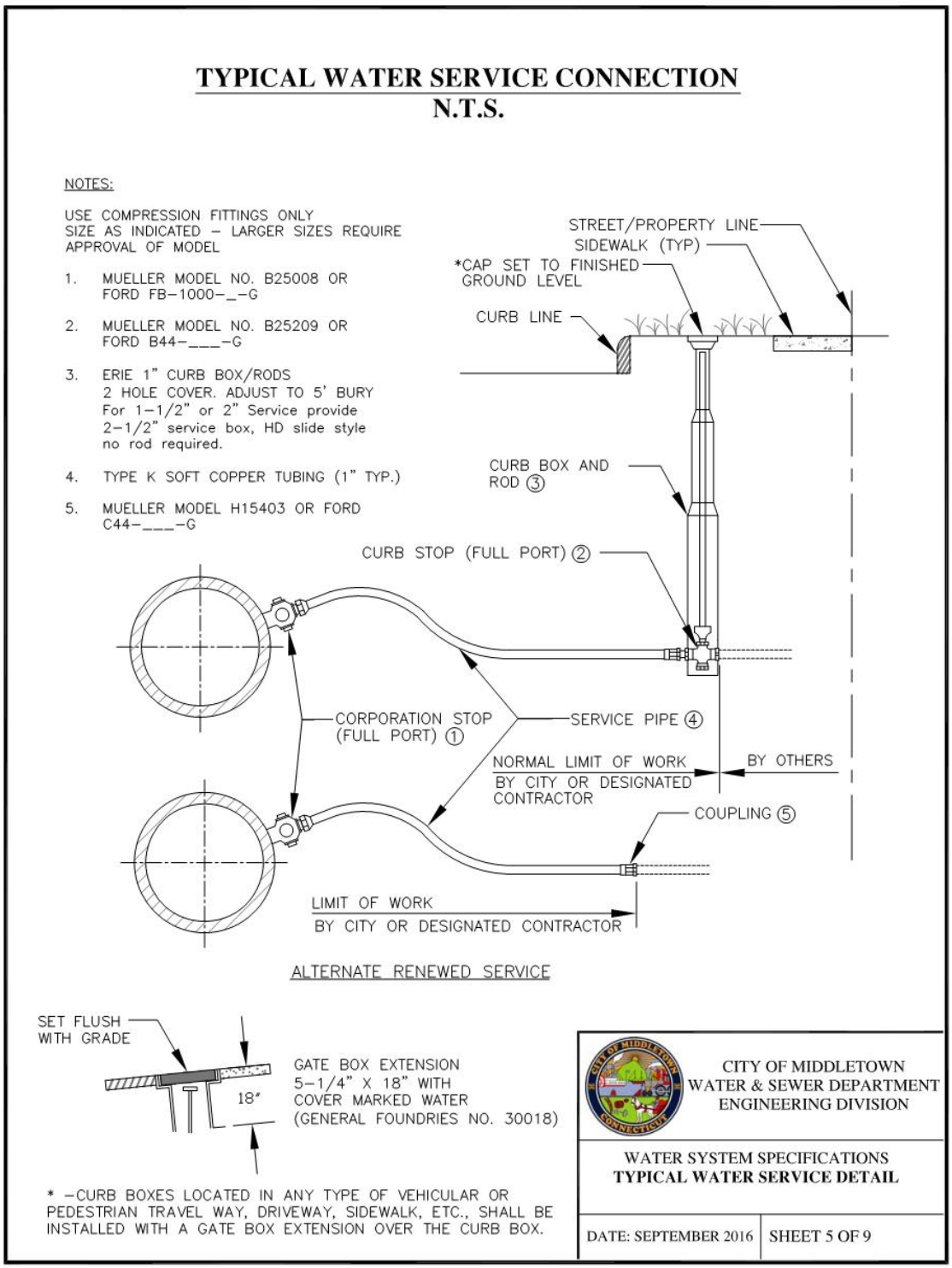
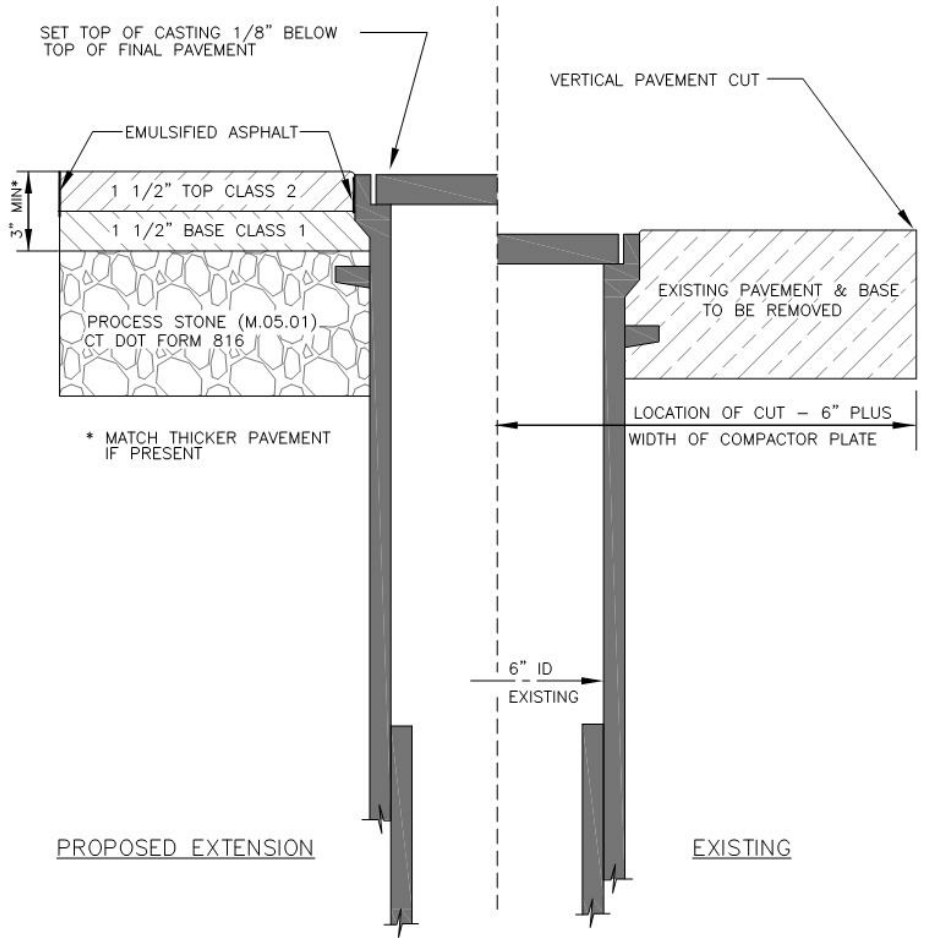


QAPP Worksheet #37: Data Usability Assessment

TYPICAL RAISING OF GATE BOX TO GRADE
N.T.S.



NOTES:

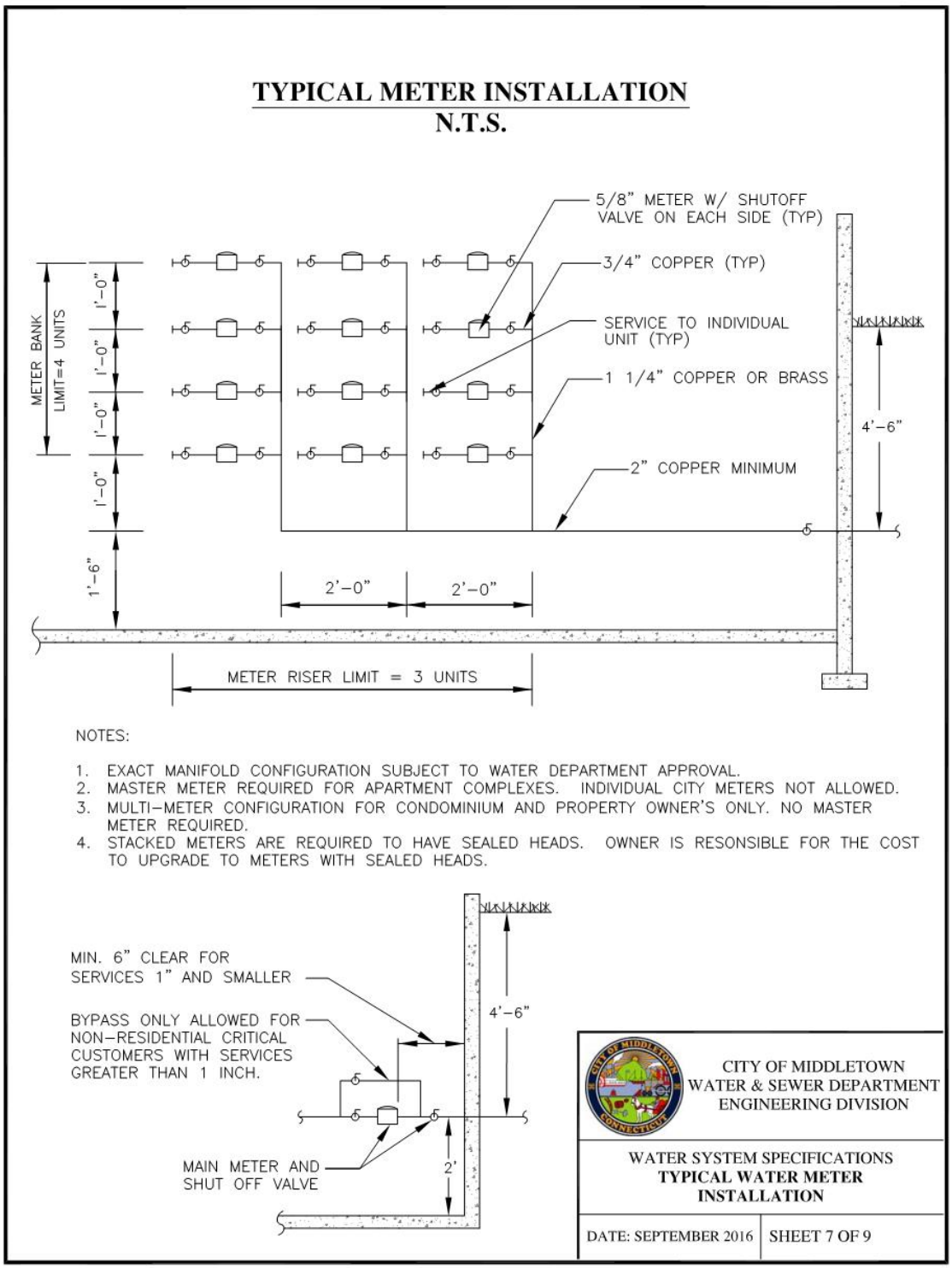
1. EXTEND EXISTING RISER TO NEW GRADE IF FEASIBLE AND REUSE EXISTING COVER.
2. IF EXTISTING GATE BOX CAN'T BE EXTENDED THEN USE A RISER EXTENSION, GENERAL FOUNDARIES 30018. NO RISER RINGS WILL BE ALLOWED.
3. PROVIDE GENECO GATE VAVLE NUT EXTENSION 5VR–D IF NEEDED.

CITY OF MIDDLETOWN
WATER & SEWER DEPARTMENT
ENGINEERING DIVISION

WATER SYSTEM SPECIFICATIONS
TYPICAL RAISING OF GATE BOX

DATE: SEPTEMBER 2016 | SHEET 6 OF 9

QAPP Worksheet #37: Data Usability Assessment



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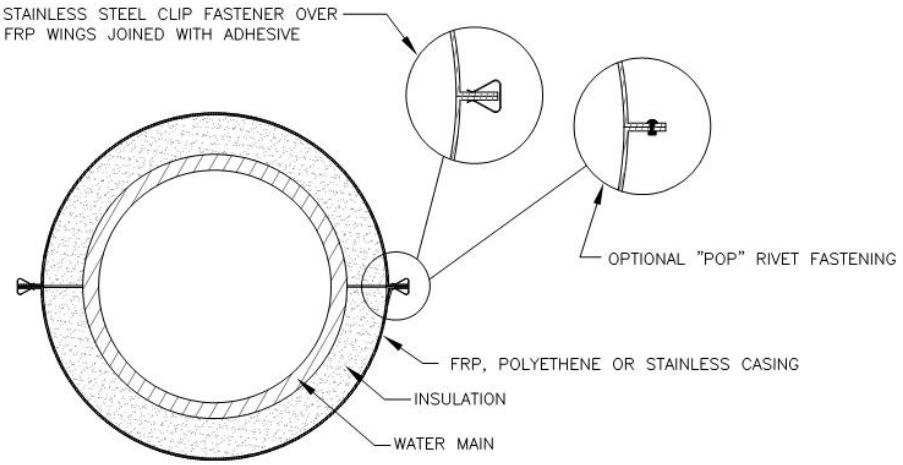
TYPICAL PRE-INSULATIED WATER MAIN PIPING
N.T.S.



NOTES:

WHERE THE POTABLE WATER MAIN IS EXPOSED OUTDOORS, OR BURIED LESS THAN 36 INCHES BELOW THE SURFACE IT SHALL BE INSULATED AND PROTECTED AS HEREIN DESCRIBED.

INSULATION SHALL BE RIGID POLYURETHANE FOAM 3 PCF MINIMUM DENSITY WITH MAXIMUM "K" OF 0.170, 90% MINIMUM CLOSED CELL QUALITY WHEN FOAM HAS CURED.

THE OUTER CASING SHALL BE:

1) CONCEALED PIPE – CONTINUOUS FIBERGLASS FILAMENT HELICALLY CROSSWOUND UNDER TENSION WITH ISOPHTHALIC THERMOSETTING POLYESTER RESIN TO 1/16 INCH MINIMUM FINISHED THICKNESS, IT SHALL BE STRUCTURALLY STRONG, CORROSION RESISTANT AND AIR TIGHT; OR HIGH DENSITY POLYETHYLENE 3/16 INCH MINIMUM THICKNESS.

2) EXPOSED PIPE – PROVIDE STAINLESS STEEL OUTER JACKET WITH A MINIMUM 22 GAUGE. THE STAINLESS STEEL SHEETS SHALL BE FACTORY BANDED WITH 1/2 INCH BANDS EVERY 12 INCHES. THERE SHALL BE AN OVERLAP OF THREE INCHES AT EVERY SEEM.

FIELD JOINTS SHALL BE COMPOSED OF HALF SEGMENTS OF INSULATION AND CASING BANDED IN PLACE AND SEALED WITH COMPATIBLE SEALANT OT ADJACENT INSULATION.

PREINSULATED PIPING SYSTEM SHALL BE U.I.P. BY INSULATED PIPE BY URECON LTD., OR APPROVED EQUAL.

FOR SITUATIONS WHERE THE PIPE IS LESS THAN 36 INCHES FROM A STORM WATER STRUCTURE PROVIDE EITHER TWO INCH RIGID INSULATION OR PREINSULATED PIPE IDENTIFIED ABOVE THE LENGTH OF THE STRUCTURE.

CITY OF MIDDLETOWN
WATER & SEWER DEPARTMENT
ENGINEERING DIVISION

WATER SYSTEM SPECIFICATIONS
TYPICAL RE-INSULATED WATER MAIN

DATE: SEPTEMBER 2016 | SHEET 8 OF 9

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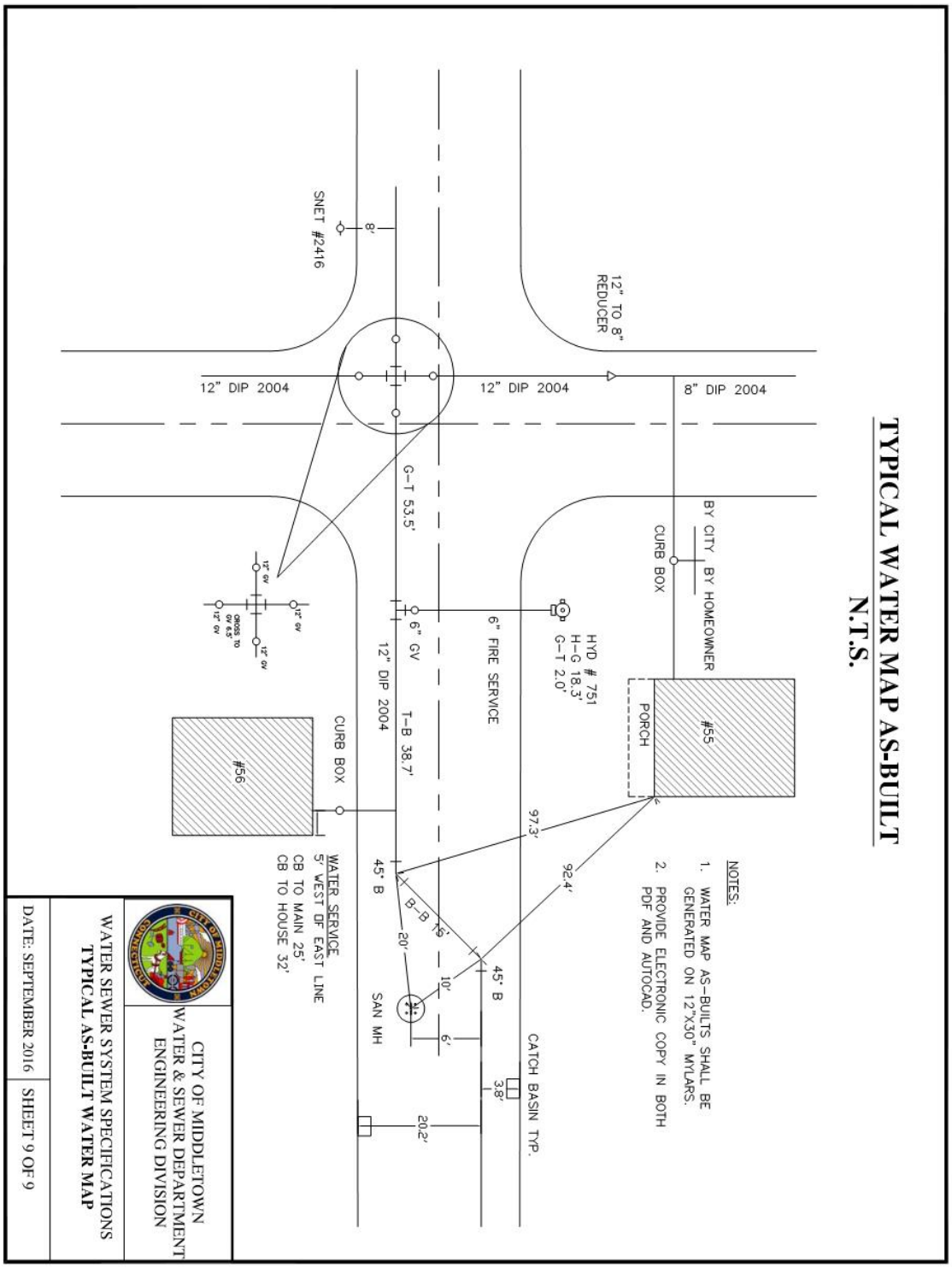

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QAPP Worksheet #37: Data Usability Assessment

Appendix C SOP-003 Laboratory Standard Operating Procedures

SOP - 003a Coliform SOP

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PHOENIX
Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O. Box 370, Manchester, CT 06040
Telephone: 860.645.1102 • Fax: 860.645.0823

Effective Date: 2/14/17
Version Number: 7.1
Initiated By: Kathy Cressea
Approved By: Kashmir Makol

SOP No.: 407

1.0 Title: Total coliform in Drinking Water by Colilert

2.0 Applicable Matrix or Matrices

2.1 This method covers the determination of coliform bacteria in drinking water.

3.0 Detection Limit

3.1 This method is not used for quantification of the bacterial density of coliform in a sample, but rather for establishing its presence or absence in a sample. Any level of coliform in a drinking water is considered potentially hazardous.

4.0 Scope and Application

4.1 Total coliform is an indicator organism for contamination of drinking water by run-off or another relatively innocuous source. Drinking waters are tested for Coliform bacteria not because they cause disease directly, but because when coliforms are present in a water source, it can be assumed that other more threatening bacteria and compounds are present. Often times, a sample found to be positive for total coliform is so because the well system has failed and is being exposed to rain runoff or animal activity. *E.coli* is an indicator organism for contamination of drinking water by septic, sewage or other sources of fecal waste. Unlike other coliforms, *E.coli* can cause disease directly, and is considered a serious health hazard.

5.0 Summary of Method

5.1 A 100 ml aliquot of sample is dosed with a packet of Colilert or Colilert-18 media. The sample is then incubated at optimum temperature for an optimum period of time. A change in the color of the sample from clear to yellow indicates the presence of Total Coliform. When a positive sample is viewed under UV light, a fluorescent glow indicates the presence of *E.coli.*

5.2 A sample that is positive for Total Coliform mayor may not be positive for *E.coli.* A sample that is negative for Total Coliform is necessarily negative for *E.coli.* A sample that is positive for *E.coli* is necessarily positive for Total Coliform.

5.3 Record into Bacteria logbook as to whether Colilert or Colilert-18 was used and record lot number of media used.

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6.0 Definitions

6.1 Blank- A portion of sterile water that is subjected to all steps of the method just like a sample. The blank is used to determine if there was possible bacterial contamination in the procedure.

6.2 Total Coliform- see Scope and Application section. It includes genuses *Enterobacter, Klebsiella, Citrobacter* and *Escherichia.*

6.3 E. Coli- *Escherichia Coli,* see Scope and Application section.

7.0 Interferences

7.1 If a sample has color, make note of the color of the sample. A colored sample may give a false positive reading if the original color of the sample is similar to the color change of positive samples. It may be necessary to compare the color of the sample before and after incubation. Reserve some unpreserved sample for this purpose if it is available.

7.2 When using Colilert, water with high iron or manganese levels in the presence of hydrogen sulfide may cause a greenish-black to black color change. Should this occur, request another sample and perform using the membrane filtration method.

8.0 Safety

8.1 The analyst must know and observe the normal safety procedures required in a microbiology laboratory while preparing, using and disposing of cultures, reagents, and materials, and while operating sterilization equipment.

8.2 Mouth pipetting is prohibited.

8.3 Refer to SOP#805 for more information on lab safety.

9.0 Equipment and Supplies

9.1 Bunsen burner.

9.2 Incubator, able to maintain an internal temperature of 35.0ºC +/- 0.5º C.

9.3 Water bath Incubator, able to maintain an internal temperature of 44.5ºC +/- 0.5ºC.

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9.4 UV light box for viewing *E.coli* fluorescence.

9.5 Sterile sample containers, 120mL with a 100mL fill-line.

9.6 Sterile sample containers, 120mL with a 100mL fill-line, with sodium thiosulfate preserve for chlorinated sources.

10.0 Reagents and Standards

10.1 Dilute Clorox solution, 10%. Dilute 50mL Clorox Bleach to 500mL DI water.

10.2 Colilert 24 hour test packets. IDEXX Cat No. WP2001. Store at room temperature. Discard after manufacturer's expiration date.

10.3 Colilert 18 hour test packets. IDEXX Cat No. WP200-18. Store at room temperature. Discard after manufacturer's expiration date.

10.4 Quanti-cult or Microbiologics Kwik-Stik dehydrated microorganisms or equivalent.

10.5 Tryptic soy broth, dehydrated media. Prepare per manufacturer's instructions.

10.6 Low level Chlorine test strips- EM Science, or equivalent.

11.0 Sample Collection, Preservation, Shipment and Storage

11.1 Drinking waters to be analyzed for total coliform and *E.coli* must be sampled aseptically in sterile containers, treated with sodium thiosulfate if from a chlorinated source.

11.2 Sterile bottles must be filled at or above the 100 ml fill line. If filled above the line, one inch of air space must be present for proper shaking.

11.3 Sample must be stored between 1-5ºC until time of analysis, and must be analyzed within 30 hours of the time of sampling.

11.4 Samples are kept separate from the general samples in the walk-in sample storage refrigerator. Store bacteria samples in the plastic bin to reduce the chance of in-house contamination.

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12.0 Quality Control

12.1 All medias are labeled with the date received, date opened, and the Phoenix Bacteria Lot Number.

12.2 All reagents and media are numbered with Phoenix Bacteria Lot Numbers as they are received in the lab.

12.3 Each manufacturer lot of media is tested with positive and negative controls: *P.aeruginosa, K.pneumoniae,* and *E.coli.*

12.3.1 Refer to the manufacturer's instructions on hydrating control bacteria samples.

12.3.2 Analyze each as a sample, being mindful of aseptic technique.

12.3.3 Interpret the findings. The *P.aeruginosa* sample should be found to be negative for total Coliform and negative for *E.coli.* The *K.pneumoniae* sample should be found to be positive for total Coliform and negative for *E. coli.* The *E. coli* sample should be found to be positive for total Coliform and positive for *E. coli.*

12.3.4 If your results match your expectations, the media is verified and may be used for sample analysis.

12.3.5 If your results do not match your expectations, the media is suspect. Repeat the experiment to make sure you did everything right. If your findings are consistent, return media to the supplier---do not use for sample analysis.

12.3.6 Record this experiment in the TCOLIDW sample logbook and in the MEDIA PREP logbook.

12.3.7 Reference the date of this experiment on each logbook page the media is used.

12.4 Each lot of sterile sample containers is tested for accurate volume markings, sterility, and auto-fluorescence.

12.4.1 Test accurate volume markings by filling a sample container up to the fill line with tap water. Pour this water into a graduated cylinder to

QAPP Worksheet #37: Data Usability Assessment

measure the true volume. The accuracy of the volume marking must be found to be +/-10mL.

12.4.2 Test the sterility of the sample containers by aseptically decanting 25mL of tryptic soy broth into the sample container. Incubate at 35.0+/-0.5ºC for 48 hours. Check for growth at 24 and 48 hours. If the tryptic soy broth is found to be free of turbidity after the incubation period, then the containers are sterile, and okay for use. If the tryptic soy broth is turbid after incubation, the sample containers need to be re-tested. If consistent results come back that they are contaminated, return to supplier---do not use for samples.

12.4.3 Test for auto-fluorescence by placing an empty container into the UV box, and turning on the light. Look through the viewing window at the container. It should not appear to fluoresce. A sample container that fluoresces may interfere with accurate determination of *E.coli* in a drinking water.

12.4.4 Document this in the STERILITY CHECK logbook.

12.5 The incubator must maintain an internal temperature of 35.0+/-0.5ºC. The temperatures are documented twice daily (at least four hours apart). The thermometers inside the incubator are calibrated annually against NIST traceable thermometers.

12.6 The water bath must maintain an internal temperature of 44.5+/-0.5Cº. The temperatures are documented twice daily (at least four hours apart). The thermometers inside the incubator are calibrated annually against NIST traceable thermometers.

13.0 Calibration and Standardization

13.1 Not applicable.

14.0 Procedure

14.1 Clean the bench top with dilute Clorox solution.

14.2 Line the bench top with a piece of aluminum foil.

14.3 Wash the aluminum foil-lined workspace with dilute Clorox solution.

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14.4 Wipe dry with a paper towel. Make sure the foil is completely dry before continuing. Residual bleach can potentially splash into the sample, giving a false negative.

14.5 Turn on the gas supply to the Bunsen burner by turning the valve so that it is at a 9:00 position. Use a flint to make a spark to light the burner. Beware of leaving the gas supply on for any period of time with no flame. The gas itself is odorless, but an additive gives off a sulfur smell, so that leaks and open valves can be detected.

14.6 Shake the sample, vigorously, for at least 20 seconds using an up and down arm motion.

14.7 Aseptically open the sample container without touching the inside or rim of the container. Aseptic technique ensures that the sample is not being exposed to outside contamination (potentially resulting in a false positive) or outside inhibition (potentially resulting in a false negative).

14.8 Test sample for chlorine by sterile pipetting a small portion onto the low level Chlorine test paper. Alternately, touch low level Chlorine test strip to drop of sample in the cap. Do not touch chlorine strip to sample. If chlorine is present, note in logbook and contact client services.

14.9 Aseptically open a Colilert-18 packet (for an 20 hour test), or a Colilert packet (for a 24 hour test) and pour its contents into the sample container that is filled to the 100 mL line. To aseptically open packet, snap it open and flame the air space above the powder.

14.9.1 If the sample is filled above the 100 ml line, shake vigorously, and carefully decant off to the 100mL line. Alternatively, pipet excess sample out with a sterile pipet.

14.9.2 If the sample is received below the 100 ml line, talk to client services to reject sample.

14.10 Aseptically close the sample container, shake vigorously, and transfer it to the incubator.

14.11 Record the date and time that the sample is transferred to the incubator, as well as the date and time the sample is removed from the incubator.

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14.12 The Colilert samples don't need to be pre-warmed, so they should be in the incubator for 24 hours. The Colilert-18 samples need to be pre-warmed, so they should be placed in the water bath for 7-10 minutes to get them up to proper temperature. Then remove from water bath, blot dry, and put into incubator for 18 hours.

14.13 After the sample has incubated at 35.0ºC for the appropriate amount of time, 20 or 24 hours depending on media used, remove the samples from the incubator and record changes immediately. See "Interpretation of Results" section of this procedure.

14.14 Place the sample into the UV viewing box and turn on the UV light. Note any fluorescence.

15.0 Data Analysis and Calculations

15.1 Colilert-18:

15.1.1 If the sample is clear, then it is negative for total Coliform and negative for *E. coli.*

15.1.2 If the sample is yellow and does not fluoresce under UV light, then it is positive for total Coliform and negative for *E.coli.*

15.1.3 If the sample is yellow and fluoresces under UV light, then it is positive for total Coliform and positive for *E.coli.*

15.1.4 If the sample is borderline yellow as compared to the color comparator in the refrigerator, allow the sample to incubate for the longest allowable time (22 hours). Note the reason for the extended incubation time in the comment section of the logbook. After the maximum incubation time has passed, assess the color changes. If presence or absence cannot be determined at this point, it is best to resample and run by a different method (membrane filtration).

15.2 Colilert (24 hour):

15.2.1 If the sample is clear, then it is negative for total Coliform and negative for *E. coli.*

15.2.2 If the sample is yellow and does not fluoresce under UV light, then it is positive for total Coliform and negative for *E.coli.*

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15.2.3 If the sample is yellow and fluoresces under UV light, then it is positive for total Coliform and positive for *E. coli.*

15.2.4 If the sample is borderline yellow as compared to the color comparator in the refrigerator, allow the sample to incubate for the longest allowable time (28 hours). Note the reason for the extended incubation time in the comment section of the logbook. After the maximum incubation time has passed, assess the color changes. If presence or absence cannot be determined at this point, it is best to resample and run by a different method (membrane filtration).

15.3 Samples found to be positive for Total Coliform or *E.coli* require subsequent action. It is considered a public safety issue, and the client must be notified immediately of the findings. Fill out a Client Notification Form with all pertinent information, attach a copy of the chain of custody, and submit it directly to the client services department.

16.0 Method Performance

16.1 This method was validated through internal QA/QC monitoring; including all quality control criteria mentioned Section XII of this procedure.

17.0 Pollution Prevention

17.1 The reagents used in this method pose little threat to the environment when managed and disposed of properly.

17.2 Reagents should be purchased in volumes consistent with laboratory use to minimize the volume of expired reagents to be disposed.

18.0 Data Assessment and Acceptance Criteria

18.1 See Section 15 above and Section 19 below.

19.0 Corrective Actions for Out·Of·Control Data

19.1 Due to the nature of this method, unacceptable data such as contamination will not be noticed until the following day. At this time, immediately go to client services to request resamples from the client. A non-conformance report must be generated at this time.

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19.2 If a sample is received past holding time, have client services notify client. Make sure it is noted on the chain of custody.

19.3 If a sample holding time is missed due to an error in the laboratory, report it to client services at once so a new sample can be obtained.

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 Due to the nature of the method, resampling is the only option for unacceptable data.

21.0 Waste Management

21.1 It is the laboratories responsibility to comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

22.0 References

22.1 Standard Methods for the Examination of Waste and Wastewater, 20th edition, Method No. 9223B, Revised 1997.

22.2 Standard Methods for the Examination of Waste and Wastewater, 22nd edition, Method No. 9223B, Revised 2004.

23.0 Tables, Diagrams, Flowcharts and Validation Data

23.1 Bacteria QC instructions attached.

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Effective Date: 02/14/17
Version: 7.1
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INSTRUCTIONS FOR USE

LYFO-DISK® Microorganism

1. Remove the LYFO DISK® vial from 4° C - 8°C storage and allow the unopened vial to equilibrate to room temperature.
2. Aseptically remove one (1) gelatin pellet from the vial. Place the pellet in 0.5 mL of sterile Tryptic Soy Broth, Brain Heart Infusion Broth, saline, or deionized water.
3. Emulsify and crush pellet with a sterile swab until the pellet particles are uniform in size and the suspension is homogenous in appearance. DO NOT INCUBATE
4. IMMEDIATELY, saturate the swab with the hydrated material and transfer the material to an appropriate, non- selective, nutrient or enriched agar medium. With pressure, rotate the swab, and inoculate a circular area (1.e. one inch or 25 mm in diameter) of the agar medium. Using the same swab or a sterile loop, repeatedly (about 10 to 20 times) streak through the inoculated area and then continue to streak the remainder of the agar surface. Discard the remaining hydrated material in accordance with the laboratory protocol for disposal of biohazardous materials.
5. IMMEDIATELY, incubate the inoculated media at temperature and conditions appropriate to the microorganism.
6. Following, incubation select representative well-isolated colonies for indicated transfers.

KWIK-STIK™ Microorganisms

1. Remove the KWIK-STIK™ unit fmm 4° C - 8° C storage and allow the unopened pouch to equilibrate to room temperature.
2. Open the pouch and remove the KWIK- STIK™ unit.
3. Tear off the pull tab portion of the label from the KWIK-STJKT" device. The label can be attached to permanent QC Records or attached to the primary plate agar medium for identification.
4. Take note of the position of the gelatin pellet in the bottom part of the device and the reservoir of hydrating fluid in the top (cap) part of the device. DO NOT DISASSEMBLE THE DEVICE DURING HYDRATION
5. Release the hydrating fluid by pinching the very top of the ampule in the cap of the device. Allow the hydrating fluid to flow through the swab shaft and INTO the bottom portion of the unit containing the gelatin pellet.
6. Holding the device vertically, with the cap up, and tapping the bottom of the device on the counter can further facilitate the flow of the fluid.
7. Using a pinching action on the bottom portion of the unit, crush and mix the pellet in the fluid until the pellet particles are uniform in size and the suspension is homogenous in appearance. DO NOT INCUBATE
8. IMMEDIATELY, saturate the swab with the hydrated material and transfer the material to an appropriate, non-selective, nutrient or enriched agar medium. With pressure, rotate the swab, and inoculate a circular area (i.e. one inch or 25 mm in diameter) of the agar medium. Using the same swab or a sterile loop, repeatedly (about 10 to 20 times) streak through the inoculated area and then continue to streak the remainder of the agar surface.
9. Discard the remaining hydrated material in accordance with the laboratory protocol for disposal of biohazardous materials.
10. IMMEDIATELY, incubate the inoculated media at temperature and conditions appropriate to the microorganism.
11. Following incubation, select representative well-isolated colonies for indicatedtransfers.

Expiration Date

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Revision History Log for SOP #407

Date:	Revision #:	Summary of Changes:	Submitted By:	Approved By:	Effective Date:
4/27/12	7	SOP moved to SOP writer, Section 9.3- added water bath, Section 11.2- added 1" air space, Section 12.6- added water bath info, Section 14.6- added "vigorously", Section 14.9.1 & 14.9.2- added language about the 100mL line, Section 14.12- added pre-warming step in water bath rather than incubator	Kathy Cressia	Rashmi Makol	4/27/12
2/14/17	7.1	SOP removed from SOP writer, added a method reference.	Kathy Cressia	Rashmi Makol	2/14/17

Expiration Date

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SOP - 003b - E.Coli SOP

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Effective Date: 7/20/12
Version Number: 1
Initiated By: Kathy Cressia
Approved By: Rashmi Makol

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SOP Number: 410.TColiQ/EColiQ

Title: Chromogenic Total Coliform/*E.coli* Test by Most Probable Number

Scope and Application: This method covers the determination of coliform bacteria in drinking, surface, ground and storm waters. This method covers the determination of total coliform and *E.coli* in the range of 0-2419cfu/100mL(colony-forming units per 100mL). Samples known or suspected to have total coliform/*E.coli* densities of greater than 2419cfu/mL may be diluted with sterile dilution water prior to analysis.
Total coliform is an indicator organism for contamination of drinking water by run-off or another relatively innocuous source. Drinking waters are tested for Coliform bacteria not because they cause disease directly, but because when coliforms are present in a water source, it can be assumed that other more threatening bacteria and compounds are present. Often times, a sample found to be positive for total coliform is so because the well system has failed and is being exposed to rain runoff or animal activity.
E.coli is an indicator organism for contamination of drinking water by septic, sewage or other sources of fecal waste. Unlike other coliforms, *E.coli* can cause disease directly, and is considered a serious health hazard.

I. Summary of Method

A. A 100mL aliquot of sample is dosed with a packet of Colilert or Colilert-18 media. The sample is transferred to a Quanti-Tray and sealed in a Quanti –Tray Sealer. The sample is then incubated at optimum temperature for an optimum period of time. A change in the color of the sample from clear to yellow indicates the presence of Total Coliform. When a positive sample is viewed under UV light, a fluorescent glow indicates the presence of *E.coli*. Number of positive large and small wells is counted and Most Probable Number (MPN) Table is used to determine the MPN.
B. A sample that is positive for Total Coliform may or may not be positive for *E.coli*. A sample that is negative for Total Coliform is necessarily negative for *E.coli*. A sample that is positive for *E.coli* is necessarily positive for Total Coliform.
C. Record into Bacteria logbook as to whether Colilert or Colilert-18 was used and record Phoenix ID number of media used.

II. Interferences

A. If a sample has color, make note of the color of the sample. A colored sample may give a false positive reading if the original color of the sample is similar to the color change of positive samples. It may be necessary to compare the color of the sample before and after incubation. Reserve some unpreserved sample for this purpose if it is available.

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B. When using Colilert, water with high iron or manganese levels in the presence of hydrogen sulfide may cause a greenish-black to black color change. Should this occur, request another sample and perform using the membrane filtration method.
C. If a sample is very turbid, dirt and other solids will become trapped in the wells. These solids can inhibit growth or make the color change undetectable. To avoid this interference, prepare a sample dilution with little to no debris.

III. Sample Collection, Preservation and Storage

A. Waters to be analyzed for total coliform and *E.coli* must be sampled aseptically in sterile containers, treated with sodium thiosulfate if from a chlorinated source and stored between 1-5°C until time of analysis.
B. Drinking waters must be analyzed within 30 hours of the time of sampling and non-potable waters must be analyzed within 8 hours of the time of sampling. It is generally accepted that our clients submit samples within 6 hours of sampling, allowing the lab 2 hours to set the samples onto the growth media.
C. Samples are kept separate from the general samples in the walk-in sample storage refrigerator. Store bacteria samples in the plastic bin to reduce the chance of in-house contamination.

IV. Equipment and Supplies

A. Bunsen burner.
B. Incubator, able to maintain an internal temperature of 35.0C +/-0.5°C.
C. UV light box for viewing *E.coli* fluorescence.
D. Sterile sample containers, 120mL with a 100mL fill-line.
E. Sterile sample containers, 120mL with a 100mL fill-line, with sodium thiosulfate preserve for chlorinated sources.
F. Quanti-Tray/2000
G. Quanti-Tray Sealer.

V. Reagents and Standards

A. Dilute Clorox solution, 10%. Dilute 50mL Clorox Bleach to 500mL DI water.
B. Colilert 24 hour test packets. IDEXX Cat No. WP2001. Store at room temperature. Discard after manufacturer's expiration date.
C. Colilert 18 hour test packets. IDEXX Cat No. WP200-18. Store at room temperature. Discard after manufacturer's expiration date.
D. Quanti-cult or Microbiologics Kwik-Stik dehydrated microorganisms or equivilent.
E. Tryptic soy broth, dehydrated media. Prepare per manufacturer's instructions.
F. Low level Chlorine test strips- EM Science.

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VI. Definitions

A. Blank- A portion of sterile water that is subjected to all steps of the method just like a sample. The blank is used to determine if there was possible bacterial contamination in the procedure.
B. Total Coliform- see Scope and Application section. Includes genuses *Enterobacter, Klebsiella, Citrobacter* and *Escherichia.*
C. *E. Coli- Escherichia Coli,* see Scope and Application section.

VII. Procedure

A. Turn on Quanti-Tray sealer and allow to warm up (approximately 20 minutes).
B. Clean the bench top with dilute Clorox solution.
C. Line the bench top with a piece of aluminum foil.
D. Wash the aluminum foil-lined workspace with dilute Clorox solution.
E. Wipe dry with a paper towel. Make sure the foil is completely dry before continuing. Residual bleach can potentially splash into the sample, giving a false negative.
F. Turn on the gas supply to the Bunsen burner by turning the valve so that it is at a 9:00 position. Use a flint to make a spark to light the burner. Beware of leaving the gas supply on for any period of time with no flame. The gas itself is odorless, but an additive gives off a sulfur smell, so that leaks and open valves can be detected.
G. Shake the sample for at least 20 seconds using an up and down arm motion.
H. Aseptically open the sample container without touching the inside or rim of the container. Aseptic technique ensures that the sample is not being exposed to outside contamination (potentially resulting in a false positive) or outside inhibition (potentially resulting in a false negative).
I. Test sample for chlorine by sterile pipetting a small portion onto the low level Chlorine test paper. Alternately, touch low level Chlorine test strip to drop of sample in the cap. If chlorine is present, note in logbook and contact client services.
J. Aseptically open a Colilert-18 packet (for an 18 hour test), or a Colilert packet (for a 24 hour test) and pour its contents into the sample container that is filled to the 100 ml line. To aseptically open packet, snap it open and flame the air space above the powder.
K. Aseptically close the sample container, shake vigorously.
L. Gently pull foil tab to separate the foil from the tray of the Quanti-Tray. Avoid touching the inside of the foil or tray.
M. Pour the reagent/sample mixture directly into the Quanti-Tray, avoiding contact with the foil tab. Tap the small wells 2-3 times to release any air bubbles. Allow foam to settle.
N. Record Phoenix sample ID on the back of the Quanti-Tray as well as any dilution performed on the sample.
O. Place the sample-filled Quanti-Tray onto the rubber insert of the Quanti-Tray Sealer with well side of the Quanti-Tray facing down.
P. Push the rubber insert to Seal the Quanti-Tray.
Q. Transfer the sealed Quanti-Tray to the incubator.

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R. Record the date and time that the sample is transferred to the incubator, as well as the date and time the sample is removed from the incubator.
S. Analyze a sample duplicate with every batch.
T. Quanti-Tray samples do not need to be pre-warmed. The Colilert-24 samples are incubated at 35.0 °C for 24 hours and Colilert-18 samples are incubated at 35.0 °C for 18 hours.
U. After the sample has incubated at 35.0°C for the appropriate amount of time, remove the samples from the incubator and record changes immediately. See "Interpretation of Results" section of this procedure.
V. Place the sample into the UV viewing box and turn on the UV light. Count and mark the number of large and small wells that fluoresce.

VIII. Interpretation of Results

A. Colilert-18:
1. If the sample is clear, then it is negative for total Coliform and negative for *E.coli*.
2. If the sample is yellow and does not fluoresce under UV light, then it is positive for total Coliform and negative for *E.coli*.
3. If the sample is yellow and fluoresces under UV light, then it is positive for total Coliform and positive for *E.coli*.
4. If the sample is borderline yellow as compared to the color comparator in the refrigerator, allow the sample to incubate for the longest allowable time (22 hours). Note the reason for the extended incubation time in the comment section of the logbook. After the maximum incubation time has passed, assess the color changes. If presence or absence cannot be determined at this point, it is best to resample and run by a different method (membrane filtration).
5. If samples are inadvertantly incubated for more than 22 hours without checking, only negative results are valid and can be reported. A positive test is invalid after 22 hours.
6. Count large and small positive wells for total coliform and *E.Coli* and use Quanti-Tray/2000 MPN Table to find the MPN.

B. Colilert (24 hour):
1. If the sample is clear, then it is negative for total Coliform and negative for *E.coli*.
2. If the sample is yellow and does not fluoresce under UV light, then it is positive for total Coliform and negative for *E.coli*.
3. If the sample is yellow and fluoresces under UV light, then it is positive for total Coliform and positive for *E.coli*.
4. If the sample is borderline yellow as compared to the color comparator in the refrigerator, allow the sample to incubate for the longest allowable time (28 hours). Note the reason for the extended incubation time in the comment section of the logbook. After the maximum incubation time has passed, assess the color changes. If presence or absence cannot be determined at this point, it is best to resample and run by a different method (membrane filtration).
5. If samples are inadvertantly incubated for more than 28 hours without checking, only negative results are valid and can be reported. A positive test is invalid after 28 hours.

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6. Count large and small positive wells for total coliform and *E.Coli* and use Quanti-Tray/2000 MPN Table to find the MPN.

C. Samples found to be positive for Total Coliform or *E.coli* require subsequent action. It is considered a public safety issue, and the client must be notified immediately of the findings. Fill out a Client Notification Form with all pertinent information, attach a copy of the chain of custody, and submit it directly to the client services department.

IX. Quality Control

A. At least 10% of suspected positive samples need to be analyzed in duplicate. Analyzing a sample at two or more dilutions that yield countable results will qualify as a duplicate.

B. Record sample duplicate result in Phoenix MDB database when entering sample results for that sample. The duplicate readings will be used to determine the ROL (Range of Logs).

C. The Phoenix MDB calculates the precision of duplicate analyses for each sample matrix according to the following procedure:

1. Perform duplicate analyses on first 15 positive samples of each type, with each set of duplicates analyzed by a single analyst.
2. Calculate the logarithm of each result. If either of a set of duplicate results is <1, add 1 to both values before calculating the logarithms.
3. Calculate the Range (R) for each pair of transformed duplicates as the mean ($\overline{R}$) of these ranges.

$$\overline{R} = \frac{\sum R_{log}}{n}$$ where "n" is the number of samples

Precision criterion = 3.27 $\overline{R}$

4. Refer to *Standard Methods for the Examination of Water and Wastewater* 20th Edition, Section 9020B.8b for examples of calculations.

D. All medias are labeled with the date received, date opened, and the Phoenix Bacteria Lot Number.

E. All reagents and media are numbered with Phoenix Bacteria Lot Numbers as they are received in the lab.

F. Each manufacturer lot of media is tested with positive and negative controls: *P.aeruginosa*, *K.pneumoniae*, and *E.coli*.

1. Refer to the manufacturer's instructions on hydrating control bacteria samples.
2. Analyze each as a sample, being mindful of aseptic technique.
3. Interpret the findings. The *P.aeruginosa* sample should be found to be negative for total Coliform and negative for *E.coli*. The *K.pneumoniae* sample should be found to be positive for total Coliform and negative for *E.coli*. The *E.coli* sample should be found to be positive for total Coliform and positive for *E.coli*.
4. If your results match your expectations, the media is verified and may be used for sample analysis.
5. If your results do not match your expectations, the media is suspect. Repeat the experiment to make sure you did everything right. If your findings are consistent, return media to the supplier---do not use for sample analysis.

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6. Record this experiment in the TCOLIDW sample logbook and in the MEDIA PREP logbook.
7. Reference the date of this experiment on each logbook page the media is used.

G. Each lot of sterile sample containers is tested for accurate volume markings, sterility, and auto-fluorescence.

1. Test accurate volume markings by filling a sample container up to the fill line with tap water. Pour this water into a graduated cylinder to measure the true volume. The accuracy of the volume marking must be within a 2.5% tolerence.
2. Test the sterility of the sample containers by aseptically decanting 25mL of tryptic soy broth into the sample container. Incubate at $35.0^{+}/-0.5^{\circ}C$ for 48 hours. Check for growth at 24 and 48 hours. If the tryptic soy broth is found to be free of turbidity after the incubation period, then the containers are sterile, and okay for use. If the tryptic soy broth is turbid after incubation, the sample containers need to be re-tested. If consistent results come back that they are contaminated, return to supplier---do not use for samples.
3. Test for auto-fluorescence by placing an empty container into the UV box, and turning on the light. Look through the viewing window at the container. It should not appear to fluoresce. A sample container that fluoresces may interfere with accurate determination of *E.coli* in a drinking water.
4. Document this in the STERILITY CHECK logbook.

H. The incubator must maintain an internal temperature of $35.0^{+}/-0.5^{\circ}C$. The temperatures are documented twice daily (at least four hours apart). The thermometers inside the incubator are calibrated annually against NIST traceable thermometers.

X. Safety

A. The analyst must know and observe the normal safety procedures required in a microbiology laboratory while preparing, using and disposing of cultures, reagents, and materials, and while operating sterilization equipment.
B. Mouth pipetting is prohibited.
C. Refer to Phoenix SOP#805 for more information on lab safety.

XI. Pollution Prevention

A. The reagents used in this method poses little threat to the environment when managed and disposed of properly.
B. Reagents should be purchased in volumes consistant with laboratory use to minimize the volume of expired reagents to be disposed.

XII. Waste Management

A. It is the laboratories responsibility to comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and

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land disposal restrictions, and to protect the air, water and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

XIII. Method Performance

A. This method was validated through internal QA/QC monitoring, including all quality control criteria mentioned Section IX of this procedure.

XIV. Corrective Action for Out-of-Control or Unacceptable Data

A. Due to the nature of this method, unacceptable data such as contamination will not be noticed until the following day. At this time, immediately go to client services to request resamples from the client. A non-conformance report must be generated at this time.
B. If a sample is received past holding time, have client services notify client. Make sure it is noted on the chain of custody.
C. If a sample holding time is missed due to an error in the laboratory, report it to client services at once so a new sample can be obtained.

XV. References

A. Standard Methods for the Examination of Waste and Wastewater, 19th edition. Method No. 9223B, Revised 1995.
B. IDEXX Quanti-Tray/2000, Insert and Most Probable Number Table, 06-02320-10.

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IDEXX Quanti-Tray*/2000 MPN Table

# Large Wells Positive	# Small Wells Positive																								
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0	<1	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.1	15.1	16.1	17.1	18.1	19.1	20.2	21.2	22.2	23.3	24.3
1	1.0	2.0	3.0	4.0	5.0	6.0	7.1	8.1	9.1	10.1	11.1	12.1	13.2	14.2	15.2	16.2	17.3	18.3	19.3	20.4	21.4	22.4	23.5	24.5	25.6
2	2.0	3.0	4.1	5.1	6.1	7.1	8.1	9.2	10.2	11.2	12.2	13.3	14.3	15.4	16.4	17.4	18.5	19.5	20.6	21.6	22.7	23.7	24.8	25.8	26.9
3	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.3	11.3	12.4	13.4	14.5	15.5	16.5	17.6	18.6	19.7	20.8	21.8	22.9	23.9	25.0	26.1	27.1	28.2
4	4.1	5.2	6.2	7.2	8.3	9.3	10.4	11.4	12.5	13.5	14.6	15.6	16.7	17.8	18.8	19.9	21.0	22.0	23.1	24.2	25.3	26.3	27.4	28.5	29.6
5	5.2	6.3	7.3	8.4	9.4	10.5	11.5	12.6	13.7	14.7	15.8	16.9	17.9	19.0	20.1	21.2	22.2	23.3	24.4	25.5	26.6	27.7	28.8	29.9	31.0
6	6.3	7.4	8.4	9.5	10.6	11.6	12.7	13.8	14.9	16.0	17.0	18.1	19.2	20.3	21.4	22.5	23.6	24.7	25.8	26.9	28.0	29.1	30.2	31.3	32.4
7	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.1	17.2	18.3	19.4	20.5	21.6	22.7	23.8	24.9	26.0	27.1	28.3	29.4	30.5	31.6	32.8	33.9
8	8.6	9.7	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5	19.6	20.7	21.8	22.9	24.1	25.2	26.3	27.4	28.6	29.7	30.8	32.0	33.1	34.3	35.4
9	9.8	10.9	12.0	13.1	14.2	15.3	16.4	17.6	18.7	19.8	20.9	22.0	23.2	24.3	25.4	26.6	27.7	28.9	30.0	31.2	32.3	33.5	34.6	35.8	37.0
10	11.0	12.1	13.2	14.4	15.5	16.6	17.7	18.9	20.0	21.1	22.3	23.4	24.6	25.7	26.9	28.0	29.2	30.3	31.5	32.7	33.8	35.0	36.2	37.4	38.6
11	12.2	13.4	14.5	15.6	16.8	17.9	19.1	20.2	21.4	22.5	23.7	24.8	26.0	27.2	28.3	29.5	30.7	31.9	33.0	34.2	35.4	36.6	37.8	39.0	40.2
12	13.5	14.6	15.8	16.9	18.1	19.3	20.4	21.6	22.8	23.9	25.1	26.3	27.5	28.6	29.8	31.0	32.2	33.4	34.6	35.8	37.0	38.2	39.5	40.7	41.9
13	14.8	16.0	17.1	18.3	19.5	20.6	21.8	23.0	24.2	25.4	26.6	27.8	29.0	30.2	31.4	32.6	33.8	35.0	36.2	37.5	38.7	39.9	41.2	42.4	43.6
14	16.1	17.3	18.5	19.7	20.9	22.1	23.3	24.5	25.7	26.9	28.1	29.3	30.5	31.7	33.0	34.2	35.4	36.7	37.9	39.1	40.4	41.6	42.9	44.2	45.4
15	17.5	18.7	19.9	21.1	22.3	23.5	24.7	25.9	27.2	28.4	29.6	30.9	32.1	33.3	34.6	35.8	37.1	38.4	39.6	40.9	42.2	43.4	44.7	46.0	47.3
16	18.9	20.1	21.3	22.6	23.8	25.0	26.2	27.5	28.7	30.0	31.2	32.5	33.7	35.0	36.3	37.5	38.8	40.1	41.4	42.7	44.0	45.3	46.6	47.9	49.2
17	20.3	21.6	22.8	24.1	25.3	26.6	27.8	29.1	30.3	31.6	32.9	34.1	35.4	36.7	38.0	39.3	40.6	41.9	43.2	44.5	45.9	47.2	48.5	49.8	51.2
18	21.8	23.1	24.3	25.6	26.9	28.1	29.4	30.7	32.0	33.3	34.6	35.9	37.2	38.5	39.8	41.1	42.4	43.8	45.1	46.5	47.8	49.2	50.5	51.9	53.2
19	23.3	24.6	25.9	27.2	28.5	29.8	31.1	32.4	33.7	35.0	36.3	37.6	39.0	40.3	41.6	43.0	44.3	45.7	47.1	48.4	49.8	51.2	52.6	54.0	55.4
20	24.9	26.2	27.5	28.8	30.1	31.5	32.8	34.1	35.4	36.8	38.1	39.5	40.8	42.2	43.6	44.9	46.3	47.7	49.1	50.5	51.9	53.3	54.7	56.1	57.6
21	26.5	27.9	29.2	30.5	31.8	33.2	34.5	35.9	37.3	38.6	40.0	41.4	42.8	44.1	45.5	46.9	48.4	49.8	51.2	52.6	54.1	55.5	56.9	58.4	59.9
22	28.2	29.5	30.9	32.3	33.6	35.0	36.4	37.7	39.1	40.5	41.9	43.3	44.8	46.2	47.6	49.0	50.5	51.9	53.4	54.8	56.3	57.8	59.3	60.8	62.3
23	29.9	31.3	32.7	34.1	35.5	36.8	38.3	39.7	41.1	42.5	43.9	45.4	46.8	48.3	49.7	51.2	52.7	54.2	55.6	57.1	58.6	60.2	61.7	63.2	64.7
24	31.7	33.1	34.5	35.9	37.3	38.8	40.2	41.7	43.1	44.6	46.0	47.5	49.0	50.5	52.0	53.5	55.0	56.5	58.0	59.5	61.1	62.6	64.2	65.8	67.3
25	33.6	35.0	36.4	37.9	39.3	40.8	42.2	43.7	45.2	46.7	48.2	49.7	51.2	52.7	54.3	55.8	57.3	58.9	60.5	62.0	63.6	65.2	66.8	68.4	70.0
26	35.5	36.9	38.4	39.9	41.4	42.8	44.3	45.9	47.4	48.9	50.4	52.0	53.5	55.1	56.7	58.2	59.8	61.4	63.0	64.7	66.3	67.9	69.6	71.2	72.9
27	37.4	38.9	40.4	42.0	43.5	45.0	46.5	48.1	49.6	51.2	52.8	54.4	56.0	57.6	59.2	60.8	62.4	64.1	65.7	67.4	69.1	70.8	72.5	74.2	75.9
28	39.5	41.0	42.6	44.1	45.7	47.3	48.8	50.4	52.0	53.6	55.2	56.9	58.5	60.2	61.8	63.5	65.2	66.9	68.6	70.3	72.0	73.7	75.5	77.3	79.0
29	41.7	43.2	44.8	46.4	48.0	49.6	51.2	52.8	54.5	56.1	57.8	59.5	61.2	62.9	64.6	66.3	68.0	69.8	71.5	73.3	75.1	76.9	78.7	80.5	82.4
30	43.9	45.5	47.1	48.7	50.4	52.0	53.7	55.4	57.1	58.8	60.5	62.2	64.0	65.7	67.5	69.3	71.0	72.9	74.7	76.5	78.3	80.2	82.1	84.0	85.9
31	46.2	47.9	49.5	51.2	52.9	54.6	56.3	58.1	59.8	61.6	63.3	65.1	66.9	68.7	70.5	72.4	74.2	76.1	78.0	79.9	81.8	83.7	85.7	87.6	89.6
32	48.7	50.4	52.1	53.8	55.6	57.3	59.1	60.9	62.7	64.5	66.3	68.2	70.0	71.9	73.8	75.7	77.6	79.5	81.5	83.5	85.4	87.5	89.5	91.5	93.6
33	51.2	53.0	54.8	56.5	58.3	60.2	62.0	63.8	65.7	67.6	69.5	71.4	73.3	75.2	77.2	79.2	81.2	83.2	85.2	87.3	89.3	91.4	93.6	95.7	97.8
34	53.9	55.7	57.6	59.4	61.3	63.1	65.0	67.0	68.9	70.8	72.8	74.8	76.8	78.8	80.8	82.9	85.0	87.1	89.2	91.4	93.5	95.7	97.9	100.2	102.4
35	56.8	58.6	60.5	62.4	64.4	66.3	68.3	70.3	72.3	74.3	76.3	78.4	80.5	82.6	84.7	86.9	89.1	91.3	93.5	95.7	98.0	100.3	102.6	105.0	107.3
36	59.8	61.7	63.7	65.7	67.7	69.7	71.7	73.8	75.9	78.0	80.1	82.3	84.5	86.7	88.9	91.2	93.5	95.8	98.1	100.5	102.9	105.3	107.7	110.2	112.7
37	62.9	65.0	67.0	69.1	71.2	73.3	75.4	77.6	79.8	82.0	84.2	86.5	88.8	91.1	93.4	95.8	98.2	100.6	103.1	105.6	108.1	110.7	113.3	115.9	118.6
38	66.3	68.4	70.6	72.7	74.9	77.1	79.4	81.6	83.9	86.2	88.6	91.0	93.4	95.8	98.3	100.8	103.4	105.9	108.6	111.2	113.9	116.6	119.4	122.2	125.0
39	70.0	72.2	74.4	76.7	78.9	81.3	83.6	86.0	88.4	90.9	93.4	95.9	98.4	101.0	103.6	106.3	109.0	111.8	114.6	117.4	120.3	123.2	126.1	129.2	132.2
40	73.8	76.2	78.5	80.9	83.3	85.7	88.2	90.8	93.3	95.9	98.5	101.2	103.9	106.7	109.5	112.4	115.3	118.2	121.2	124.3	127.4	130.5	133.7	137.0	140.3
41	78.0	80.5	83.0	85.5	88.0	90.6	93.3	95.9	98.7	101.4	104.3	107.1	110.0	113.0	116.0	119.1	122.2	125.4	128.7	132.0	135.4	138.8	142.3	145.9	149.5
42	82.6	85.2	87.8	90.5	93.2	96.0	98.8	101.7	104.6	107.6	110.6	113.7	116.9	120.1	123.4	126.7	130.1	133.6	137.2	140.8	144.5	148.3	152.2	156.1	160.2
43	87.6	90.4	93.2	96.0	99.0	101.9	105.0	108.1	111.2	114.5	117.8	121.1	124.6	128.1	131.7	135.4	139.1	143.0	147.0	151.0	155.2	159.4	163.8	168.2	172.8
44	93.1	96.1	99.1	102.2	105.4	108.6	111.9	115.3	118.7	122.3	125.9	129.6	133.4	137.4	141.4	145.5	149.7	154.1	158.5	163.1	167.9	172.7	177.7	182.9	188.2
45	99.3	102.5	105.8	109.2	112.6	116.2	119.8	123.6	127.4	131.4	135.4	139.6	143.9	148.3	152.9	157.6	162.4	167.4	172.6	178.0	183.5	189.2	195.1	201.2	207.5
46	106.3	109.8	113.4	117.2	121.0	125.0	129.1	133.3	137.6	142.1	146.7	151.5	156.5	161.6	167.0	172.5	178.2	184.2	190.4	196.8	203.5	210.5	217.8	225.4	233.3
47	114.3	118.3	122.4	126.6	130.9	135.4	140.1	145.0	150.0	155.3	160.7	166.4	172.3	178.5	185.0	191.8	198.9	206.4	214.2	222.4	231.0	240.0	249.5	259.5	270.0
48	123.9	128.4	133.1	137.9	143.0	148.3	153.9	159.7	165.8	172.2	178.9	186.0	193.5	201.4	209.8	218.7	228.2	238.2	248.9	260.3	272.3	285.1	298.7	313.0	328.2
49	135.5	140.8	146.4	152.3	158.5	165.0	172.0	179.3	187.2	195.6	204.6	214.3	224.7	235.9	248.1	261.3	275.5	290.9	307.6	325.5	344.8	365.4	387.3	410.6	435.2

Expiration Date

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*Quanti-Tray is either a trademark or a registered trademark of IDEXX Laboratories, Inc. in the United States and/or other countries. Covered by U.S. Patent Numbers 4,925,789 ; 5,429,933 ; 5,518,892. Other patents pending.

QAPP Worksheet #37: Data Usability Assessment

IDEXX Quanti-Tray*/2000 MPN Table

# Large Wells Positive	# Small Wells Positive 25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
0	25.3	26.4	27.4	28.4	29.5	30.5	31.5	32.6	33.6	34.7	35.7	36.8	37.8	38.9	40.0	41.0	42.1	43.1	44.2	45.3	46.3	47.4	48.5	49.5
1	26.6	27.7	28.7	29.8	30.8	31.9	32.9	34.0	35.0	36.1	37.2	38.2	39.3	40.4	41.4	42.5	43.6	44.7	45.7	46.8	47.9	49.0	50.1	51.2
2	27.9	29.0	30.0	31.1	32.2	33.2	34.3	35.4	36.5	37.5	38.6	39.7	40.8	41.9	43.0	44.0	45.1	46.2	47.3	48.4	49.5	50.6	51.7	52.8
3	29.3	30.4	31.4	32.5	33.6	34.7	35.8	36.8	37.9	39.0	40.1	41.2	42.3	43.4	44.5	45.6	46.7	47.8	48.9	50.0	51.2	52.3	53.4	54.5
4	30.7	31.8	32.8	33.9	35.0	36.1	37.2	38.3	39.4	40.5	41.6	42.8	43.9	45.0	46.1	47.2	48.3	49.5	50.6	51.7	52.9	54.0	55.1	56.3
5	32.1	33.2	34.3	35.4	36.5	37.6	38.7	39.9	41.0	42.1	43.2	44.4	45.5	46.6	47.7	48.9	50.0	51.2	52.3	53.5	54.6	55.8	56.9	58.1
6	33.5	34.7	35.8	36.9	38.0	39.2	40.3	41.4	42.6	43.7	44.8	46.0	47.1	48.3	49.4	50.6	51.7	52.9	54.1	55.2	56.4	57.6	58.7	59.9
7	35.0	36.2	37.3	38.4	39.6	40.7	41.9	43.0	44.2	45.3	46.5	47.7	48.8	50.0	51.2	52.3	53.5	54.7	55.9	57.1	58.3	59.4	60.6	61.8
8	36.6	37.7	38.9	40.0	41.2	42.3	43.5	44.7	45.9	47.0	48.2	49.4	50.6	51.8	53.0	54.1	55.3	56.5	57.7	59.0	60.2	61.4	62.6	63.8
9	38.1	39.3	40.5	41.6	42.8	44.0	45.2	46.4	47.6	48.8	50.0	51.2	52.4	53.6	54.8	56.0	57.2	58.4	59.7	60.9	62.1	63.4	64.6	65.8
10	39.7	40.9	42.1	43.3	44.5	45.7	46.9	48.1	49.3	50.6	51.8	53.0	54.2	55.5	56.7	57.9	59.2	60.4	61.7	62.9	64.2	65.4	66.7	67.9
11	41.4	42.6	43.8	45.0	46.3	47.5	48.7	49.9	51.2	52.4	53.7	54.9	56.1	57.4	58.6	59.9	61.2	62.4	63.7	65.0	66.3	67.5	68.8	70.1
12	43.1	44.3	45.6	46.8	48.1	49.3	50.6	51.8	53.1	54.3	55.6	56.8	58.1	59.4	60.7	62.0	63.2	64.5	65.8	67.1	68.4	69.7	71.0	72.4
13	44.9	46.1	47.4	48.6	49.9	51.2	52.5	53.7	55.0	56.3	57.6	58.9	60.2	61.5	62.8	64.1	65.4	66.7	68.0	69.3	70.7	72.0	73.3	74.7
14	46.7	48.0	49.3	50.5	51.8	53.1	54.4	55.7	57.0	58.3	59.6	60.9	62.3	63.6	64.9	66.3	67.6	68.9	70.3	71.6	73.0	74.4	75.7	77.1
15	48.6	49.9	51.2	52.5	53.8	55.1	56.4	57.8	59.1	60.4	61.8	63.1	64.5	65.8	67.2	68.5	69.9	71.3	72.6	74.0	75.4	76.8	78.2	79.6
16	50.5	51.8	53.2	54.5	55.8	57.2	58.5	59.9	61.2	62.6	64.0	65.3	66.7	68.1	69.5	70.9	72.3	73.7	75.1	76.5	77.9	79.3	80.8	82.2
17	52.5	53.9	55.2	56.6	58.0	59.3	60.7	62.1	63.5	64.9	66.3	67.7	69.1	70.5	71.9	73.3	74.8	76.2	77.6	79.1	80.5	82.0	83.5	84.9
18	54.6	56.0	57.4	58.8	60.2	61.6	63.0	64.4	65.8	67.2	68.6	70.1	71.5	73.0	74.4	75.9	77.3	78.8	80.3	81.8	83.3	84.8	86.3	87.8
19	56.8	58.2	59.6	61.0	62.4	63.9	65.3	66.8	68.2	69.7	71.1	72.6	74.1	75.5	77.0	78.5	80.0	81.5	83.1	84.6	86.1	87.6	89.2	90.7
20	59.0	60.4	61.9	63.3	64.8	66.3	67.7	69.2	70.7	72.2	73.7	75.2	76.7	78.2	79.8	81.3	82.8	84.4	85.9	87.5	89.1	90.7	92.2	93.8
21	61.3	62.8	64.3	65.8	67.3	68.8	70.3	71.8	73.3	74.9	76.4	77.9	79.5	81.1	82.6	84.2	85.8	87.4	89.0	90.6	92.2	93.8	95.4	97.1
22	63.8	65.3	66.8	68.3	69.8	71.4	72.9	74.5	76.1	77.6	79.2	80.8	82.4	84.0	85.6	87.2	88.9	90.5	92.1	93.8	95.5	97.1	98.8	100.5
23	66.3	67.8	69.4	71.0	72.5	74.1	75.7	77.3	78.9	80.5	82.2	83.8	85.4	87.1	88.7	90.4	92.1	93.8	95.5	97.2	98.9	100.6	102.4	104.1
24	68.9	70.5	72.1	73.7	75.3	77.0	78.6	80.3	81.9	83.6	85.2	86.9	88.6	90.3	92.0	93.8	95.5	97.2	99.0	100.7	102.5	104.3	106.1	107.9
25	71.7	73.3	75.0	76.6	78.3	80.0	81.7	83.3	85.1	86.8	88.5	90.2	92.0	93.7	95.5	97.3	99.1	100.9	102.7	104.5	106.3	108.2	110.0	111.9
26	74.6	76.3	78.0	79.7	81.4	83.1	84.8	86.6	88.4	90.1	91.9	93.7	95.5	97.3	99.2	101.0	102.9	104.7	106.6	108.5	110.4	112.3	114.2	116.2
27	77.6	79.4	81.1	82.9	84.6	86.4	88.2	90.0	91.9	93.7	95.5	97.4	99.3	101.2	103.1	105.0	106.9	108.8	110.8	112.7	114.7	116.7	118.7	120.7
28	80.8	82.6	84.4	86.3	88.1	89.9	91.8	93.7	95.6	97.5	99.4	101.3	103.3	105.2	107.2	109.2	111.2	113.2	115.2	117.3	119.3	121.4	123.5	125.6
29	84.2	86.1	87.9	89.8	91.7	93.7	95.6	97.5	99.5	101.5	103.5	105.5	107.5	109.5	111.6	113.7	115.7	117.8	120.0	122.1	124.2	126.4	128.6	130.8
30	87.8	89.7	91.7	93.6	95.6	97.6	99.6	101.6	103.7	105.7	107.8	109.9	112.0	114.2	116.3	118.5	120.6	122.8	125.1	127.3	129.5	131.8	134.1	136.4
31	91.6	93.6	95.6	97.7	99.7	101.8	103.9	106.0	108.2	110.3	112.5	114.7	116.9	119.1	121.4	123.6	125.9	128.2	130.5	132.9	135.3	137.7	140.1	142.5
32	95.7	97.8	99.9	102.0	104.2	106.3	108.5	110.7	113.0	115.2	117.5	119.8	122.1	124.5	126.8	129.2	131.6	134.0	136.5	139.0	141.5	144.0	146.6	149.1
33	100.0	102.2	104.4	106.6	108.9	111.2	113.5	115.8	118.2	120.5	122.9	125.4	127.8	130.3	132.8	135.3	137.8	140.4	143.0	145.6	148.3	150.9	153.7	156.4
34	104.7	107.0	109.3	111.7	114.0	116.4	118.9	121.3	123.8	126.3	128.8	131.4	134.0	136.6	139.2	141.9	144.6	147.4	150.1	152.9	155.7	158.6	161.5	164.4
35	109.7	112.2	114.6	117.1	119.6	122.2	124.7	127.3	129.9	132.6	135.3	138.0	140.8	143.6	146.4	149.2	152.1	155.0	158.0	161.0	164.0	167.1	170.2	173.3
36	115.2	117.8	120.4	123.0	125.7	128.4	131.1	133.9	136.7	139.5	142.4	145.3	148.3	151.3	154.3	157.3	160.5	163.6	166.8	170.0	173.3	176.6	179.9	183.3
37	121.3	124.0	126.8	129.6	132.4	135.3	138.2	141.2	144.2	147.3	150.3	153.5	156.7	159.9	163.1	166.5	169.8	173.2	176.7	180.2	183.7	187.3	191.0	194.7
38	127.9	130.8	133.8	136.8	139.9	143.0	146.2	149.4	152.6	155.9	159.2	162.6	166.1	169.6	173.2	176.8	180.4	184.2	188.0	191.8	195.7	199.7	203.7	207.7
39	135.3	138.5	141.7	145.0	148.3	151.7	155.1	158.6	162.1	165.7	169.4	173.1	176.9	180.7	184.7	188.7	192.7	196.8	201.0	205.3	209.6	214.0	218.5	223.0
40	143.7	147.1	150.6	154.2	157.8	161.5	165.3	169.1	173.0	177.0	181.1	185.2	189.4	193.7	198.1	202.5	207.1	211.7	216.4	221.1	226.0	231.0	236.0	241.1
41	153.2	157.0	160.9	164.8	168.9	173.0	177.2	181.5	185.8	190.3	194.8	199.5	204.2	209.1	214.0	219.1	224.2	229.4	234.8	240.2	245.8	251.5	257.2	263.1
42	164.3	168.6	172.9	177.3	181.9	186.5	191.3	196.1	201.1	206.2	211.4	216.7	222.2	227.7	233.4	239.2	245.2	251.3	257.5	263.8	270.3	276.9	283.6	290.5
43	177.5	182.3	187.3	192.4	197.6	202.9	208.4	214.0	219.8	225.8	231.8	238.1	244.5	251.0	257.7	264.6	271.7	278.9	286.3	293.8	301.5	309.4	317.4	325.7
44	193.6	199.3	205.1	211.0	217.2	223.5	230.0	236.7	243.6	250.8	258.1	265.6	273.3	281.2	289.4	297.8	306.3	315.1	324.1	333.3	342.8	352.4	362.3	372.4
45	214.1	220.9	227.9	235.2	242.7	250.4	258.4	266.7	275.3	284.1	293.3	302.6	312.3	322.3	332.5	343.0	353.8	364.9	376.2	387.9	399.8	412.0	424.5	437.4
46	241.5	250.0	258.9	268.2	277.8	287.8	298.1	308.8	319.9	331.4	343.3	355.5	368.1	381.1	394.5	408.3	422.5	437.1	452.0	467.4	483.3	499.6	516.3	533.5
47	280.9	292.4	304.4	316.9	330.0	343.6	357.8	372.5	387.7	403.4	419.8	436.6	454.1	472.1	490.7	509.9	529.8	550.4	571.7	593.8	616.7	640.5	665.3	691.0
48	344.1	360.9	378.4	396.8	416.0	436.0	456.9	478.6	501.2	524.7	549.3	574.8	601.5	629.4	658.6	689.3	721.5	755.6	791.5	829.7	870.4	913.9	960.6	1011.2
49	461.1	488.4	517.2	547.5	579.4	613.1	648.8	686.7	727.0	770.1	816.4	866.4	920.8	980.4	1046.2	1119.9	1203.3	1299.7	1413.6	1553.1	1732.9	1986.3	2419.6	>2419.6

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Expiration Date

QAPP Worksheet #37: Data Usability Assessment

PRODUCT INSERT **PI.035**

INSTRUCTIONS FOR USE

LYFO-DISK® Microorganisms

1. Remove the **LYFO DISK®** vial from 4° C - 8° C storage and allow the unopened vial to equilibrate to room temperature.
2. Aseptically remove one (1) gelatin pellet from the vial. Place the pellet in 0.5 mL of sterile Tryptic Soy Broth, Brain Heart Infusion Broth, saline, or deionized water.
3. Emulsify and crush pellet with a sterile swab until the pellet particles are uniform in size and the suspension is homogenous in appearance.

DO NOT INCUBATE

4. IMMEDIATELY, saturate the swab with the hydrated material and transfer the material to an appropriate, non-selective, nutrient or enriched agar medium. With pressure, rotate the swab, and inoculate a circular area (i.e. one inch or 25 mm in diameter) of the agar medium. Using the same swab or a sterile loop, repeatedly (about 10 to 20 times) streak through the inoculated area and then continue to streak the remainder of the agar surface.
5. Discard the remaining hydrated material in accordance with the laboratory protocol for disposal of biohazardous materials.
6. IMMEDIATELY, incubate the inoculated media at temperature and conditions appropriate to the microorganism.
7. Following, incubation select representative well-isolated colonies for indicated transfers.

KWIK-STIK™ Microorganisms

1. Remove the **KWIK-STIK™** unit from 4° C -8° C storage and allow the unopened pouch to equilibrate to room temperature.
2. Open the pouch and remove the **KWIK-STIK™** unit.
3. Tear off the pull tab portion of the label from the **KWIK-STIK™** device. The label can be attached to permanent QC Records or attached to the primary plate agar medium for identification.
4. Take note of the position of the gelatin pellet in the bottom part of the device and the reservoir of hydrating fluid in the top (cap) part of the device.

DO NOT DISASSEMBLE THE DEVICE DURING HYDRATION

5. Release the hydrating fluid by pinching the very top of the ampule in the cap of the device. Allow the hydrating fluid to flow through the swab shaft and INTO the bottom portion of the unit containing the gelatin pellet.
6. Holding the device vertically, with the cap up, and tapping the bottom of the device on the counter can further facilitate the flow of the fluid.
7. Using a pinching action on the bottom portion of the unit, crush and mix the pellet in the fluid until the pellet particles are uniform in size and the suspension is homogenous in appearance.

DO NOT INCUBATE

8. IMMEDIATELY, saturate the swab with the hydrated material and transfer the material to an appropriate, non-selective, nutrient or enriched agar medium. With pressure, rotate the swab, and inoculate a circular area (i.e. one inch or 25 mm in diameter) of the agar medium. Using the same swab or a sterile loop, repeatedly (about 10 to 20 times) streak through the inoculated area and then continue to streak the remainder of the agar surface.
9. Discard the remaining hydrated material in accordance with the laboratory protocol for disposal of biohazardous materials.
10. IMMEDIATELY, incubate the inoculated media at temperature and conditions appropriate to the microorganism.
11. Following incubation, select representative well-isolated colonies for indicated transfers.

QAPP Worksheet #37: Data Usability Assessment

SOP - 003c HPC SOP

QAPP Worksheet #37: Data Usability Assessment

PHOENIX
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Effective Date: 7/26/17
Version Number: 8.1
Initiated By: Kathy Cressia
Approved By: Rashmi Makol

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SOP Number: 406.HPC

Title: Heterotrophic Plate Count (HPC) formerly known as Standard Plate Count (SPC)

Scope and Application: This method covers the enumeration of a wide range of bacteria species in drinking water and in pool water. This method is applicable to sources with low bacterial density, and is not applicable to solid samples. This method is not used for quantification of specific bacterial species, but rather total enumeration of all species (excluding some anaerobic species) present in the sample. While there are no limits on the HPC level allowable in drinking waters, this test aids in the overall assessment of the sterility of a water source. This method is applicable to samples with a bacterial density of 0 to 5700 cfu/mL (colony-forming units/mL sample). Samples that are known or suspected to have greater than 5700 cfu/mL may be diluted with sterile buffer water prior to plating.

I. Summary of Method

A. Plate Count agar is melted in a hot waterbath and tempered to 44.5°C. One mL of sample is pipetted into a petri dish, followed by the tempered agar. The sample and agar are swirled to ensure even dispersion of bacteria, and once the agar has congealed, it is incubated for 48 hours at 35.0°C. After the incubation period has passed, the bacterial colonies on the sample plates are counted with the aid of a dark-field colony counter.

II. Interferences

A. Samples very high in bacteria may overgrow plate, making counting difficult. Limit sample size to 1.0 mL. For samples with known high bacterial densities use 0.1 mL.
B. Air bubbles in the media can be mistaken for bacteria colonies. When melting agar and pouring plates, take care not to introduce air bubbles.

III. Sample Collection, Preservation and Storage

A. Samples to be analyzed for HPC must be sampled aseptically in sterile containers, stored at 4°C until time of analysis, and must be analyzed within 8 hours of the time of sampling.
B. Sealed bottled waters must be analyzed within 8 hours of opening.
C. Samples are kept separate from the general samples in the walk-in sample storage refrigerator. Store bacteria samples in the plastic bin to reduce the chance of in-house contamination.

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IV. Equipment and Supplies

A. Bunsen burner.
B. Sterile sample containers, 120mL with a 100mL fill-line.
C. Petri dishes with lid.
D. Disposable sterile pipets, 1mL, 10mL.
E. Culture tubes, with screw caps.
F. Autoclave.
G. Incubator, able to maintain an internal temperature of 35.0C $^{+}$/-0.5^{o}C.

V. Reagents and Standards

A. Standard Methods Agar.
B. Dilute Clorox solution, 10%. Dilute 50mL Clorox Bleach to 500mL DI water.
C. Microbiologics dehydrated *S.aureus* samples.
D. Tryptic soy broth, dehydrated media. Prepare per manufacturer's instructions.

VI. Definitions

A. HPC- Heterotrophic plate count measures the number of live heterotrophic bacteria in water.
B. CFU- Colony forming unit are colonies that form from pairs, chains, clusters or single cells of bacteria.
C. Blank- A sample containing only melted agar that is subjected to all steps of the method. The blank is used to determine if there was possible bacterial contamination in the procedure.

VII. Procedure

A. Prepare Standard Methods agar in advance and store in the refrigerator at 4^{o}C until time of use. Agar is good to use for 3 months if stored in screw-cap tubes at 4^{o}C.
1. Suspend 23.5g dehydrated media in 1L DI water. Heat with agitation, boil to dissolve completely. Remove from heat immediately after boil.
2. Remove a portion of the agar to test the pH, allowing time for it to cool first. The pH must be within 6.8-7.2 pH units, else begin again.
3. Dispense 12-15 mL of agar into screw-cap tubes, lightly screw caps onto the tubes.
4. Autoclave at 121^{o}C for 15 minutes.
5. Remove from autoclave within 45 minutes of the beginning of the cycle.
6. Allow the tubes to cool, and tighten the caps to seal.
7. Mark the tubes with the proper ID number and expiration date.
8. Store in refrigerator at 4^{o}C.

Expiration Date

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B. Melt enough agar to plate each sample to be tested twice, plus two extras.
1. Place the agar-filled tubes into a large beaker.
2. Add water to the beaker to match the level of the agar in the tubes.
3. Heat the beaker on a hot plate. The water will boil, and the agar will melt.
4. Remove the tubes from the beaker once the agar has completely liquefied.
5. Transfer the tubes to a culture tube rack.

C. Temper the liquefied media in the 44.5°C waterbath for 20 minutes.
1. Be sure there are no samples incubating in the waterbath when the tubes are to be tempered. The hot tubes will work to heat the water in the waterbath, jeopardizing any samples that may be incubating. Alternatively, use the extra waterbath, set at 44.5°C before use.
2. Be sure the level of the water in the waterbath is not high enough to reach the caps of the tubes. Bail some water out if necessary.
3. Be sure the level of the water in the waterbath is high enough to completely submerge the liquid agar inside the tubes. Add some water if necessary.
4. Keep the tubes in the waterbath for at least 20 minutes, up to 3 hours.
5. Do not re-solidify liquefied agar, rather, throw away extra media.

D. Clean the counter top with a dilute solution of Clorox bleach.

E. Line the bench top with a piece of aluminum foil.

F. Wash the aluminum foil-lined workspace with dilute Clorox solution.

G. Wipe dry with a paper towel. Make sure the foil is completely dry before continuing. Residual bleach can potentially splash into the sample, giving an erroneous low result.

H. Test sample for chlorine by shaking the sample and pouring off a small portion onto an EM QUANT low-level test strip. If chlorine is present, note in logbook and contact client services.

I. Turn on the gas supply to the Bunsen burner by turning the valve so that it is at a 9:00 position. Use a flint to make a spark to light the burner. Beware of leaving the gas supply on for any period of time with no flame. The gas itself is odorless, but an additive gives off a sulfur smell, so that leaks and open valves can be detected.

J. Get the plates ready.
1. Remove the petri dishes from their sealed plastic bags, being mindful not to open the dishes.
2. Get enough petri dishes out so that a replicate can be run for each sample, plus one extra for a blank. If two samples are to be analyzed, five petri dishes will be required.
3. Label the plates with the proper ID number, the volume to be used, and a notation of which is a replicate for each sample.

K. Shake the sample to be tested for 20 seconds with an up and down arm motion.

L. Quickly, aseptically open the sample container without touching the inside or rim of the container. Aseptic technique ensures that the sample is not being exposed to outside contamination (potentially resulting in an erroneously high result) or

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outside inhibition (potentially resulting in an erroneously low result). To open a sample container aseptically, swipe the rim of the opening along the flame, unscrew the cap, and immediately expose the air space over the level of the sample to the flame.

M. Quickly, aseptically transfer 1mL (or other suitable portion such as 0.10mL) of sample from the sample container to the petri dish.
1. Flame the length of a disposable sterile 1mL pipet.
2. Place it in the sample container so that the tip of the pipet is in the center of the sample.
3. Measure 1mL of sample.
4. Open the top of the plate as little as possible, and add the 1mL of sample to the plate.
5. Touch the tip of the pipet to the bottom of the dish to ensure proper delivery of sample.
6. Return the lid of the petri dish

N. After the tubes have tempered adequately, remove one tube of agar from the waterbath. Wipe down the sides of the tube with a paper towel. Dry the outside of the tube completely. Failure to do so may result in erroneously high results, as the water from the waterbath can potentially drip into the petri dish as the agar is poured.

O. Aseptically pour the agar into the petri dish.
1. Swipe the tube over the Bunsen burner, flaming the screw-cap area.
2. Twist open the tube to break the seal, and flame again.
3. Remove the cap from the tube, and flame the mouth of the tube.
4. Lift open the top of a petri dish as little as possible, and pour the contents of the tube into the dish.
5. Return the lid of the petri dish.

P. Slowly swirl the plate so that the agar and sample mix completely, and so that the sample is evenly distributed around the plate.

Q. Once the agar has solidified on the bottom of the petri dishes, they are transferred to the 35.0°C incubator inverted and in stacks of four for a 48-hour incubation period. For bottled water samples, incubate inverted in stacks no more than four high at 35.0°C for a 72 hour incubation period.

R. Repeat steps VII.J through VII.Q with the remainder of samples, running every sample in replicate.

S. At the end of the batch of samples, an agar blank is analyzed. This blank will demonstrate proper technique throughout the batch.

T. Discard extra agar, do not reuse it.

U. Record the date and time that the samples are transferred to the incubator, the start time, as well as the date and time the samples are removed from the incubator, the end time.

V. After the samples have incubated for the appropriate amount of time, 48 hours (plus or minus 3 hours) or 72 hours (plus or minus 4 hours) for bottled water,

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remove the samples from the incubator. Count and record results immediately. See "Interpretation of Results" section of this procedure.

VIII. Interpretation of Results and Calculations

A. Use the dark-field colony counter to aid in enumeration of colonies present on a plate.
1. If there are more than 10 colonies per cm^2, count four representative blocks (cm^2), average the result, and multiply by a factor of 57 (or 65 if glass plates were used—glass plates are larger).
2. If the plates are completely overgrown, a result of >5700cfu/mL is reported.

B. Samples that required an initial dilution require an additional calculation. Multiply the plate count by the dilution factor to get the reported result.

C. If the blank exhibits significant bacterial growth, all results from the batch must be discarded, and samples resampled.

IX. Quality Control

A. All reagents and media are labeled with the date received, date opened, and the Phoenix Bacteria Lot Number (recorded as materials are received).

B. Each batch of Standard Methods agar is tested with a control organism: S.aureus.
1. Refer to the manufacturer's instructions in Appendix I on hydrating control bacteria samples.
2. Analyze the control as a sample, being mindful of aseptic technique.
3. Interpret the findings. S.aureus should grow on Standard Methods agar, with consistent results. Refer to the Media Prep Logbook for average S.aureus control densities.
4. If your results match your expectations, the media is verified and may be used for sample analysis.
5. If your results do not match your expectations, the media is suspect. Repeat the experiment to make sure you did everything right. If your findings are consistent, return media to the supplier---do not use for sample analysis.
6. Record this experiment in the HPC sample logbook and in the Media Prep logbook.
7. Reference the date of this experiment on each logbook page the media is used.
8. Each new lot of media should be checked against the old lot of media using comparison counts. These comparisons must be done with countable results. See Use Test. Record comparison counts in Media Lot Comparison Logbook.

C. Each lot of sterile sample containers is tested for accurate volume markings and sterility.

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1. Test accurate volume markings by filling a sample container up to the fill line with tap water. Pour this water into a graduated cylinder to measure the true volume. The accuracy of the volume marking must be within a 2.5% tolerence.
2. Test the sterility of the sample containers by aseptically decanting 25mL of tryptic soy broth into a sterile sample container. Incubate at 35.0^{+}/-0.5^{o}C for 48 hours. Check and record findings after 24 hours of incubation and at 48 hours. If the tryptic soy broth is found to be free of turbidity after the incubation period, then the containers are sterile, and okay for use. If the tryptic soy broth is turbid after incubation, the sample containers need to be re-tested. If consistent results come back that they are contaminated, return to supplier---do not use for samples.
3. Document this in the Sterility Check logbook.

D. The incubator must maintain an internal temperature of 35.0^{+}/-0.5^{o}C. The temperatures are documented twice daily (at least four hours apart). The thermometers inside the incubator are calibrated annually against NIST traceable thermometers.

E. Avoid excessive drying of the agar medium; agar medium in plates should not lose more than 15% by weight during the 48 hours of incubation. Check loss periodically by weighing plates before and after incubation. Record in HPC logbook.

F. The sterilizing capability of the autoclave is tested monthly with Sterikon ampoules.

G. The timing mechanism of the autoclave is checked weekly. Refer to the autoclave maintenance log for information on timing adjustments.

H. The internal temperature of the autoclave is monitored at each use with a maximum temperature thermometer.

I. Monthly, have another analyst count the plates. These duplicate plate counts should agree within 10%.

X. Safety

A. The analyst must know and observe the normal safety procedures required in a microbiology laboratory while preparing, using and disposing of cultures, reagents, and materials, and while operating sterilization equipment.

B. Mouth pipetting is prohibited.

C. Refer to Phoenix SOP#805 for more information on lab safety.

XI. Pollution Prevention

A. The reagents used in this method poses little threat to the environment when managed and disposed of properly.

B. Reagents should be purchased in volumes consistant with laboratory use to minimize the volume of expired reagents to be disposed.

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XII. Waste Management

A. It is the laboratories responsibility to comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

XIII. Method Performance

A. This method was validated through internal QA/QC monitoring, including all quality control criteria mentioned Section IX of this procedure.

XIV. Corrective Action for Out-of-Control or Unacceptable Data

A. Due to the nature of this method, unacceptable data such as contamination will not be noticed until the following day. At this time, immediately go to client services to request resamples from the client. A non-conformance report must be generated at this time.

B. If a sample is received past holding time, have client services notify client. Make sure it is noted on the chain of custody.

XV. References

A. Standard Methods for the Examination of Waste and Wastewater, 19th edition. Method No. 9215B, Revised 1995.

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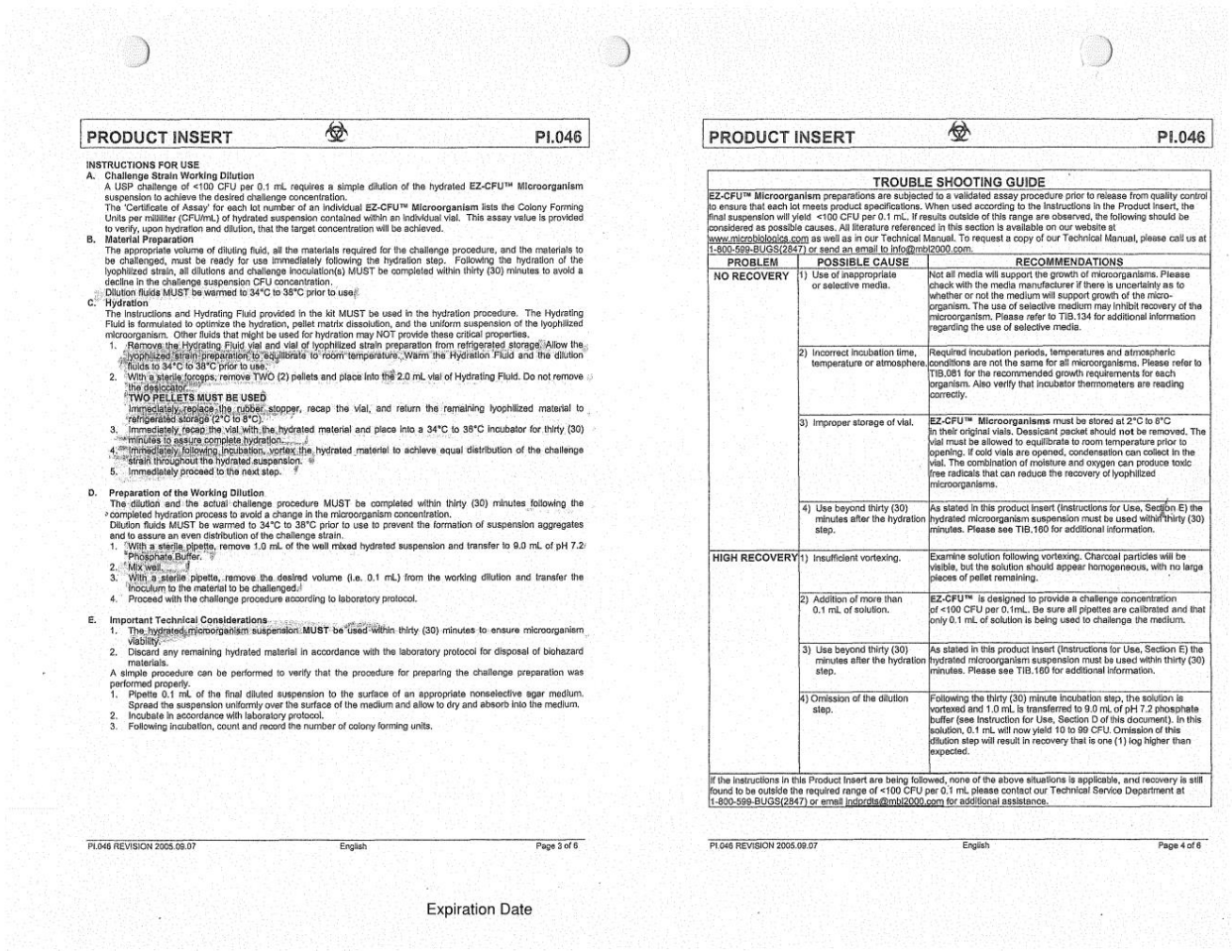

PRODUCT INSERT PI.046

INSTRUCTIONS FOR USE

A. Challenge Strain Working Dilution

A USP challenge of <100 CFU per 0.1 mL requires a simple dilution of the hydrated **EZ-CFU™ Microorganism** suspension to achieve the desired challenge concentration.
The 'Certificate of Assay' for each lot number of an individual **EZ-CFU™ Microorganism** lists the Colony Forming Units per milliliter (CFU/mL) of hydrated suspension contained within an individual vial. This assay value is provided to verify, upon hydration and dilution, that the target concentration will be achieved.

B. Material Preparation

The appropriate volume of diluting fluid, all the materials required for the challenge procedure, and the materials to be challenged, must be ready for use immediately following the hydration step. Following the hydration of the lyophilized strain, all dilutions and challenge inoculation(s) MUST be completed within thirty (30) minutes to avoid a decline in the challenge suspension CFU concentration.
Dilution fluids MUST be warmed to 34°C to 38°C prior to use.

C. Hydration

The Instructions and Hydrating Fluid provided in the kit MUST be used in the hydration procedure. The Hydrating Fluid is formulated to optimize the hydration, pellet matrix dissolution, and the uniform suspension of the lyophilized microorganism. Other fluids that might be used for hydration may NOT provide these critical properties.

1. Remove the Hydrating Fluid vial and vial of lyophilized strain preparation from refrigerated storage. Allow the lyophilized strain preparation to equilibrate to room temperature. Warm the Hydration Fluid and the dilution fluids to 34°C to 38°C prior to use.
2. With a sterile forceps, remove TWO (2) pellets and place into the 2.0 mL vial of Hydrating Fluid. Do not remove the desiccator.
   TWO PELLETS MUST BE USED
   Immediately replace the rubber stopper, recap the vial, and return the remaining lyophilized material to refrigerated storage (2°C to 8°C).
3. Immediately recap the vial with the hydrated material and place into a 34°C to 38°C incubator for thirty (30) minutes to assure complete hydration.
4. Immediately following incubation, vortex the hydrated material to achieve equal distribution of the challenge strain throughout the hydrated suspension.
5. Immediately proceed to the next step.

D. Preparation of the Working Dilution

The dilution and the actual challenge procedure MUST be completed within thirty (30) minutes following the completed hydration process to avoid a change in the microorganism concentration.
Dilution fluids MUST be warmed to 34°C to 38°C prior to use to prevent the formation of suspension aggregates and to assure an even distribution of the challenge strain.

1. With a sterile pipette, remove 1.0 mL of the well mixed hydrated suspension and transfer to 9.0 mL of pH 7.2 Phosphate Buffer.
2. Mix well.
3. With a sterile pipette, remove the desired volume (i.e. 0.1 mL) from the working dilution and transfer the inoculum to the material to be challenged.
4. Proceed with the challenge procedure according to laboratory protocol.

E. Important Technical Considerations

1. The hydrated microorganism suspension **MUST** be used within thirty (30) minutes to ensure microorganism viability.
2. Discard any remaining hydrated material in accordance with the laboratory protocol for disposal of biohazard materials.

A simple procedure can be performed to verify that the procedure for preparing the challenge preparation was performed properly.

1. Pipette 0.1 mL of the final diluted suspension to the surface of an appropriate nonselective agar medium. Spread the suspension uniformly over the surface of the medium and allow to dry and absorb into the medium.
2. Incubate in accordance with laboratory protocol.
3. Following incubation, count and record the number of colony forming units.

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TROUBLE SHOOTING GUIDE

EZ-CFU™ Microorganism preparations are subjected to a validated assay procedure prior to release from quality control to ensure that each lot meets product specifications. When used according to the Instructions in the Product Insert, the final suspension will yield <100 CFU per 0.1 mL. If results outside of this range are observed, the following should be considered as possible causes. All literature referenced in this section is available on our website at www.microbiologics.com as well as in our Technical Manual. To request a copy of our Technical Manual, please call us at 1-800-599-BUGS(2847) or send an email to info@mbl2000.com.

PROBLEM	POSSIBLE CAUSE	RECOMMENDATIONS
NO RECOVERY	1) Use of inappropriate or selective media.	Not all media will support the growth of microorganisms. Please check with the media manufacturer if there is uncertainty as to whether or not the medium will support growth of the microorganism. The use of selective medium may inhibit recovery of the microorganism. Please refer to TIB.134 for additional information regarding the use of selective media.
	2) Incorrect incubation time, temperature or atmosphere.	Required incubation periods, temperatures and atmospheric conditions are not the same for all microorganisms. Please refer to TIB.081 for the recommended growth requirements for each organism. Also verify that incubator thermometers are reading correctly.
	3) Improper storage of vial.	**EZ-CFU™ Microorganisms** must be stored at 2°C to 8°C in their original vials. Desiccant packet should **not** be removed. The vial must be allowed to equilibrate to room temperature prior to opening. If cold vials are opened, condensation can collect in the vial. The combination of moisture and oxygen can produce toxic free radicals that can reduce the recovery of lyophilized microorganisms.
	4) Use beyond thirty (30) minutes after the hydration step.	As stated in this product insert (Instructions for Use, Section E) the hydrated microorganism suspension must be used within thirty (30) minutes. Please see TIB.160 for additional information.
HIGH RECOVERY	1) Insufficient vortexing.	Examine solution following vortexing. Charcoal particles will be visible, but the solution should appear homogeneous, with no large pieces of pellet remaining.
	2) Addition of more than 0.1 mL of solution.	**EZ-CFU™** is designed to provide a challenge concentration of <100 CFU per 0.1mL. Be sure all pipettes are calibrated and that only 0.1 mL of solution is being used to challenge the medium.
	3) Use beyond thirty (30) minutes after the hydration step.	As stated in this product insert (Instructions for Use, Section E) the hydrated microorganism suspension must be used within thirty (30) minutes. Please see TIB.160 for additional information.
	4) Omission of the dilution step.	Following the thirty (30) minute incubation step, the solution is vortexed and 1.0 mL is transferred to 9.0 mL of pH 7.2 phosphate buffer (see Instruction for Use, Section D of this document). In this solution, 0.1 mL will now yield 10 to 99 CFU. Omission of this dilution step will result in recovery that is one (1) log higher than expected.

If the instructions in this Product Insert are being followed, none of the above situations is applicable, and recovery is still found to be outside the required range of <100 CFU per 0.1 mL please contact our Technical Service Department at 1-800-599-BUGS(2847) or email indprdts@mbl2000.com for additional assistance.

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Expiration Date

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Revision History Log for SOP # 406

Date:	Revision #:	Summary of Changes:	Submitted By:	Approved By:	Effective Date:
7/26/17	8.1	Section III.B.- added holding time for bottled waters, Section VI.C. updated definition of blank per NY auditor, Section VIII.Q, S, V- updated blank and bottled water information	Kathy Cressia	Rashmi Makol	7/26/17

Expiration Date

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SOP – 003d Turbidity SOP

QAPP Worksheet #37: Data Usability Assessment

PHOENIX
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Effective Date: 03/07/18
Version No.: 2.1
Initiated By: Kathy Cussia
Approved By:

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SOP No: 360.PCT

Title: PC Titrator for pH, Alkalinity, Conductivity & Turbidity

Scope and Applications:

pH: This method covers the electrometric determination of the pH of samples. Corrosivity is then determined as a function of the pH of a sample. The range of this method is from 0 to 14 pH units. A sample is deemed "corrosive" if its pH is less than 2.00 or greater than 12.50 pH units. Ideally, the pH is determined in the field by the sampler because the holding time is 'immediate'. Samples received in the lab should be analyzed as soon as possible, before the sample is submitted to the sample storage refrigerators by the sample receipt department. All pH samples analyzed in the laboratory are flagged as past holding time.

Turbidity: Turbidity is a measure of water's clarity, and is important in producing products destined for human consumption. This method covers the determination of a sample's turbidity in the range of 0 to 40 NTU. Samples that have a turbidity of greater than 40 NTU require sample dilution prior to analysis. This method is suitable for any water that is free of debris and rapidly settling coarse sediment. Samples should be stored at 4°C prior to analysis, and analyzed within 48 hours from the time of sampling.

Conductivity: This method is applicable to the measurement of conductivity in drinking, surface, and saline waters, domestic and industrial wastes. This method is suitable for samples with conductivity values of 5.0 to 10000*u*mhos/cm. Samples with conductivity values of greater than 10000*u*mhos/cm may be diluted prior to analysis. Resistance may be determined from the conductivity result, as follows: 1/C = R; where C = conductivity (*u*mhos/cm), and R = resistivity (Mohm/cm).

Alkalinity: This method covers the determination of alkalinity in drinking, surface, and saline waters, domestic and industrial wastes. This method is suitable for samples with alkalinity values between 5.0 mg/L to 2000 mg/L. Samples with an alkalinity greater than 2000 mg $CaCO_3$/L need to be diluted prior to titration.

QAPP Worksheet #37: Data Usability Assessment

Effective Date: 03/07/18
Version No.: 2.1
SOP No.: 360. PCT

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I. Summary of Methods:

A. This method covers the operation and maintenance of the PC Titrator auto-analyzer which measures for 4 analytes: pH (electrode), Alkalinity (titration), Conductivity (electrode) and Turbidity (nephelometric).

pH: The pH of the sample is determined electrometrically using a combination electrode. The pH meter is calibrated before each use using a series of standard solutions of known pH.

Turbidity: A turbidimeter is used to quantify the amount of light that is scattered as it is passed through a sample.

Conductivity: Conductivity is the numerical expression of the ability of an aqueous solution to carry an electric current. The conductivity is measured by use of a conductivity meter (wheatstone bridge).

Alkalinity: The Alkalinity of a sample represents the acid-neutralizing capacity of a sample. Strong acid is added to the sample until it reaches a designated pH. The amount of acid added is a function of the alkalinity of the sample.

II. Interferences:

pH:

A. Coatings of oily material or particulate matter can impair electrode response. These coatings can usually be removed by gently wiping or detergent washing, followed by rinsing with DI water. An additional treatment with 1:10 HCl may be necessary to remove any remaining film.

B. Temperature effects the electrometric determination of pH. It is important to analyze standards and samples at the same temperature or use an automatic temperature compensation (ATC) probe if the temperatures are different.

Turbidity:

A. Dirty glassware and the presence of air bubbles are positive interferences, both of which can be avoided. Be sure all glassware is

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free of scratches, smears from fingerprints, and stray dust. Discard any scratched or otherwise permanently marred piece of glassware.

B. True color, i.e., water color due to dissolved substances that absorb light, causes measured turbidities to be low. This effect is usually not significant in treated water.

Conductivity:

A. Because conductivity is a function of temperature, samples are analyzed at a standard 25°C. Remove samples from refrigerator and allow warming to room temperature before analysis.

Alkalinity:

A. Dissolved gases may be lost or gained during sample storage, and can add to or reduce the alkalinity of a sample. Minimize this interference by titrating promptly, by avoiding vigorous shaking, and by keeping the sample at a constant temperature.

III. Sample Collection, Preservation and Holding Times:

pH:

A. pH is a field parameter and should be analzyed immediately after sampling. Samples analyzed for pH in the laboratory must be flagged as analyzed past holding time.

B. Collect sample in a clean plastic or glass bottle with no preservative.

Turbidity:

A. Collect sample in a clean plastic or glass bottle with no preservative and stored at 4°C until time of analysis.

B. The holding time for Turbidity is 48 hours from time of collection.

Conductivity:

A. Collect sample in a clean plastic or glass bottle with no preservative and stored at 4°C until time of analysis.

B. The holding time for Conductivity is 28 days from time of collection.

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Alkalinity:

A. Samples should be collected in a separate plastic 100mL container. They must be unpreserved and stored at 4°C until time of analysis.
B. Samples must be analyzed within 14 days of collection.

IV. Equipment and Supplies:

A. Man-Tech PC-Titration Analyzer with Autosampler; Cat. No. PC-1000-102.
B. 50mL Conical Vials; Environmental Express Cat. No. SC461 (or equivalent).

V. Reagents and Standards:

A. Primary Standard Buffer, 4.00 pH units; RICCA # IBF-040-L (or equivalent).
B. Primary Standard Buffer, 7.00 pH units; RICCA # IBF-070-L (or equivalent).
C. Primary Standard Buffer, 10.00 pH units; RICCA # IBF100-L (or equivalent).
D. 1412 µmhos/cm Potassium Chloride Conductivity Standard, Ricca Cat. No. 5890-1 (or equivalent).
E. NIST Traceable Conductivity Standard, 10.0*u*mhos/cm at 25°C. RICCA P/N 2236-16 (or equivalent).
F. NIST Traceable Conductivity Standard, 100*u*mhos/cm at 25°C. RICCA P/N 2237-16 (or equivalent).
G. NIST Traceable Conductivity Standard, 1000*u*mhos/cm at 25°C. RICCA P/N 2243-16 (or equivalent).
H. NIST Traceable Conductivity Standard, 10000*u*mhos/cm at 25°C. VWR Cat.#23226-625 (or equivalent).
I. NIST Traceable Conductivity LCS, 100*u*mhos/cm at 25°C. VWR Cat.#23226-589 (or equivalent second source).
J. 100 NTU Turbidity Standard; Man-Tech Cat. No. PC-1000-164 (or equivalent).
K. 0.02N H_2SO_4 Alkalinity Titrant: In a 2-Liter volumetric flask containing approximately 1500mL DI water, add 1.12mL concentrated H_2SO_4 and bring up to volume with DI water. **Carefully** invert to mix.
L. 0.02N NaOH: In a 1-Liter volumetric flask containing approximately 500mL DI water, add 2.0mL 10N NaOH (VWR Cat. No. JT5674-2 or

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equivalent) and bring up to volume with DI water. **Carefully** invert to mix.

M. LCS Solution (pH, Conductivity and Alkalinity)- Ultra Minerals # QCI-710 or equivalent.

N. LCS Stock Solution (Turbidity)- Amco Clear Turbidity Standard 40 NTU #8017 or equivalent.

O. LCS Working Solution: 100mL LCS Stock Solution into 1L DI Water.

VI. Definitions

A. Laboratory Control Sample (LCS)- A purchased standard of a known concentration that is from a different source than the calibration standards. The LCS is used to determine laboratory performance.

B. Preparation Blank (Prep Blank)- An aliquot of reagent water that is treated exactly as a sample. The prep blank is used to determine if method analytes are present in the lab environment, reagents or glassware.

C. Calibration standard- A solution prepared from the dilution of stock standard solutions. The calibration solutions are used to calibrate instrument response with respect to analyte concentration.

D. Sample Replicates (Rep)- Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of the sample and duplicate indicate precision associated with laboratory procedures.

VII. Procedure:

A. Daily Maintenance

1. Prior to running calibrations and samples the instrument must go through a daily maintenance check to ensure accurate results.
2. The pH probe must be rinsed with deionized water, wiped with a kimwipe, and filled with pH fill solution.
3. The conductivity probe must be taken out of the holder, rinsed with deionized water, and gently wiped with a kimwipe on the outside only. NOTE: **DO NOT** wipe the black sensors on the inside of the probe as this will adversely affect the probes performance.
4. Rinse and wipe the metal turbidity sample tube. Check the plastic tubing that goes from the metal turbidity sample tube to the turbidimeter for anything that might affect the result.

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This tubing should be changed on a monthly basis or earlier if needed.

5. Fill the DI water reservoir at the back of the instrument to the "fill" line and also empty the two waste containers (check the pH of the waste, if it is neutral then it can be poured down the sink. If the waste is either acidic or alkaline then dispose of the waste in the appropriate satellite container.)
6. Fill the Alkalinity titrant bottle with 0.02N H_2SO_4 titrant.

B. Calibration

pH Calibration

1. The pH calibration is done daily. First, click the PC Titrator icon  on the desktop to open the software. Next, select "Run Titration" from the drop-down menu under the Titration tab (see Figure 4).
2. When the "Run Titration" screen opens, click on the "Add x Rows" button and type in the number of rows needed. For the pH calibration, normally 4 rows are added.
3. Double click on the "Schedule" box for Row1.
4. When the "Schedule Search Form" window opens select **pH only** from the "Available Selections" list and click "OK".
5. Repeat the last step for Rows 2, 4, & 5. Row 3 is similar except **pH calibration** is selected from the "Available Selections" list.
6. Next, click on the "Auto-Generate Order Number" button. The software will automatically assign an Order Number to the run, which is put in the "Order Number" box for row 1.
7. Click on & drag the order number until the entire column is full.
8. Type in a description of each sample in the "Sample Name" column. The first two rows are Blanks, the third row is the "pH Calibration", the fourth row is a LCS, and the last row is a "pH 7.00" calibration check.
9. Under the Vial column, type in "1" for row 1, "2" for row 2, "3" for row 3, "**6**" for row 4 (the pH cal for line 3 needs 3 vials), "7" for the last row. The pH timetable should mimic that in Figure 7.
10. Next, pour 45mL of deionized water into a conical 50mL Vial for each of the two BLANKS. Place the 2 vials into the tray holes marked 1 & 2.
11. Pour 45mL of a pH 4.00 buffer into a vial and place vial into hole #3.

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12. Pour 45mL of a pH 7.00 buffer into a vial and place vial into hole #4.
13. Pour 45mL of a pH 10.00 buffer into a vial and place vial into hole #5.
14. Pour 45mL of LCS into a vial and place vial into hole #6.
15. Pour 45mL of a pH 7.00 buffer into a vial and place vial into hole #7.
16. Once the vials are all in the tray click the green "Start" button (Figure 7.) to start the calibration.
17. Once the calibration is complete, the system will verbally notify you whether the calibration passed or failed.
18. Print out the passing calibration and include a copy with the data report.

Turbidity Calibration

The Turbidity calibration is done for any of the following: new standards, new tubing, new turbidity lamp, or calibration standards fail to meet QA/QC requirements.

1. First, click the PC Titrator icon  on the desktop to open the software. Next, select "Run Titration" from the drop-down menu under the Titration tab (see Figure 4).
2. When the "Run Titration" screen opens, click on the "Add x Rows" button and type in the number of rows needed. For the turbidity calibration, normally 5 rows are added.
3. Double click on the "Schedule" box for Row1.
4. When the "Schedule Search Form" window opens select TURBIDITY from the "Available Selections" list and click "OK".
5. Repeat the last step for Rows 2, 4-6. Row 3 is similar except Turbidity Calibration is selected from the "Available Selections" list.
6. Next, click on the "Auto-Generate Order Number" button. The software will automatically assign an Order Number to the run, which is put in the "Order Number" box for row 1.
7. Click on & drag the order number until the entire column is full.
8. Type in a description of each sample in the "Sample Name" column. The first two rows are Blanks, the third row is the "Turb Cal", the fourth row is a LCS, the fifth row is a "2.0 NTU Std" and the last row is a "Blank".
9. Under the Vial column, type in "1" for row 1, "2" for row 2, "3" for row 3, "**11**" for row 4 (the Turbidity cal for line 3 needs 8

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vials), "12" for the fifth row & "13" for the last row. The turidity timetable should mimic that in Figure 8.

10. Next, pour 45mL of deionized water into a conical 50mL Vial for each of the two BLANKS. Place the 2 vials into the tray holes marked 1 & 2.
11. Pour 45mL of deionized water (0.02 NTU Std) into a vial and place into hole #3.
12. Pour 45mL of 0.20 NTU Standard into a vial and place vial into hole #4.
13. Pour 45mL of 0.50 NTU Standard into a vial and place vial into hole #5.
14. Pour 45mL of 1.00 NTU Standard into a vial and place vial into hole #6.
15. Pour 45mL of 2.00 NTU Standard into a vial and place vial into hole #7.
16. Pour 45mL of 5.00 NTU Standard into a vial and place vial into hole #8.
17. Pour 45mL of 10.0 NTU Standard into a vial and place vial into hole #9.
18. Pour 45mL of 50 NTU Standard into a vial and place vial into hole #10.
19. Pour 45mL of LCS into a vial and place vial into hole #11.
20. Pour 45mL of 2.0 NTU Std into a vial and place vial into hole #12.
21. Pour 45mL of deionized water (Blank) into a vial and place into hole #13.
22. Once the vials are all in the tray click the green "Start" button (Figure 8) to start the calibration.
23. The calibration is a point-to-point calibration and has no pass/fail criteria. However, should any of the calibration equations have a negative slope then the calibration must be rerun.
24. Print out the calibration and include a copy with every relevant data report.

Conductivity Calibration

The Conductivity calibration is done when QA/QC samples fail to meet acceptable criteria or when a new standard is opened.

1. First, pour a fresh aliquot of 1412 µmhos/cm conductivity standard into a 50mL conical vial.

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2. Immerse the conductivity probe into the vial containing the 1412 standard until a stable reading is achieved.
3. Press the "CAL/CLR" button twice on the Mantech 4510 Conductivity Meter.
4. Check at least one other conductivity standard to ensure the calibration is valid.
5. If the calibration is not valid repeat steps 1-4.

C. Building a Sequence

1. To build a sequence for the PC Titrator open up the Phoenix LIMS program, select "QA/QC Batching" from the Main Menu, and "PCT Sequence File" from the right hand list (see Figure 1).
2. The LIMS program will automatically list all pending non-soil samples from the WET3 & WET6 backlogs that require pH, turbidity, alkalinity, & conductivity (see Figure 2). The analyst has the choice of analyzing *just* the samples from WET3, *just* the samples from WET6, or the samples from *both* backlogs.
3. At this point any sample that is deemed "too dirty" to run on the PC Titrator can be unselected from the list and the necessary analysis can be completed using other approved methods.
4. To select a sample replicate simply click on a line that is designated "Rep-19" (19 is just an example as shown in Figure 2. The number will change to whatever vial number it is) and select a sample from the drop-down list. A replicate sample will be listed every tenth sample.
5. At this point click the "Build Sequence File" button at the bottom of the window. The file will be saved as the date (ie. 03-03-09A.txt) in the folder **P:/PCT**. When the new window opens and asks "Generate PCT Sequence File?" click "YES" and then "OK".
6. Before proceeding, ensure that the correct LCS lot numbers and true values are entered in the "LCS TV" tab (see Figure 3). These values are used to automatically calculate the percent recoveries during the data entry procedure.

D. Importing the Sequence

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1. First, click the PC Titrator icon on the desktop to open the software. Next, select "Run Titration" from the drop-down menu under the Titration tab (see Figure 4).
2. Click on the "Load from Text File" button (see Figure 5), select the file you wish to import (ie. 03-03-09A.txt) and click "Open".
3. If a dilution is needed you must click on the Phoenix sample ID (ie. AR33245) and place a "space", dilution factor, & "x" after the sample ID (ie. AR33245 10x) so that the automatic data transfer program will calculate the correct result.
4. Once the sequence is ready to run, click the "Print Existing Timetable" button (see Figure 5). When the new window opens up (Figure 6) click the "Printer" option in the "Destination" box and then click the "Print" button. Press "Done" after the timetable prints out.

E. Loading the Sample Trays

1. Using the sequence timetable printout as a guide, pour the samples, blanks & QC samples into 50mL conical vials (up to the 45mL mark) and place the filled vials into the corresponding holes of the 122-position sample tray.

NOTE: Vial positions 121 & 122 are always reserved for turbidity cleaning solution & pH 4 buffer (to store probe) respectively.

2. If more than 120 vials are needed then the sequence will repeat starting again at vial position 1. The analyst must wait for the first set of duplicated vial numbers to finish being analyzed before replacing them with the second set.
3. Once the samples have been poured the instrument can be started simply by clicking the green "Start' button (see Figure 5).

F. Data Entry

Upon completing the samples the instrument will automatically print out the data (Water Quality Report) at the defaulted printer. Check the printout to ensure all QC parameters are met as defined in the QA/QC section of this SOP. If all the data passes the QA/QC requirements it can be entered using the Phoenix LIMS program:

1. First, double-click the "Copy PCT Data to Server" icon on the desktop of the Titrator computer. This will send the data to the server so it can be reviewed and entered.

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2. From the LIMS Main Menu click the "Data Transfer" → "PCT Data Transfer" option (see Figure 9) to open up the data entry screen.
3. Select the file you are transferring. Generally, it is the very last file in the folder.
4. When the data file opens up the file will display the results with a checkmark in the "S" column for all pending analysis (unchecked boxes mean the sample is either already entered in Labworks or it is an unreportable QC sample). If a result is not needed, for any reason, uncheck the box.
5. Once all the data has been closely looked over & all the appropriate boxes have been checked, the analyst enters their initials in the space provided at the bottom of the screen and clicks the "Transfer Results to Labworks" button.
6. Click the "Print" button at the bottom left of the screen to print the results.
7. The Final Report will consist of the Run List, Sequence List, Calibrations, Raw Data (Water Analysis Report), & the Data Transfer Log. The completed report will then be put on the Wetlab Supervisor's desk for review.

VIII. Calculations

A. Multiply sample result by dilution factor where applicable.

B. Calculating RPD:
The RPD is the relative percent difference, and is a measure of the consistency of the sample replicate for the sample set. First, calculate the results for both the sample and the sample replicate. Then apply the two results to the following calculation:

$$\text{RPD, \%} = \frac{(R1 - R2)}{(R1+R2)/2} \times 100$$

where: R1 = value achieved for sample, mg/L
R2 = value achieved for sample replicate, mg/L

C. Calculating the LCS:

The LCS is the laboratory control standard and is a test of the accuracy of the calibration and the test overall. To calculate the %

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recovery of the LCS, calculate the LCS sample, and then apply it to the following calculation:

$$\% \text{ Recovery, } \% = \frac{(RL)}{(LTV)} \times 100$$

where: RL = achieved value for LCS sample, mg/L
LTV = true value of LCS, mg/L

IV. Quality Control

A. All reagents and standards are to be labeled with the following information: date prepared, date expires, preparer's initials, analyte, contents, and concentration of contents. Record preparation of all reagents in the reagent prep logbook.
B. The primary pH buffers and calibration standards are poured fresh at each calibration.
C. A sample prep blank of dilution water must be analyzed with each batch of twenty or fewer samples, as well as at the end of every run. Prep blanks must be determined to be BRL (below reporting level).
D. A bought standard (LCS) is run with each batch of twenty or fewer samples. The acceptable recovery of a LCS is 85-115%.
E. Sample replicates are analyzed every 10 of fewer samples. The RPD must be $\leq$20%, else repeat sample and duplicate analysis to prove matrix effect.

V. Safety

A. The toxicity and carcinogenicity of each reagent used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable. A reference file of material data handling sheets are available to all personnel involved in the chemical analysis.
B. Always wear safety glasses for eye protection as well as lab coats.

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C. Refer to Phoenix SOP #805: Hazardous Chemical and Laboratory Safety Procedures

VI. Pollution Prevention

A. Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation.
B. Standards should be purchased in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

VII. Waste Management

A. It is the laboratories responsibility to comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

VIII. Method Performance

A. This method was validated through internal QA/QC monitoring, including annual method detection limit studies, precision and accuracy studies, initial and continuing calibration verifications, blank analysis, laboratory control samples and matrix spikes and duplicates.
B. See section IX Quality Control in this SOP for acceptable limits.

IX. Corrective Action for Out-of-Control or Unacceptable Data

A. Should the preparation blank, LCS or in-house standard fail acceptance criteria, reanalyze batch.
B. Should the sample duplicate analysis fail acceptance criteria, a non-conformance report must be generated or the sample QC must be reanalyzed.

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X. References

A. Standard Methods for the Examination of Water and Wastewater, 22nd edition, Turbidity Method 2130B, Revised 2011.

B. Standard Methods for the Examination of Waste and Wastewater, 22nd edition, pH Method No. 4500-H^+ B, Revised 2011.

C. Standard Methods for the Examination of Waste and Wastewater, 22nd edition, Alkalinity Method No. 2320B, Revised 2011.

D. Standard Methods for the Examination of Water and Wastewater, 22nd edition, Conductivity Method 2510B, Revised 2011.

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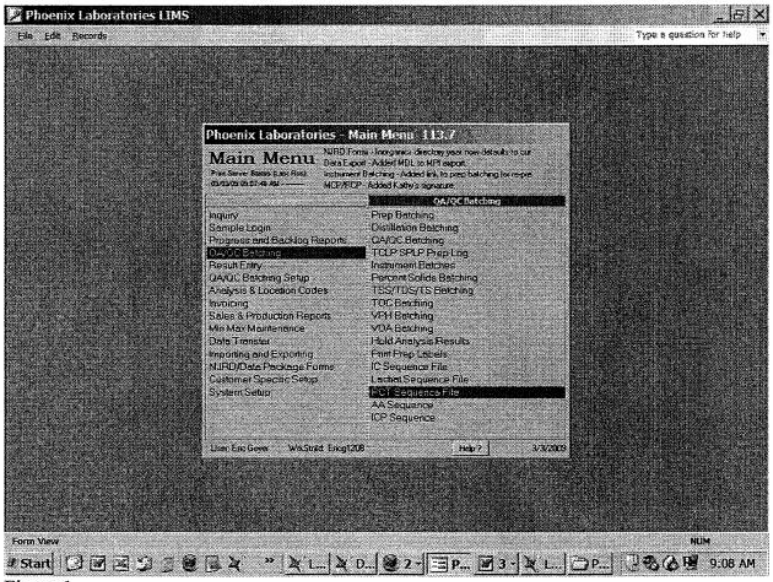
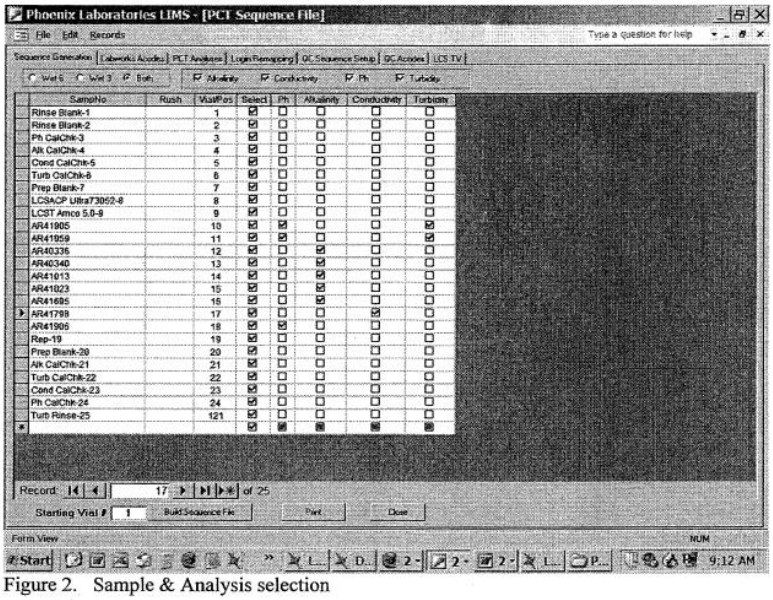


Figure 1.



SampNo	Rush	VialPos	Select	Ph	Alkalinity	Conductivity	Turbidity
Rinse Blank-1		1	☑	☐	☐	☐	☐
Rinse Blank-2		2	☑	☐	☐	☐	☐
Ph CalChk-3		3	☑	☐	☐	☐	☐
Alk CalChk-4		4	☑	☐	☐	☐	☐
Cond CalChk-5		5	☑	☐	☐	☐	☐
Turb CalChk-6		6	☑	☐	☐	☐	☐
Prep Blank-7		7	☑	☐	☐	☐	☐
LCSACP Ultra73052-8		8	☑	☐	☐	☐	☐
LCST Amco 5.0-9		9	☑	☐	☐	☐	☐
AR41905		10	☑	☑	☐	☐	☑
AR41959		11	☑	☑	☐	☐	☑
AR40335		12	☑	☐	☑	☐	☐
AR40340		13	☑	☐	☑	☐	☐
AR41013		14	☑	☐	☑	☐	☐
AR41023		15	☑	☐	☑	☐	☐
AR41695		16	☑	☐	☑	☐	☐
AR41799		17	☑	☐	☐	☑	☐
AR41906		18	☑	☑	☐	☐	☐
Rep-19		19	☑	☐	☐	☐	☐
Prep Blank-20		20	☑	☐	☐	☐	☐
Alk CalChk-21		21	☑	☐	☐	☐	☐
Turb CalChk-22		22	☑	☐	☐	☐	☐
Cond CalChk-23		23	☑	☐	☐	☐	☐
Ph CalChk-24		24	☑	☐	☐	☐	☐
Turb Rinse-25		121	☑	☐	☐	☐	☐
*			☑	☑	☑	☑	☑

Figure 2. Sample & Analysis selection

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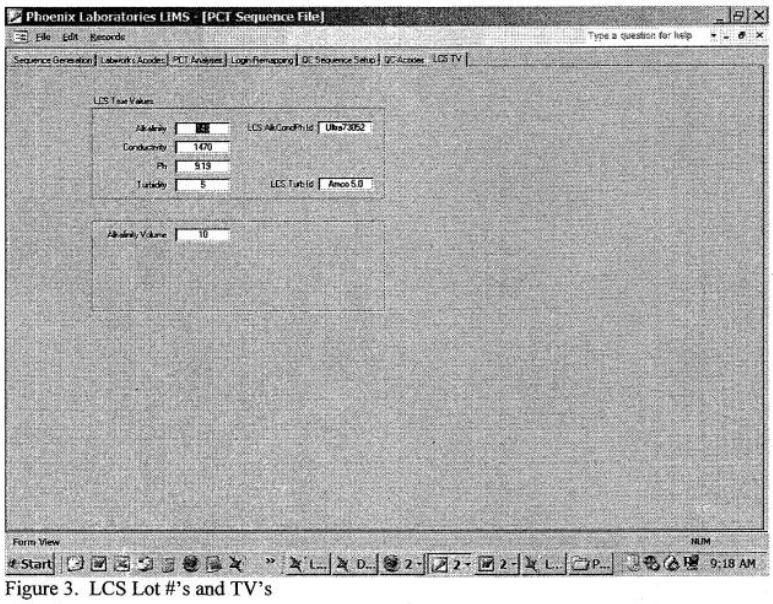

Figure 3. LCS Lot #'s and TV's

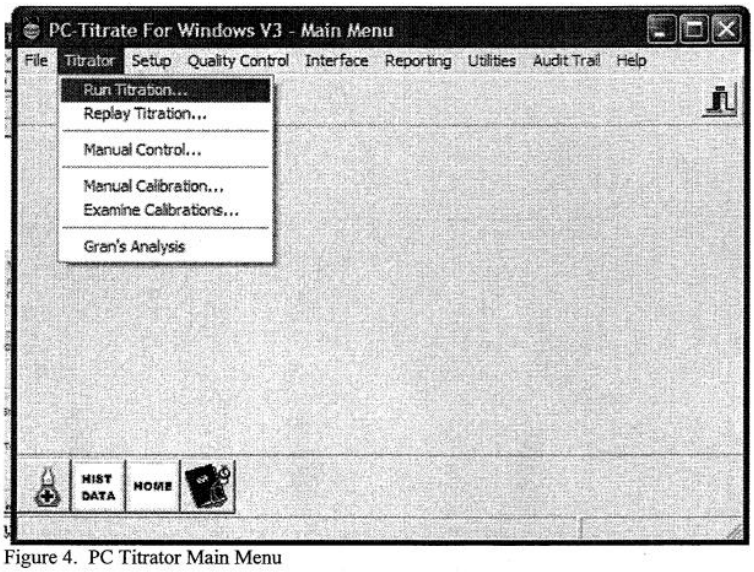

Figure 4. PC Titrator Main Menu

Expiration Date

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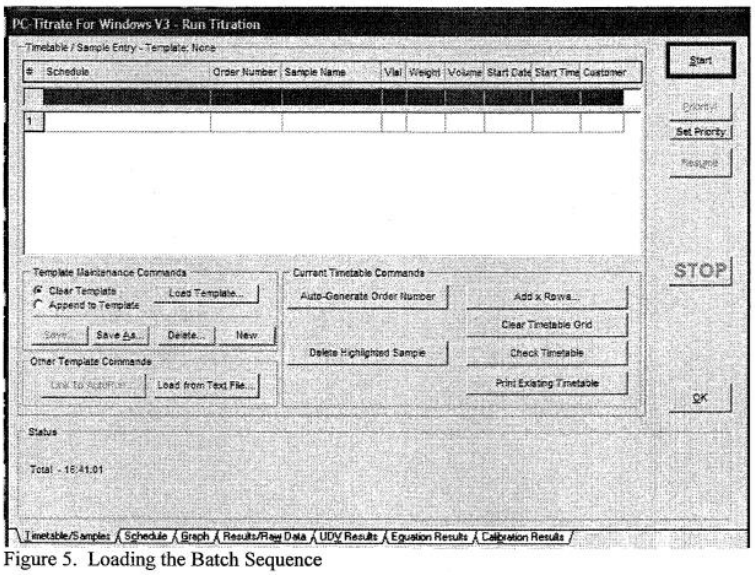

Figure 5. Loading the Batch Sequence

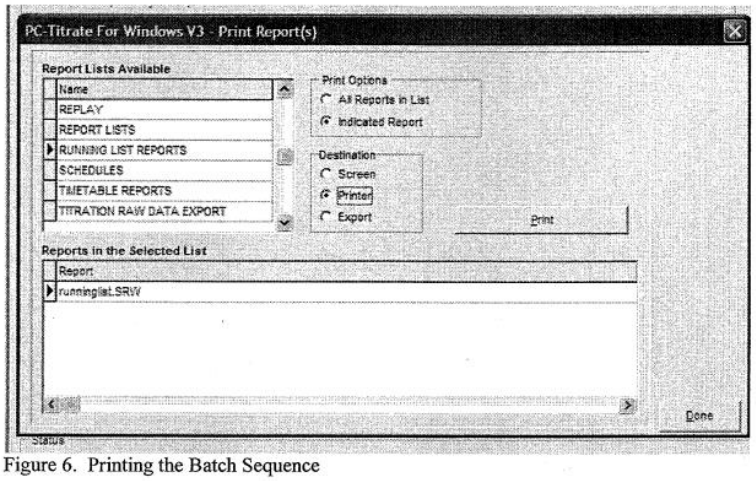

Figure 6. Printing the Batch Sequence

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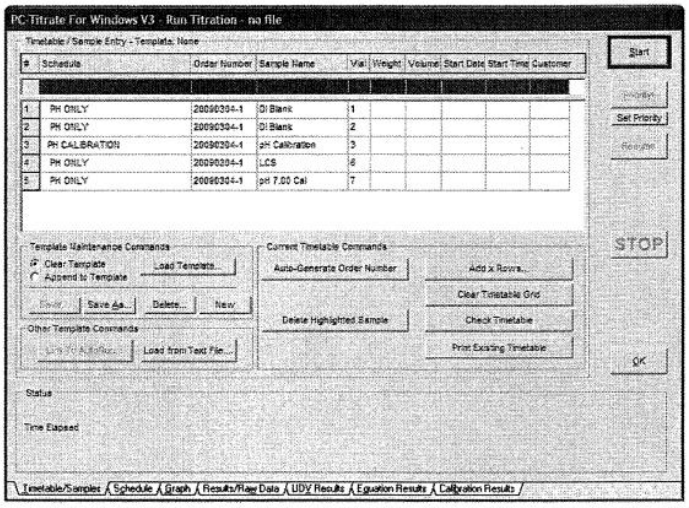

Figure 7. pH Calibration Timetable

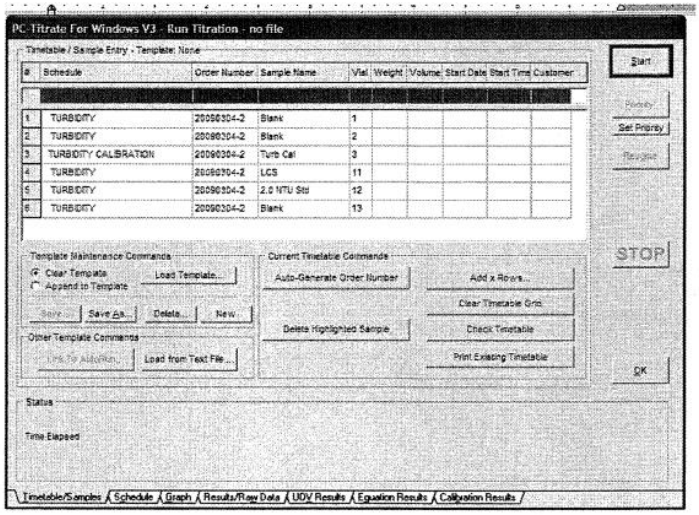

Figure 8. Turbidity Calibration Timetable

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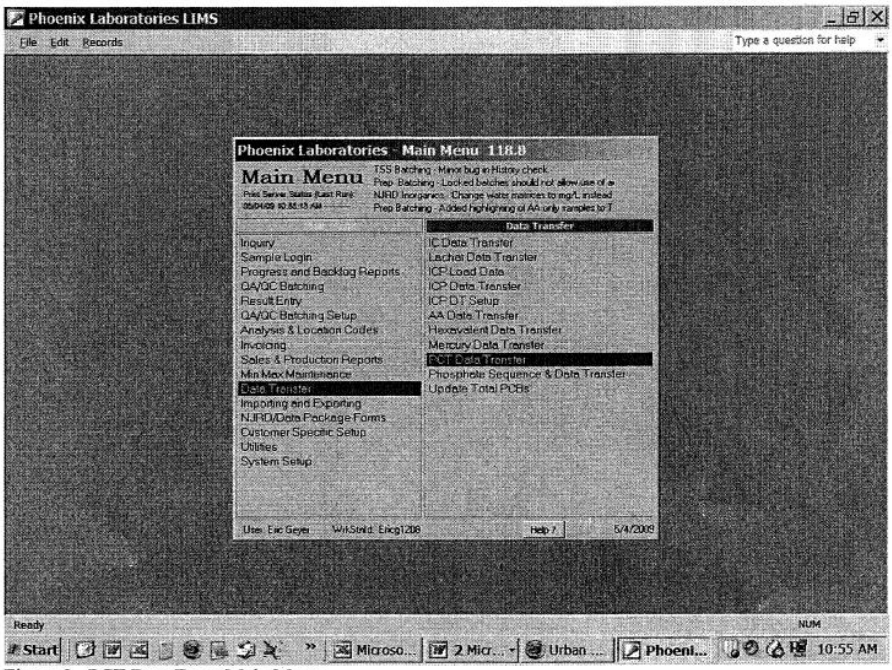

Figure 9. PCT Data Entry Main Menu

Expiration Date

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PCT Data Entry Instructions

Checking the Results Sheet

1) A (-1.00) on the results sheet indicates the sample was NOT analyzed for that analyte.
2) A pH of 5.80 – 6.10 MAY indicate a missing vial or is DI water (check rack to ensure a vial is present)
3) Brian will leave a note of which samples he did not run due to dirtiness or that he couldn't find.
4) Erratic Alkalinity results can be caused by a few different factors such as:
   - a leaking drain valve
   - a clogged sample line
   - no titrant
   - no fill solution in pH probe
   - sample valve is clogged
   - sample swaps

I don't expect you to fix these problems but it is important to be aware of them. Do not enter Alk results if the QC fails or if it appears any of these problems had occurred.

5) If a sample has a high turbidity result (over ~200) I usually do not enter the sample after it just in case there is contamination. If a sample is extremely high (~1000) do not enter any sample you feel has been contaminated (history should give you a good idea of what was contaminated).
6) Conductivity results are very reliable. The only problem we have sometimes is that the blanks come out slightly high (2.0 – 5.0) if they follow a sample with a high result. If this happens talk to Kathy or Greg L. I usually just raise the detection limit of the blank.

Entering results

1) In the Phoenix MDB click "Data Transfer → PCT Data Transfer"
2) Each analyte is entered separately (alk, cond, pH, & turb)
3) Click "Load Data" and select the two newest runs (2 highest numbers) & click "Load selected Data Files".

   The second highest run number is the beginning QC
   The highest run number is the subsequent samples and QC

The reason we split the beginning QC from the rest of the run is to ensure the system is running properly before we run it for 20 hours. Brian checks the beginning QC and will rerun anything that needs to in order to get the system 100% before starting the sample run.

4) Once the data loads you ill notice "check marks". These check marks indicate the sample has not been entered into labworks or that it is a non-reportable value (such as a calcheck). All pending results will default to be "checked".
5) Should a sample need a dilution, is contaminated, or should not be entered for any reason then it needs to be "unchecked".
6) Any sample that falls outside of past history will show the actual history in the right-hand column and will be in yellow. It is up to your discretion on whether these outliers should be entered or rerun.
7) Any failing QC will be hi-lighted in RED. Again it is your discretion on whether the failing QC warrants reruns.
8) Once all the appropriate data has been checked, enter the initials of the person who set the samples as well as your own in the provided field and click the "Transfer Data to Labworks" button.
9) Print out the Data using the print button at the bottom left corner.
10) Repeat steps 4 – 9 for each analyte.
11) Staple all sheets together. The report should include:
    a) Run list (make sure Brian wrote in the QC Lot #'s)
    b) Calibration curves for pH & turbidity
    c) Data sheets for the opening QC run & the sample run
    d) Data Transfer Logs for all analytes

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LCS TV's for Ultra Lot# 77133 (must be 85% - 115% recovered):
pH = 9.10 (8.95 – 9.25)
conductivity = 510 umhos/cm (433 – 586)
Alkalinity = 226 mg/L (192 – 260)
Turbidity = 4.00 NTU (3.40 – 4.60)

CALCHK TV's (must be 90% - 110% recovered):
pH = 7.00 (6.85 – 7.15)
conductivity = 100 umhos/cm (90 – 110)
Alkalinity = 125 mg/L (112 – 138)
Turbidity = 5.00 NTU (4.50 – 5.50)

Highest reportable concentrations
(anything over these limits MUST be diluted) Leave Brian a note of dilutions that need to be run.
pH = no upper limit
conductivity = 10000 umhos/cm
Alkalinity = 2000 mg/L (sample must be run by hand)
Turbidity = 40 NTU

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Revision History Log for SOP # 360

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3/7/18	2.1	Out of MDB, section V. A, B, C- new supplier and part numbers, V.O- new dilution for working solution, section VII.4- added metal to turbidity sample tube, section VII.B Calibration- Conductivity 1-5- new due to error in last SOP, section X- references updated per MUR	Kathy Cressia	Eric Geyer	3/7/18

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SOP – 003E - Odor SOP

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Effective Date: 09/20/13
Version Number: 6
Initiated By:
Approved By:

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SOP Number: 317.Odor

Title: Threshold Odor

Scope: This method describes the determination of the physical parameter of odor. Odor is recognized as a quality factor affecting acceptability of drinking water. Most organic and some inorganic chemicals contribute odor to water, and are detected in this test. This method is applicable to any water source, but is usually used for drinking waters. This method is suitable for samples with odors at any level.

I. Summary of Method

A. The threshold odor is determined by smelling a heated sample, and performing serial dilutions until the odor is no longer perceivable.

II. Interferences

A. Environmental odor can interfere with proper determination of sample odor, so testing must be done at a time when no other odiferous test is being performed in the lab. Analysts must demonstrate that they are sensitive to odor by passing the Phoenix Odor Test. Analysts must also be free of any smell that may inhibit perception of small odors (such as perfume, cigarette smoke, or popcorn). Insure that tester is free of colds or allergies that may affect odor response.

B. People vary widely as to odor sensitivity, and even the same person will not be consistent in the concentrations they can detect from day to day. Therefore, panels of people are recommended to overcome the variability in using a single observer. At a minimum, three people must be present; one to do the sample dilutions, and two to observe the threshold odor of the sample.

C. Most tap water samples and some wastewaters are chlorinated. It may be desirable to the client to determine the odor of these samples after dechlorination.

III. Sample Collection, Preservation and Holding Time

A. Samples are to be unpreserved and collected in clean glass containers.

B. Samples should be analyzed as soon as possible. If samples aren't analyzed immediately, they should be stored at 4 °C and analyzed within 48 hours of the time they are sampled.

IV. Equipment and Supplies

A. Erlenmeyers flasks, 500 mL with glass watch glass covers.

B. Hot Plates

C. Water bath, capable of maintaining 60°C +/- 1 °C.

D. Volumetric pipets, Class A, assorted volumes.

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E. Graduated cylinders, assorted volumes.
F. Thermometer, 0 - 110 °C range.

V. Reagents and Standards

A. Laboratory water, odor-free.
B. Sodium thiosulfate dechlorinating reagent- Dissolve 3.5g of sodium thiosulfate, $Na_2S_2O_3 \cdot 5H_2O$, in odor free water and dilute to 1 L. Use 0.5 mL of reagent to neutralize 1 mg/L of chlorine in a 250mL sample.

VI. Definitions

A. Preparation Blank (Prep Blank)- An aliquot of odor free reagent water that is treated exactly as a sample. The prep blank is used to determine if method analytes are present in the lab environment, reagents or glassware.
B. Threshold Odor Number (TON)- The greatest dilution of sample with odor-free water yielding a definitely perceptible odor.

VII. Procedure for Odor-NY

A. Test analysts using the Phoenix Odor Test, to ensure they are capable of performing this analysis. A copy of the P.O.T. must be put in their training folder if approved.
B. Pour 200mL of sample into a clean Erlenmeyer flask and place in water bath.
C. When sample reaches 60°C, swirl the sample in the flask.
D. Smell the vapors created by the sample in the flask, taking proper precautions (wafting if necessary).
E. If there is no perceivable odor, report the odor as "no odor detected".
F. If there is an odor, use the table below as a guide in determining the Threshold Odor Number. Depending on the strength of the odor, make the appropriate dilutions.

mL of Sample volume diluted to 200mL	Threshold Odor #	mL of Sample volume diluted to 200mL	Threshold Odor #
200	1	12	17
140	1.4	8.3	24
100	2	5.7	35
70	3	4.0	50
50	4	2.8	70
35	6	2.0	100
25	8	1.4	140
17	12	1.0	200

G. Place a volume of sample in a clean flask, and bring up to 200mL with DI water.
H. Heat dilutions to 60°C and swirl the sample in the flask.

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I. Have two certified odor analysts smell the dilutions, taking proper precautions (wafting if necessary).
J. Determine at what volume the odor is just undetectable.
K. Calculate the Threshold Odor Number for each analyst.

VIII. Procedure for Connecticut Drinking Water Odor (Odor-WM)

A. The CT Department of Public Health procedure is used, which is based on a scale of 0 – 5 as follows:
0 = No odor
1 = Very Faint odor
2 = Faint odor
3 = Moderate odor (distinct, but not strong)
4 = Decided odor
5 = Strong odor
B. Allow sample to come to room temperature.
C. Shake sample, remove cap, and smell the sample, taking proper precautions (wafting if necessary). If the sample is chlorinated, dechlorinate as described in section V.B.
D. If an odor is detected, have another analyst smell and concur with findings. Record all results.
E. If the sample has no odor, report as "No odor detected".

IX. Calculations

A. Calculating Threshold Odor Number (TON):

$$TON = \frac{A + B}{A}$$

where: A = mL sample
B = mL DI water

B. Calculating RPD:
The RPD is the relative percent difference, and is a measure of the consistency of the sample replicate for the sample set. First, calculate the results for both the sample and the sample replicate. Then apply the two results to the following calculation:

$$RPD, \% = \frac{(R1 - R2)}{(R1+R2)/2} \times 100$$

where: R1 = value achieved for sample, mg/L
R2 = value achieved for sample replicate, mg/L

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X. Quality Control

A. A sample prep blank of dilution water must be analyzed with each batch of twenty or fewer samples, as well as at the end of every run. Prep blanks must be determined to be BDL (below detectable level).
B. A sample replicate is analyzed with every batch of ten or fewer samples. The acceptable relative percent difference (RPD) for a sample replicate is less than or equal to 20%.
C. Samples labeled as trip blanks, field blanks, or equipment blanks are ineligible samples for replicating.

XI. Safety

A. Always wear safety glasses for eye protection as well as lab coats and gloves.
B. Refer to Phoenix SOP #805: Hazardous Chemical and Laboratory Safety Procedures

XII. Pollution Prevention

A. Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation.
B. Reagents and chemicals should be purchased and/or prepared in volumes consistent with laboratory use to minimize the volume of disposal.

XIII. Waste Management

A. It is the laboratories responsibility to comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

XIV. Method Performance

A. This method was validated through internal QA/QC monitoring, including blank analysis, sample duplicates and initial odor sensitivity tests.
B. See section IX Quality Control in this SOP for acceptable limits.

XV. Corrective Action for Out-of-Control or Unacceptable Data

A. Should the preparation blank contain a detectable odor, use DI water from another source in the laboratory.
B. Should the sample duplicate analysis fail acceptance criteria, reanalyze sample.
C. Should analyst's results differ by more than one threshold odor number, have a third certified tester sniff the dilutions.

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XVI. References

A. Standard Methods for the Examination of Water and Wastewater, 19th ed., Method 2150B, Revised 1995.

XVII. Appendix I = Phoenix Odor Test, attached

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Phoenix Odor Test (POT)

Introduction: People vary widely as to odor sensitivity, and even the same person will not be consistent in the concentrations they can detect from day to day. Therefore, panels of people are recommended to overcome the variability of using one observer. As an absolute minimum, three people are necessary: One to make the sample dilutions and two others to determine the threshold odor.

Phoenix assesses an analysts smell capability by administering an odor test. If they analyst can pass the odor test, they are "approved" to sit on the odor panel. The analyst must correctly identify all the odors given in the POT test. The test will consist of any six odors from the following list, although only one fruit and one vegetable can used per test.

Odorant Name	Concentration	Description
Clove	3 buds to 200 mL lab water. Swirl and let stand overnight.	Clove
Dried Grass	Air dry cut grass. Fill 500mL flask half full.	Grassy
Rubber Hose	Boil several inches of rubber hose In 200mL lab water. Let sit over- night. Remove hose.	Rubber
Soap	Add 5g of chipped Ivory soap bar In 200mL lab water. Swirl.	Soap
Wood shavings	Sniff fresh Pencil shavings or wood shavings from Maintenance Dept.	Wood
Chlorine	Dilute Clorox bleach solution to a concentration of 0.5 ppm.	Chlorine
Lemon	Add 1 tsp of Lemon juice to 100mL lab water.	Lemon/Citrus
Dill pickle	Dilute 1 tsp dill pickle juice to 100mL lab water.	Dill pickle
Cinnamon	Add ¼ tsp of cinnamon to 200mL lab water.	Cinnamon
Natural gas	Take analyst to Micro lab to smell after gas valve has been opened and closed.	Natural gas
Fruit	Dilute the juice of a watermelon, orange, strawberry, or other available fruit in lab water.	Name of Fruit used
Vegetable	Dilute asparagus, tomato, or other appropriate vegetable in lab water.	Name of Vegetable used

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9/20/13	6	Added info on dechlorination of non-NY samples	Eric Geyer	Kathy Cressia	09/20/13

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SOP – 003F - 602.624.1 –Measurement of volatile organic compounds by capillary column gas chromatrography/mass spectrometry

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PHOENIX
Environmental Laboratories, Inc.
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Effective Date : 04/10/18
Version Number : 9.1
Initiated By : Kathy Cressia
Approved By :

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SOP No.: **602.624.1**

Title: MEASUREMENT OF VOLATILE ORGANIC COMPOUNDS BY CAPILLARY COLUMN GAS CHROMATROGRAPHY/MASS SPECTROMETRY

Scope: This procedure is used for the identification and simultaneous measurement of volatile organic components in soils, waste water, and wastes. Table VII lists the compounds that may be determined by this method.

1.0 SUMMARY OF METHOD

1.1 An inert gas is bubbled through the solution at ambient temperature and the volatile components are transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are adsorbed. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column interfaced to a mass spectrometer. A temperature program is used in the gas chromatograph to separate the organic compounds that are then detected by the MS. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a database.

1.2 Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples. The concentration of each analyte is measured by the comparison of the relative response factor of the compound in the sample to the average relative response of the compound in the calibration standard. Surrogate components are measured with the same internal calibration procedure.

2.0 INTERFERENCES

2.1 Major contaminant sources are volatile materials in the laboratory and impurities in the purging gas and sorbent trap. Analysis of calibration blanks, reagent blanks and trip blanks provide information about the presence of contaminants. Extra precautions are taken in the laboratory to eliminate common laboratory solvent contamination, such as methylene chloride.

2.2 Contamination may occur when a sample containing low concentrations of volatile organic compounds is analyzed immediately after a sample containing high concentrations of these compounds. The autosampler is programmed to rinse

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between each sample numerous times to prevent this from occurring. Suspect samples are reanalyzed.

2.3 The purging device is cleaned and baked before each run to prevent contamination from samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high concentration samples.

2.4 The following compounds have been separated into a separate analysis code $624ADD: Acrolein, Acrylonitrile, and 2-Chloroethyl vinyl ether. The HCL preserved vial can not be used to analyze and report these compounds. In the volatile prep batch screen, if the analyst checks that only HCL vials are received, the LIMS system deletes the code, a sample comment is made on the report, and an email that is forwarded to the client is sent to the client services department.

3.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

3.1 Samples must be collected in clear or amber glass VOA vials, 40-mL capacity, with polyethylene screw caps with Fluoropolymer-lined (PTFE, Teflon) silicone septa. Aqueous samples must be supplied with non-preserved and HCl preserved vials. Samples containing residual chlorine must be collected in vials that also contain sodium thiosulfate preservative. Two VOA vials must be collected for each sample with no headspace.

3.1.1 All samples must be iced or refrigerated from time of collection until analyzed. All samples are checked for free chlorine before analysis.

3.2 Samples must be stored at 4°C in the Volatile Laboratory refrigerators until the time of analysis. The holding time for samples is 14 days from collection.

3.3 The following compounds have been separated into a separate analysis code $624ADD: Acrolein, Acrylonitrile, and 2-Chloroethyl vinyl ether. These compounds are received in a non-preserved VOA vial. The hold time for this analysis code is set at the required three days from collection.

4.0 EQUIPMENT AND SUPPLIES

4.1 Syringes (microliter)
4.2 Syringe valve (2 way with Luer ends)
4.3 5mL syringe (gastight with shutoff valve)
4.4 Glass scintillation vials (40mL) with screw tips and Teflon liners
4.5 Volumetric flasks (100mL)
4.6 Disposable Pasteur pipets

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4.7 Purge and Trap device
- 4.7.1 Centurion robotic autosampler, designed to accept 40ml VOA vials, with EST Encon Evolution concentrator.
- 4.7.2 Sample purger designed to accept 5.0mL samples with a water column at least 3.0cm deep. A moisture control module is used to deter trapped water vapor from entering the GC/MS.
- 4.7.3 Trap (VOCARB 3000 K) Prior to daily use, the trap is baked for at least 30 minutes with backflushing.
- 4.7.4 Desorber

4.8 Gas Chromatography/Mass Spectrometer/Data System
- 4.8.1 Interfaces between the GC and MS (220°C) column length towards detector is 19.8cm
- 4.8.2 Mass Spectrometer (HP 5977)
  - 4.8.2.1 Column RTX-VMS Restek
    Length: 20 meters; ID: 0.18 mm; Film: 1.0micron

5.0 REAGENTS AND STANDARDS

5.1 Organic free reagent water (Prepared with Barnstead water purification system)
5.2 Methanol (Purge and Trap Grade) demonstrated to be free of analytes.
5.3 Stock Standards- see section 7.1.1 for standard information.

6.0 DEFINITIONS

6.1 Internal Standard (IS) -- A pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes and surrogates that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component.

6.2 Surrogate -- A pure analyte(s), which is extremely unlikely to be found in any sample, and which is added to a sample aliquot in known amount(s) before extraction or other processing and is measured with the same procedures used to measure other sample components. The purpose of the SA is to monitor method performance with each sample.

6.3 Laboratory Duplicates -- Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of duplicates indicates precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

6.4 Laboratory Reagent Blank -- An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents,

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reagents, internal standards, and surrogates that are used with other samples. The laboratory reagent blank is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

6.5 Field Blank (FB) -- An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FB is to determine if method analytes or other interferences are present in the field environment.

6.6 Sample Matrix Spike / Matrix Spike Duplicate (MS/MSD) -- An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS/MSD analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS/MSD corrected for background concentrations.

6.7 Stock Standard Solution -- A concentrated solution containing one or more method analytes prepared in the laboratory using reference materials purchased from a reputable commercial source.

6.8 Calibration Standard -- A solution prepared from the dilution of stock standard solutions. The calibration standard solutions are used to calibrate the instrument response with respect to analyte concentration.

6.9 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD) -- A solution of method analytes of known concentrations which is used to fortify an aliquot of reagent blank. The LCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

7.0 PROCEDURE

7.1 Standard Preparation

7.1.1. Preparation of Initial Calibration Standards
For each analyte of interest, prepare calibration standards at a minimum of five concentrations. The following is a list of the stock standards and concentrations used to prepare the calibration curve:

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	Concentration	Part Number	Vendor
Tert-butanol	2000 ug/mL	90782	Absolute
Custom Std (6 analytes)	Various	CUS-11008	Ultra
1-4 Dioxane	10,000 ug/mL	95426	Absolute
Methylcyclohexane	1000 ug/mL	71627	Absolute
Methyl Acetate	1000 ug/mL	71031	Absolute
Carbon disulfide	1000 ug/mL	70060	Absolute
MTBE	1000 ug/mL	70209	Absolute
Ketones	2000 ug/mL	82402	Absolute
Cyclohexane	2000 ug/mL	96162	Absolute
502/524 mix (54 compounds)	2000 ug/mL	32001	Absolute
502/524 6 compounds	2000 ug/mL	30058	Absolute
2-Chloroethylvinyl ether (2-CEVE)	1000 ug/mL	70074	Absolute
2-Chloroethylvinyl ether (2-CEVE)	100 ug/mL	HC-070-1	Ultra
Vinyl Acetate	10,000 ug/mL	RCC-218	Ultra

7.1.1.1. TABLE II lists the concentration of analytes in the calibration curve. The following compounds are multiples of the concentration of the curve levels: Acrolein (5x), Tetrahydrofuran (2.5x), 2-Chloroethylvinyl ether (2x), m&p xylenes (2x), trans-1,4 dichloro-2-butene (5x), tert-butyl alcohol (10x), 1,4 dioxane (20x).

7.1.1.2 TABLE III lists the volumes of stock standard used to prepare 50ppm/100ppm primary dilution standards.

7.1.1.3 TABLE IV lists the volumes of the primary dilution standards injected into 100mL of reagent water in a volumetric flask to achieve the concentrations listed in TABLE II. The contents of the volumetric flask are then poured into 2 VOA vials with zero headspace.

7.1.2. Laboratory Control Standard (LCS) Preparation.

	Concentration	Part Number	Vendor
Tert Butanol	10000 ug/mL	N-13523	Chem Service
Custom Standard	Various	CUS-11008	Ultra
1-4 Dioxane	10000 ug/mL	RC-180	Ultra
Methyl Cyclohexane	1000 ug/mL	S-12469M4	Chem Service

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Methyl Acetate	10000 ug/mL	N-12411	Chem Service
Carbon Disulfide	5000 ug/mL	EPA-1012	Ultra
MTBE	2000 ug/mL	STS-4401	Ultra
VOA calibration mix	5000 ug/mL	30006	Restek
Cyclohexane	1000 ug/mL	S-11526M4	Chem Service
VOC mix (54 compound)	2000 ug/mL	DWM-589N-1	Ultra
VOC Gas Mix	2000 ug/mL	DWM-544-1	Ultra
2-CEVE	5000 ug/ml	EPA-1016	Ultra
Vinyl Acetate	10,000 ug/mL	N-13746-1G	Chem Service

7.1.2.1 Tert Butanol, 1-4 Dioxane, and Methyl Acetate standards at a concentration of 10,000 ppm are prepared by weighing 0.1000 grams of neat compound and diluting to 10 mL with methanol.

7.1.2.2 Table VIA & VIB lists volumes of standards used to make LCS dilution solutions "A" at 50 ppm and "B" at a 1000 ppm concentration. A concentration of 20/40 ppb is prepared by adding 4 uL of LCS Standard A and 40 uL of LCS Standard B to 100 mL of reagent water in volumetric flask. Flask is shaken a maximum of three times. The contents are poured into 2 VOA vials with zero headspace.

7.1.3. Spike Standard Preparation
Volatiles Spiking Solution from Table III: A concentration of 20/40 ppb is prepared by adding 40 uL of Primary Dilution Standard A and 4 uL of Primary Dilution Standard B to 100 mL of reagent water in volumetric flask. Flask is shaken a maximum of three times. The contents are poured into 2 VOA vials with zero headspace.

7.1.4. Internal Standard/Surrogate Standard Preparation

Internal Standard Mixture	2000ppm	(ULTRA CAT# STS-341N)
Surrogate Standard Mixture	2000ppm	(ULTRA CAT# STM-330N)
1,2-Dichlorobenzene Solution	2000ppm	(ULTRA CAT# STS-210)
1-4 Dioxane-d8	10000 ppm	(Cambridge Isotope CAT# DLM-28-10)

Preparation of 50ppm/500 ppm Dioxane, Internal Standard/Surrogate:
Add 500 uL Internal Standard Mixture, 500 uL Surrogate Standard Mixture, 500 uL 1,2-Dichlorobenzene Solution, 1.0 mL 1-4 Dioxane-d8 + 17.5mL methanol = 20mL Internal Standard/Surrogate Standard at 50ppm/500 ppm.

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It is then loaded into the "Standard 1" position of Centurion and programmed to add 3 uL to all blanks, standards and samples. TABLE I lists the surrogates and their recovery requirements.

7.2 Tuning the MS

Calibrate the mass and abundance scales of the MS. Purge 150 ng of BFB and acquire MS data. The sample is split at the injector at a 1:25 ratio so the actual amount of BFB injected on column is comparable to 6 ng. If spectrum does not meet the mass abundance criteria, the MS must be re-tuned before running initial calibration. The MS tune must be verified every 12 hours during which analyses are performed and adjusted to meet all criteria before the continuing calibration standard is analyzed.

7.3 Initial Calibration/Continuing Calibration

The initial calibration must meet appropriate requirements before samples are run. Continuing calibration checks must be run at the beginning of each 12 hour period during which analyses are performed.

7.4 Loading Samples/Standards

Place the VOA vial into the Centurion Autosampler tray. Remove label if it will obstruct the autosampler gripper. Program the correct position, 5.0mL method and the addition of internal standard/surrogate with Centurion Autosampler software.

7.5 Purge and Trap Conditions or equivalent

System Setup	
Trap Name	VO CARB 3000
Trap Desorb Max	260
Trap Bake Max	270
Method Setup	
Standby Flow	40
Auto Drain	Y
Bake Gas Bypass	N
Transfer Line	150
Valve Oven	150
Purge & Trap	
Trap Ready	35

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Mort Ready	39
Purge Flow Rate	40
Purge Time	11
Dry Purge Flow Rate	40
Dry Purge Time	0.5
DPC	ON/5
Desorb Preheat	245
Desorb Temp	250
Desorb Time	1
Trap Bake Temp	260
Mort Bake Temp	210
Bake Flow Rate	80
Bake Time	8
Sample Heater	N
Centurion	
Matrix	Water
Sample Type	Loop
Sample Fill	15
Loop Equilibrium	5
Sample Transfer	15
Needle Rinse	ON/20
Needle Sweep	10
Sample Loop Rinse	ON/20
Sample Loop Sweep	20
Concentrator Desorb	64
Sparge Rinse	ON/3
Rinse Transfer	5
Rinse Drain	10
Foam Rinse	3
Conc #1 Cycl	0
Conc #2 Cycl	0
Water Temp	85

7.6 GC Temperature Program or equivalent
40°C for 1 minutes
Ramp 15°C/min to 165°C
Hold for 0.10 minutes
Ramp 30°C/min to 230°C
Hold at 230°C for 0 minutes

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Constant flow through column is 1.0 ml/min., split ratio 1:25

8.0 CALCULATIONS

8.1 Response Factor

Calculate the response factor (RF) for each analyte in each calibration standard using the internal standard.

$$RF = \frac{(Ax)\,(Qis)}{(Ais)\,(Qx)}$$

where:

Ax = Integrated abundance of the quantitation ion of the analyte in the sample
Ais = Integrated abundance of the quantitation ion of the internal standard in the sample
Qis = Total quantity (in micrograms) of internal standard added to the water sample
Qx = Quantity of analyte purged in concentration units

For each analyte and surrogate, calculate the average RF from analyses of calibration standards. Calculate the standard deviation (SD) and the relative standard deviation (RSD) from each average.

$$RSD = 100\,(SD/\text{average RF})$$

8.1.1 If the RF value over working range is a constant (<35% RSD) the RF can be assumed to be invariant and average RF can be used for calculations.

8.2 Internal Standard Calibration Technique

The internal standard calibration technique is used to calibrate the chromatographic system. The concentration of each compound in the sample is calculated using the results of the initial calibration.

$$\text{Concentration (ug/L)} = \frac{(Ax)(Qis)(1000)}{(Ais)(RF)(V)}$$

where:

V = Original water sample volume in mL

9.0 QUALITY CONTROL

9.1 Calibrate the mass and abundance scales of the MS by purging 6 ng of BFB and acquire the mass spectra. If the spectrum does not meet all the criteria in Table I, the MS must be retuned before running the initial calibration. The MS tune must be verified

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every 12 hours during which analyses are performed and adjusted to meet all criteria before the continuing calibration standard is analyzed.

9.2 Before running any samples, it should be demonstrated through the analysis of a reagent blank that interferences from the analytical system, glassware and reagents are under control. Each time there is a change in organic free reagent water, a blank should be run to ensure against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement steps. Blanks must also be analyzed at intervals throughout the sequence to demonstrate a continually contaminant free system. The frequency of these blanks should be equal to 5% of all samples analyzed. Method blanks should contain no compounds over 50% of the reporting limit except for acetone and methylene chloride, which are allowed for up to three times the reporting limit.

9.3 The number of calibration standards used depends on the calibration range that is needed. A minimum of 5 calibration standards are required. A minimum of six concentration levels are required for a second order, non-linear (quadratic) calibration. Calibrations higher than second order are not allowed. When a curve function is employed the calculated values will be evaluated vs the theoretical value and presented. The %Relative Standard Deviation of the calibration check compounds must be <35%.

9.4 After a calibration curve has been constructed, the curve must be checked with Laboratory Control Samples (LCS/LCSD). The LCS/LCSD must be obtained from a vendor different than the calibration standards. The response for each analyte in the LCS/LCSD must be within the acceptance criteria listed in Appendix A. Do not proceed with analysis if the LCS/LCSD does not meet these criteria.

9.5 The calibration relationship established during the initial calibration must be verified at the beginning of each 12-hour period during which analyses are performed. Continuing calibration standards should be prepared at 20 ppb. For each compound, compare response (Q) with Table VII for acceptance criteria. If this criterion cannot be met, instrument maintenance (such as cleaning the ion source) and recalibration may be necessary.

9.6 The absolute areas of the quantitation ions for the internal standard of the samples should be within -50% to +100% as compared to the areas measured in the most recent continuing calibration check.

9.7 Sample surrogate recoveries must be within criteria specified in Table 1.0 in Section 18.0 of this SOP. Should surrogate recoveries fall outside of range, re-analyze sample or narrate non-conformance.

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9.8 For each analytical batch (up to twenty samples) a spike and spike duplicate must be analyzed. The acceptance criterion for spiked samples must be within the acceptance criteria listed in Appendix A. The relative percent difference (%RSD) between the spike and spike duplicate must not exceed the criteria in Appendix A to demonstrate acceptable precision. If the MS/MSD does not meet this criterion, reanalyze or narrate non-conformance.

9.9 Manual integration is used only when a peak is not identified correctly. This may be a peak next to a similar peak and the software had identified the wrong peak or it may be poorly resolved peak. Manual integration can never be used to increase or decrease the area of a response.

9.10 A Method Detection Limit is performed yearly. At least seven vials are spiked at a level of 2-5 times the expected detection limit. The standard deviation of the seven or more analyses is multiplied by the degrees of freedom to obtain the calculated method detection limit. Refer to 40 CFR Part 136 Appendix B, Revision 2.

9.11 An accuracy and precision study is performed yearly and with each new employee. Four standards at a level approximately ten times higher than the detection limit are evaluated for accuracy (%recovery) and precision (standard deviation). See Appendix A for criteria.

10.0 MAINTENANCE

10.1 Bake the trap and MCS loop every morning. This will set the Centurion and Encon in bake mode. In the bake mode, the trap and MCS loop are heated to 260°C and 210°C respectively and are backflushed with Helium gas. This removes any water vapor accumulation on the trap and MCS loop and improves chromatography.

10.2 Change the trap as required whenever low response of aromatics or tailing of late eluting compounds is observed.

10.3 Cleaning of Ion Source is usually done after 6-8 weeks or as needed (e.g. when response drops and increasing multiplier voltage results in increase in multiplier noise resulting in a noisy baseline or when calibration peaks are deformed and ratios of ion spectra for PF43 cannot be properly adjusted by changing the MS Tune parameters.

10.4 Check mechanical pump oil every three months.
10.5 Change Turbo pump oil as needed.

11.0 DATA REVIEW

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11.1 Q edit files prior to sending results.

11.2 Use "MDB" template, which has only VOA codes to get clear report before sending data. The LIMS system automatically flags issues.

12.0 SAFETY

12.1 The toxicity and carcinogenicity of each reagent used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable. A reference file of material data handling sheets are available to all personnel involved in the chemical analysis.

12.2 Refer to Phoenix SOP #805: Hazardous Chemical and Laboratory Safety Procedures

13.0 POLLUTION PREVENTION

13.1 No solvents are utilized in this method except the extremely small volumes of methanol needed to make calibration standards. The only other chemicals used in this method are the neat materials in preparing standards and sample preservatives. All are used in extremely small amounts and pose no threat to the environment.

14.0 WASTE MANAGEMENT

14.1 There are no waste management issues involved with this method. Due to the nature of this method, the discarded samples are chemically less contaminated than when they were collected.

15.0 METHOD PERFORMANCE

15.1 This method was validated through internal QA/QC monitoring, including annual method detection limit studies, precision and accuracy studies, initial and continuing calibration verifications, blank analysis, laboratory control samples and matrix spikes and duplicates.

15.2 See Section 9.0 Quality Control and Section 18.0 Table 1.0, and Appendix A in this SOP for acceptable limits.

16.0 CORRECTIVE ACTION FOR OUT-OF-CONTROL OR UNACCEPTABLE DATA

16.1 See Section 9.0 Quality Control in this SOP for corrective actions.

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17.0 REFERENCES

17.1 40 CFR Part 136, Appendix B, Revision 2- Procedure for the determination of the Method Detection Limit (MDL).

17.2 United States Environmental Protection Agency, EPA-821-R-14-014, Method 624.1 – Purgeables by GC/MS, December 2014, as printed in 40CFR part 136.

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18.0 TABLES AND CHARTS

TABLE I
SURROGATE RECOVERY CRITERIA

COMPOUND	% REC. WATER
Dibromofluoromethane	70-130
Toluene-d8	70-130
4-Bromofluorobenzene	70-130
1,2-Dichloroethane-d4	70-130

TABLE II
CONCENTRATIONS OF ANALYTES IN 6 LEVEL CURVE

	Concentration*
LEVEL 1	0.5 ppb
LEVEL 2	5.0 ppb
LEVEL 3	10 ppb
LEVEL 4 (mid)	20 ppb
LEVEL 5	50 ppb
LEVEL 6	100 ppb

* See note in Section 7.1.1.1

TABLE III
STOCK STANDARD VOLUMES USED TO PREPARE PRIMARY DILUTION STANDARD "A"

STANDARD	CONCENTRATION	VOLUME
Tert Butanol	2000 ug/mL	1.0mL
Custom Standard	Various concentrations	1.0mL
1-4 Dioxane	10000 ug/mL	400 uL
Methyl Cyclohexane	1000 ug/mL	200 uL
Methyl Acetate	1000 ug/mL	200 uL
Carbon disulfide	1000 ug/mL	200 uL
MTBE	1000 ug/mL	200 uL
Ketones	2000 ug/mL	100 uL
Cyclohexane	2000 ug/mL	100 uL
502/524 Mix (54 Comp)	2000 ug/mL	100 uL
502/504 (6 comp)	2000 ug/mL	100 uL
Methanol	Pure	380 uL
Vinyl Acetate	10,000 ug/mL	20 uL

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TABLE IV
PRIMARY DILUTION STANDARD VOLUMES USED TO PREPARE THE SIX LEVEL CURVE

	LEVEL DL	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
"A"	1.0 uL	10 uL	20 uL	40 uL	100 uL	200 uL
2-CEVE	5.0 uL of 100 std	10 uL of 100 std	2 uL of 1000 std	4 uL of 1000 std	10 uL of 1000 std	20 uL of 1000 std

TABLE V
ION ABUNDANCE CRITERIA FOR BFB

MASS (M/z)	RELATIVE 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	< 2% of mass 174
174	> 50% of mass 95
175	5 to 9% of mass 174
176	> 95% but < 101% of mass 174
177	5 to 9% of mass 176

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TABLE VI-A
LCS STANDARD VOLUMES TO MAKE STANDARD "A"

Component	Total Volume = 4mL
Meoh	1580 uL
Tert-Butanol	200 uL
Custom Standard	1000 uL
Vinyl Acetate	20 uL
1,4-Dioxane	400 uL
Methyl Cyclohexane	200 uL
Methyl Acetate	20 uL
Carbon Disulphide	40 uL
MTBE	100 uL
Ketones	40 uL
Cyclohexane	200 uL
Volatile 502/524	100 uL
Volatile Gases	100 uL

TABLE VI-B
LCS STANDARD VOLUME USED TO PREPARE 1.0 ML STANDARD "B"

STANDARD	CONCENTRATION	VOLUME
2-CEVE	5000 ug/mL	200 uL
Methanol	Pure or Neat	800 uL

TABLE VII Common Analytes

Compound	CAS #
Acetone	67641
Acrolein	107028
Acrylonitrile	107131
Benzene	71432
Bromobenzene	108861
n-Butylbenzene	104518
Sec-Butylbenzene	135988
Tert-Butylbenzene	98066

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Bromochloromethane	74975
Bromodichloromethane	75274
Bromoform	75252
Bromomethane	74839
2-Butanone (MEK)	78933
Carbon Disulfide	75150
Carbon Tetrachloride	56235
Chlorobenzene	108907
Chloroethane	75003
2-Chloroethylvinyl ether (2-CEVE)	110758
Chloroform	67663
Chloromethane	74873
2-Chlorotoluene	95498
4-Chlorotoluene	106434
Cyclohexane	110827
1,2-Dibromo-3-chlorpropane(DBCP)[1]	96128
1,2-Dibromoethane (EDB)[1]	106934
Dibromochloromethane	124481
Dibromomethane	74953
1,2-Dichlorobenzene	95501
1,3-Dichlorobenzene	541731
1,4-Dichlorobenzene	106467
trans-1,4-Dichloro-2-butene	110576
Dichlorodifluoromethane	75718
1,1-Dichloroethane	75343
1,2-Dichloroethane	107062
1,1-Dichloroethene	75354
cis-1,2-Dichloroethene	156592
trans-1,2-Dichloroethene	156605
1,2-Dichloropropane	78875
1,3-Dichloropropane	142289
2,2-Dichloropropane	594207
1,1-Dichloropropene	563586
cis-1,3-Dichloropropene	10061015
trans-1,3-Dichloropropene	10061026
Diethyl Ether	60297
1,4-Dioxane	123911
Ethyl Acetate	141786
Ethylbenzene	100414
Hexachlorobutadiene	87683

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2-Hexanone	591786
Isopropyl Alcohol	67630
Isopropylbenzene	98828
2-Isopropyltoluene	527844
4-Isopropyltoluene	99876
Methyl Acetate	79209
Methylene Chloride	75092
Methylcyclohexane	108872
Methyl Iodide	74884
4-Methyl-2-pentanone (MIBK)	108101
Methyl-tert-butylether (MTBE)	1634044
Naphthalene	91203
n-Propylbenzene	103651
Styrene	100425
Tert-butyl Alcohol	75650
1,1,1,2-Tetrachloroethane	630206
1,1,2,2-Tetrachloroethane	79345
Tetrachloroethene (Perc)	127184
Tetrahydrofuran (THF)	109999
Toluene	108883
1,2,3-Trichlorobenzene	87616
1,2,4-Trichlorobenzene	120821
1,1,1-Trichloroethane	71556
1,1,2-Trichloroethane	79005
Trichloroethene (TCE)	79016
Trichlorofluoromethane	75694
1,2,3-Trichloropropane	96184
Trichlorotrifluoroethane (Freon-113)	76131
1,2,4-Trimethylbenzene	95636
1,3,5-Trimethylbenzene	108678
Vinyl Chloride	75014
o-Xylene [2]	95476
m-Xylene [2]	108383
p-Xylene [2]	106423

1. These compounds require analysis by either Methods 504.1 or other method approved by the Commissioner to achieve the RSR limit in aqueous samples. 2. May be reported as total xylenes or any combination of the three isomers.

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Revision History Log for SOP #602

Date:	Revision #:	Summary of Changes:	Submitted By:	Approved By:	Effective Date:
10/29/14	8	Took out all 8260 information, updated curve, standards, LCS	Raman Makol	Phyllis Shiller	10/29/14
04/21/15	8.1	Added policy about acid sensitive compounds	Phyllis Shiller	Kathy Cressia	04/21/15
2/23/17	8.2	Section 4.7.2- changed to 3cm deep, section 7.1.1 & 7.1.2- added Vinyl acetate standard to tables, section 7.5- updated conditions, section 10.0- updated maintenance, Table IIIA updated, Table IV "B" updated	Harry Mullin	Phyllis Shiller	2/23/17
11/17/17	9	Section 7.1.1- added second 2-CEVE stock standard to table, Table II- renamed curve standards, sec. 7.1.1.1- added additional cmpds that have concentration at a multiple of the curve [ ], Tables IIIA & IIIB are now one table (Table III), sec. 7.1.2- LCS= 1,4-dioxane & 2-CEVE new vendors / part #, Table VIB- amt of 2-CEVE changed for LCS, sec. 7.1.4- new 1,4-dioxane vendor / part#, sec. 7.2- amt BFB changed for tune, sec. 9.3 updated minimum of 5 cal stds, sec. 9 LCS, MS, DOC all reference Appendix A, sec. 9.10 – update MDL procedure to Revision 2, sec. 10- some minor adjustments to maintenance, sec. 17 updated method references, added several cmpds to Table VII.	Harry Mullin	Kathy Cressia	11/17/17

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4/10/18	**9.1**	**Section 7.4- removed sentence about dilution and smell. Section 9.1- changed BFB to 6 ng**	**Kathy Cressia**	**Harry Mullin**	**4/10/18**

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SOP – 003G - 651.524.2 - Measurement of purgeable organic compounds in water by capillary column gas chromatography/mass spectrometry

QAPP Worksheet #37: Data Usability Assessment

PHOENIX
Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O. Box 370, Manchester, CT 06040
Telephone: 860.645.1102 • Fax: 860.645.0823

Effective Date: 03/10/17
Version No.: 3.1
Initiated By:
Approved By: Kathy Cressia
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1.0 SOP No.: 651.524.2

MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER BY CAPILLARY COLUMN GAS CHROMATOGRAPHY/MASS SPECTROMETRY

2.0 Applicable Matrix or Matrices

2.1 Drinking water

3.0 Detection Limit

3.1 The detection limit is determined annually by MDL study. The MRL (method reporting level) is 0.5 ug/L for most compounds.

4.0 Scope and Application

4.1 This is a general purpose method for the identification and simultaneous measurement of purgeable volatile organic compounds in surface water, ground water, and drinking water in any stage of treatment. The method is applicable to a wide range of organic compounds, including the four trihalomethane disinfection by-products that have sufficiently high volatility and low water solubility to be removed from water samples with purge and trap procedures

5.0 Summary of Method

5.1 Headspace-free samples are collected in clear, glass vials with polytetrafluoroethylene (PTFE)-faced septa. Samples are dechlorinated if required, with ascorbic acid and the pH is adjusted with hydrochloric acid. A 5.0- milliliter (mL) aliquot of the sample is transferred to a glass sparging vessel along with appropriate amounts of internal standard and quality control compounds. The method analytes are purged from the water using helium and trapped on a sorbent material. After purging, the trap may be dry purged for a short period to remove water. Additional water management techniques may be applied. The trap is heated and backflushed with helium to transfer the analytes directly into a gas chromatographic inlet. The inlet is operated in the split mode in order to achieve the desired desorb flow rates and further reduce water transmission. Analytes are transferred onto a capillary GC column, which is temperature programmed to optimize the separation of method analytes. Compounds eluting from the GC are directed into a mass spectrometer for detection and quantitation. The method analytes are identified by comparing the acquired mass spectra and retention times to reference spectra and retention times for calibration standards acquired under identical GC/MS conditions. The concentration of each analyte is calculated using the internal standard technique and response curves obtained via procedural calibration

5.2 Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples. The concentration of

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each analyte is measured by the comparison of the relative response factor of the compound in the sample to the average relative response of the compound in the calibration standard. Surrogate components are measured with the same internal calibration procedure.

6.0 Definitions

6.1 Internal Standard (IS) -- A pure analyte(s) added to a sample, extract, or standard solution in known amount(s) and used to measure the relative responses of other method analytes and surrogates that are components of the same sample or solution. The internal standard must be an analyte that is not a sample component.

6.2 Surrogate-- A pure analyte(s), which is extremely unlikely to be found in any sample, and which is added to a sample aliquot in known amount(s) before extraction or other processing and is measured with the same procedures used to measure other sample components. The purpose of the SA is to monitor method performance with each sample.

6.3 Laboratory Duplicates --Two aliquots of the same sample taken in the laboratory and analyzed separately with identical procedures. Analyses of duplicates indicate precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

6.4 Laboratory Reagent Blank-- An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The laboratory reagent blank is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

6.5 Field Blank (FB) --An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FB is to determine if method analytes or other interferences are present in the field environment.

6.6 Sample Matrix Spike / Matrix Spike Duplicate (MSIMSD) --An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MSIMSD analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MSIMSD corrected for background concentrations.

6.7 Stock Standard Solution-- A concentrated solution containing one or more method analytes prepared in the laboratory using reference materials purchased from a reputable commercial source.

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6.8 Calibration Standard --A solution prepared from the dilution of stock standard solutions. The calibration standard solutions are used to calibrate the instrument response with respect to analyte concentration.

6.9 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCSILCSD) --A solution of method analytes of known concentrations which is used to fortify an aliquot of reagent blank. The LCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

7.0 Interferences

7.1 Major contaminant sources are volatile materials in the laboratory and impurities in the purging gas and sorbent trap. Analysis of calibration blanks; reagent blanks and trip blanks provide information about the presence of contaminants. Extra precautions are taken in the laboratory to eliminate common laboratory solvent contamination, such as methylene chloride.

7.2 Contamination may occur when a sample containing low concentrations of volatile organic compounds is analyzed immediately after a sample containing high concentrations of these compounds. The Autosampler is programmed to rinse between each sample numerous times to prevent this from occurring. Suspect samples are reanalyzed.

7.3 The purging device is cleaned and baked before each run to prevent contamination from samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high concentration samples.

7.4 METHANOL- Traces of ketones, methylene chloride, and other organic solvents could be present in methanol. Purge-and-trap-grade methanol is prescribed for use with this method.

7.5 SAMPLE CONTAINERS- Volatile organic compounds have also been observed to leach from the septa of some VOA vials. Each lot of vials is assessed before preparing for client use.

8.0 Safety

8.1 The toxicity and carcinogenicity of each reagent used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable. A reference file of material data handling sheets are available to all personnel involved in the chemical analysis.

8.2 Refer to SOP #805: Hazardous Chemical and Laboratory Safety Procedures

9.0 Equipment and Supplies

9.1 Syringes (microliter)

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9.2 Syringe valve (2 way with Luer ends)

9.3 5mL syringe (gastight with shutoff valve)

9.4 Glass scintillation vials (40mL) with screw tips and Teflon liners

9.5 Volumetric flasks (100ml)

9.6 Disposable Pasteur pipets

9.7 Purge and Trap device (EST)

9.7.1 Centurion robotic autosampler. Designed to accept 40ml VOA vials.

9.7.2 Sample purger designed to accept 5mL samples with a water column at least 5 cm. deep. A moisture control module is used to deter trapped water vapor from entering the GC/MS.

9.7.3 Trap: Supelco (VOCARB 3000 K)

Trap Contents: CarbopakB/Carboxen 1000 &1001

Prior to daily use, the trap is baked for at least ten minutes with backflushing.

9.8 Gas Chromatography/Mass Spectrometer/Data System

9.8.1 Gas Chromatograph (Agilent 7890A or 7890B)

9.8.2 Mass Spectrometer (Agilent 5975C or 5977A)

9.8.2.1 Column RTX-VMS Restek
Length: 20 meters; ID: 0.18 mm; Film: 1.0 micron

9.8.3 Data System (Agilent Chemstation Version E)

10.0 Reagents and Standards

10.1 Organic free reagent water (Prepared with Barnstead water purification system)

10.2 Methanol (Purge and Trap Grade) demonstrated to be free of analytes.

10.3 Stock Standards, see below.

10.4 Hydrochloric Acid, 1:1

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11.0 Sample Collection, Preservation, Shipment and Storage

11.1 Samples must be collected in clear or amber glass VOA vials, 40-ml capacity, with polyethylene screw caps with fluoropolymer-lined (PTFE, Teflon) silicone septa. Aqueous samples must contain HCl preservative. Two VOA vials must be collected for each sample with no headspace.

11.2 If samples, such as finished drinking water or waste water, are suspected to contain residual chlorine, add about 25 mg of ascorbic acid per 40 mL of sample to the sample bottle before filling in the field. If the residual chlorine is likely to be present >5 mg/L, a determination of the amount of the chlorine may be necessary. Diethyl-p-phenylenediamine (DPD) test kits are commercially available to determine residual chlorine in the field. Add an additional 25 mg of ascorbic acid per each 5 mg/L of residual chlorine. Mark the vial indicating ascorbic acid has been added.

11.3 Samples must be stored at 4°C in the Volatile Laboratory refrigerators until the time of analysis. The holding time for samples is 14 days from collection.

12.0 Quality Control

12.1 Calibrate the mass and abundance scales of the MS by purging 25ng or less of BFB and acquire the mass spectra. If the spectrum does not meet all the criteria in Table IV, the MS must be retuned before running the initial calibration. The MS tune must be verified every 12 hours during which analyses are performed and adjusted to meet all criteria before the continuing calibration standard is analyzed.

12.2 Before running any samples, it should be demonstrated through the analysis of a reagent blank that interferences from the analytical system, glassware and reagents are under control. Each time there is a change in organic free reagent water, a blank should be run to ensure against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement steps. Blanks must also be analyzed at intervals throughout the sequence to demonstrate a continually contaminant free system. The frequency of these blanks should be equal to 10% of all samples analyzed.

12.3 The number of calibration standards used depends on the calibration range that is needed. A minimum of 3 calibration standards are required to calibrate a range of a factor of 20 in concentration. A factor of 50 requires 4 standards and a factor of 100 requires at least 5 standards. A calibration range of 100 is suggested and therefore, the initial calibration curve is constructed with a minimum of five concentrations. The %Relative Standard Deviation of the

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calibration factor must be <20% in order for linearity to be assumed.

12.4 After a calibration curve has been constructed, the curve must be checked with a Quality Control Sample (QCS). The QCS must be obtained from a vendor different than the calibration standards. The calibration stock standards are purchased from Ultra Scientific and the QCS is obtained from Supelco. The response for each analyte in the QCS must be within: 1:30% of the true value in order to demonstrate that the curve is accurate.

12.5 The calibration relationship established during the initial calibration must be verified at the beginning of each 12-hour period during which analyses are performed. Continuing calibration standards should be prepared at a concentration near the midpoint of the initial calibration range. The absolute areas of the quantitation ions for the internal standard and surrogates should not decrease by more than 30% from the areas measured in the most recent continuing calibration check or by more than 50% from the response obtained during the initial calibration. The concentration of each analyte and surrogate in the continuing calibration standard must be within 30% of the true value of the concentration, with no outliers from the 524 compound list. If this criterion cannot be met, instrument maintenance (such as cleaning the ion source) and recalibration may be necessary.

12.6 For each analytical batch (up to twenty samples) a spike and spike duplicate must be analyzed. The acceptance criterion for spiked samples is 70-130% recovery. The relative percent difference (%RSD) between the spike and spike duplicate must be <30% to demonstrate acceptable precision.

12.7 A Method Detection Limit is performed yearly. At least seven vials are spiked at a level of 2-5 times the expected detection limit. The standard deviation of the seven or more analyses is multiplied by the degrees of freedom to obtain the calculated method detection limit. Refer to 40 CFR Part 136 Appendix B

12.8 An accuracy and precision study is performed yearly and with each new employee. Four standards at a level approximately ten times higher than the detection limit are evaluated for accuracy (%recovery) and precision (standard deviation).

12.9 A Limit of Detection (LOD) study must be performed for each target analyte of concern. All sample processing steps of the analytical method shall be included in the determination of the LOD. The LOD study is achieved by analyzing a standard at 1-4x the LOD for multiple analyte tests. A 1:1 dilution of the low level standard (0.5 ppb) is analyzed with each batch, and recoveries should fall into the 50- 150% recovery range.

13.0 Calibration and Standardization

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13.1 Calibrate the mass and abundance scales of the MS using the BFB in the surrogate solution and acquire the mass spectra. If the spectrum does not meet all the criteria in Table 2, the MS must be retuned before running the initial calibration.

13.2 Initial Calibration

13.2.1 CALIBRATION STANDARDS Prepare a set of six calibration standards. The lowest concentration of the calibration standards must be at or below the MRL. Additionally, field samples must be quantified using a calibration curve that spans the same concentration range used to collect the IDC data (Sect. 12.8), e.g., analysts are not permitted to use a restricted calibration range to meet the IDC criteria and then use a larger dynamic range during analysis of field samples.

14.0 Procedure

14.1 Internal Standard and Surrogate Preparation

14.1.1 Internal and Surrogate Mix: Ultra Scientific Cat. STM320N in methanol

Surrogate	Conc. (ug/ml)
Fluorobenzene	2000
Bromoflurobenzene	2000
1,2 Dichlorobenzene-d4	2000

14.1.2 Preparation of Internal/Surrogate Mix

14.1.2.1 4ml of 50ug/ml stock: For Chem 2 (50ppm)

100 ul of Internal std /Surrogate (STM 320N) into 3900 ul Methanol.

14.1.2.2 1 ul of this stock is added to 5ml of each sample/standard for a 10 ng/ml concentration.

14.1.2.3 4ml of 10ug/ml stock: For Chem 15 (10ppm)

20 ul of Internal std /Surrogate (STM 320N) into 3980 ul Methanol.

14.1.2.4 5 ul of this stock is added to 5ml of each sample/standard for a 10 ng/ml concentration.

14.2 Initial Calibration Standard Preparation

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14.2.1 The following is a list of the stock standards and concentrations used to prepare the calibration curve. All calibration standards are purchased from ULTRA SCIENTIFIC.

	Concentration	Part Number	Vendor
Tert-butanol	2000 ug/mL	90782	Absolute
CustomStd (6analytes)	Various	CUS-11008	Ultra
1-4 Dioxane	10,000 ug/mL	95426	Absolute
Methylcyclohexane	1000 ug/mL	71627	Absolute
Methyl Acetate	1000 ug/mL	71031	Absolute
Carbon disulfide	1000 ug/mL	70060	Absolute
MTBE	1000 ug/mL	70209	Absolute
Ketones	2000 ug/mL	82402	Absolute
Cyclohexane	2000 ug/mL	96162	Absolute
502/524mix 54compounds	2000 ug/mL	32001	Absolute
502/524 6 compounds	2000 ug/mL	30058	Absolute
2-Chloroethylvinyl ether (2-CEVE)	1000 ug/mL	70074	Absolute
Vinyl Acetate	10,000ug/ml	RCC-218	Ultra

14.2.2 Working Calibration Standard: VOA-50PPM STOCK STANDARD

Component	Volume = 4mL
MeOH	380 uL
Tert-Butanol	1000 uL
Custom Standard	1000 uL
Vinyl Acetate	20 uL
1,4-Dioxane	400 uL
Methyl Cyclohexane	200 uL
Methyl Acetate	200 uL

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Carbon Disulphide	200 uL
MTBE	200 uL
Ketones	100 uL
Cyclohexane	100 uL
Volatile 502/524	100 uL
Volatile Gases	100 uL

14.2.3 Calibration Standards Preparation:

Level	STD conc ppb	Cal Std.vol (mL)	Working Std added (uL)
1	0.5	100	1
2	2	100	4
3	4	100	8
4	10	100	20
5	20	100	40
6	30	100	60
7*	100	100	100

*For Chloroform only.

Each level is prepared by adding the appropriate mL of working standard (Sec, 14.2.2) to 100mL of reagent water that contains the preservative HCl in a volumetric flask. The flask is shaken a maximum of three times. The contents are poured into 2 VOA vials with zero headspace.

14.3 LCS- Second Source Standard Preparation

14.3.1 Laboratory Control Standard (LCS) Stock Standards:

	Concentration	Part Number	Vendor
Tert Butanol	10000 ug/mL	N-13523	Chem Service
Custom Standard	Various	CUS-11008	Ultra
1-4 Dioxane	2000 ug/mL	30287	Restek
Methyl Cyclohexane	1000 ug/mL	S-12469M4	Chem Service
Methyl Acetate	10000 ug/mL	N-12411	Chem Service
Carbon Disulfide	5000 ug/mL	EPA-1012	Ultra

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MTBE	2000 ug/mL	STS-44051	Ultra
VOA calibration mix	5000 ug/mL	30006	Restek
Cyclohexane	1000 ug/mL	S-11526M4	Chem Service
VOC mix (54 compound)	2000 ug/mL	DWM-589N-1	Ultra
VOC Gas Mix	2000 ug/mL	DWM-544-1	Ultra
2-CEVE	1000 ug/mL	70074	Absolute
Vinyl Acetate	10,000 ug/mL	N-13746-1G	Chem Service

14.3.2 LCS Working Standard: LCS-50 PPM STOCK STANDARD

Component	Volume = 4mL
Meoh	1580 uL
Tert-Butanol	200 uL
Custom Standard	1000 uL
Vinyl Acetate	20 uL
1,4-Dioxane	400 uL
Methyl Cyclohexane	200 uL
Methyl Acetate	20 uL
Carbon Disulphide	40 uL
MTBE	100 uL
Ketones	40 uL
Cyclohexane	200 uL
Volatile 502/524	100 uL
Volatile Gases	100 uL

14.3.3 LCS: A concentration of 10 ppb is prepared by adding 20 uL of the LCS Working Standard to 100 mL of reagent water and HCL in a volumetric flask. The flask is shaken a maximum of three times. The contents are poured into 2 VOA vials with zero headspace.

14.4 Spiking Solution Preparation

14.4.1 Volatiles Matrix Spike (MS) Solution- A concentration of 10 ppb is prepared by adding 20ul of LCS Working Standard (Sec. 14.3.2) to 100mL of reagent water and preservatives in a volumetric flask. The flask is shaken a maximum of three times. The contents are poured into 2
VOA vials with zero headspace.

14.5 Tuning the MS

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Calibrate the mass and abundance scales of the MS using the BFB in the surrogate solution and acquire the mass spectra. If the spectrum does not meet all the criteria in Table 23.2, the MS must be retuned before running the initial calibration.

14.6 Initial Calibration/Continuing Calibration
The initial calibration must meet appropriate requirements before samples are run. Continuing calibration checks must be run at the beginning of each 12-hour period during which analyses are performed.

14.7 Loading Water Samples/Standards
Place the VOA vial into the Centurin autosampler tray. Remove label if it will obstruct the autosampler gripper. Program the correct position, 5ml method and the addition of internal standard/surrogate with Centurion software.

14.8 Purging Trap Method (EST Encon Evolution):

14.8.1

Temp	
Purge Flow	40ml
Purge Time:	11.0
Purge Volume:	5 ml
Desorb Time	4.0
Purge Gas:Helium	Helium
Bake Time:	8 minutes

14.9 GC Conditions (or equivalent)

14.9.1

GC Conditions	
Inlet	Split/Splitless
Inlet Temp	210C
Pressure	20.22 psig
Total Flow	44 mL/min
Septum Purge Flow	3 mL/min
Mode	Split
Split Ratio	40:01:00
Flow	40 mL/min

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Oven Program	Value	Hold Time	Run Time
Initial	40C	1 min	
Ramp Rate 18C/min	160C	0.1 min	
Ramp Rate 30C/min	225C	1.0 min	10.933
Aux Temp	J230C		

14.10 MS SIM/SCAN Parameters

14.10.1

MS SIM Parameters	
Solvent Delay	0.4 min
EMV Mode	Relative
Acquistion Mode	Scan

Scan Window
0.4 min to 10.933 min (35.0 amu to 260 amu)

14.11 Bake the trap and MCS loop every morning This removes any water vapor accumulation on the trap and MCS loop and improves chromatography.

14.12 Change the trap after every 6-8 weeks or whenever low response of aromatics or tailing of late eluting compounds is observed.

14.13 Flow rates must be checked once in a month or whenever the trap is changed.

14.14 Cleaning of Ion Source is usually done after 6-8 weeks or as needed (e.g. when response drops and increasing multiplier voltage results in increase in multiplier noise resulting in a noisy baseline or when calibration peaks are deformed and ratios of ion spectra for PF43 cannot be properly adjusted by changing the MS Tune parameters.

15.0 Data Analysis and Calculations

15.1 Response Factor
Calculate the response factor (RF) for each analyte in each calibration standard using the internal standard.

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RF = (Ax)
(Qis) (Ais)
(Qx) where:
Ax=Integrated abundance of the quantitation ion of the analyte in the sample
Ais =Integrated abundance of the quantitation ion of the internal standard in the sample

Qis=Total quantity (in micrograms) of internal standard added to the water sample
Qx =Quantity of analyte purged in concentration units

For each analyte and surrogate, calculate the average RF from analyses of calibration standards. Calculate the standard deviation (SD) and the relative standard deviation (RSD) from each average. RSD = 100 (SO/average RF)

15.2 Internal Standard Calibration Technique
The internal standard calibration technique is used to calibrate the chromatographic system. The concentration of each compound in the sample is calculated using the results of the initial calibration. Concentration (ug/L) = (Ax)(Qis)(1000)
(Ais)(RF)(V) where: V=Original water sample volume in ml

16.0 Method Performance

16.1 This method was validated through internal QA/QC monitoring, including annual method detection limit studies, precision and accuracy studies, initial and continuing calibration verifications, blank analysis, laboratory control samples, matrix spikes and duplicates, surrogate recoveries and proficiency analysis.

16.2 See Section 12 Quality Control in this SOP for acceptable limits.

17.0 Pollution Prevention

17.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation.

17.2 Reagents and standards should be purchased and/or prepared in volumes consistent with laboratory use to minimize the volume of disposal.

18.0 Data Assessment and Acceptance Criteria

18.1 Data is assessed, for criteria listed in section 12, by a color coded system in the LIMS

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instrument batching system. Out of control compounds are flagged.

19.0 Corrective Actions for Out-Of-Control Data

19.1 Refer to section 12 Quality Control for corrective actions.

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

20.1 When a problem is encountered that is outside those listed in the above SOP, a nonconformance report is generated in the LIMS system.

21.0 Waste Management

21.1 It is the laboratories responsibility to comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

22.0 References

22.1 Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Method 524.2. Revision 4.0 Environmental Monitoring and Support, Environmental Protection Agency, August 1992.

22.2 Determinative Chromatographic Separations, Method 80008. Environmental Monitoring and Support, Environmental Protection Agency, , December 1996.

22.4 Purge and Trap, Method 50308. Environmental Monitoring and Support, Environmental Protection Agency, final update III, December 1996.

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23.0 Tables, Diagrams, Flowcharts and Validation Data

23.1

Name	CAS
% 1,2-dichlorobenzene-d4	2199-69-1
% Bromofluorobenzene	460-00-4
% Dibromofluoromethane	1868-53-7
% Toluene-d8	2037-26-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,1-Trichloroethane	71-55-6
1,1,2,2-Tetrachloroethane	79-34-5
1,1,2-Trichloroethane	79-00-5
1,1-Dichloroethane	75-34-3
1,1-Dichloroethene	75-35-4
1,1-Dichloropropene	563-58-6
1,2,3-Trichlorobenzene	87-61-6
1,2,3-Trichloropropane	96-18-4
1,2,4-Trichlorobenzene	120-82-1
1,2,4-Trimethylbenzene	95-63-6
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dichloroethane	107-06-2
1,2-Dichloropropane	78-87-5
1,3,5-Trimethylbenzene	108-67-8
1,3-Dichlorobenzene	541-73-1
1,3-Dichloropropane	142-28-9

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1,4-Dichlorobenzene	106-46-7
2-Chlorotoluene	95-49-8
4-Chlorotoluene	106-43-4
Benzene	71-43-2
Bromobenzene	108-86-1
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroform	67-66-3
Chloromethane	74-87-3
cis-1,2-Dichloroethene	156-59-2
cis-1,3-Dichloropropene	10061-
Dibromochloromethane	124-48-1
Dibromoethane	106-93-4
Dibromomethane	74-95-3
Dichlorodifluoromethane	75-71-8
Ethylbenzene	100-41-4
Hexachlorobutadiene	87-68-3
Isopropylbenzene	98-82-8
m&p-Xylene	106-42-3
Methyl t-butyl ether	1634-04-
Methylene chloride	75-09-2
Naphthalene	91-20-3
n-Butylbenzene	104-51-8
n-Propylbenzene	103-65-1
o-Xylene	95-47-6
p-Isopropyltoluene	99-87-6
sec-Butylbenzene	135-98-8
Styrene	100-42-5
tert-Butylbenzene	98-06-6
Tetrachloroethene	127-18-4
Toluene	108-88-3
Total Xylenes	1330-20-7
trans-1,2-Dichloroethene	156-60-5
trans-1,3-	10061-02-
Trichloroethene	79-01-6
Trichlorofluoromethane	75-69-4
Vinyl chloride	75-01-4

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23.2 TUNE Criteria (BFB)

m/z	Required intensity (relative abundance)
50	15-40% of Mass 95
75	30-80% of Mass 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

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Changes since Prior Version:

Version 3:
Section 11.2 - added the addition of ascorbic acid in the field for samples containing residual chlorine.

Version 2:

Section 12.1 changed from 8 hr to 12 hours.

Section 12.9- added LOD study.

Section 14.2- made Standards easier to understand, added Level 7 to curve.

Section 14.3 - added all LCS/MS Standards and made them easier to understand.

Section 14.8 & 14.9- slight updates to conditions.

Section 22 - Corrected method reference for 524.2.

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Revision History Log for SOP # 651

Date:	Revision #:	Summary of Changes:	Submitted By:	Approved By:	Effective Date:
3/10/17	3.1	Section 9.8- added additional instrument models, added sections 14.1.2.3 and 14.1.2.4, section 14.2- added new standard tables, section 14.3- new LCS tables, section 14.8.1- updated conditions	Harry Mullin	Kathy Cressia	3/10/17

QAPP Worksheet #37: Data Usability Assessment

SOP – 003H – 646 - Determination of 1,4-dioxane in water by solid phase extraction (spe) and gas chromatography/mass spectrometry (gc/ms) with selected Ion monitoring (sim)

QAPP Worksheet #37: Data Usability Assessment

PHOENIX
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Effective Date: 6/12/19
Version Number: 2.4
Initiated by:
Approved by:

SOP No.: 646

Title: DETERMINATION OF 1,4-DIOXANE IN WATER BY SOLID PHASE EXTRACTION (SPE) AND GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS) WITH SELECTED ION MONITORING (SIM)

1. SCOPE AND APPLICATION

1.1 This is a gas chromatography/mass spectrometry (GC/MS) method for the determination of 1,4-dioxane (CASRN 123-91-1) in water.
1.2 The Minimum Reporting Level (MRL) is based on the low point of the calibration curve and the extraction parameters. This method describes the procedure for a MRL of 0.20 ug/L with a working range up to approximately 20.0 ug/L. 1,4-dioxane samples that do not require the low MRL can be analyzed using SOP #631.
1.3 This method is intended for use only by analysts skilled in solid phase extraction (SPE), the operation of GC/MS instruments, and the interpretation of the associated data.

2. SUMMARY OF METHOD

2.1 A water sample that has been dechlorinated and preserved with a microbial inhibitor is fortified with the isotopically labeled SUR, 1,4-dioxane-d_8. The sample is extracted with a Sep-Pak Plus AC-2 cartridge (or equivalent). The compounds are eluted from the solid phase with a 1 ml of dichloromethane (DCM), dried with anhydrous sodium sulfate and the IS, tetrahydrofuran-d_8 (THF-d_8), is added. Analysis of the extract is performed by GC/MS (SIM) analysis but the analysis may also be performed in full scan mode if the sensitivity achieved meets the data user's requirements.

3. INTERFERENCES

3.1 All glassware must be meticulously cleaned. Wash glassware with tap water, rinse with tap water, followed by reagent water.
3.2 Method interferences may be caused by contaminants in solvents, reagents (including reagent water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. Subtracting blank values from sample results is not permitted.
3.3 Purge and trap grade methanol must be used for all steps where methanol is used in this method. Other grades of methanol contain numerous low molecular weight compounds that contain interfering ions which may prohibit accurate identification and quantitation of the analyte, SUR and IS.

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3.4 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 water.

3.5 A preservative is added to samples to ensure sample stability during shipping and storage prior to analysis. The potential exists for trace-level organic contaminants in the reagent. Interferences from these sources should be monitored by analysis of Laboratory Reagent Blanks (LRB), particularly when new lots of reagents are acquired.

3.6 Solid phase extraction cartridges may be a source of interferences. The analysis of field and laboratory reagent blanks can provide important information regarding the presence or absence of such interferences. Brands and lots of SPE devices should be tested to ensure that contamination does not preclude analyte identification and quantitation.

3.7 Analyte carry-over may occur when a relatively "clean" sample is analyzed immediately after a sample containing relatively high concentrations of compounds. A LRB may need to be analyzed to ensure that accurate values are obtained for the next sample.

4. SAMPLE COLLECTION, PRESERVATION, AND STORAGE

4.1 SAMPLE PRESERVATIVE - Sodium bisulfate, at approximately 1 g/L is added to the sample bottles prior to sampling. This acts as a microbial inhibitor. If a sample has chlorine present, Sodium sulfite must be added first to remove chlorine.

4.2 SAMPLE COLLECTION

4.2.1 Fill sample bottles, taking care not to flush out the preservative. Samples do not need to be collected headspace free.

4.2.2 After collecting the sample, cap the bottle and agitate by hand until the sodium bisulfate is dissolved. Unless field verification of pH is to be performed, keep the sample sealed until just prior to extraction.

4.2.3 Field verification of pH 4 (optional). It is anticipated that 1 g/L of sodium bisulfate will be sufficient to acidify most samples to < pH 4. If there is reason to suspect that more may be needed, the pH can be verified with narrow range pH paper at the time of sample collection. After acidification and mixing, pour a small amount of sample over a strip of the pH paper (do not dip the strip in the sample). Read the result as instructed on the pH paper package. If the pH is ≥ 4, add additional sodium bisulfate until pH < 4 is obtained. Seal the bottle, and keep the sample sealed until extraction.

4.3 SAMPLE SHIPMENT AND STORAGE - Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °C when they are received at the laboratory. Samples stored in the lab must be held at or below 6 °C until extraction, but should not be frozen. Freezing samples may compromise the sealed cap or result in sample bottle breakage.

4.4 SAMPLE AND EXTRACT HOLDING TIMES - Aqueous samples may be stored as described above for up to 28 days from collection. Sample extracts may be stored at -5 °C and protected from light for an additional 28 days.

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5. REAGENTS AND STANDARDS

5.1 REAGENTS AND SOLVENTS - Reagent grade or better chemicals should be used in all steps.
- 5.1.1 HELIUM - 99.999 % or better, GC carrier gas.
- 5.1.2 REAGENT WATER - Purified water which does not contain any measurable quantities of the method analytes.
- 5.1.3 METHANOL- Purge and trap grade only.
- 5.1.4 DICHLOROMETHANE (DCM) (CASRN 75-09-02) - High purity, demonstrated to be free of analytes and interferences.
- 5.1.5 SODIUM SULFATE, ANHYDROUS (CASRN 7757-82-6) - ACS grade, suitable for pesticide residue analysis, or equivalent, anhydrous sodium sulfate is recommended.
- 5.1.6 SODIUM BISULFATE (CASRN 7681-38-1) - Anhydrous, technical grade. It is added to acidify the samples to pH < 4 to act as a microbial inhibitor during sample shipping and storage.
- 5.1.7 SODIUM SULFITE- is added to sample containers for samples from chlorinated systems in order to remove the chlorine before shipping or storage.

5.2 STANDARD SOLUTIONS - It is recommended that standard solutions be stored at 0°C or less, with minimal headspace. The expiration date provided by the vendor should be used for unopened vials. Once the ampule has been opened, its expiration date becomes 6 months; unless the vendor assigned expiration date is sooner.
- 5.2.1 STOCK STANDARD SOLUTIONS (SSS) - Stock standard solutions include 1,4 Dioxane d8 (1000ug/ml- Absolute 71882), 1,4 Dioxane (100ug/ml-Ultra NV-150), Tetrahydrofuran d8 (1000ug/mL Absolute 72261), 1,4 Dioxane LCS (1000ug/mL-Absolute 97216), 4,Bromofluorobenzene (1000ug/mL-Absolute 70048), 1,4-dioxane second source (1000ug/mL – Absolute 70373).
- 5.2.2 CALIBRATION STANDARD SOLUTIONS (CAL) - Prepare a series of calibration standards to encompass the desired calibration range. Calibration standards must contain varying amounts of 1,4-dioxane, and a fixed amount of both the SUR and the IS, and be prepared in DCM. The number of standards required is determined by the calibration range. Three standards are required for one order of magnitude, six standards for two orders of magnitude and nine standards for three orders of magnitude. A six point calibration curve is analyzed for the working range described above.
- 5.2.3 SAMPLE FORTIFICATION SOLUTIONS
  - 5.2.3.1 ANALYTE FORTIFICATON SOLUTION - Prepare one or more solutions in methanol for use in preparing LFBs and LFSMs. The number of solutions needed depends upon the calibration range and/or sample volume.
  - 5.2.3.2 SURROGATE (SUR) SOLUTION - Prepare one or more solutions of 1,4-dioxane-d_8 in methanol to be used for fortification of the SUR into samples, LFBs, LRBs and LFSMs.
  - 5.2.3.3 INTERNAL STANDARD (IS) SOLUTION – Prepare one or more solutions of THF-d_8 in DCM to be used to add the IS to all extracts.

Expiration Date

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5.2.4 GC/MS TUNE CHECK SOLUTION - Stock standard solutions of BFB (CASRN 460-00-4) are available commercially. Prepare a BFB solution at a concentration of 1-2 µg/mL in DCM by dilution of the stock standard.

6. EQUIPMENT AND SUPPLIES

6.1 SAMPLE CONTAINERS – 250 mL (8oz) Amber glass bottles fitted with teflon or polytetrafluoroethylene (PTFE) lined screw caps.
6.2 VIALS - Various sizes of glass vials with PTFE-lined screw caps for storing standard solutions and extracts, including glass 2-mL autosampler vials with PTFE-faced septa.
6.3 LOW LEVEL CHLORINE indicator strips.
6.4 NARROW RANGE PH 0-14 indicator strips.
6.5 GRADUATED CYLINDERS - Glass, various sizes, including 50, 100 and 500 mL for measurement of sample volumes.
6.6 MICRO SYRINGES - Suggested sizes include 10, 25, 50, 100, 250, 500, and 1000 µL.
6.7 SYRINGE – Gastight luer lock 5 mL syringe.
6.8 SOLID PHASE EXTRACTION (SPE) APPARATUS
6.8.1 SPE CARTRIDGES – Waters Sep-Pak Plus AC-2 SPE cartridges (cat. # JJAN20229) or equivalent.
6.8.2 VACUUM EXTRACTION MANIFOLD - Equipped with flow/vacuum control (Supelco cat. # 57250-U or equivalent).
6.8.3 SPE Tubes – empty SPE tubes, 150cc (Phenomenex Part #AH0-7809) or equivalent.
6.8.3 DRYING COLUMN – containing glass wool and sodium sulfate.
6.9 LABORATORY OR ASPIRATOR VACUUM SYSTEM - Sufficient capacity to maintain a vacuum of approximately 15 to 25 inches of mercury.
6.10 GAS CHROMATOGRAPH/MASS SPECTROMETER (GC/MS) SYSTEM
6.10.1 FUSED SILICA CAPILLARY GC COLUMN – J&W DBVRX 30 m x 0.25-mm i.d. with a 1.4 µm film thickness, or equivalent.
6.10.2 GC INJECTOR AND OVEN – Injector 230° C. Oven 40°C (1min), rate 20°C/minute to final temp 230°C for 3 minutes.
6.10.3 GC/MS INTERFACE - The interface allows the capillary column or transfer line exit to be placed within a few millimeters of the ion source.
6.10.4 MASS SPECTROMETER (MS) - Any type of mass spectrometer may be used which meets the criteria in Table 1 when a solution containing approximately one to two nanograms of bromo-fluorobenzene (BFB) is injected into the GC/MS. This test must be performed in the full scan mode. Use a single spectrum at the apex of the BFB peak, an average spectrum of the three highest points of the peak, or an average spectrum across the entire peak to evaluate the performance of the system. Appropriate background subtraction is permitted. The scan time should be set so that there is a minimum of five scans across the chromatographic peak. Ten scans across chromatographic peaks are recommended.
6.10.5 DATA SYSTEM - An interfaced data system is required to acquire, store, and output MS data. The computer software should have the capability of processing stored GC/MS data by recognizing a GC peak within a given retention time window. The

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software must allow integration of the ion abundance of any specific ion between specified times or scan number limits. The software must be able to construct linear regressions and quadratic calibration curves, and calculate analyte concentrations.

7. DEFINITIONS

7.1 ANALYSIS BATCH - A set of samples that is analyzed on the same instrument during a 12-hour period that begins and ends with the analysis of the appropriate Continuing Calibration Check (CCC) Standards. Additional CCCs may be required depending on the length of the analysis batch and/or the number of Field Samples.

7.2 CALIBRATION STANDARD (CAL) - A solution prepared from stock standard solution(s) and the ISs and SURs. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

7.3 CONTINUING CALIBRATION CHECK (CCC) STANDARD - A calibration standard containing the method analyte, IS and SUR which is analyzed periodically to verify the accuracy of the existing calibration for those analytes.

7.4 EXTRACTION BATCH - A set of up to 20 Field Samples (not including QC samples) extracted together by the same person(s) during a work day using the same lot of SPE devices, solvents, SUR solution, and fortifying solutions. Required QC samples include Laboratory Reagent Blank (LRB), Laboratory Fortified Blank (LFB), and Laboratory Fortified Sample Matrix (LFSM).

7.5 FIELD DUPLICATES (FD1 and FD2) - Two separate samples collected at the same time and place under identical circumstances, and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as with laboratory procedures.

7.6 INTERNAL STANDARD (IS) - A pure analyte, which is extremely unlikely to be found in any sample, which is added to an extract or standard solution in a known amount and used to measure the relative responses of the method analyte and SUR. The IS must be an analyte that is not a sample component.

7.7 LABORATORY FORTIFIED BLANK (LFB) - An aliquot of reagent water or other blank matrix to which known quantities of the method analyte and all the preservation compounds are added. The LFB is processed and analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

7.8 LABORATORY FORTIFIED SAMPLE MATRIX (LFSM) - An aliquot of a Field Sample to which known quantities of the method analyte and all the preservation compounds are added. The LFSM is processed and analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analyte in the sample matrix must be determined in a separate aliquot or duplicate sample and the measured values in the LFSM corrected for background concentrations.

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7.9 LABORATORY REAGENT BLANK (LRB) - An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, sample preservatives, ISs, and SURs that are used in the extraction batch. The LRB is used to determine if the method analyte or other interferences are present in the laboratory environment, the reagents, or the apparatus.

7.10 MINIMUM REPORTING LEVEL (MRL) - The minimum concentration that can be reported by a laboratory as a quantitated value for a target analyte in a sample following analysis. This defined concentration must not be any lower than the concentration of the lowest calibration standard for that analyte.

7.11 QUALITY CONTROL SAMPLE (QCS) - A sample or standard prepared using a Stock Standard Solution (SSS) of the method analyte that is obtained from a source external to the laboratory and different from the source of calibration standards. The second source SSS is used to fortify the QCS at a known concentration. The QCS is used to check calibration standard integrity.

7.12 SELECTED ION MONITORING (SIM) - A GC/MS technique where only one or a few ions are monitored. When used with gas chromatography, the set of ions monitored is usually changed periodically throughout the chromatographic run, to correlate with the characteristic ions of the analyte, SUR and IS as they elute from the chromatographic column.

7.13 STOCK STANDARD SOLUTION (SSS) - A concentrated solution containing the method analyte prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

7.14 SURROGATE ANALYTE (SUR) - A pure analyte, which is extremely unlikely to be found in any sample, and which is added to a sample aliquot in a known amount before extraction or other processing, and is measured with the same procedures used to measure other sample components. The purpose of the SUR is to monitor method performance with each sample.

8. CALIBRATION AND STANDARDIZATION

8.1 Demonstration and documentation of acceptable mass spectrometer (MS) tune and initial calibration is required before any samples are analyzed. After the initial calibration is successful, a CCC is required at the beginning and end of each period which analyses are performed. Verification of mass spectrometer tune must be repeated each time a major instrument modification is made or maintenance is performed, and prior to establishing or re-establishing an initial calibration.

8.2 INITIAL CALIBRATION

8.2.1 MS TUNE/MS TUNE CHECK - Operate the MS in the electron ionization mode. Calibrate the mass and abundance scales of the MS with calibration compounds and procedures prescribed by the manufacturer with any modifications necessary to meet tuning requirements. Inject 2 ng or less of the BFB solution into the GC/MS system. Acquire a mass spectrum that includes data for m/z 45 to 180. The GC and MS parameters must be set such that a minimum of five scans (10 scans are recommended) are obtained during the elution of the BFB chromatographic peak. Use a single spectrum of the BFB peak, an average

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spectrum of the three highest points of the peak, or an average spectrum across the entire peak to evaluate the performance of the system. Appropriate background subtraction is permitted. If the BFB mass spectrum does not meet all criteria in Table 1, the MS must be re-tuned and adjusted to meet all criteria before proceeding with the initial calibration.

8.2.2 CALIBRATION CURVE - Use the GC/MS software to create a calibration curve for 1,4-dioxane using the IS technique. Concentrations may be calculated through the use of a linear or quadratic calibration curve. A weighted curve is permitted at the discretion of the analyst. Because the SUR is added to all samples and standards at a single concentration, calibrate for the SUR using the average response factor.

8.2.3 CALIBRATION ACCEPTANCE CRITERIA - When quantitated using the calibration curve, each calibration point, except the lowest point, should calculate to be within 80-120% of its true value. The lowest point should calculate to be within 60-140% of its true value. If these criteria cannot be met, the analyst will have difficulty meeting ongoing QC criteria. It is recommended that corrective action be taken to re-analyze the CALs, restrict the range of calibration, or select an alternate method of calibration.

8.3 CONTINUING CALIBRATION CHECK (CCC) - The CCC verifies the initial calibration at the beginning and end of each group of analyses. The beginning CCC for each analysis batch must be at or below the MRL in order to verify instrument sensitivity prior to any analyses. Subsequent CCCs must alternate between medium and high concentration CALs.

8.3.1 Inject an aliquot of the appropriate concentration CAL solution and analyze with the same conditions used during the initial calibration.

8.3.2 Determine that the absolute area of the IS has not changed by more than ± 50% from the average area measured during initial calibration, or more than - 50% to +200% from the most recent CCC. If the IS area has changed by more than this amount, remedial action must be taken.

8.3.3 Calculate the concentration of 1,4-dioxane and the SUR in the check standard. The calculated amount for 1,4-dioxane for medium and high level CCCs must be ± 30% of the true value. The calculated amount for the lowest calibration level for 1,4-dioxane, which must be at a concentration less than or equal to the MRL,must be within ± 50% of the true value. If these criteria are not met, then all data for the problem analyte must be considered invalid, and remedial action should be taken. This may require recalibration. Any Field Sample extracts that have been analyzed since the last acceptable calibration verification should be re-analyzed after adequate calibration has been restored, with the following exception: if the CCC fails at the end of an analytical sequence because the calculated concentration of the target compound or SUR is greater than 130% (150% for the low-level CCC), and Field Sample extracts show no detection for the target compound, non-detects may be reported without re-analysis.

8.3.4 REMEDIAL ACTION - Failure to meet CCC QC performance criteria may require remedial action. Major maintenance such as cleaning the ion source, cleaning the mass analyzer, replacing filament assemblies, replacing the GC column, etc., require returning to the initial calibration step.

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9. PROCEDURE

9.1 The SPE cartridges and sodium sulfate drying materials described in this section are designed as single use items and must be discarded after use. They may not be refurbished for re-use in subsequent analyses.

9.2 SAMPLE PREPARATION

9.2.1 All Field and QC samples (LRBs and LFBs), must contain the anti-microbial agent sodium bisulfate. Verify that Field Samples were acidified to < pH 4 at the time of collection by checking with narrow range pH paper. Add sodium bisulfate to all LRBs and LFBs, prior to fortification with the SUR and analyte.

9.2.2 Check sample for residual chlorine. If present, add sodium sulfite as needed and record the presence of chlorine in prep batch.

9.2.2 Transfer the sample into a clean 100mL graduated cylinder.

9.2.3 ADDITION OF SURROGATE (SUR) ANALYTE - Add an aliquot of the Surrogate Analyte Fortification Solution to all samples and mix by swirling the sample. Addition of 10 µL of a 50-µg/mL solution to a 100-mL sample will result in a concentration of 5µg/L.

9.2.4 FORTIFICATION WITH METHOD ANALYTE - If the sample is an LFB, LFSM, or LFSMD, add the necessary amount of Analyte Fortification Solution (see below). Swirl each sample to ensure all components are properly mixed.

9.2.4.1 For DIOX_EXT- Addition of 25 µL of a 10-µg/mL solution to a 100-mL sample will result in a concentration of 2.5 µg/L.

9.2.4.2 For DIOX_EXTDW- Fortification amounts must vary each batch. Alternate between low, medium, and higher level concentrations (0.50, 2.5, and 5.0 ug/L) using 5, 25, and 50 µL of a 10-µg/mL solution to a 100-mL sample. Make sure the correct concentration is recorded in Prep Batch.

9.3 SPE PROCEDURE; EXTRACTION OF SAMPLES - Proper conditioning of the solid phase sorbent can have a marked effect on method precision and accuracy. This section describes the SPE procedure using Waters Sep-Pak Plus AC-2 cartridges.

9.3.1 CARTRIDGE CONDITIONING

9.3.1.1 Rinse the cartridge with approximately 1 mL of DCM, turn on the vacuum, and pull the solvent through, aspirating completely.

9.3.1.2 Rinse the cartridge with approximately 2 – 5 mL of methanol, turn on the vacuum, and pull the solvent through, aspirating completely.

9.3.1.3 Rinse the cartridge with approximately 5 mL of reagent water preserved with sodium bisulfate- not allowing the cartridge to go dry at the end. From this point forward do not allow the cartridge to go dry.

9.3.2 SAMPLE EXTRACTION – Using the Suppelco Visiprep sampling system adjust the vacuum so that the approximate flow rate is 3 mL/min. After the sample has passed through the SPE cartridge, detach the reservoir and draw air though through the cartridge for 15 min at full vacuum. Turn off and release the vacuum. Proceed with cartridge elution.

9.3.3 CARTRIDGE ELUTION – Slowly elute the cartridge with a final volume of 1ml of Methylene chloride, which is passed through a drying column of Sodium Sulfate

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and glass wool, and collect the extracts in an autosampler vial. Addition of 10 ul of THF-d8 (50ug/ml) in to a 1 ml extract will result in an IS concentration of 500 ng/ml. NOTE: Experiments during method development indicated that this extract cannot be reliably concentrated by nitrogen evaporation because of the volatility of the method analyte. Therefore, extract concentration to enhance sensitivity is not permitted.

9.4 Analyze the extract under the same conditions used for the initial and continuing calibrations.

10. DATA REDUCTION AND CALCULATIONS

10.1 IDENTIFICATION OF ANALYTES - At the conclusion of data acquisition, use the same software that was used in the calibration procedure to identify peaks in predetermined retention time windows of interest. Use the data system software to examine the ion abundances of components of the chromatogram. Identify a sample component by comparison of its SIM (or full scan) mass spectrum to a SIM (or full scan) reference spectrum in the user-created database. The GC retention time of a method analyte should be within one to two sec of the retention time observed for that same compound in the most recently analyzed CCC standard. Ideally, the width of the retention time window should be based upon measurements of actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time can be used to calculate a suggested window size for an analyte. However, the experience of the analyst should weigh heavily in the interpretation of the chromatogram. When this method is performed in the SIM mode, verification of retention times is particularly important because less mass spectral information is being collected.

10.2 IDENTIFICATION VERIFICATION USING ION RATIOS - When the QI of 1,4-dioxane (m/z 88) is observed at the correct retention time, verify that it is truly present by verifying that the ratio of the confirmation ion (m/z 58) to the QI (m/z 88) is within an absolute ±20% of the ratio observed in a mid-range calibration standard. Use similar procedures for identification of the IS and SUR.

10.3 Calculate analyte and SUR concentrations using the multi-point calibration. Do not use daily CCC data to quantitate 1,4-dioxane or the SUR in samples. The integrated abundances of the QIs of the analyte, SUR and IS should be used for all calculations. Adjust the final analyte concentrations to reflect the actual sample volume.

10.4 EXCEEDING CALIBRATION RANGE - An analyst must not extrapolate beyond the established calibration range. If an analyte result exceeds the range of the initial calibration curve, the extract may be diluted with DCM, with the appropriate amount of IS added to match the original concentration, and the diluted extract injected.

11. QUALITY CONTROL

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11.1 QC requirements include the Initial Demonstration of Capability (IDC) and ongoing QC requirements that must be met when preparing and analyzing Field Samples.

11.2 INITIAL DEMONSTRATION OF CAPABILITY (IDC) - The IDC must be successfully performed prior to analyzing any Field Samples. Prior to conducting the IDC, the analyst must first generate an acceptable Initial Calibration.

11.2.1 INITIAL DEMONSTRATION OF LOW BACKGROUND - Before any samples are analyzed, or any time a new lot or brand of SPE materials or solvents are received from a supplier, it must be demonstrated that an extraction blank is reasonably free of any contamination that would prevent the identification or quantitation of 1,4-dioxane, the IS or SUR.

11.2.1.1 A source of potential contamination is the SPE materials which may contain phthalate esters, silicon compounds, and other contaminants that could interfere with the determination of the method analyte, SUR or IS. Although extraction media are generally made of inert materials, they may still contain extractable organic material.

11.2.1.2 Other sources of background contamination are solvents, reagents (including reagent water), room air and glassware. Background contamination must be reduced to an acceptable level before proceeding with the IDP.

11.2.2 INITIAL DEMONSTRATION OF PRECISION (IDP) - Prepare, extract, and analyze four to seven replicate LFBs fortified near the midrange of the initial calibration. The (RSD) of the results of the replicate analyses must be less than 20%.

11.2.3 INITIAL DEMONSTRATION OF ACCURACY (IDA) - Using the same set of replicate data generated for Section 11.2.2, calculate average recovery. The average recovery of the replicate values must be within ± 20% of the true value.

11.2.4 MINIMUM REPORTING LEVEL (MRL) CONFIRMATION – Establish a target concentration for the MRL for 1,4-dioxane based on the intended use of the method. In some cases, the MRL may be dictated by USEPA or another regulatory body. Establish an Initial Calibration following the procedure outlined in section 8.2. The lowest calibration standard used to establish the Initial Calibration (as well as the low-level CCC) must be at or below the concentration of the MRL. Establishing the MRL concentration too low may cause repeated failure of ongoing QC requirements. Validate the MRL following the procedure outlined below.

11.2.4.1 Fortify, extract, and analyze seven replicate LFBs at the proposed MRL concentration. These LFBs must contain all method preservatives described in Section 7.7. Calculate the mean (*Mean*) and standard deviation for these replicates. Determine the Half Range for the prediction interval of results (HR_{PIR}) using the equation below:

$$HR_{PIR} = 3.963S$$

where S is the standard deviation, and 3.963 is the constant value for seven replicates.

NOTE: The mass spectrum (either SIM or full scan) for the method analyte in

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the LFBs must meet all the analyte identification criteria in Section 10.1 and 10.2, i.e., the MRL verification may not be performed on LFBs where only the base peak is observed. If during MRL confirmation all identification ions are not observed, the MRL selected is too low.

11.2.4.2 Confirm that the upper and lower limits for the Prediction Interval of Result ($PIR = Mean \pm HR_{PIR}$) meet the upper and lower recovery limits as shown below.

The Upper PIR Limit must be $\leq$ 150% recovery.

$$\frac{Mean + HR_{PIR}}{\text{Fortified Concentration}} \times 100\% \leq 150\%$$

The Lower PIR Limit must be $\geq$ 50% recovery.

$$\frac{Mean - HR_{PIR}}{\text{Fortified Concentration}} \times 100\% \geq 50\%$$

11.2.4.3 The MRL is validated if both the Upper and Lower PIR Limits meet the criteria described above (Sects.11.2.4.2). If these criteria are not met, the MRL for 1,4-dioxane has been set too low and must be re-evaluated at a higher concentration.

11.2.5 CALIBRATION CONFIRMATION - Analyze a QCS confirm the accuracy of the standards and calibration curve.

11.3 ONGOING QC REQUIREMENTS - This section summarizes the ongoing QC criteria that must be followed when processing and analyzing Field Samples.

11.3.1 LABORATORY REAGENT BLANK (LRB) - An LRB is required with each extraction batch to confirm that potential background contaminants are not interfering with the identification or quantitation of the method analyte, SUR or IS.

11.3.2 CONTINUING CALIBRATION CHECK (CCC) - CCC Standards are analyzed at the beginning of each analysis batch and at the end of the analysis batch. (%D </= 20% to meet MCP).

11.3.3 LABORATORY FORTIFIED BLANK (LFB) - A LFB is required with each extraction batch. Results of the mid and high level LFB analyses must be 70-130% of the true value. Results of the low level LFB analysis must be 50-150% of the true value. If the LFB results do not meet these criteria for 1,4-dioxane, then all data must be considered invalid for all samples in the extraction batch. (40 – 140% to meet MCP).

11.3.4 MS TUNE CHECK - Acceptance criteria for the MS Tune Check are summarized in Table 1. The MS Tune Check must be performed each time a major change is made to the mass spectrometer and prior to establishing and/or re-establishing an initial calibration. In this method, daily BFB analysis is not required.

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11.3.5 INTERNAL STANDARDS (IS) - The analyst must monitor the peak area of the IS in all injections during each analysis day. The IS response (peak area) in any chromatographic run must not deviate from the response in the most recent CCC by more than 30%, and must not deviate by more than 50% from the mean area measured during initial calibration. If the IS area in a run does not meet these criteria, inject a second aliquot of that extract. If the reinjected aliquot produces an acceptable IS response, report results for that aliquot. If the reinjected extract fails again, the analyst should check the calibration by reanalyzing the most recently acceptable calibration standard. If the calibration standard fails the criteria, recalibration is in order and the impacted extracts will be reanalyzed.

11.3.6 SURROGATE (SUR) RECOVERY - The SUR standard is fortified into the aqueous portion of all samples, LRBs, LFBs, CCCs, LFSMs and LFSMDs prior to extraction. It is also added to the calibration standards. The SUR is a means of assessing method performance from extraction to final chromatographic measurement.

11.3.6.1 SUR recovery must be in the range of 70-130% of the true value. When SUR recovery is less than 70% or greater than 130%, check for problems, and once corrected reanalyze the extract.

11.3.6.2 If the extract reanalysis meets the SUR recovery criterion, report only data for the reanalyzed extract.

11.3.6.3 If the extract reanalysis fails the 70-130% recovery criterion, the analyst should check the calibration by injecting the last CCC that passed. If the CCC fails recalibration is in order. If the calibration standard is acceptable, extraction of the sample should be repeated provided the sample is still within the holding time. If the re-extracted sample also fails the recovery criterion, report all data for that sample as "suspect/SUR recovery" to inform the data user that the results are suspect due to SUR recovery. (15 – 110% to meet MCP).

11.3.7 LABORATORY FORTIFIED SAMPLE MATRIX (LFSM) – Analysis of a LFSM is required in each extraction batch and is used to determine that the sample matrix does not adversely affect method accuracy.

11.3.7.1 Within each extraction batch, a minimum of one Field Sample is fortified as an LFSM for every 20 samples extracted. The LFSM is prepared by spiking a sample with an appropriate amount of the Analyte Fortification Solution. Select a spiking concentration that is greater than or equal to the matrix background concentration, if known.

11.3.7.2 Calculate the percent recovery (%R) for the analyte.

11.3.7.3 Analyte recoveries may exhibit matrix bias. For samples fortified at or above their native concentration, recoveries should range between 70-130% for the mid and high level spike concentrations. Low level spike recoveries should range between 50-150% recovery. If the accuracy of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the CCCs, the recovery is judged to be matrix biased. The result for that analyte in the unfortified sample is labeled "suspect/matrix" to inform the data user

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that the results are suspect due to matrix effects. (30 – 140% to meet MCP, RPD < 30%).

11.3.8 QUALITY CONTROL SAMPLES (QCS) - As part of the IDC each time new calibration standards are prepared, and at least quarterly, analyze a QCS sample from a source different from the source of the calibration standards. The QCS should be prepared and analyzed just like a CCC. The calculated amount for the analyte in the QCS must be ± 20% of the expected value. If measured analyte concentrations are not of acceptable accuracy, check the entire analytical procedure to locate and correct the problem, or obtain another QCS.

11.4 METHOD MODIFICATION QC REQUIREMENTS - The analyst is permitted to modify the GC injection technique, GC column and conditions, and MS conditions. Each time method modifications are made, the analyst must repeat the procedures of the IDC and verify that all QC criteria can be met in ongoing QC samples. When implementing method modifications, it is the responsibility of the laboratory to closely review the results of ongoing QC. If repeated failures are noted, the modification must be abandoned.

12. SAFETY

12.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined. Each chemical should be treated as a potential health hazard, and exposure to these chemicals should be minimized. 1,4-Dioxane is classified as a class B2 or probable human carcinogen. Each laboratory is responsible for maintaining an awareness of OSHA regulations regarding safe handling of chemicals used in this method. A reference file of MSDSs should be made available to all personnel involved in the chemical analysis.

12.2 Pure standard materials and stock standard solutions of these compounds should be handled with suitable protection to skin and eyes, and care should be taken not to breathe the vapors or ingest the materials.

12.3 Sodium bisulfate is used as a sample preservative to inhibit microbial growth and potential decay of 1,4-dioxane. Sodium bisulfate is highly acidic and should be used with appropriate caution.

13. METHOD PERFORMANCE

13.1 METHOD PERFORMANCE IN SAMPLES WITH HIGH CONCENTRATIONS OF 1,1,1-TRICHLORETHANE -Because of its widespread use as a chlorinated solvent stabilizer, 1,4-dioxane may be found in the presence of high concentrations of 1,1,1-trichloroethane. The method was tested in a high TOC water matrix with up to 500 µg/L of 1,1,1-trichloroethane added as a co-contaminant. No adverse affect was observed, and the method performed well within QC limits.

13.2 This method was validated through internal QA/QC monitoring, including annual method detection limit studies, precision and accuracy studies, initial and continuing calibration verifications, blank analysis, laboratory control samples and matrix spikes and duplicates.

13.3 See Section 8.0 and Section 11.0 of this SOP for acceptance limits.

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14. POLLUTION PREVENTION

14.1 This method utilizes SPE to extract the analyte from water. It requires the use of very small volumes of organic solvent and very small quantities of pure analyte, thereby minimizing the potential hazards to both the analyst and the environment as compared to the use of large volumes of organic solvents in conventional liquid-liquid extractions.

15. WASTE MANAGEMENT

15.1 The analytical procedures described in this method generate relatively small amounts of waste since only small amounts of reagents and solvents are used. Waste management practices must be conducted consistent with all applicable rules and regulations, and laboratories must protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations.

16. CORRECTIVE ACTION FOR OUT-OF-CONTROL OR UNACCEPTABLE DATA

16.1 See Section 11.0 Quality Control in this SOP for corrective actions.

17. REFERENCES

17.1 Massachusetts Dept of Environmental Protection Bureau of Waste Site Cleanup, WSC-CAM Section II B, Appendix II B-4 Analytical Notes for 1,4-Dioxane Analysis.
17.2 "Test Methods for Evaluating Solid Waste (SW-846), Fourth Edition, EPA Office of Solid Waste, Final Update IV February 2007 (Method 8270D).
17.3 METHOD 522 DETERMINATION OF 1,4-DIOXANE IN DRINKING WATER BY SOLID PHASE EXTRACTION (SPE) AND GAS CHROMATOGRAPHY/ MASS SPECTROMETRY (GC/MS) WITH SELECTED ION MONITORING (SIM) EPA/600/R-08/101 Version 1.0 September, 2008

Table 1

Bromofluorobenzene (BFB) Tune Verification Criteria

Mass (m/z)	Relative Abundance Criteria
50	15-40% of mass 95
75	30-80% of mass 95
95	Base peak, 100% relative abundance
96	5-9% of mass 95
173	<2% of mass 174
174	>50% of mass 95
175	5-9% of mass 174
176	>95% but <101% of mass 174
177	5-9% of mass 176

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Revision History Log for SOP #646

Date:	Revision #:	Summary of Changes:	Submitted By:	Approved By:	Effective Date:
9/18/14	2	Changed cartridges, add more info about chlorine testing	Lauren Muirhead	Kathy Cressia	9/18/14
1/06/16	2.1	Sec 5.2.1- added new stock standards, Sec 6- added pH strips, syringes, new SPE tubes, drying column, Sec 9.2.2- added the check for residual chlorine, fixed several grammatical errors	Lauren Muirhead	Kathy Cressia	1/06/16
11/21/16	2.2	Section 5.2- clarified standard expiration dates, added Section 11.2.4 + all subsections describing the MRL confirmation procedure	Kathy Cressia	Phyllis Shiller	11/21/16
2/23/17	2.3	Added Sections 9.2.4.1 & 9.2.4.2 to distinguish between DW requirements, added low spike criteria to sections 11.3.3 & 11.3.7.3	Kathy Cressia	Keith Aloisa	2/23/17
6/12/19	2.4	Section 1.2 – MRL of 0.20 Section 3.1 – removed detergent	Lauren Muirhead	Kathy Cressia	6/12/19

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SOP – 0003I – Color

PHOENIX
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Effective Date: 03/22/18
Version No.: 4.1
Initiated By: Kathy Cressia
Approved By:

SOP Number: 310.2120B

Title: Color

1.0 Applicable Matrix or Matrices

1.1 This method is applicable to drinking, surface, and ground waters in which the color is due to naturally occurring materials, and domestic and industrial wastes.

2.0 Detection Limit

2.1 This method is suitable for samples with color levels of 0 to 50 color units. Samples with color levels of greater than 50 color units require sample dilution prior to analysis.

2.2 Report color units in whole numbers.

3.0 Scope and Application

3.1 The Platinum-Cobalt method is useful for measuring color of water derived from naturally occurring materials, i.e., vegetable residues such as leaves, barks, roots, humic matter, and peat materials. Industrial wastewaters can contain lignins, tannins, dyes, and other organic and inorganic chemicals that cause color.

4.0 Summary of Method

4.1 Color is measured by visual comparison of the sample with platinum-cobalt standards. One unit of color is that produced by 1 mg/L platinum in the form of the chloroplatinate ion. The ratio of cobalt to platinum in the standard matches the color of natural waters.

5.0 Definitions

5.1 Preparation Blank (Prep Blank)- An aliquot of reagent water that is treated exactly as a sample. The prep blank is used to determine if method analytes are present in the lab environment, reagents or glassware.

5.2 Laboratory Control Sample (LCS)- A purchased standard of a known concentration that is from a different source than the calibration standards. The LCS is used to determine laboratory performance.

5.3 True Color- The color of water from which turbidity has been removed by pre-filtration. Colloidal and larger suspended particles scatter light interfering with the determination of true color.

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5.4 Apparent Color- The color of water that includes color due to suspended matter. Apparent color is determined without prior filtration.

6.0 Interferences

6.1 Even a slight turbidity can cause interference with the color comparison, so turbid samples must be filtered before "True "color testing is performed.

6.2 The color value is extremely pH-dependent, and invariably increases as the pH of the water is raised. For this reason, an unpreserved aliquot is used for analysis, and the pH of the sample is also reported.

7.0 Equipment and Supplies

7.1 Nessler tubes, matched, tall form, 50 mL capacity.

7.2 Nessler tube rack with white deck.

7.3 Membrane filters, 0.45 µm (for true color)

7.4 Filtration set up with vacuum pump (for true color)

8.0 Reagents and Standards

8.1 Platinum-Cobalt Standard, 500 color units, HACH (Part #141453). Expires 6 months from opening.

8.2 Platinum-Cobalt Standard, 15 color units, HACH (Part #2602853). Lot number must differ from curve standard. Expires 6 months from opening.

9.0 Sample Collection, Preservation, and Storage

9.1 The color determination is performed within 48 hours of sample collection because biological or physical changes occurring in storage may affect color.

9.2 Samples are stored at 4°C until time of analysis.

9.3 Samples are to be unpreserved and collected in new plastic or glass bottles. Preferably 100 mL of sample volume is available for color analysis.

10.0 Calibration and Standardization

10.1 Prepare standards having color of 5, 10, 15, 20, 25, 30, 40, and 50 by diluting 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, and 5.0 mL of stock color standard with distilled water to 50mL Nessler tubes.

10.2 Protect standards against evaporation and contamination when not in use by replacing the tube stoppers.

10.3 Store in the dark when not in use. Remake standards after 1 month.

11.0 Procedure

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11.1 For apparent color (COLOR), observe sample color by filling a matched Nessler tube to the 50 mL mark with sample and comparing it to the 50 mL standards.

11.2 Look vertically downward through the tubes toward the white surface placed at such an angle that the light is reflected upward through the columns of liquid.

11.3 If the color exceeds 50, dilute the sample with distilled water in known proportions until the color is within the range of the standards. Record dilution.

11.4 For true color (COLORTR), filter about 60 mL of the sample through a 0.45 µm membrane filter prior to analysis to remove turbidity. Pour filtrate into Nessler tube to 50 mL mark, and proceed to section 11.2-11.3.

11.5 Analyze a Prep blank and LCS per batch of 20 samples. Analyze a sample duplicate every ten samples. Record all information in PREP LOGBOOK in LIMS, under Color. Be sure to notate and report any sample that has been filtered as COLORTR.

11.6 Report Color, Apparent or Color, True in CU (color units).

12.0 Data Analysis and Calculations

12.1 If a sample required a dilution, calculate color units by the following equation:

$$\text{Color} = \frac{A \times 50}{B}$$

Where: A= estimated color of the diluted sample, and
B= mL sample used for dilution

12.2 Calculating RPD:

The RPD is the relative percent difference, and is a measure of the consistency of the sample replicate for the sample set. First, calculate the results for both the sample and the sample replicate. Then apply the two results to the following calculation:

$$\text{RPD, \%} = \frac{(R1 - R2)}{(R1+R2)/2} \times 100$$

Where: R1 = Color value achieved for sample, in CU
R2 = Color value achieved for sample replicate, in CU

12.3 Calculating the LCS:

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The LCS is the laboratory control standard and is a test of the accuracy of the calibration and the test overall. To calculate the % recovery of the LCS:

$$\% \text{ Recovery}, \% = \frac{(RL)}{(LTV)} \times 100$$

Where: RL = Color value for LCS sample, in CU
LTV = true value of LCS, in CU

13.0 Quality Control

13.1 All reagents and standards are labeled with the following: concentration, analyte, initials, dates prepared or opened, and date expires. All chemicals are used on a first in first out system. All reagent and standard preparations are logged in reagent prep logbook or standards prep logbook.

13.2 A preparation blank of dilution water must be analyzed with each batch of twenty or fewer samples, as well as at the end of every run. Prep blanks must be determined to be below reporting level (BRL).

13.3 A platinum-cobalt standard (LCS) is run every batch. The acceptable recovery of the LCS is 90-110% recovery.

13.4 A sample replicate is analyzed with every batch of ten or fewer samples. The acceptable relative percent difference (RPD) for a sample replicate is less than or equal to 20%. Samples labeled as trip, field, or equipment blanks are ineligible samples for replicating.

14.0 Safety

14.1 The toxicity and carcinogenicity of each reagent used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable. A reference file of material data handling sheets are available to all personnel involved in the chemical analysis.

14.2 Always wear safety glasses for eye protection, as well as a lab coat and gloves.

14.3 Refer to SOP #805: Hazardous Chemical and Laboratory Safety Procedures.

15.0 Method Performance

15.1 This method was validated through internal QA/QC monitoring, including blank analysis, laboratory control samples, and sample duplicates.

15.2 See Section 13.0 in this SOP for acceptable limits.

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16.0 Pollution Prevention

16.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation.

16.2 Standards should be prepared or purchased in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed.

17.0 Data Assessment and Acceptance Criteria

17.1 See Section 13.0 in this SOP for acceptable limits.

18.0 Corrective Action for Out-of-Control or Unacceptable Data

18.1 Should the prep blank, LCS, or sample duplicate fail acceptance criteria, reanalyze. If LCS is still out of acceptance limits, remake it, and / or standards, as needed.

19.0 Waste Management

19.1 It is the laboratories responsibility to comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

20.0 References

20.1 Standard Method for the Examination of Water and Wastewater, 22nd ed, Method 2120B, Color, 2011.

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Revision History Log for SOP

Date:	Revision #:	Summary of Changes:	Submitted By:	Approved By:	Effective Date:
5/24/12	3	Procedure now describes 50 mL color tubes rather than the color wheel from HACH	Kathy Cressia	Eric Geyer	5/24/12
2/5/15	4	Section 4- updated application, Section 13- added section 13.3- standards are made monthly, section 22.1- updated method reference	Kathy Cressia	Eric Geyer	2/5/15
3/22/18	4.1	Out of MDB, section 5.0- added definitions of true and apparent color, section 8.0- updated part # of HACH standards, section 20.0- updated method reference for MUR	Kathy Cressia	Eric Geyer	3/22/18

Expiration Date

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Lab Equipment List

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PHOENIX ENVIRONMENTAL LABORATORIES, INC.
Major Equipment List

Organics GC	17 - Perkin Elmer Autosystem with dual Electron Capture Detectors.
	1 - Markelov HS 9000 Headspace Analyzer with Perkin Elmer Autosystem with F10.
	1 - Perkin Elmer Autosystem with Nitrogen Phosphorus Detector.
	10 - Perkin Elmer Autosystem with Flame Ionization Detectors.
	1 - Agilent 7890A Autosystem with PID and FID detectors, Centurion autosampler and Tekmar 3000 Purge and Trap concentrator.
	13 - PE Nelson 970 Data Interfaces.
	6 - PE Nelson 600 Series Link Interfaces.
	8 - PE Nelson Turbochrom 4.1 Data System.
Organics GC/MS	2 - Agilent 5973 MSD with 6890 GC, Arcon 8100 Autosampler, two Tekmar 3000 Purge and Trap concentrators, PT2 switching valve box, HP Chemstation and Enviroquant software.
	1 - Agilent 5973 MSD with 6890 GC, Centurion autosampler, Tekmar 3000 Purge and Trap concentrator. HP Chemstation and Enviroquant software.
	1 - Agilent 5975 MSD with 7890 GC, Centurion autosampler, two Encon Evolution Purge and Trap concentrators.
	4 - Agilent 5973 MSD with 6890 GC, 7683 injector, HP Chemstation and Enviroquant software Semivolatiles.
	1 - Agilent 5975 MSD with GC, 7683B injector, HP Chemstation and Enviroquant software Semivolatiles.

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	1 - Agilent 5973 MSD with 6890 GC, Arcon 8100 autosampler, two EST Encon Purge and Trap concentrators, PT2 switching valve box. 8- Agilent 5973 MSD with 6890 GC, 7683 injector, HP 1- Agilent 5973 MSD with 6850 GC, 7683 injector HP 2- Agilent 5975 MSD with 7890 GC, 7683 injector, HP 6- Agilent 5973 MSD with 68790GG, Encon Evolution Purge and trap concentrator, Centurion Autosampler, Chemstation Enviroquant software. 1- Agilent 5973 M purge and trap concentrator SD with 6890GG, Centurion Autosampler, Encon Evolution purge and trap concentrator. 2- Agilent 5975 MSD, 7890A GC, Centurion Autosampler, Encon Evolution purge and trap concentrator 1- Agilent 5977A MSD, 7890B GC, Centurion Autosampler, Encon Evolution purge and trap concentrator 1- Agilent 7980A GC with OI 4430 PID/FFD Centurion Autosampler, Tekman 300 Purge and Trap Concentrator
Organics HPLC	3 - Hewlett Packard 1090 Series II HPLC with Diode Array Detectors, (DAD), HP programable autosampler, Pickering 8100 Post Column Derivatization unit, and HP Fluorescence Detector. 2- Agilent 100 series with Diode Array Detectors G131SB. G1316A Colum Thermostat, G1312A Binary Pump, G1367A. 2- Agilent 100 series with FLD (1321A) Autosampler (G1313A), column thermostat (G1316a) Quarter Pump (G1311a), Pickering PCX5100, Pickering vector derivatization unit.

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Air Laboratory	1 - Agilent 5975 with 7890 GC and HP Chemstation 1-Agilent 5977A with 7890 GC and HP Chemstation 1 - Entech 7100AR Cryogenic concentrator- cold trap dehydration 1-Entech 7200 Cryogenic concentrator 1-Entech 7650 20 Minican Autosampler with 18 auxiliary positions. 1 - Entech 7500A minican Autosampler with 9 auxillary positions. 2 - Entech 3100A canister cleaner accompanied with Thermoscience oven 1-Thermoscience oven- Entech 3100D canister cleaner accompanied with. 1 - Entech 4600A Dynamic Dilutor 1- Entech 4700 Precision Dilutor
Organics TOC	1 - GE Sievers InnovOx Lab TOC Analyzer with Sievers 900 Autosampler 1 - Tekmar LOTIX TOC Analyzer with 30 position Autosampler 1 - Tekmar Apollo TOC in soil Analyzer
Metals	1 - Spectro Blue 37 Channel Simultaneous Axial Plasma ICP Spectrometer with Autosampler and Smart Analyzer software 1 - Perkin Elmer NexION 350X ICP Mass Spectrometer 2 - Perkin Elmer AAnalyst 600 Atomic Absorption Spectrophotometer (AA) with graphite furnace, Zeeman background & AS 800 Autosampler

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	1 -	PSA Mercury Millennium System with autosampler and mercury cold vapor detector.
Prep Department	2 -	UTC Vacuum Solid Phase Extractor Manifolds
	48-	Liquid/Liquid Extraction Systems
	7 -	Buchi Synacore Concentration Systems with V-855 Vacuum Controllers
	11-	Zymark TurboVap II Automated Sample Concentration Workstations (6 and 24 position)
	2 -	Precision Scientific 8 Position Water Baths
	1 -	Vacuum and Pressure Filtration System, 11 positions
	2 -	Branson DHA1000 Ultrasonic Cleaners
	2 -	VWR 250D Ultrasonic Cleaners
	25-	Millipore Zero Headspace Extraction Chambers
	3 -	Millipore TCLP Rotary Extractors ZHE, 12 positions
	2 -	Multi Position TCLP Rotation Extraction Systems
	8 -	Dionex ASE200 Accelerated Solvent Extractors
	25-	Radley Manual Soxhlet Extractors- 5 position
	1 -	Questron Vulcan 84 AutoBlock Digester
	5 -	Environmental Express HotBlocks Digesters, 54 Position
	1 -	Milestone Ethos UP Microwave Digester
	1 -	IEC Centra-8 Centrifuge
	3 -	Tekmar TM600-2 Dual Horn Sonic Disruptors
	6 -	Mettler PB802S/PB1502S/PB3002 Balances
	1 -	Mettler Analytical AE240 Balance

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	1 - PlasLabs 863-CG Dessicator
	1 - Blue M DC336F Oven
	1 - VWR 1300U Oven
	1 - GCA/Precision Scientific Gravity Convection Oven
	2 - GlasCol 3D Separatory Funnel Shaker, 8 position
	1 - GlasCol 3D Separatory Funnel Shaker, 4 position
Wet Lab	1 - Lachat Quikchem 8000 Dual Channel Wet Chem Autoanalyzer with 360 Position Autosampler.
	2 - Lachat Quikchem 8500 Four Channel Wet Chem Autoanalyzer with 360 Position Autosampler.
	1 - HACH DR5000 Spectrophotometer
	1 - Pall Cascada Ultra Pure DI Water Systems
	2 - YSI 33 Salinity, Conductance, Turbidity Meter
	3 - VWR 2020 BOD Incubators, High Volume
	3 - VWR 2030 BOD Incubators, High Volume
	1 - YSI 52 Oxygen Meter (BOD)
	1 - VWR 8000 pH meter
	4 - Precision Scientific Pensky-Martens Flash Point Testers
	1 - Labline DuoVac 1520 Vacuum Drying Oven
	1 - Beckman ϕ 12 Meter (Fluoride/Chloride)
	1 - Orion 162 Conductivity Meter
	1 - Man-Tech GX271 Liquid Handler (pH, Alkalinity, Conductivity, Turbidity)

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	2 - Mettler XS-104 Analytical Electronic Balance
	1 - Mettler PB5001-5 Analytical Electronic Balance
	3 - LabCrest Midi Distillation Systems, 10 position
	3 - AIM 500 Automated Block Digestors, 28 position
	1 - Dionex DX120 Ion Chromatograph with Autosampler
	1 - Dionex ICS2000 Ion Chromatograph with Autosampler
	2 - Beckman DU640 Spectrophotometer
	1 - Thermolyne 48000 Furnace
	1 - Thermolyne 1300 Furnace
	1 - Hach COD reactor, 25 position
	2 - Horizon SpeedVap II 9000 Solvent Evaporation System
	1 - Hach 2100AN Turbidimeter
	1 - VWR 750HT Ultrasonic Cleaner
	1 - GlasCol 3D Separatory Funnel Shaker, 8 position
	1 - CAI SmartBlock 226 COD Digester, 100 position
	1 - Hydro System Reverse Osmosis 500 gallon water system
Microbiology	1 - Baush & Lomb and Spencer Microscope
	3 - Precision Coliform Incubator Water baths
	2 - VWR Bacteriological Incubators
	1 - Market Forge Sterilmatic Autoclave
	1 - Vacuum Filtration System, 3 position
	1 - Fisher Scientific Isotemp Bacteriological Incubator

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1 - Thermo Scientific Heratherm Bacteriological Incubator

1 - Reihert-Juns Quebec Darkfield Colony Counter

1 - Spectroline EA-160 UV light (366 nm)

1 - American UV Company UV box (254 nm)

2 - IDEXX Quanti-Tray Sealer

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Appendix D SOP-002 LCC Standard Operating Procedures

SOP-002A - Sampling of Water Lines and Tank.

LCC will collect samples per AWWA guidelines.

- Sampling spigot will be attached to the line
- Sampling spigot will be disinfected per AWWA C-651
- The sampling spigot will be flushed with water to remove hypochlorite solution
- A proper sampling container for each analyte will be utilized
  (refer to worksheet 19 and 30 (1) The sample will then be taken with rubber gloves)
- Once the bottle is filled it will be capped and labeled
- The completed sample will be placed into a cooler and the chain of custody sheet will be updated with the sample's information (Sample type, sample number, date and time of collection and signatures of the collector)
- The samples will be transported by vehicle in a cooler to the laboratory by Ludlow Construction personnel, who will fill out the remaining chain of custody form with lab personnel taking custody of samples.
- Chain of custody sheets will be scanned/copied to maintain records to be accessed in the LCC Field Office

Sample Identification Controls

Each sample container shall be clearly identified with the name of the project, the field sample number, date and time of sampling and the name of the sampling personnel. Field information shall be written in indelible ink and the label shall be affixed in such a manner to ensure that is does not become separated from its respective container.

The sample custody procedures will assure that any sample which is analyzed will yield results representative of the sample's condition at the time of sampling. The procedures provided are in conformance with the appropriate EPA guidelines.

The following information will be recorded:

1) Sample type, sample number, date and time of collection and signatures of the collector.
2) Signatures of persons involved in sample chain of custody.
3) Inclusive dates of possession of all individuals involved in sample possession.
4) Additional remarks the sample handler may have to transcribe onto the chain of custody form.
5) Analytical parameters required (name and method number).
6) Name of the project.

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7) Name and telephone number of the point of contact to call for any questions on the sample shipment.

SOP-002B -Testing and Disinfection of Water Mains

All Testing and Disinfection Procedures will be coordinated by LCC's PM, Michael Pio, with the Town of Middletown and the Town of Durham water operators prior to commencement of work.

Pressure Testing will be completed in 1,000 ft. sections per the specifications. The pressure test will be tested at 150% of the existing working pressure or 150 psi., whichever is greatest for a 2- hour duration per AWWA Standards or at the direction of the Town of Middletown and the Town of Durham water operators. Pressure tests will be completed by Ludlow Construction and the results will be forwarded to the Contracting Officer, and the Town of Durham and Middletown Water Operators.

Disinfection of new water mains will follow the American Water Works Association (AWWA) Standard 651 "Disinfecting Water Mains". This section describes the requirements for pressure and leak testing, and disinfection of water mains and appurtenances.

Disinfection method will be "Continuous Feed Method". The injection will be installed at a sampling point at the beginning of the segment to be tested. Chlorine will be injected at a measured rate into the section being disinfected at a dosage rate to maintain at a minimum, 25 mg/L throughout the segment. Water used for disinfection purposes will be supplied by The Town of Middletown Water Department which will be notified in advance. Proper backflow devices will be in place prior to the start of the testing. This chlorinated water will remain in the pipes for disinfection purposes for a 24-hour period per AWWA Standards.

Final Flushing will be completed after the pressure test and disinfection process has been completed. Highly Chlorinated water will be discharged into the existing town drainage systems through a Dichlorination unit, which will remove the high concentrations of chlorine

Bacteriologic Sampling will be done after the final flushing has been completed. Ludlow Construction will collect two sets of samples per AWWA C651, Section 5.1 every 1,200 linear feet of pipeline and deliver to a State of Connecticut Certified Laboratory (Phoenix Environmental Laboratories) within six hours of obtaining Samples. Laboratory tests shall show chlorine residual, after final flushing, of less than 1mg/L for each sample point. Water mains will not be activated until a satisfactory Bacteriological sample has been received and with the approval of the Contracting Officer.

Repetition of Procedure will be completed if initial chlorination process has failed to produce the required residuals and bacteriological tests.

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Durham Meadows Waterline Testing Plan

Water Main Testing Sections

Water main testing sections shall not exceed 2,000 feet in length. Proposed testing segments are indicated in Table 1 below.

Table 1 – Proposed Water Main Testing Sections

Location	Station	Length (feet)	Water Main Size (Inches)	Volume (Gallons)
SECTION A				
South Main Street	51+90 to 52+35 & 100+00 to 119+37	1,982	16	20,700
Main Street at Royal Oak Drive	119+37 to 136+61	1,724	16	18,006
Main Street at Parsons Lane	136+61 to 151+51	1,490	16	15,562
Main Street at Haddam Quarter Road	151+51 to 166+32	1,481	16	15,468
Main Street	166+32 to 183+65	1,733	16	18,100
Main Street at Pickett Lane	183+65 to 204+45	2,080	16	21,724
Main Street at Mill Pond Lane	204+45 to 209+25	480	16	5,013
SECTION B				
Talcott Ridge Drive and Watch Hill Drive	35+74 to 51+90 600+00 to 604+31 605+00 to 607+12	1,616 431 212	16 8 8	18,557
Talcott Ridge Drive	31+84 to 35+74 30+00 to 31+84 10+79 to 23+26 10+30 to 10+79	390 184 1,247 49	16 20 20 16	27,937
SECTION C				
Maple Avenue	900+00 to 920+65	2,065	12	12,131
Wallingford Road	600+00 to 606+87 606+87 to 609+46	687 259	12 8	4,712
Maple Avenue	920+80 to 940+88	2,008	8	5,243
Talcott Lane	300+00 to 306+13	613	8	1,601
SECTION D				
Maiden Lane	400+00 to 410+47	1,047	12	6,151
Maiden Lane	410+47 to 426+03	1,556	12	9,141
Pickett Lane	500+00 to 509+21	921	12	5,411
Pickett Lane	509+21 to 530+90	2,169	12	12,742
Pickett Lane	530+90 to 538+51	761	12	4,471

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Water Main Testing Procedures

Water main testing will conform to the requirements of the Contract, AWWA C651 – Disinfecting Water Mains, AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances, and the requirements of the City of Middletown and the Town of Durham. Chemicals used in the disinfection process will be certified to NSF Standard 60. Each section of water main will be tested in accordance with the procedure described in Table 2 below.

Table 2 – Water Main Testing Procedure

Steps	Description
1.	Insure water main section is ready for testing with isolation valves and appurtenances in the correct positions.
2.	Install corporation stops as needed for air release, chlorine injection, sampling, and hydrostatic testing. Water service corporation stops may be utilized if located in appropriate locations. Corporation stops only used for testing will be closed and capped and noted on the as-built record drawings.
3.	Make arrangements with City of Middletown for existing valve and water supply operations.
4.	Slowly fill water main section to be tested and expel all air.
5.	Preliminarily flush the water main to remove any particulate matter.
6.	Inject liquid sodium hypochlorite using potable water to attain a 25 mg/l concentration in the entire main and let sit for a minimum period of 24 hours in accordance with AWWA C651, 4.4. Free chlorine shall be measured at the downstream end of the section being disinfected to insure adequate chlorine residual is achieved.
7.	After 24 hour period test to make sure chlorine residual is not less than 10 mg/l prior to sampling. If residual is too low repeat chlorination step.
8.	Collect water quality samples for testing by an independent laboratory approved by the Connecticut Department of Public Health. Samples to be tested for compliance with the water quality standards listed in Table 3 below. Hydrants will not be used for sample collection.
9.	If water quality samples do not meet requirements, flush, repeat disinfection procedure, and retest.
10.	Flush water main to remove highly chlorinated water and dechlorinate water prior to release to the environment. Monitor chlorine residual in water discharge to confirm dechlorination effectiveness. Do not let highly chlorinated water to remain in the water main any longer than necessary.
11.	Utilizing sterile potable water perform a hydrostatic pressure test on the completed water main. Insure that all air has been removed from the section of pipe being tested prior to beginning testing. All testing equipment will be disinfected prior to use.
12.	Test pressure shall be 150 psi for a period of 2 hours. Pressure during testing shall not vary more than 5 psi from the initial test pressure. Test pressure shall be maintained by adding makeup water through a metered pressure test pump. The volume of makeup water added to maintain the test pressure shall not exceed the testing allowance specified in Table 5A of AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances (copy attached).
13.	After successfully passing the disinfection and hydrostatic testing perform a final water system flushing, collect a representative water sample, and analyze at a CT DPH approved independent laboratory for compliance with the water quality standards contained in Table 3. If water quality meets the applicable standards, and if approved by the City of Middletown or the Town of Durham, as applicable, place the water main into active service.

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Table 3 – Water Quality Testing Standards	
Parameter	**Standard**
Total Coliform Bacteria	0 or absent
HPC	Less than 100 organisms/mL
Total Chlorine Residual	
Free Chlorine Residual	
Color	Less than 15 CU
Turbidity	Less than 5 NTU
Odor	Less than 2
pH	Range 6.4 – 10
Source: CT DPH Water Works Design and Construction Guidelines	

Water Tank Testing

Water tank will be tested in accordance with the Contract and AWWA C652 – Disinfection of Water-Storage Facilities, Chlorination Method 3. Chemicals used in the disinfection process will be certified to NSF Standard 60. Tank sub-contractor will provide a step by step procedure for tank testing and disinfection.

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Table 5A Hydrostatic testing allowance per 1,000 ft of pipeline*—gph†

Average Test Pressure, *psi*	Nominal Pipe Diameter, *in.*																	
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	0.43	0.57	0.86	1.15	1.43	1.72	2.01	2.29	2.58	2.87	3.44	4.30	5.16	6.02	6.88	7.74	8.60	9.17
400	0.41	0.54	0.81	1.08	1.35	1.62	1.89	2.16	2.43	2.70	3.24	4.05	4.86	5.68	6.49	7.30	8.11	8.65
350	0.38	0.51	0.76	1.01	1.26	1.52	1.77	2.02	2.28	2.53	3.03	3.79	4.55	5.31	6.07	6.83	7.58	8.09
300	0.35	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81	3.51	4.21	4.92	5.62	6.32	7.02	7.49
275	0.34	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69	3.36	4.03	4.71	5.38	6.05	6.72	7.17
250	0.32	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21	3.85	4.49	5.13	5.77	6.41	6.84
225	0.30	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04	3.65	4.26	4.86	5.47	6.08	6.49
200	0.29	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87	3.44	4.01	4.59	5.16	5.73	6.12
175	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68	3.22	3.75	4.29	4.83	5.36	5.72
150	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48	2.98	3.48	3.97	4.47	4.97	5.30
125	0.23	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27	2.72	3.17	3.63	4.08	4.53	4.83
100	0.20	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03	2.43	2.84	3.24	3.65	4.05	4.32

* If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.
† Calculated on the basis of Eq 1.

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SOP-002C - Hydrostatic Test SOP

Hydrostatic Test Pump

Designed For:

- Underground waterlines
- Industrial piping
- Oil & gas lines
- Steam lines
- Fire hoses
- Sprinkler systems

Features:

- Honda GX 160 5.5 HP engine with oil alert
- Corrosion resistant double diaphragm pump
- 9.5 G.P.M. maximum (550 max pressure)
- Stainless steel roll cage with pneumatic vibration isolation
- 15' high pressure hose with quik connects
- Complete with 6' suction hose (3/4" diameter) with strainer, and 6' return line
- 0-1000 liquid filled gauge on pump
- 0-300 liquid filled gauge on test set-up
- High pressure test set-up with stainless steel ball valves
- Dry weight : approx. 100 lbs.
- Dimensions: (l x w x h) 36x22x29

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SOP-002D - Water Tank Disinfection

City of Middletown Water and Sewer Department will collect all water quality sample with Contractor assistance and will perform all required water quality testing LCC shall provide at least 72 hours advance notice for scheduling testing.

Leakage testing shall be carried out in accordance with AWWA D110 and ACI 350.1 prior to tank backfilling. Tank shall not be backfilled until it has successfully passed leakage testing.

3.09 TANK DISINFECTION:

A. Disinfect tank and connecting piping with chlorine not sooner than seven days after completion all work but before tank is placed in operation. City of Middletown Water and Sewer Department will furnish water for disinfection and testing. Contractor shall furnish all labor, chlorinating agent, hoses and water-injecting apparatus for delivering Prestressed Concrete Tanks Durham Meadows Waterline RD Section No. 13225-32 chlorine-bearing water into the tank and for the satisfactory completion of tank disinfection.
B. Method of tank disinfection shall conform to AWWA C652, Chlorination method 3, and to the requirements of the City of Middletown Water and Sewer Department, except as otherwise specified herein. Chemicals used in the disinfection process shall comply with NSF/ANSI 60.
C. Close the valve nearest to the tank. Thoroughly hose down the interior of the tank with water containing 50 ppm chlorine content. Solution shall be pumped into the tank to a depth that when the remainder of the tank is filled with water the resulting chlorine content will be 2 ppm. The 50 ppm solution shall be held in the tank for 6 hours prior to the addition of water to fill tank. The 2 ppm solution shall be held in the tank for 24 hours at which point the tank shall be placed directly into service without draining the tank provided that the piping downstream of nearest valve has been properly disinfected.
D. City of Middletown Water and Sewer Department will collect all water quality samples with Contractor assistance and will perform all required water quality testing. Contractor shall provide at least 72 hours advance notice for scheduling testing.
E. Contractor shall not place any portion of the tank in service unless authorized by the City of Middletown Water and Sewer Department.

SOP-002E – Field Analysis Chlorine and PH

During sampling, disinfection and testing of the water lines and tanks Ludlow will conduct field analysis to verify chlorine and PH levels. LCC will utilize PH testing strips and Chlorine testing kits.

Disinfection of water lines and water tanks.

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When the waterlines are to be disinfected LCC will add chlorine to the line or tank. Samples will be drawn per the sampling SOP-002a. To verify appropriate chlorine levels, LCC will utilize chlorine testing kits to measure the ppm of chlorine.

Flushing and Testing

After disinfection, LCC will flush the lines and tanks and remeasure the chlorine levels utilizing the chlorine testing kit to verify chlorine levels have been reduced to acceptable levels.

Once the line or tank has been flushed the PH will be measured. LCC will utilize PH testing strips in the field to verify PH levels.

Results of field tests will be recorded in the field logbook and submitted to the Government.

Calibration of field Equipment

LCC will not be utilizing equipment requiring calibration to test for PH or Chlorine levels. Inspections of testing kits and supplies will be inspected for correct sensitivity and undamaged. Sampling and testing procedures laid out in SOP-002a and SOP-022b will be followed.