FINAL

United States Army Corps of Engineers
New England District

Area 3 Phase II Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances – Stage 1

Operable Units 8 and 14

Former Fort Devens Army Installation

Devens, Massachusetts

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Acronyms and Abbreviations

>	greater than
<	less than
µg/kg	microgram per kilogram
ABB-ES	ABB Environmental Services Inc.
AFFF	aqueous film-forming foam
ANL	Argonne National Laboratory
AOC	area of contamination
Arcadis	Arcadis U.S., Inc.
Army	United States Army
BERS-Weston	BERS-Weston Services JVA, LLC
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMR	Code of Massachusetts Regulations
CSF	cancer slope factor
CSM	conceptual site model
Devens	former Fort Devens Army Installation
DoD	Department of Defense
DOE	Department of Energy
DQO	data quality objective
DRFTA	Devens Reserve Forces Training Area
EPC	exposure point concentration
ESV	ecological screening value
FTA	Firefighting Training Area
GZA	GZA GeoEnvironmental, Inc.
HFPO-DA	hexafluoropropylene oxide dimer acid (GenX)
HHRA	human health risk assessment
HLA	Harding Lawson Associates
ID	identification
ITRC	Interstate Technology and Regulatory Council
KGS	KOMAN Government Solutions, LLC
KOC	organic carbon-water partition coefficient
LHA	lifetime health advisory
LOD	limit of detection
LTM	long-term monitoring

219	MAAF	Moore Army Airfield
220	MassDEP	Massachusetts Department of Environmental Protection
221	MassDevelopment	Massachusetts Development and Finance Agency
222	MCP	Massachusetts Contingency Plan
223	MEK	methyl ethyl ketone
224	mgd	million gallons per day
225	MMCL	Massachusetts maximum contaminant level
226	MW (BR)	bedrock monitoring well
227	MW (OB)	overburden monitoring well
228	NAVD88	North American Vertical Datum of 1988
229	NCP	National Oil and Hazardous Substances Pollution Contingency Plan
230	ng/L	nanogram per liter
231	NPL	National Priorities List
232	NRWA	Nashua River Watershed Association
233	OU	Operable Unit
234	PA	preliminary assessment
235	PCE	tetrachloroethene
236	PFAA	perfluoroalkyl acid
237	PFAS	per- and polyfluoroalkyl substances
238 239	PFAS6	perfluorooctanesulfonic acid, perfluorooctanoic acid, perfluorononanoic acid, perfluorohexanesulfonic acid, perfluoroheptanoic acid, and perfluorodecanoic acid
240	PFBA	perfluorobutanoic acid
241	PFBS	perfluorobutanesulfonic acid
242	PFDA	perfluorodecanoic acid
243	PFHpA	perfluoroheptanoic acid
244	PFHxA	perfluorohexanoic acid
245	PFHxS	perfluorohexanesulfonic acid
246	PFNA	perfluorononanoic acid
247	PFOA	perfluorooctanoic acid
248	PFOS	perfluorooctanesulfonate or perfluorooctanesulfonic acid
249	PFPrA	perfluoropropanoic acid
250	ppt	part per trillion
251	PSCS	preliminary site characterization summary
252	QAPP	Quality Assurance Project Plan
253	RI	remedial investigation
254	RSL	regional screening level
255	S-A JV	SERES-Arcadis Joint Venture, LLC

256	SA	study area
257	SI	site inspection
258	SLERA	screening-level ecological risk assessment
259	SSSL	site-specific screening level
260	TBD	to be determined
261	TFSI	bis(trifluoromethylsulfonyl)amine
262	TGI	technical guidance instruction
263	U.S.	United States
264	U.S.C.	United States Code
265	USACE	United States Army Corps of Engineers
266	USEPA	United States Environmental Protection Agency
267	USFWS	United States Fish & Wildlife Service
268	VAP	vertical aquifer profile
269	VHB	Vanasse Hangen Brustlin, Inc.
270	WP	work plan
271	WWTP	wastewater treatment plant

1 Introduction

The SERES-Arcadis Joint Venture, LLC (hereafter referred to as the S-A JV),[1] has prepared this Area 3 Phase II Remedial Investigation (RI) Work Plan (WP) for Per- and Polyfluoroalkyl Substances (PFAS) – Stage 1 on behalf of the United States (U.S.) Army Corps of Engineers (USACE) to conduct a Comprehensive Environmental Response, Compensation, and Liability Act- (CERCLA-) compliant RI for Area 3 at the former Fort Devens Army Installation (Devens) located in Devens, Massachusetts (**Figure 1-1**).

The U.S. Army (Army) Base Realignment and Closure (BRAC) Office is responsible for addressing potential contamination at former active Army installations that is the direct result of historical Army activities. Site identification, investigations, and any potential environmental remedies are in compliance with CERCLA (42 U.S. Code [U.S.C.] §§9601 et. seq.), the Defense Environmental Restoration Program (10 U.S.C. §2701 et. seq.), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 Code of Federal Regulations Part 300). This work is being conducted in accordance with the U.S. Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA 1988). The investigation activities will be conducted in accordance with procedures outlined in the Area 3 PFAS Uniform Federal Policy for Quality Assurance Project Plan (QAPP) included as **Appendix A**.

This Phase II RI WP details the next stage of the Area 3 RI. Results from the most recent investigation are presented in the Area 3 Preliminary Site Characterization Summary (PSCS; KOMAN Government Solutions, LLC [KGS] 2021). Data from the Area 3 PSCS are presented in **Appendix B**. RI work summarized in the Area 3 PSCS is referred to herein as having occurred during "Phase I" of the RI.

The majority of PFAS detected in Area 3 during Phase I of the RI have been attributed to release(s) of aqueous film-forming foam (AFFF) to the environment. AFFF was developed in the mid-1960s in response to a need for a firefighting foam better suited to extinguish Class B fuel-based fires (i.e., flammable liquid fires [Occupational Safety and Health Administration 1910.155(c)(9)]) and was used by both military and civilian firefighters. AFFF formulations consist of water, an organic solvent, up to 5% hydrocarbon surfactants, and 1 to 3% PFAS (Interstate Technology and Regulatory Council [ITRC] 2020a). Perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were the predominant PFAS in AFFF historically. The AFFF concentrates are designed to be diluted with water to become a 1, 3, or 6% foam.

Area 3 is comprised of Operable Units (OUs) 8 (Former Moore Army Airfield) and 14 (Basewide PFAS), and includes the following AOCs where PFAS has previously been detected:

- Wastewater Treatment Plant Sand Infiltration Beds (AOC 20);
- Wastewater Treatment Plant Sludge Drying Beds (AOC 21);
- Drum Storage Area (AOC 30);
- Firefighting Training Area (FTA; AOC 31); and
- Former Moore Army Airfield (MAAF; AOC 50).

[1] The S-A JV is composed of protégé firm SERES Engineering & Services, LLC, and its mentor, Arcadis U.S., Inc. (Arcadis).

1.1 Phase II Remedial Investigation Objectives

The Area 3 Phase II investigation will be performed in two stages (Stages 1 and 2). This WP includes the methodology and proposed plan to execute the first stage of the Phase II investigation.

1.1.1 Stage 1

The objectives of Stage 1 are:

1. Characterize the areas greatest concentrations of PFAS at Area 3 to assess maximum exposure point concentrations (EPCs) in the impacted media;
2. Evaluate if PFAS in groundwater is migrating off-site; and
3. Identify/confirm potential on-site and off-site exposure pathways for PFAS.

The following activities will be conducted to achieve these objectives:

- Installation and sampling of monitoring wells at the two locations in the overburden aquifer where the greatest concentrations of PFAS have been detected in vertical aquifer profiles (VAPs);
- Installation and sampling of a bedrock monitoring well beneath, and immediately downgradient of, the area where the greatest concentrations of PFAS are detected in overburden groundwater;
- VAP sampling in off-site areas to evaluate PFAS concentrations in groundwater;
- Overburden and bedrock monitoring well installation (based on the results of VAP sampling) and sampling in off-site areas to confirm PFAS concentrations;
- Evaluation of groundwater flow direction through synoptic water level measurement in all existing and newly installed monitoring wells;
- Surface water sampling to evaluate PFAS concentrations in the Nashua River that may be attributed to releases that occurred in Area 3; and
- Soil sampling in areas around the former MAAF fire station upgradient of where the greatest concentrations of PFAS have been detected in overburden groundwater.

These data will refine and expand the identification of exposure pathways, including potential connections between existing AOCs and off-site drinking water resources; evaluate potential impacts to the Nashua River; and will contribute to the assessment of risk to human and ecological receptors from PFAS in Area 3.

1.1.2 Stage 2

Stage 2 of the Phase II PFAS RI will be scoped using the data collected from Stage 1 to complete the evaluation of the nature and extent of PFAS associated with Area 3 in soil, groundwater, and surface water, and to complete the collection of data required to evaluate the risk to human health and the environment.

1.2 Site Background

The following sections present site descriptions and historical information on Devens and the AOCs included in Area 3.

1.2.1 Site Location and Historical Information

Devens is located in the Towns of Ayer and Shirley in Middlesex County, and the Towns of Harvard and Lancaster in Worcester County, Massachusetts, approximately 35 miles northwest of Boston, Massachusetts (**Figure 1-1**). The former installation occupied approximately 9,260 acres and was divided into the North Post, Main Post, and South Post. Route 2 divides the South Post from the Main Post. The Nashua River runs through the North, Main, and South Posts. The area surrounding the former installation primarily consists of rural residential properties. Portions of Devens have been redeveloped for commercial/industrial use. Several of the surrounding areas and portions of Devens are undeveloped and consist of hardwood vegetated uplands, riparian corridors, old fields, wet meadows, emergent and forested wetlands, and open waters.

Camp Devens was established in 1917 as a temporary training area for soldiers during World War I. In 1932, the site was named Fort Devens and made a permanent installation with the primary mission of commanding, training, and providing logistical support for non-divisional troop units. Fort Devens was used for a variety of training missions between 1917 and 1990. Pursuant to the CERCLA, Fort Devens was placed on the National Priorities List (NPL) on November 21, 1989, due to environmental contamination at several portions of the installation.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense BRAC Act of 1990, and was officially closed in March 1996. The Reuse Plan for Devens (Vanasse Hangen Brustlin, Inc. [VHB] 1994) identifies major reuse themes for Devens. The current and foreseeable future land use for the AOCs within Area 3 as identified in the Devens Reuse Plan (VHB 1994) are Environmental Business and Open Space/Recreation for AOCs at the wastewater treatment plan (WWTP; AOCs 20 and 21) and Special Use II for AOCs associated with MAAF (AOCs 30, 31, and 50). Special Use II includes a broad range of industrial, light industrial, office, and research and development use. Land use is discussed in more detail in **Section 2.3.1**.

As part of the Devens BRAC Program, the Army retained portions of the property formerly occupied by Fort Devens for reserve forces training and renamed the area the Devens Reserve Forces Training Area (DRFTA). Areas not retained as part of the DRFTA were transferred to new owners (the Massachusetts Development and Finance Agency [MassDevelopment], U.S. Department of Labor, U.S. Department of Justice, and the U.S. Fish & Wildlife Service [USFWS]) for reuse and redevelopment. In 2009, the DRFTA was renamed the U.S. Army Garrison Fort Devens.

As described above, Area 3 and the former North Post include several AOCs where PFAS nature and extent is being investigated:

- WWTP Sand Infiltration Beds (AOC 20);
- WWTP Sludge Drying Beds (AOC 21);
- Drum Storage Area (AOC 30);
- FTA (AOC 31); and
- Former MAAF (AOC 50).

1.2.1.1 Wastewater Treatment Plant (AOC 20 and AOC 21)

The Devens WWTP is situated in the former North Post area of Devens, southwest of the Nashua River and former MAAF (**Figures 1-1** and **1-2**). The WWTP was constructed by the Army in 1942 and is still in operation by MassDevelopment. The site consists of structures to support wastewater treatment including 18 rapid infiltration beds, three Imhoff tanks (settling tanks and sludge digestors), a dosing tank, and a support building.

The WWTP has a design capacity of 3.0 million gallons per day (mgd) and is currently operated under a MassDEP groundwater discharge permit. While Devens was active, the average daily flow was approximately 1.3 mgd, with less than 1 percent of the flow from industrial sources, including vehicle wash rack discharge, caustic radiator wash water, floor drains, heating plant boiler blowdown, and swimming pool filter backwash (ANL 1992; KGS 2017).

Wastewater is carried to the main pumping station via a gravity-flow sanitary sewer and several small pump stations. At the main pumping station, the wastewater is pretreated by passing through a bar screen, grit chamber, and comminutor. The wastewater is then pumped to three parallel Imhoff tanks. The primary effluent from the Imhoff tanks discharges into a dosing tank, which intermittently applies wastewater to the rapid infiltration beds (originally 22 beds, 0.8 acre each). The rapid infiltration beds are used in rotation. The original application cycle involved discharge to nine basins for 9 days, to another seven basins for 7 days, and to the remaining six basins for 6 days. The application rate for each rapid infiltration bed was calculated to be about 25 to 28 meters per year (ANL 1992). Sludge from the Imhoff tanks is drained to four uncovered sludge drying beds two to three times annually. The sludge drying beds are equipped with 4-, 8-, and 10-inch clay pipe underdrains to collect supernatant. Before 1985, the supernatant was discharged to an adjacent wetland area located on the east bank of the Nashua River. After 1985, supernatant was collected and pumped back into an infiltration basin. The 1992 Devens Master Environmental Plan (ANL 1992) noted that because the pipes had collapsed over the years and the sludge drying beds are located on the kame deposit it was likely that most of the supernatant infiltrated the permeable subsurface. Prior to 1993, dried sludge, typically about 70 percent solids, from the sludge drying beds was removed and applied to the land at the former MAAF per the requirements of a state Class III Sludge application permit. Land application of dried sludge from the sludge drying beds at the former MAAF is no longer conducted (ANL 1992).

The WWTP was upgraded to provide advanced treatment (secondary treatment, nitrogen removal, and disinfection) through sequence batch reactors and ultraviolet disinfections (Nashua River Watershed Association [NRWA] 2008). The upgraded WWTP has been in operation since September 2001 and treats less than 1 mgd of wastewater from Devens and the Massachusetts Correctional Institution in Shirley. The treated effluent is currently discharged to the groundwater via 18 rapid infiltration beds (NRWA 2008).

Three components of the WWTP were initially identified for PFAS investigation as SAs: Imhoff tanks (SA 19), rapid infiltration beds (SA 20), and sludge drying beds (SA 21). Based on results of a site inspection (SI) conducted in 2017, SAs 20 and 21 were subsequently reclassified as AOCs (BERS-Weston Services, JVA, LLC [BERS-Weston] 2018b).

1.2.1.2 Drum Storage Area (AOC 30)

The former MAAF Drum Storage Area comprises two locations (labeled Area “A” and Area “B” for the PFAS RI) located north of the main airfield runway at the MAAF (**Figure 1-2**). The western pad (Area A) is constructed of asphalt and measures approximately 80 feet by 65 feet. The eastern pad (Area B) is located approximately 440 feet east of Pad A, and approximately 445 feet northwest of the former MAAF fire station. The Area B pad is

constructed of concrete. The former Drum Storage Area was an outdoor satellite accumulation point for storage of containerized hazardous waste for 90 days or less. Pallets with space for 10 to 15 55-gallon drums were positioned at the end of the aircraft defueling area. This area was used to store materials such as alkaline cleaners, methyl ethyl ketone, contaminated JP-4 jet fuel, and paint thinners. In addition to hazardous waste, 55-gallon drums of AFFF concentrate were also stored in the Drum Storage Area (KGS 2017).

In 1990, Fort Devens constructed a prefabricated 90-day storage area at another location, and the Drum Storage Area was no longer used (KGS 2017).

The former Drum Storage Area, as part of the former MAAF, is currently leased by the Massachusetts State Police, and police vehicles are stored on the pad. A radio tower is located immediately to the west (**Figure 1-2**).

1.2.1.3 Firefighting Training Area (AOC 31)

The former Firefighting Training Area (FTA) is located at the west end of the east/west trending runway (**Figure 1-2**). The former FTA consisted of a 100-foot by 100-foot asphalt covered concrete pad approximately 8-inches thick surrounded by a 12-inch-high by 24-inch-wide earthen containment berm (ANL 1992) (**Figure 1-2**).

Approximately once a year between 1975 and 1986, as part of fire training exercises, an abandoned shell of a U-8 airplane was placed on the bermed FTA pad, doused with contaminated fuel and paint thinner (ANL 1992), and open-burned (ABB Environmental Services Inc. [ABB-ES] 1993). Other reported disposal activities included burning of fuel samples from a laboratory approximately once per year (KGS 2017). AFFF was historically used during the fire training exercises. Fire suppression foams were mixed with water, placed in a pump tank, and then transported to the training area for use (KGS 2017).

The former FTA, as part of the former MAAF, is currently leased by the Massachusetts State Police. The area is not currently used and contains small brush and broken up concrete and asphalt (KGS 2021).

1.2.1.4 Former Moore Army Airfield (AOC 50)

The former MAAF is located in the former North Post area of Devens, northeast of the Devens WWTP (**Figure 1-2**). The main portion of the former MAAF consisted of two fixed-wing runways, two rotary-wing runways, a parking area for 15 rotary-wing aircraft, and aircraft hangars (Buildings 3813 and 3818). The AOC is roughly bound by a railroad to the east and by Fitchburg Road to the north and northeast. The Nashua River wraps around the AOC in the north and west, with the WWTP (AOCs 20/21) on the west side of the Nashua River. Bishop Road extends along the south side of the MAAF (**Figure 1-2**). The northern part of the former MAAF, south and west of Route 2A/Fitchburg Road, was used for the maintenance, including a fueling system, and storage of parachutes.

All but approximately 14 acres of the former MAAF (approximately 246 acres total) were transferred to MassDevelopment for reuse in 1997. The Devens Army Installation retained approximately 9 acres of the former airfield for vehicle storage and maintenance around the hangars, and approximately 4 acres in and around the AOC 50 source area for tetrachloroethene (PCE) remediation activities. The hangars are not occupied.

Currently, the airfield is closed to aircraft traffic and is used by the Massachusetts State Police for training purposes and vehicle storage. The USFWS owns undeveloped land south and west of the former airfield. The area is zoned Open Space/Recreation.

The Merrimack Warehouse Realty Co., Inc., owns the area north of Rt. 2A. The property is zoned commercial and is developed with a building used for the manufacture of windshield washer fluid and as a storage facility. A fire

pond/detention basin is located on the property and would be used for fire suppression source water in the event of a fire.

For the PFAS RI field program, AOC 50 consists of the entire former MAAF including the PCE source area, the former MAAF fire station, Hangar Buildings 3818 and 3813, and the airfield. The other PFAS AOCs associated with the former MAAF (AOC 30 and AOC 31) are discussed separately. These locations are indicated on **Figure 1-2**.

- **PCE Source Area** – There was no documented use or storage of AFFF at the AOC 50 PCE plume source area identified during the PA (KGS 2017) or SI (BERS-Weston 2018b).
- **Former MAAF Fire Station** – AFFF concentrate was reportedly stored in 5-gallon pails and within firefighting equipment at the former MAAF fire station (KGS 2019).
- **Hangar Buildings 3818 and 3813** – There is no documentation of AFFF being used in the fire suppression systems at the former hangar buildings (Buildings 3813 and 3818). However, AFFF may have been stored in the former hangar area during the operational period of the airfield (KGS 2017).
- **Airfield Fueling** – Due to the age of the fueling systems associated with AOC 50 (discontinued after the late 1940s), AFFF was not used for fire suppression (KGS 2017).
- **Airfield Crash Training** – The main airfield runway may have been foamed with either AFFF or "training foam" during firefighting and crash training (KGS 2017).

1.2.2 Regulatory Framework

Activities completed under this Phase II RI WP are subject to and will be consistent with CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (42 U.S.C. § 9601 et seq.), and the NCP requirements, with regulatory coordination from MassDEP and the USEPA.

On October 2, 2020, MassDEP promulgated final regulations in 310 Code of Massachusetts Regulations (CMR) 22.00, establishing a Massachusetts maximum contaminant level (MMCL) for PFAS6 concentrations in drinking water (Massachusetts Contingency Plan [MCP] groundwater category GW-1). The MMCL has been used to review existing groundwater data and to inform the scope of work in this Phase II RI WP.

In 2018, USEPA Region 1 provided site-specific screening levels (SSSLs) for human contact with PFOS, PFOA, and PFBS via groundwater, soil, surface water, and sediment exposure pathways (USEPA Region 1 2018). The SSSLs were calculated using the USEPA Regional Screening Level (RSL) Calculator (USEPA 2024b). In 2022, USEPA Region 1 updated the Devens SSSLs for PFOS, PFOA, and PFBS, and included SSSLs for PFNA, PFHxS, and HFPO-DA (USEPA Region 1 2022). The most recent update to the SSSLs, provided on June 13, 2023, was based on May 2023 RSLs, and included SSSLs for PFBA and PFHxA (USEPA Region 1 2023).

Tables 1-1a and 1-1b summarize the screening levels that will be used to evaluate the Area 3 Phase II PFAS RI data. In accordance with DoD (2025) guidance, Area 3 Phase II PFAS RI soil and groundwater data will be screened against current RSLs for PFAS that have DoD-approved toxicity values. As of January 2025, the PFAS with DoD-approved toxicity values and RSLs are PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, PFBA, PFDA, HFPO-DA, PFPrA, and TFSI (DoD 2025).

Area 3 Phase II PFAS RI surface water and sediment data will be screened against the SSSLs for recreational adult or child for PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, PFBA, PFDA, HFPO-DA, PFPrA, and TFSI (USEPA Region 1 2023, updated with the USEPA RSL calculator using toxicity values for the PFAS included on

the ASD website (DoD 2025). USEPA Region 1 June 2023 SSSLs and supporting documentation for updates of the SSSLs are included in **Appendix C**. The most conservative (recreator child-based) SSSLs for surface water and sediment have been used to develop the scope of work in this Phase II RI WP.

As noted on the DoD PFAS website (DoD 2024), HFPO-DA was manufactured and used after 1995, after Fort Devens ceased operations. However, HFPO-DA data (if detected) will be screened against the corresponding RSL for informational purposes.

1.2.3 Previous Investigations

Multiple investigations related to PFAS have been conducted at Devens since 2016, as described below. As mentioned above, Area 3 encompasses the former North Post area of Devens and includes the following PFAS AOCs:

- WWTP Sand Infiltration Beds (AOC 20);
- WWTP Sludge Drying Beds (AOC 21);
- Drum Storage Area (AOC 30);
- FTA (AOC 31); and
- Former MAAF (AOC 50).

Exhibit 1-1 below indicates which sites at Devens were included in the previous PFAS investigations and the sites included in each of the three Areas of ongoing and future PFAS investigations. In addition, documents summarizing previous investigation activities and sampling results are publicly available at https://www.nae.usace.army.mil/missions/projects-topics/former-fort-devens-environmental-cleanup/, as well as at the Town of Ayer library.

Exhibit 1-1. Devens PFAS Investigations by Site

Area of Post	Area of Contamination (AOC) / Site Name	Devens Areas Investigated for PFAS								
		2016 PA	2017 SI	2017 – 2018 LTM Well Monitoring	2018 to 2020 RI (Phase I)			Phase II Sites		
					Area 1	Area 2	Area 3	Area 1	Area 2	Area 3
North	AOC 50 Former Moore Army Airfield (MAAF)	x	x	x			x			x
	AOC 30 MAAF Drum Storage Area	SA30	AOC 30				x			x
	AOC 31 MAAF Firefighting Training Area (FTA)	SA31	AOC 31				x			x
	SA19 Wastewater Treatment Plant (WWTP) Imhoff Settling Tanks	x	No further investigation warranted							
	AOC 20 WWTP Sand Filter Beds	SA20	AOC 20				x			x
	AOC 21 WWTP Sludge Drying Beds	SA21	AOC 21				x			x
South	AOC 25/26/27/28 Former Ranges	x	No further investigation warranted							
	AOC 46 Former Training Area 6D	x	No further investigation warranted							
Main	SA54 Building 2680	x	No further investigation warranted							
	AOC 5 Shepley's Hill Landfill	x	x	x		x			x	
	AOC 32 Former Defense Reutilization and Marketing Office	x	x	x		x			x	
	AOC 43A - Petroleum, Oil, Lubricants Storage Area			x		x			x	
	AOC 43G Historical Gas Station G			x		x		x		
	AOC 43J Historical Gas Station J			x		x		x		
	AOC 40 Cold Spring Brook Landfill					x		x		
	AOC 57 Former Vehicle Storage and Motor Repair Shops Site			x	x			x		
	AOC 74 Barnum Road Firefighting Exercise Site	SA74	AOC 74		x			x		
	AOC 75 Former Building T-1445 Warehouse Fire	SA75	AOC 75		x			x		
	AOC 76 Devens Fire Station	SA76	AOC 76			x			x	
Supply Wells	MacPherson Water Supply Well	x				x			x	
	Grove Pond Wellfield				x			x		
	Patton Water Supply Well					x		x		
	Shabokin Water Supply Well					x		x		

Notes: Orange-shaded sites are included in this Phase II RI WP.
LTM = long-term monitoring
PA = preliminary assessment
PFAS = per- and polyfluoroalkyl substances
RI = remedial investigation
SI = site inspection
x = included in investigation

1.2.3.1 Preliminary Assessment

Investigations related to PFAS at Devens began in 2016 with a base-wide PA (KGS 2017) to determine if there were potential historical releases of PFAS associated with the former installation. The potential PFAS sources at Devens were evaluated using all available documents, interviews with current and former Devens workers, available sampling data, and findings from environmental database searches. The base-wide assessment determined that potential sources of PFAS were limited to areas of the former North Post, South Post, and Main Post where AFFF may have been used, stored, or disposed, and that these areas warranted further investigation (KGS 2017).

1.2.3.1 Site Inspection

The Army conducted an SI in 2017 to determine the presence or absence of PFAS in soil, groundwater, and/or sediment and surface water at sites identified in the PA (BERS-Weston 2018b). The SI activities for Area 3 are listed below:

- At AOC 20 and AOC 21, three components of the WWTP were initially identified for PFAS investigation: Imhoff tanks (SA 19), rapid infiltration beds (SA 20), and sludge drying beds (SA 21). Because treated wastewater is applied to infiltration beds (SA 20), and sludge from the wastewater treatment process is managed in sludge drying beds (SA 21), sample locations for the SI were selected to assess PFAS impacts to soil and groundwater from potential infiltration of PFAS-impacted process water into groundwater.
- At AOC 30, soil and groundwater sampling were conducted at select locations within and downgradient of the former Drum Storage Area. Soil and groundwater samples were collected to evaluate potential PFAS impacts caused by the storage of AFFF concentrate in this area.
- At AOC 31, soil and groundwater sample locations were selected to evaluate potential PFAS impacts to soil and groundwater due to AFFF application in this area.
- At AOC 50, soil and groundwater samples were collected in areas where former PFAS storage or use were suspected (i.e., former MAAF fire station area and runways/taxiways where AFFF may have been deployed) and at stormwater outfalls that may have directed PFAS-impacted surface runoff to areas adjacent to the former airfield. Sampling was also planned at the terminus of former stormwater outfalls where PFAS-impacted surface water may have been formerly directed (BERS-Weston 2018b).

The results of the SI confirmed the presence of PFAS at each of the Area 3 AOCs. The SI groundwater results indicated that all sites investigated had groundwater that exceeded the LHA of 70 nanograms per liter (ng/L) in place at that time. In soil, the highest concentrations of PFAS detected were at the former MAAF sites SA 30 and 31, which included the bermed area where firefighting training was conducted. The SI noted that soil containing PFAS could continue to be a source for groundwater impacts. PFOA and PFOS were detected in sediment and surface samples at stormwater outfalls discharging from MAAF. Based on the SI findings, an RI was recommended to further delineate the nature and extent of PFAS contamination. The SI also recommended that, given that the former airfield impacts are widespread from multiple release sites, the impacts to groundwater should be evaluated as one groundwater operable unit (BERS-Weston 2018b). Area 3 SAs 20, 21, 30, and 31 were subsequently reclassified as AOCs (BERS-Weston 2018b). The SI results for Area 3 AOCs 20, 21, 30, and 31 are discussed in more detail in **Section 3.2.1.1**.

1.2.3.2 Phase I Remedial Investigation (Preliminary Site Characterization Study)

Phase I RI field investigations were conducted at Devens at locations identified above in accordance with the RI WP for PFAS (KGS 2020). Activities included collection of surface water and sediment samples, sampling of soils at soil borings, VAP of groundwater, installation of piezometers and monitoring wells, sampling of new and existing groundwater monitoring wells, and synoptic water level measurements. Planned field activities by site were detailed in Field Sampling Plans for Area 1, Area 2, and Area 3, prepared as addenda to the PFAS RI WP (KGS 2020). The results of the investigations were presented in area-specific PSCS reports. Results for Area 3 sites were reported in Tables 3-1 to 6-4 in the Area 3 PSCS (KGS 2021), included as **Appendix B**.

1.2.3.3 Supplemental Sampling

As part of the Area 3 Field Sampling Plan, Addendum No.1 (KGS 2022) to the PFAS RI WP (KGS 2020), supplemental investigation locations were sampled at AOC 31 and AOC 50 in the summer and fall of 2022. An additional 32 soil borings and 28 groundwater sampling locations in AOC 31 were advanced to better characterize PFAS impacts at the former FTA. Of those 28 groundwater locations, 15 comprised three VAP transects (AFT-A-1 through AFT-A-5, AFT-B-1 through AFT-B-5, and PFT-A-1 through PFT-A-5). The location of the transects are oriented perpendicular to groundwater flow. The remaining 13 groundwater locations (31VP-21-01 through 31VP-21-13) consisted of a single sample collected at the water table. One monitoring well, 31MW-21-01, was also installed in AOC 31 during this event to help assess groundwater flow direction and be sampled at future dates. These groundwater locations are shown on **Figure 1-3**. The 32 soil borings at AOC 31 included shallow and deep soil borings, along with multiple step outs around the bermed area. These soil locations are shown on **Figure 1-4**. An additional 16 soil borings and five VAPs in AOC 50 were advanced to better characterize PFAS impacts from the former MAAF fire station. 50SB-22-01 was advanced near the former MAAF fire station and 50SB-22-02 through 50SB-22-16 were advanced in the northwestern portion of the MAAF, between the taxiway and the runway. Three of the five VAP locations (50VP-22-01, 50VP-22-02, and 50VP-22-03) were advanced between the taxiway and the runway, corresponding with the soil boring locations of 50SB-22-06, 50SB-22-08, and 50SB-22-10, respectively. The last two, 50VP-22-04 and 50VP-22-05, were advanced at the northwest and to the southwest of AOC 31, respectively; these locations are shown on **Figure 1-5**.

At AOC 31, soil exceedances of the PFOS SSSL (USEPA Region 1 2022) were identified throughout the vadose zone, greatest from the ground surface to 20 feet below ground surface (bgs). The highest concentration of PFOS was identified at 7 to 8 feet bgs at 31SB-21-02 (1,500 micrograms per kilogram [µg/kg]). Some exceedances of PFOA were also detected, with the highest concentration (41 µg/kg) also at 31SB-21-02. Sixteen soil borings installed at the periphery of AOC 31 (31SB-21-10, -12, -15, -17-19, -21-22, -25-32) provided lateral and vertical delineation of PFOS and PFOA exceedances (**Figure 1-4**). The vertical delineation of these soil borings is discussed in **Section 2.2.3**. Groundwater SSSL exceedances were identified at all locations. The detected analytes at these locations include PFHxS, PFHxA, PFNA, PFOS, and PFOA were identified at all locations in AOC 31. VAP location AFT-B-4 had the highest concentration of PFAS6 at AOC 31, detected at 22,900 ng/L at 88 to 92 feet bgs. At the water table (approximately 65 feet bgs), groundwater SSSL exceedances consist of primarily PFOS, PFOA, and some PFHxA. The highest concentration of PFAS6 (5,510 ng/L) was detected at 31VP-21-05 at the western edge of AOC 31 (location shown on **Figure 1-3**). Additional well installations for delineation of groundwater impacts in AOC 31 are proposed in **Section 5.3.2**.

At AOC 50, PFOS exceeded the soil SSSL at 50SB-22-04, 50SB-22-05, and 50SB-22-12, with the highest concentration (330 µg/kg) at 50SB-22-04 (7 to 15 feet bgs). These soil locations and exceedances are shown on **Figure 1-5.** One SSSL exceedance of PFOA (26 µg/kg) was identified at 50SB-22-01 (field duplicate at 7 to 15 feet bgs). At AOC 50, groundwater SSSL exceedances were identified at all locations. The detected analytes at these locations include PFHxS, PFHxA, PFNA, PFOS, and PFOA. VAP location 50VP-22-02 had a PFAS6

concentration of 23,900 ng/L at 78 to 82 feet bgs, with PFAS concentrations 1000 times greater than the SSSLs down to boring termination at 141 feet bgs. This location is in the middle of the former MAAF, downgradient of the former MAAF fire station. VAP location AFT-A-3, downgradient of AOC 50 and upgradient of the AOC 31 source area, had an even greater PFAS6 concentration of 26,200 ng/L from 98 to 102 feet bgs. As part of this Phase II RI WP, additional soil borings and monitoring wells are proposed for further delineation of soil and groundwater impacts in AOC 50. **Section 4** addresses existing data gaps; proposed investigation locations are discussed in **Section 5.3**.

1.3 Report Organization

The remainder of this Phase II RI WP is organized as follows:

- **Section 2 – Conceptual Site Model:** Summarizes the physical characteristics of Area 3, describes the regional hydrogeology, presents the nature and extent of known PFAS contamination, describes land use and PFAS fate and transport, and identifies potential receptors and exposure pathways.
- **Section 3 – Project Approach and Data Quality Objectives:** Describes the project approach and presents the data quality objectives (DQOs) of the RI.
- **Section 4 – Remedial Investigation Data Gaps:** Provides the principal study questions to be addressed by the RI.
- **Section 5 – Proposed Remedial Investigation Activities:** Summarizes the planned Phase II RI activities, including field methodologies.
- **Section 6 – Reporting:** Identifies the deliverables that will be generated for Stage 1 of the Phase II PFAS RI.
- **Section 7 – Project Schedule:** Presents the Area 3 Phase II RI WP project schedule.
- **Section 8 – References:** Provides a list of references cited throughout this WP. References cited in attached tables, figures, and appendices are provided in those documents and are not repeated herein.

In addition, the following appendices are provided to supplement this Phase II RI WP:

- **Appendix A:** Area 3 Uniform Federal Policy–QAPP, Phase II RI for PFAS.
- **Appendix B:** Area 3 PSCS Report.
- **Appendix C:** USEPA Region 1 Site-Specific Screening Levels (2023) and Update Documentation.
- **Appendix D:** Regional Groundwater Flow Model of the Former Fort Devens, Massachusetts.
- **Appendix E:** Response to Regulatory Comments.

2 Conceptual Site Model

This section presents a discussion of the preliminary conceptual site model (CSM) for Area 3 at Devens, including a description of the regional and local physical characteristics and hydrogeology. This section also presents an overview of PFAS fate and transport and identifies potential receptors. To support this CSM, a site-wide three-dimensional numerical groundwater flow model was developed (constructed and calibrated) for Devens (Arcadis 2022). Results from the calibrated model, along with the various components of the CSM presented herein, were used to characterize groundwater flow patterns, identify data gaps, and guide the investigation activities outlined in this Phase II RI WP. The detailed modeling report is included as **Appendix D**.

2.1 Site Setting

This section describes the physical characteristics, hydrogeology, and geology/hydrogeology of Devens and the surrounding area.

2.1.1 Physical Characteristics

Regionally, Devens lies within the Nashua River basin. The Nashua River flows north through the former North, Main, and South Posts, forming the eastern boundary on the former South Post, much of the western boundary of the former Main Post, and bisecting the former North Post. The topography of Devens is characterized by undulating glacial terrain derived from glacial erosion and deposition on crystalline bedrock. Landforms at Devens include extensive flat uplands (kame terraces) such as those found at the former MAAF and WWTP areas on the former North Post, and kame and kettle topography that range from areas of comparatively low topographic relief to elongated hills (i.e., drumlins), such as the areas encountered on the former South Post and former Main Post (Harding Lawson Associates [HLA] 2000b). The terrain at Devens generally falls into three types:

- **Bedrock Terrain:** Generally consisting of crystalline bedrock topographical highs that are resistant to both glacial and fluvial erosion. Where bedrock is not directly exposed, a thin veneer of glacial sediments may be present.
- **Glacial Till:** Primarily consisting of highly variable sediments deposited by glaciers and conforming to the underlying bedrock surface.
- **Glacial-Meltwater Streams and Lake Deposits:** Most common; predominantly consisting of sediments deposited by glacial-meltwater outwash and ancient proglacial lake accumulations.

The terrain in Area 3 generally consists of low-grade metasedimentary rocks, gneisses, and granites overlain by unconsolidated glacial meltwater sediments.

2.1.2 Hydrology

Regionally, groundwater and surface water bodies across Devens ultimately discharge into the Nashua River, which flows through the middle of Area 3 from the south to the north. South of Area 3, notable surface water features at Devens include the Plow Shop Pond, Mirror Lake, Grove Pond, Cold Spring Brook, Robbins Pond, Willow Brook, Nonacoicus Brook, which are located in or adjacent to Areas 1 and 2 (**Figure 1-1**). Within Area 3, Willow Brook and Nonacoicus Brook converge in the south of Area 3 and feed into the Nashua River from the east, while Morse Brook and Walker Brook feed into the Nashua River from the west. Baseflow conditions for the

numerous ponds, wetlands, and tributaries across Devens are maintained by groundwater discharge. Various wetlands are present east and south of AOC 20 and an unnamed pond is present north of AOC 20.

2.1.3 Geology and Hydrogeology

The geology across Devens consists of major glacial sediment units comprised of till, deltaic deposits from former glacial Lake Nashua, and deposits from glacial meltwater streams that overlie a complex series of sedimentary, igneous, and metamorphic bedrock formations. The thickness of glacial till at Devens varies between 10 to 60 feet, consists of unstratified gravel to silt, and typically contains boulders. The glacial lake deposits consist mainly of sand and gravelly sand. Lake bottom deposits consist of sand, silt, and clay. Post-glacial deposits consist mainly of river terrace sands and gravels, fine alluvial sands, and silts, as well as peat, silt, and sands in swampy areas. Overburden deposits are up to 300 feet thick (areas along Cold Spring Brook), whereas lowland Nashua River floodplain deposits, consisting of sand, fine gravel, and silt, are up to 25 feet thick. In Area 3, the overburden is thickest beneath the former MAAF, reaching up to approximately 210 feet thick, to as thin as approximately 25 feet thick beneath the Nashua River. The depth to bedrock is greatest through the center of Area 3, particularly south of AOC 20 and beneath the former MAAF, as shown on **Figure 2-2**. As a result, fluvial sediments have accumulated in these portions of deep bedrock to produce the generally flat valley and wetland area that the Nashua River flows through along its course across Area 3.

The overburden at Devens is underlain by competent (i.e., unweathered) to slightly weathered, sparsely fractured, low-grade metasedimentary rocks, gneisses, and granites (HLA 2000b). Bedrock strikes and dips are variable across Devens due to the folded nature of the formations and the presence of numerous faults that align with major unit contacts. The bedrock units present across Devens are:

- **Oakdale Formation:** metamorphosed thin-bedded, pelitic and calcareous siltstone and muscovite schist;
- **Devens Gneiss Complex:** coarse-grained quartz-potassium (k)-spar biotite granite-gneiss (intruded by the Ayer Granite);
- **Worcester Formation:** carbonaceous slate and phyllite and minor metagraywacke;
- **Berwick Formation:** thin- to thick-bedded metamorphosed calcareous sandstone, siltstone, and minor muscovite schist;
- **Chelmsford Granite:** light gray, even and medium-grained muscovite-biotite granite;
- **Ayer Granite:** two or three facies present:
  - **Clinton Facies:** porphyritic biotite granite with a non-porphyritic border phase intrudes the Berwick Formation; and
  - **Devens-Long Pond Facies:** equigranular to porphyritic gneissic biotite granite and granodiorite.

Area 3 is predominantly underlain by the Berwick Formation in the northern two-thirds of the SA, while the Oakdale Formation underlies the southern portion (**Figure 2-2**). The dominant structural alignment is generally oriented to the northeast/southwest within the Berwick Formation and to the north-northwest/south-southeast in the Oakdale Formation.

2.1.3.1 Overburden Hydrogeology

Overburden (glacial meltwater deposits) groundwater constitutes the primary groundwater aquifer at Devens. Zones of highest transmissivity within the overburden are generally found in areas of thick glacial meltwater deposits on the former North and Main Posts (e.g., along Cold Spring Brook). Water supply wells at Devens Area

1 and Area 2 are all completed within these meltwater deposits and can easily yield several hundred gallons per minute. There are no water supply wells in Area 3, and Area 3 is not within a Zone 1 or Zone 2 protection area for nearby potable water wells. However, groundwater underlying Area 3 falls within an administrative Aquifer Protection District. Hydraulic conductivity values have been reported to vary between 30 to 300 feet per day in meltwater deposits, while lake bottom sediments are significantly less permeable, with reported hydraulic conductivities ranging from 0.002 to 0.3 foot per day (HLA 2000a).

The depth to groundwater across Area 3 ranges from about 3 feet bgs to more than 70 feet bgs and averages approximately 40 feet bgs. Overburden groundwater is recharged in upland areas, and flow generally follows topography—from topographic highs to topographic lows, where it discharges to wetlands, ponds, streams, and directly into the Nashua River. Groundwater flow across Area 3, as shown on **Figure 2-3**, is consistent with regional observations of flow towards and discharge into the Nashua River. Topography that has been modified by artificial fill, such as the steep plateau edges of the former MAAF in Area 3, does not have as much of an influence on overburden groundwater flow as native topography, such as west of the former MAAF, near AOC 20. Where the bedrock surface increases in elevation relative to the central portion of Area 3, such as north of and along the western sides of Area 3, the overburden groundwater gradients are steeper as a result.

2.1.3.2 Bedrock Hydrogeology

The zones of lowest groundwater transmissivity at Devens are typically associated with glacial till and fractured bedrock. Groundwater flow occurs in the underlying bedrock; however, it is more restrictive relative to the overburden because the bedrock lacks primary porosity and/or has been impacted by metamorphism. Groundwater in bedrock predominantly flows through secondary porosity features such as fractures, joints, and dissolution voids. While faulting and foliation of the bedrock align with major unit contacts (**Figure 2-2**), the fracture orientations are less systematic than the foliation patterns (Kopera et al. 2006; GZA GeoEnvironmental, Inc. [GZA] 2011a,b). Therefore, groundwater flow paths in the bedrock are constrained by the resulting (sparse) fracture network and biased by the underlying bedrock fabric, which results in preferential movement along strike (i.e., north-south/northeast-southwest direction) (Kopera et. al. 2006). Domestic bedrock wells on hilltops in crystalline rock in Massachusetts (such as those in the Devens area) have a median yield of 6 gallons per minute (U.S. Geological Survey 1994). Observations from the Devens Pathfinder and the Ayer Pathfinder wells (**Figure 1-1** and summarized below) support these conclusions. These wells are located in PFAS Area 1 and are expected to be representative of bedrock conditions in Area 3.

- **Devens Pathfinder well (GZA 2011a):** Gneiss bedrock; Open hole from 47 to 1,500 feet bgs; Three transmissive fractures (occurring at 134, 425, and 488 feet bgs) were associated with points of inflow during pumping. Based on borehole geophysics, 77% of the transmissivity was associated with the fracture at 134 feet bgs, 16% of the transmissivity was associated with the fracture at 425 feet bgs, and 7% of the transmissivity was associated with the fracture at 488 feet bgs.
- **Ayer Pathfinder well (GZA 2011b):** Phyllite and quartzite; open hole from 220 to 1,506 feet bgs; two transmissive fractures (occurring at 302 and 329 feet bgs) were associated with points of inflow during pumping. Based on borehole geophysics, 75% of the transmissivity was associated with the fracture at 302 feet bgs, and 25% of the transmissivity was associated with the fracture at 329 feet bgs.

For both Pathfinder wells, water-yielding bedrock fractures located in the upper 500 feet of the boreholes exhibited greater transmissivity than deeper fractures. No distinct, continuous confining unit has been identified between overburden and bedrock. However, the combination of much higher overburden permeability and a limited fracture network in the bedrock (i.e., groundwater preferentially flows within the overburden) likely impedes

vertical migration of potential contaminants. Bedrock areas that are most likely to be impacted are areas where there is a thin overburden cover and areas where the observed water level is below the top of bedrock, which does not occur in Area 3. Additional overburden/bedrock well pairs along with additional sampling and analysis of groundwater for PFAS at depth are needed, where data gaps exist, to characterize vertical gradients and the potential for downward migration across Area 3. This is discussed in more detail in **Sections 3** and **4**. Pumping from bedrock may induce localized gradient reversals; however, the flow rates attainable from the off-site residential bedrock water supply wells in the area are unlikely to alter overburden flow patterns and induce vertical migration to any meaningful degree at Area 3.

2.2 Preliminary Summary of Nature and Extent Based on Existing Data

Investigations conducted to date have identified PFAS in soil, groundwater, surface water, and sediment samples within Area 3. The mixture of PFAS constituents detected in environmental samples provide information that can help identify PFAS in groundwater as it originated from separate sources. In soil, consistent mixtures of specific PFAS across different samples may indicate a common source. The types and relative amounts of different PFAS in a sample are referred to herein as the PFAS "fingerprint." Pie charts showing PFAS fingerprints in groundwater are presented on **Figures 2-4** through **2-12,** and pie charts showing PFAS fingerprints in soil are shown on **Figures 2-13** through **2-18,** regardless of whether the concentration exceeded the SSSLs and/or MMCLs for PFAS. Differential transport and transformation of individual PFAS may partially account for a difference in PFAS fingerprints across multiple samples in the same area.

The relative concentrations and mixtures of PFAS in groundwater and soil can help indicate the location and direction of a particular PFAS source, as described below:

- Total PFAS concentrations will typically be highest in groundwater and soil near the source area and gradually decline along the hydraulically downgradient groundwater pathway (Adamson et al. 2020). Hydraulically upgradient, PFAS concentrations will typically be much lower than those observed near or immediately downgradient of the source.
- It is typical to see different fingerprints between proximate groundwater and soil samples due both to different partitioning coefficients of individual PFAS (e.g., PFOS retained in soil more so than PFOA) and the potential for upgradient groundwater to migrate beneath impacted soils.
- Relatedly, differential transport of PFAS due to sorption to soils and partitioning at the air-water interface can result in a change in the dominant PFAS compound(s) at the distal portion of a plume relative to the source area.
  - Perfluoroalkyl acids (PFAAs), including PFOS and PFOA, tend to hydrophobically partition to soils (organic carbon), electrostatically interact with charged surfaces, and aggregate at air-water interfaces. As the perfluoroalkyl chain length increases, PFAAs generally become more sorptive to soil and less mobile in groundwater (Anderson et al. 2019). PFAS with shorter carbon chains will, in general, migrate more readily into and in groundwater. For example, PFHxA has been documented to have a lower organic carbon-water partition coefficient (KOC) than PFOA (log KOC of 1.3 versus log KOC of 1.89 to 2.63, respectively; ITRC 2020b). If a groundwater sample were composed of 50% PFOA and 50% PFHxA in the source area, it is likely that PFHxA would be the more dominant compound in downgradient groundwater due to there being a higher degree of sorption to soil organic carbon by PFOA (thereby attenuating it from advective transport in groundwater) than PFHxA.

- PFAS precursor transformation to terminal products (PFAAs) can also affect the PFAS fingerprint in groundwater with increasing distance from the source area. Aerobic conditions in groundwater generally support transformation of precursor PFAS, if present, to PFAAs. The three highest concentration PFAS identified in Area 3 groundwater (PFHxS, PFOS, and PFOA) are terminal products, meaning that they do not transform to other PFAS (ITRC 2020b).

The potential routes of contaminant migration in Area 3 include:

- Releases to surface and subsurface soils → transport via leaching to groundwater → partitioning to sediment/discharge to surface water;
- Releases to surface and subsurface soils → erosion/stormwater runoff → discharge to surface water → partitioning to sediment; and
- Potential uptake in aquatic biota (e.g., fish) from surface water.

Vertical leaching of PFAS through unsaturated (vadose-zone) soils to groundwater can occur during percolation of precipitation, flooding, or irrigation through the soil column in a source area. Studies to date have shown that a significant portion of PFAS mass tends to be retained over time on shallow soils (Sepulvado et al. 2011; Stahl et al. 2013; Anderson et al. 2016; Adamson et al. 2020), particularly for the more retentive longer-chain PFAS and cationic and zwitterionic (e.g., carrying both positive and negative charges that result in a neutral charge for the molecule) precursors (Adamson et al. 2020). Perfluoroalkyl carboxylates (including PFOA, PFHpA, and PFHxA) leach more readily than perfluoroalkyl sulfonates (PFOS, perfluoroheptanesulfonic acid, and PFHxS) with an equivalent carbon chain length (Anderson et al. 2019). As perfluoroalkyl chain length increases, anionic PFAAs generally become more sorptive to soils and less mobile in groundwater (Anderson et al. 2019).

To better understand the vertical distribution of PFAS in groundwater for AOCs 30, 31 and 50, VAP samples were collected at the locations shown on **Figure 2-19**. Cross section profiles across these AOCs with PFAS results by depth are shown on **Figures 2-19a** through **2-19f**. Pie charts showing PFAS fingerprints (east and west of the Nashua River) are presented on **Figures 2-4** through **2-12**, regardless of whether the concentration exceeded the SSSLs and/or MMCLs for PFAS.

Environmental samples collected for PFAS analysis in previous investigations were analyzed by modified USEPA Method 537 compliant with DoD and Department of Energy (DOE) Quality Systems Manual for Environmental Laboratories, Table B-15 (DoD and DOE 2023) for 16 PFAS compounds. Samples collected during Phase II will be analyzed using USEPA Method 1633, which will provide an expanded list of 40 PFAS compounds.

2.2.1 Areas of Concern 20 and 21 – Wastewater Treatment Plant Sand Infiltration Beds and Sludge Drying Beds

AOCs 20/21 are associated with the WWTP located on the west side of the Nashua River (**Figure 1-2**). The sand infiltration beds (AOC 20) are located on a kame deposit approximately 70 feet above the Nashua River floodplain. The former sludge drying beds are located to the east of the infiltration beds, below ground surface and within a lined, raised secondary containment. As shown on **Figure 2-3**, groundwater in the vicinity of these AOCs generally flows easterly across the sand infiltration beds and former sludge drying beds toward the Nashua River, and southeasterly towards the Nashua River in the southern portion of the AOCs. Hydraulic mounding likely occurs beneath the infiltration beds, resulting in temporary localized radial groundwater flow, but ultimately migrates east/northeast toward the Nashua River in the direction of regional groundwater flow. PFAS mixtures in this portion of Area 3 indicate:

- Although soil impacts vary across AOC 20, overall, soil sample results in AOCs 20 and 21 are dominated by PFOS, followed by N-methylperfluorooctanesulfonamidoacetic acid, particularly throughout AOC 20 (**Figure 2-14**). Previous soil sampling results are presented on **Appendix B, Figure 3-9**.
- In AOC 21, soil sampling results suggest historical sludge from WWTP operations has contributed to soil contamination above SSSLs (**Figure 2-14**).
- In groundwater, PFOS and PFOA are the two PFAS consistently detected in the vicinity of the infiltration beds and sludge drying beds at higher concentrations relative to other compounds (**Figure 2-5)**. Downgradient, to the east of the infiltration beds, the top three analytes at monitoring well MW-02A in order of decreasing concentration were PFHxS, PFHxA, and PFOA.
- Nashua River surface water sample NR-19-06, downgradient of AOC 20, generally reflects the PFAS mixture (PFOS, PFOA, and PFHxA, in order of decreasing concentration) of the water table sample at 20VP-19-07 (63 to 67 feet bgs) and downgradient SI water table grab sample SA20-17-02, which is suggestive of groundwater to surface water discharge in this area. Surface water sample UP-19-01, collected from the unnamed pond north of AOC 20, also exhibits a similar PFAS signature. As shown on **Appendix B, Figure 3-10**, 5 surface water samples (NR-19-01 through -05) were collected upstream of NR-19-06 and 8 surface water samples (NR-19-07 through -14) were collected downstream of this location. PFAS concentrations in both the upstream and downstream locations were lower than that detected at NR-19-06.

2.2.2 Area of Concern 30 – Drum Storage Area

AOC 30 is located on top of the glacial kame terrace on the north end of the former MAAF on the eastern side of the Nashua River in Area 3 (**Figure 1-2**) and consists of one asphalt and one concrete pad approximately 400 feet apart: Area A, to the west, and Area B, to the east. Groundwater flows from northeast of AOC 30 to the southwest, then west through AOC 30 toward the Nashua River (**Figure 2-3**); therefore, Area B is generally upgradient of Area A. Former uses at AOC 30 include the storage of AFFF drums, alkaline cleaners, methyl ethyl ketone (MEK), JP-4 jet fuel, aircraft cleaners, lube oil, waste solvents, paint thinner, dry-cleaning solutions, and naphtha. PFAS mixtures in this portion of Area 3 indicate:

- The soil signature is largely dominated by PFOS, followed by PFHxS. These compounds are primary ingredients in AFFF, indicating that it was likely stored at this location and released to the soil (**Figure 2-15**). Previous soil sampling results are shown on **Appendix B, Figure 4-9**.
- The three primary PFAS in groundwater in Area A are PFHxS, PFOA, and PFHpA (**Figure 2-6**). Results from 30VP-19-03 indicate that the highest PFAS concentration is at the water table, suggesting a release did occur at Area A (**Figure 2-19a**) (**Appendix B, Appendix H-2**).
- Results from Area B VAP 30VP-19-06 indicate PFOS is most prevalent, followed by PFHxS and PFOA, with the highest concentrations deeper than the water table (**Appendix B, Appendix H-2**).
- Downgradient of AOC 30 at 30VP-19-04, PFAS results are comparatively low at the water table (73 to 77 feet bgs) down to 107 feet bgs, increasing at 123 to 135 feet bgs, as shown on **Figure 2-19f**. These increases in deeper overburden groundwater, along with groundwater flow direction, suggest that groundwater that has been impacted by PFAS upgradient is moving deeper in overburden as groundwater flows toward the Nashua River within the MAAF.

2.2.3 Area of Concern 31 – Firefighting Training Area

AOC 31 is located on a topographic high at the edge of the glacial kame terrace on the southwest side of the runway in the former MAAF (**Figure 1-2**). The former fire training area overlays the abandoned east-west trending runway. The western edge of AOC 31 and the airfield abruptly slopes down towards the Nashua River; groundwater flow follows the slope, moving west-southwest towards the river (**Figure 2-3**). PFAS mixtures in this area indicate:

- Soil exhibits exceedances of soil SSSLs for PFOS down to the water table in some locations, and with additional soil sampling in 2022, these impacts are well delineated (**Figure 2-16**). The primary PFAS detected in soil is PFOS, followed by PFHxS and PFOA. The locations with the highest detections of PFAS are located within the footprint of the former FTA and to the west of that area, where wind may have carried AFFF or AFFF may have been otherwise pushed in that direction following training. PFOS and PFHxS are major ingredients in AFFF. PFOS results are displayed using cross sections on **Figures 2-20a** through **2-20c**.
- Due to AOC 31's location downgradient of the former MAAF, there appears to be a mixture of several signatures in groundwater that vary in concentration vertically at AOC 31 VAP locations:
  - High concentrations of primarily PFOS and PFHxS were detected at the water table (approximately 63 feet bgs) in VAP borings. Moving deeper in the borings, PFOA, PFHxS, and PFHxA are dominant, and PFOA and PFHxS become dominant deep in overburden. These variations in concentrations with depth across VAPs suggest groundwater in this area has been impacted by releases in the former FTA as well as from additional upgradient sources (likely AFFF on runways or potentially associated with the former MAAF fire station). PFAS fingerprint pie charts show this variation of dominant analytes with depth on **Figures 2-11** and **2-12**.
  - High PFAS concentrations at 31VP-19-01 (maximum PFAS6 of 10,200 ng/L at 123 to 127 feet bgs) suggest PFAS impacts are traveling to AOC 31 from upgradient sources. Higher concentrations in groundwater at VAP locations AFT-B-3 and AFT-B-4, drilled in 2022 at the edge of the airfield downgradient of the FTA, support this (**Figures 2-19c, d, and e**).
- The PFAS types and concentrations in groundwater, as well as their depth relative to where they are detected in upgradient VAP locations, in VAP samples collected at the edge of the Nashua River suggest that PFAS-impacted groundwater is migrating to the river from those sources. The highest concentrations of PFAS detected in this area along the riverbank at 31VP-19-06 and 31VP-19-07, located west and west northwest of AOC 31 adjacent to the Nashua River have PFAS6 concentrations greater than 1,000 ng/L down to 37 and 42 feet bgs, respectively (see **Appendix B**, **Figure 5-6**).
- On the west side of the Nashua River, 31VP-19-05 groundwater was below applicable standards; results were non-detect with depth. This suggests that underflow of PFAS in groundwater from AOC 31 beneath the Nashua River to the west bank is likely not occurring.

2.2.4 Area of Concern 50 – Former Moore Army Airfield

AOC 50 comprises the portions of the former MAAF not included in AOCs 30 and 31, including the PCE source area of the AOC 50 groundwater plume, former MAAF fire station, Hangar Buildings 3813 and 3818, and the airfield itself (**Figure 1-2**). The northern portion of the MAAF, just south of Route 2A/Fitchburg Road, was used for the maintenance and storage of parachutes and the storage of fueling systems. There is no documentation of AFFF having been used in the former hangar buildings, but detections of PFAS in this soil indicate that it is possible it could have been stored there. The elevation of this area is slightly lower than the airfield. Groundwater

flows southwest toward the Nashua River in AOC 50; as the Nashua curves north and northeast in the northern portion of the site, groundwater flows more westward in response. PFAS mixtures in this area indicate:

- Soil samples generally exhibit a similar signature (predominantly PFOS, with smaller portions of PFHxS, followed by PFOA). Samples collected at 50SB-22-04 and 50SB-22-05, across the taxiway from the former MAAF fire station, have the highest PFOS concentrations identified at AOC 50. PFOS and PFHxS are major ingredients of AFFF (**Figures 2-17 and 2-18**). Previous soil sampling results are shown on **Appendix B, Figure 6-7**.
- The various areas and purposes of AOC 50 contribute to a variety of PFAS fingerprints in groundwater investigation locations, as shown on **Figures 2-8** through **2-10**:
  - The AOC 50 parachute storage and PCE source area has exceedances of the groundwater SSSLs from the water table (approximately 10 feet bgs) to 70 feet bgs, except for monitoring wells G6M-04-13X and G6M-96-26B. Concentrations are largely dominated by PFHxS, followed by PFOS and PFOA.
  - Upgradient of the parachute storage/PCE source area north of Route 2A/Fitchburg Road, PFAS6 exceedances in all intervals at 50VP-19-01 and 50VP-19-02, which suggests there is a potential offsite contribution to PFAS concentrations in the PCE source area from releases from this area.
  - In the former hangar area on the north end of the airfield, concentrations in groundwater at the water table vary among VAP locations, but PFHxS and then PFOS is dominant, as they generally are across AOC 50. Variability in concentrations with depth across the VAPs suggests a potential mix of local releases (shallow detections) and those from upgradient source(s) (deeper detections). For example, VAP locations 50VP-19-05 and 50VP-19-06 each have groundwater sample results at two depths that are separated by 20 feet or more vertical thickness with PFAS concentrations higher than the depth above and below them. At 50VP-19-05, these “peaks” in concentration occur in samples collected at 63 to 67 feet bgs (the water table) and 103 to 107 feet bgs (the deepest sampled interval). At 50VP-19-06, they occur at 73 to 77 feet bgs (10 feet below the water table) and 92 to 96 feet bgs (the deepest sampled interval). In between these “peak” sample depths, PFAS concentrations are an order of magnitude lower. Shallow high concentrations point to a local release, while deeper high concentrations point to an upgradient release of PFAS. Previous groundwater sampling results are shown in **Appendix B, Appendix H-2**.
  - At 50VP-19-06, hydraulically downgradient of the hangars, the maximum PFAS concentration was detected 10 feet below the water table (63 feet bgs). Concentrations decrease from 77 to 87 feet bgs, then increase again at the 92 to 96 feet interval. The most dominant analytes at the water table are PFHxS, PFOA, and PFHpA; below the water table, there is an increase of PFOS compared to PFHpA. Similar shallower and deeper peak concentration patterns with different PFAS mixtures in VAP borings downgradient between two runways (50VP-22-02 and 50VP-22-03) suggest that groundwater from upgradient sources adjacent to the hanger area has migrated to the airfield (**Figure 2-19f**). VAP location 50VP-22-02 has a wide variety of PFAS concentrations and mixtures: groundwater is below the SSSLs at the water table (68 to 72 feet bgs), but PFAS6 is detected at 23,900 ng/L 10 feet below. The primary PFAS at this depth, at 21,000 ng/L, is PFHxS. Twenty feet below this depth, at 98 to 102 feet bgs, the PFAS6 concentration is 10,100 ng/L, but the highest concentration compound is PFOS, at 5,500 ng/L. This variation in concentrations and PFAS with the greatest concentrations at different depths is indicative of multiple upgradient releases contributing to groundwater at this location.

2.3 Potential Receptors and Exposure Pathways

This section presents a preliminary, general understanding of potential human and ecological receptors and exposure pathways based on the current and most likely future land uses within Area 3. A more detailed evaluation of potential receptors and exposure pathways will be presented in a future risk assessment.

2.3.1 Human Receptors and Exposure Pathways

Area 3 encompasses a portion of the former North Post area of Devens and is currently used for commercial/ industrial purposes and recreational open space. It is anticipated that future land use will be consistent with the Devens Reuse Plan (VHB 1994), which identifies major reuse themes for Devens.

There are no water supply wells in Area 3, and Area 3 is not within a Zone 1 or Zone 2 protection area for nearby potable water wells. However, groundwater underlying Area 3 falls within an administrative Aquifer Protection District.

Based on the current and reasonably anticipated future land uses, potential human receptors may include commercial/industrial workers, construction workers, utility workers, and recreational users. Drinking water users from existing water supply wells will not be considered because there are no potable water supply wells in Area 3. Residential development of the Area 3 AOCs is not a realistic future scenario; however, a residential scenario (i.e., exposure to soil outdoors and to untreated groundwater used as a source of potable water) will be included to evaluate a future hypothetical unrestricted use/unlimited exposure scenario.

The exposure media of concern for human receptors potentially include surface soil (0 to 0.5 foot bgs), subsurface soil (0.5 to 15 feet bgs [or the depth to groundwater, whichever is encountered first]), groundwater, surface water, and sediment (0 to 0.5 foot bgs).

Generally, human exposure to PFAS in soil may occur through incidental ingestion, dermal contact, and inhalation (particulates). However, inhalation of constituents in soil released to outdoor air as particulates is generally not evaluated because inhalation toxicity values are not currently available for PFAS.

2.3.2 Ecological Receptors and Exposure Pathways

Most of the former airfield is developed into buildings, paved areas, and maintained grassed areas. These areas provide limited habitat for ecological receptors. The portions of Area 3 outside of the airfield and WWTP, including the USFWS Oxbow Wildlife Refuge, are undeveloped, and consist of hardwood vegetated uplands, riparian corridors, old fields, wet meadows, emergent and forested wetlands, and open waters. These areas provide habitat that includes wooded uplands and successional open fields that support terrestrial plants, invertebrates, reptiles/amphibians, birds, and mammals. Ecological receptors in terrestrial areas may be exposed to PFAS in soil through direct contact. Incidental ingestion of soil and by uptake through the terrestrial food web are additional pathways for ecological receptors.

The aquatic habitat associated with Area 3 includes the Nashua River, small ponds, wetland areas, and vernal ponds. These areas provide habitat that support aquatic plants, aquatic invertebrates, fish, and reptiles/amphibians. Birds and mammals also use these areas. Ecological receptors in aquatic areas may be exposed to PFAS in surface water and sediment. Aquatic plants, invertebrates, fish, amphibians, and reptiles may be exposed to PFAS in surface water and sediment through direct contact. Incidental ingestion of sediment,

drinking water ingestion, and uptake through the aquatic food web are additional pathways for ecological receptors.

The depth to groundwater in Area 3 is variable. The average depth to groundwater in the kame terrace of the MAAF (the eastern portion of Area 3) is approximately 40 feet bgs. At this depth, the expression of groundwater at the ground surface as seeps or springs, and the contribution of groundwater to streams or ponds is unlikely, thereby preventing potential ecological exposure of both terrestrial and aquatic receptor groups. In the western portion of Area 3 (AOCs 20 and 21) and closer to the Nashua River the depth to groundwater is shallower with potential contribution to ponds that exist in this area.

3 Project Approach and Data Quality Objectives

This section discusses the project approach and the DQOs for the project.

3.1 Project Approach

Previous investigations have confirmed the presence of PFAS at concentrations exceeding risk-based screening levels in Area 3. The field investigation performed under this WP will be utilized primarily to evaluate fate and transport pathways of PFAS from identified source areas to areas of potential exposure. The data collected will also be used to identify potential human health or ecological risks and will be utilized in future CERCLA-compliant risk assessments, if needed, and development of potential remedial alternatives, if needed. A second stage of the Phase II investigation is anticipated to be required following this first stage, both to complete delineation of the nature and extent of PFAS, and to collect remaining samples needed to evaluate human health or ecological risks. The scope of the Stage 2 investigation will be presented in a Work Plan Addendum that will be submitted to EPA and MassDEP for review prior to implementation.

3.2 Data Quality Objectives

The DQOs are qualitative and quantitative statements that clarify study objectives, define the appropriate type of data, and specify the tolerable levels of potential decision errors that are used as the basis for establishing the quality and quantity of data needed to support decisions. These project-specific statements describe the intended data use, the data need requirements, and the means to achieve acceptable data quality for the intended use. Guidelines followed in the preparation of DQOs for CERCLA investigations are set out as steps in the Data Quality Objectives Process for Hazardous Waste Site Investigations (USEPA 2000). These seven steps are listed below:

- **Step 1. State the Problem:** Summarize the problem that will require environmental data, the resources required, and the preliminary CSM.
- **Step 2. Identify the Decision (Project Goals):** Identify the decisions needed to solve the problem.
- **Step 3. Identify Information Inputs:** Identify the information and measurements needed to make the decisions.
- **Step 4. Define the Boundaries of the Study:** Identify the conditions such as spatial and temporal boundaries.
- **Step 5. Develop a Decision Rule:** Define the conditions under which the data will be used.
- **Step 6. Specify Limits on Decision Errors (Performance Criteria):** Identify the limits on decision errors to establish performance goals.
- **Step 7. Develop/Optimize the Plan for Obtaining Data:** Design an effective data collection strategy based on the previous steps.

The seven-step process was used to develop the DQOs for this Phase II RI WP, which are presented below and are summarized in the Area 3 PFAS QAPP Worksheet #11 (**Appendix A**).

3.2.1 Step 1: State the Problem

Historical use of AFFF in Area 3 has resulted in the release of PFAS to environmental media. PFAS have been detected in groundwater, soil, sediment, and surface water.

3.2.1.1 Site Inspection and Remedial Investigation Sample Collection and Analysis

Groundwater samples were collected and analyzed for PFAS during the 2017 SI activities (BERS-Weston 2018a,b). Groundwater, soil, sediment, and surface water samples were collected and analyzed for PFAS during 2018-2019 RI activities (KGS 2021). The RI soil samples were collected from 0 to 0.5, 0.5 to 3, 3 to 7, 7 to 15 feet bgs, and from the 2-foot interval above the water table (at select locations). Additional groundwater samples were collected from VAP borings on the former airfield (AOC 50) during supplemental sampling performed in 2022.

SI groundwater results were compared to the USEPA LHA of 70 ng/L for PFOA and/or PFOS concentrations. RI groundwater results were compared to the USEPA LHA and the PFAS6 MMCL/GW-1 standard of 20 ng/L. Soil analytical results were compared to the MCP Method 1 S-1 Soil Category (S-1)/GW-1 standard. Surface water and sediment sampling results were compared to USEPA PFAS SSSLs for Former Fort Devens (USEPA Region 1 2018).

The following samples were collected during the SI (BERS-Weston 2018b) and Phase I RI (KGS 2021) at each of the Area 3 AOCs. Previous sampling locations and results are presented on **Appendix B, Figures 3-1 through 6-7**.

AOC 20:

- SI (2017)
  - Three groundwater samples collected from existing monitoring wells;
  - One groundwater sample collected from a temporary well; and
  - One soil sample collected from temporary well location.
- RI (2018-2020)
  - 11 groundwater samples collected from seven existing monitoring wells and four piezometers;
  - 35 VAP groundwater samples collected from seven locations;
  - 35 soil boring soil samples collected from eight locations; and
  - One surface water and one sediment sample collected from an unnamed pond located north of AOC 20.

Results: The four SI groundwater samples exceeded USEPA LHA (70 ng/L). The SI soil samples did not exceed screening criteria. Five of the 11 RI monitoring well samples exceeded the USEPA LHA, and eight samples had concentrations of PFAS6 greater than the MMCL/GW-1 standard (20 ng/L). Of the VAP groundwater samples, 25 of the 35 samples had concentrations greater than the USEPA LHA, and all 35 samples had concentrations greater than the PFAS6 MMCL/GW-1 standard. Of the 35 soil samples, six samples from three locations exceeded at least one MCP S-1/GW-1 standard screening criteria. PFAS were detected in the surface water and sediment samples, but no concentrations exceeded the USEPA Region 1 SSSLs (**Appendix C**; USEPA Region 1 2023).

AOC 21:

- SI (2017)
  - Two groundwater samples collected from temporary wells; and
  - Two soil samples collected from temporary well locations.

- RI (2018-2019)
  - 20 VAP groundwater samples collected from two locations;
  - 13 soil boring soil samples collected from three locations; and
  - One sediment sample collected from an unnamed stream located east of AOC 21. A surface water sample could not be collected because the stream was dry.

Results: The two SI groundwater samples exceeded USEPA LHA. The SI soil samples did not exceed screening criteria. Of the 23 RI VAP groundwater samples, 19 had concentrations greater than the USEPA LHA, and all 20 had concentrations greater than the PFAS6 MMCL/GW-1 standard. Of the 13 soil samples, nine samples from the three locations exceeded at least one MCP S-1/GW-1 standard screening criteria. PFAS were detected in the sediment sample, but no concentrations exceeded the USEPA Region 1 SSSLs (**Appendix C**; USEPA Region 1 2023).

AOC 30:

- SI (2017)
  - Six groundwater samples collected from temporary wells; and
  - Six soil samples collected from temporary well locations.
- RI (2018-2019)
  - 23 VAP groundwater samples collected from six locations; and
  - 26 soil boring soil samples collected from six locations.

Results: Five of the six SI groundwater samples exceeded USEPA LHA. The SI soil samples did not exceed screening criteria. Of the 23 RI VAP groundwater samples, 11 had concentrations greater than the USEPA LHA, and 20 samples had concentrations greater than the PFAS6 MMCL/GW-1 standard. Of the 26 soil samples, 13 samples from four locations exceeded at least one MCP S-1/GW-1 standard screening criteria.

AOC 31

- SI (2017)
  - Four groundwater samples collected from temporary wells; and
  - Four soil samples collected from temporary well locations.
- RI (2018-2019)
  - 50 VAP groundwater samples collected from six locations; and
  - 26 soil boring soil samples collected from seven locations.
- Supplemental Sampling (2022)
  - 179 VAP groundwater samples collected from 28 locations; and
  - 438 soil samples collected from 32 soil borings.

Results: The four SI groundwater samples exceeded USEPA LHA. The SI soil samples did not exceed screening criteria. Of the 50 RI VAP groundwater samples, 38 had concentrations greater than the USEPA LHA, and 43 samples had concentrations greater than the PFAS6 MMCL/GW-1 standard. All soil samples from the seven soil boring locations exceeded at least one MCP S-1/GW-1 standard screening criteria. Of the 179 VAP groundwater samples analyzed from the 2022 sampling, 173 had concentrations greater than the PFAS6 MMCL/GW-1 standard. 140 of 438 soil samples exceeded the 2023 SSSLs (**Appendix C**; USEPA Region 1 2023) for PFOS, PFOA, or both.

The Area 3 PSCS noted that the upward vertical gradients observed at the edge of the Nashua River downgradient of AOC 31 suggested some portion of the PFAS-impacted groundwater is discharging to the river. Soil sample locations with the maximum detected PFAS compounds were located within the former FTA footprint and were PFOS, PFOA, and PFHxS dominant (KGS 2021).

AOC 50

- SI (2017)
  - 18 groundwater samples collected from temporary wells;
  - 18 soil samples collected from temporary well locations; and
  - Two surface water/sediment samples collected from storm water outfalls that may have directed PFAS-impacted surface runoff to areas adjacent to the former airfield.
- RI (2018-2019)
  - 45 groundwater samples collected from 33 existing monitoring wells;
  - 98 VAP groundwater samples collected from 15 locations;
  - 51 soil boring soil samples collected from 12 locations; and
  - 14 surface water and 14 sediment samples collected from locations within the Nashua River, and two surface water/sediment samples collected from locations within an unnamed wetland west of the airfield.
- Supplemental Sampling (2022)
  - 47 VAP groundwater samples collected at five locations; and
  - 64 soil samples collected from 16 soil borings.

Results: Eight of the 18 SI groundwater samples had PFAS concentrations exceeding the USEPA LHA. The SI soil samples did not exceed screening criteria. PFAS were detected in the surface water and sediment samples collected during the SI, but screening values had not yet been established. Of the 98 RI VAP groundwater samples, 55 had concentrations greater than the USEPA LHA, and 77 samples had concentrations greater than the PFAS6 MMCL/GW-1 standard. Of the 51 RI soil samples, 25 samples from seven locations exceeded at least one MCP S-1/GW-1 standard screening criteria. PFAS were detected in the surface water and sediment samples collected in the Nashua River and the unnamed wetland, but no concentrations exceeded the 2018 USEPA Region 1 SSSLs (**Appendix C**; USEPA Region 1 2023). Of the 47 VAP groundwater samples analyzed from the 2022 sampling, 42 had concentrations greater than the PFAS6 MMCL/GW-1 standard. Eight of 64 soil samples exceeded the 2023 SSSLs (**Appendix C**; USEPA Region 1 2023) for PFOS or PFOA.

3.2.1.2 Conclusions from Site Inspection and Phase I Remedial Investigation

Data from laboratory analysis of samples collected from groundwater, soil, sediment, and surface water during the SI (BERS-Weston 2018b), Phase I RI (KGS 2021), and the 2022 supplemental groundwater sampling event were compiled and used to evaluate locations of the greatest concentrations of PFAS in Area 3 and potential migration pathways for PFAS in soil and groundwater. However, additional data are needed to characterize the nature and extent of PFAS in Area 3 and meet the project goals identified below.

3.2.2 Step 2: Identify the Decision (Project Goals)

The goals of the Area 3 Phase II PFAS RI are as follows:

- Complete the identification of the nature and extent of PFAS in soil, groundwater, and surface water (sediment is characterized by Phase I sampling); refine and expand the identification of exposure pathways; and assess potential risks to human and ecological receptors from PFAS in Area 3 (fish tissue (edible portions) sampling and analysis was previously performed as part of the Area 1 Phase II PFAS RI).
- Collect and document data that are both representative of field conditions and defensible within the precision, accuracy, representativeness, completeness, and comparability parameters. This includes sufficient field samples to fully characterize field conditions and heterogeneity as well as quality control samples sufficient to demonstrate data quality. Collect legally defensible samples with a known provenance via an unbroken chain of custody maintained from sampling through analysis.

These data will be collected in two stages, as discussed herein. The data will also be used in the development of potential remedial alternatives, if needed.

3.2.3 Step 3: Identify Information Inputs

The information inputs required to accomplish the project goals are as follows:

- All information reviewed and gathered to date, including the results of previous investigations.
- Analytical data from environmental media. These data may be obtained through collection of soil samples, sampling of new VAP points, installation of overburden and/or bedrock groundwater monitoring wells, and collection of co-located surface water and sediment samples.
- Geologic, hydrogeologic/hydraulic, and chemical data required to evaluate PFAS fate and transport in groundwater, soil, sediment, and surface water.
- Existing, current toxicological data necessary to evaluate the potential risks of human or ecological exposures to PFAS in groundwater, soil, sediment, and surface water.

To collect sufficient data to perform AOC-specific human health risk assessments (HHRAs) and screening level ecological risk assessments (SLERAs), the following samples will be collected:

- Soil samples to supplement the existing soil data and evaluate potential human and ecological exposure pathways.
- Groundwater samples from temporary VAP points and permanent monitoring wells to evaluate potential human exposure pathways.
- Surface water samples to evaluate potential human and ecological exposure pathways.

3.2.4 Step 4: Define the Boundaries of the Study

The general areal boundaries for the investigation are Area 3 (**Figure 1-1**). The vertical boundaries of the study will include overburden groundwater and/or bedrock groundwater to the extent necessary to evaluate the pathways for human or ecological exposures to PFAS released in Area 3. The temporal boundary is 1 year during which data will be collected.

3.2.5 Step 5: Develop Decision Rules

The list of required analytical samples and media was determined following review of historical data. All samples will be collected and analyzed in accordance with the technical guidance instruction (TGI) and standard operating procedure documents included in the Area 3 PFAS QAPP (**Appendix A**) to ensure that subsequent decisions are made based on valid data. Decisions will be based on the criteria described in the subsections below.

3.2.5.1 General

The presence or absence of PFAS will be based on the laboratory limits of detection (LODs) presented in the Area 3 PFAS QAPP (**Appendix A**).

Human health risk-based screening levels will be used, among other criteria, as decision criteria with regard to further investigative action. **Tables 1-1a and b** summarize the screening levels that will be used to evaluate the Area 3 Phase II PFAS RI data. In accordance with DoD (2024) guidance, soil and groundwater data will be screened against current USEPA RSLs for PFAS that have DoD-approved toxicity values. As of January 2025, the PFAS with DoD-approved toxicity values and RSLs are PFOS, PFOA, PFBS, PFNA, PFHxS, HFPO-DA, PFBA, PFHxA, PFPrA, and TFSI (DoD 2025).

The DoD (2024) guidance does not include health risk-based screening levels for surface water and sediment. Therefore, surface water and sediment data will be screened against the SSSLs for the Fort Devens NPL Site (**Appendix C**; USEPA Region 1 2023). The SSSLs were based on exposure scenarios and receptor-specific assumptions that are appropriate for screening the RI sample data. However, the scenarios and assumptions that will be used to calculate human health risks will be based on the site-specific human health CSM and may be refined based on information gathered during the RI. Chemical-specific values related to the dermal exposure route for water were updated in the November 2023 RSLs (USEPA 2023). This information was used to update the child recreator surface water SSSLs for these compounds and is noted in **Tables 1-1a and b**.

Although there are screening levels for HFPO-DA, as noted on the DoD PFAS website (DoD 2024), HFPO-DA was manufactured and used after 1995, after Fort Devens ceased operations. However, HFPO-DA data (if detected) will be screened against the corresponding RSL for informational purposes.

Ecological risk-based screening levels remain under development at the time of finalization of this Phase II RI WP and are not used in the decision rules with regard to further investigative action because of the uncertainty associated with decision making based upon so few ecological screening criteria. To evaluate potential ecological risks, the soil, sediment, and surface water data will be screened against PFAS Ecological Screening Values (ESVs), which area currently based on the Final Recommended Aquatic Life Criteria and Benchmarks for Select PFAS. United States Environmental Protection Agency, Office of Water, September 2024 (USEPA 2024c) and Derivation of PFAS Ecological Screening Values, Update, Environmental Sciences Division, Argonne National Laboratory, October 2024 - prepared by ANL on behalf of DoD, for use at DoD installations where PFAS have been detected in soils and surface waters (ANL 2024). The SLERA prepared as part of the RI Report will also consider relevant and appropriate PFAS ESVs current at the time the SLERA is prepared.

3.2.5.2 Groundwater

Decisions for the groundwater investigation will be based on the LODs and the approved USEPA RSLs for PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, PFBA, PFPrA, and TFSI in tapwater (**Table 1-1a**). The following decision rules will be used for groundwater:

- If the PFAS compounds listed in **Table 1-1a** are not detected at concentrations greater than the LODs, the LODs are less than or equal to the appropriate screening value, and the data are judged to be acceptable

through validation that has occurred, then the PFAS compounds will be considered to not be present, and no further investigation will be required.

- If the PFAS compounds listed in **Table 1-1a** are detected at concentrations less than the RSLs, then no further investigative action will be required.
- If the PFAS compounds listed in **Table 1-1a** are detected at concentrations greater than RSLs, then further investigation may be required to evaluate human health risks.

3.2.5.3 Soil

Decisions for soil investigation will be based on the LODs and the approved USEPA RSLs for PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, and PFBA in soil for commercial/industrial worker exposure to soil (**Table 1-1a**). The following decision rules will be used for soil:

- If the PFAS compounds listed in **Table 1-1a** are not detected at concentrations greater than the LODs, the LODs are less than or equal to the appropriate screening value, and the data are judged to be acceptable through validation that has occurred, then the PFAS compounds will be considered to not be present, and no further investigation will be required.
- If the PFAS compounds listed in **Table 1-1a** are detected at concentrations less than the RSLs, then no further investigative action will be required.
- If the PFAS compounds listed in **Table 1-1a** are detected at concentrations greater than the RSLs, then further investigation may be required to evaluate human health risk.

3.2.5.4 Surface Water

Decisions for the surface water investigation will be based on the LODs and the RSLs for the child recreator exposure to surface water (**Table 1-1b**). The following decision rules will be used for surface water:

- If the PFAS compounds listed in **Table 1-1b** are not detected at concentrations greater than the LODs, the LODs are less than or equal to the appropriate screening value, and the data are judged to be acceptable through validation that has occurred, then PFAS compounds will be considered to not be present, and no further investigation will be required.
- If the PFAS compounds listed in **Table 1-1b** are detected at concentrations less than SSSLs, then no further investigative action will be required.
- If the PFAS compounds listed in **Table 1-1b** are detected at concentrations greater than SSSLs, then further investigation may be required to evaluate human health risk.

3.2.5.5 Sediment

No additional sediment sampling is proposed at this time; existing sediment data are adequate for risk assessment.

3.2.5.6 Fish Tissue

Fish tissue (edible portions) sampling and analysis was previously performed as part of the Area 1 Phase II PFAS RI and included surface water bodies in Area 3.

3.2.6 Step 6: Specify Limits on Decision Errors (Performance Criteria)

The potential decision errors associated with this investigation include:

- The false presumption that the PFAS compounds listed in **Tables 1-1a and b** are not present at concentrations greater than the applicable decision criteria when, in fact, they are.
- The false presumption that the PFAS compounds listed in **Tables 1-1a and b** are present at concentrations greater than the applicable decision criteria when, in fact, they are not.

The data usability assessment process will be followed to limit decision errors based on field and analytical data. This process is described in the Area 3 PFAS QAPP (**Appendix A**).

3.2.7 Step 7: Develop/Optimize the Plan for Obtaining the Data

Investigations are proposed to collect the following data in Area 3. These data will be collected in two stages (Stages 1 and 2). The data to be collected in Stage 2 will build upon the data from Stage 1 to meet the RI requirements, which include:

- Nature and extent of PFAS in soil. Soil sample locations have been proposed based on Phase I data and where soil samples have not been collected previously. Select soil samples will be analyzed for total organic carbon, pH, and grain size (to include clay content) to further support analysis of PFAS transport in the unsaturated zone.
- Nature and extent of PFAS in groundwater. VAP groundwater sampling and analysis will be completed where data are not present from Phase I to characterize hydrostratigraphy and assess transport of PFAS in groundwater migrating from assumed source areas.
- Bedrock and overburden groundwater interaction, including vertical flow gradients at key locations such as those adjacent to surface water bodies. Monitoring wells will be installed upgradient of source areas where needed, within the source area/plume core, and downgradient of the source area (along preferential transport pathways) to delineate PFAS concentrations in groundwater exceeding the RSLs and update or refine the CSM.
- Nature and extent of PFAS in surface water and sediment. Surface water samples will be collected once again. Sediment samples from the Phase I RI are adequate for risk assessment. These data support the RI and will be used to refine the CSM, specifically, groundwater discharge locations and interaction to, and with, surface water and sediment.

4 Stage 1 Remedial Investigation Data Gaps

Data gaps for the Area 3 PFAS RI were evaluated based on whether the following study questions, related to the DQOs described in **Section 3**, could be answered using Phase I RI data alone or if additional (Phase II) field investigation would be required to meet those objectives. The data gap questions include:

- **Question 1:** Are there portions of Area 3 where soil sampling to assess suspected PFAS release areas has not been performed, or portions of Area 3 where the PFAS fingerprint or location/depth in groundwater suggests the potential for a separate source of PFAS?
- **Question 2:** Are there sufficient groundwater data in the areas of greatest PFAS concentrations in groundwater to evaluate fate and transport mechanisms/discharge locations?
- **Question 3:** Have the migration pathways of PFAS from Area 3 to receptors been assessed?

If the response to any of these questions is "No," additional investigation is required. The scope for the associated investigation is included in **Section 5**. **Figures 4-1** through **4-10** show the existing and proposed investigation locations for groundwater, surface water, and soil across all AOCs in Area 3.

4.1 Data Gap Question 1

During the Phase I RI, soil samples were collected from portions of Area 3 (KGS 2020). Sampling locations were sited on the analysis of groundwater samples from existing monitoring wells and/or interviews conducted as part of the Devens PFAS PA (KGS 2017). The PFAS fingerprint at SI and Phase I soil sample locations in the former MAAF area is consistent with that of AFFF. In the WWTP area, the soil fingerprint differs, indicating that a different source material was disposed of by industrial and residential users. **Exhibit 4-1** below summarizes whether the collection of additional soil samples is necessary, or if the existing soil data is sufficient, in order to answer the question "Are there portions of Area 3 where soil sampling to assess suspected PFAS release areas has not been performed, or portions of Area 3 where the PFAS fingerprint in groundwater suggests the potential for a separate source of PFAS?"

Exhibit 4-1. Question 1: Soil Sampling Data Gap Analysis

AOC	Data Gap?	Soil Sampling Locations Representative of Each Area, Collected During the Phase I RI	Sampling Location Reference
AOC 20	No – Existing soil data are sufficient	• A total of 36 soil samples were collected from one surface soil grab sample (SA20-17-01) and eight soil borings (20SB-19-01 through -08) at the sand infiltration beds in AOC 20. At 20SB-19-08, the 0 to 0.5 feet bgs sample slightly exceeded the SSSL for PFOS (detected at 13 µg/kg, the SSSL is 12.6 µg/kg), but this contamination is vertically and laterally delineated by nearby samples.	Figure 4-8

AOC	Data Gap?	Soil Sampling Locations Representative of Each Area, Collected During the Phase I RI	Sampling Location Reference
AOC 21	Yes – Additional soil sampling proposed	• 15 soil samples were collected from two surface soil grab samples (SA21-17-01 and -02) and three soil borings (21SB-19-01 through -03) at the sludge drying beds. Surface sample SA21-17-02 exceeded the SSSL for PFOS (12.6 µg/kg), and 21SB-19-01 and 21SB-19-03 slightly exceeded the SSSL for PFOS at 0.5-3 (19 µg/kg) and 3 to 7 feet bgs (13 µg/kg), respectively. Although the area of SSSL exceedances are not yet bounded, the existing data is consistent with the conceptual site model that the WWTP sludge beds/sludge disposal areas are the likely source of PFAS in groundwater. However, three additional soil borings (21SB-26-01, -02, and -03) are proposed to delineate the exceedances.	Figure 4-8
AOC 30	Yes – Additional soil sampling proposed	• 32 soil samples were collected from six surface soil grab samples (SA30-17-01 to -06) and six soil borings (30SB-19-01 through -06) in Areas A and B. The SSSL for PFOS was exceeded at four of the six surface soil locations (SA30-17-02, -03, -04, and -06), 30SB-19-06 (3 to 7 and 7 to 15 feet bgs), and 30SB-19-01 (0 to 0.5 and 0.5 to 3 feet bgs). Four additional soil borings (30SB-26-01, -02, -03, and -04) are proposed to delineate the exceedances.	Figure 4-9
AOC 31	No – Existing soil data are sufficient	• A total of 532 soil samples, consisting of 482 environmental samples and 50 QA/QC samples, have been collected and analyzed for PFAS analysis to date. SSSL exceedances of PFOS were identified throughout the vadose zone, greatest from the ground surface to 20 feet bgs. Some exceedances of PFOA were also detected. 16 soil borings installed in 2022 at the periphery of the AOC provided lateral and vertical delineation of PFOS and PFOA exceedances (31SB-21-10, -12, -15, 17 through -19, -21, -22, and -25 through -32).	Appendix B Figure 5-1 and Figure 1-4

AOC	Data Gap?	Soil Sampling Locations Representative of Each Area, Collected During the Phase I RI	Sampling Location Reference
AOC 50	Yes – Additional soil sampling proposed	• A total of 127 soil samples, consisting of 115 environmental samples and 12 QA/QC samples, have been collected and analyzed for PFAS analysis to date. • SSSL exceedances of PFOS and slight exceedances of PFOA were present at 50SB-19-03: from 0 to 0.5 foot bgs for PFOS (detected at 45 µg/kg, SSSL is 12.6 µg/kg) and PFOA (detected at 22 µg/kg versus the SSSL of 19 µg/kg) and from 0.5-3 for PFOA (26 µg/kg versus the SSSL of 19 µg/kg), adjacent to the former MAAF fire station. The PFOS SSSL was also exceeded in shallow sample AOC50-17-01 in that area. Soil borings 50SB-24-01 through 50SB-24-08 are proposed to delineate exceedances in soil in the area of the former MAAF fire station.	Figure 4-10

4.2 Data Gap Question 2

During the Phase I RI, groundwater samples were collected both from existing monitoring wells (primarily some at AOCs 20 and 21, and LTM wells for the AOC 50 PCE plume) and from temporary VAP points sampling. Proposed groundwater investigation locations in **Exhibit 4-2** are based on these results. **Exhibit 4-2** below summarizes whether installation of a monitoring well to establish EPCs at each of the locations with the greatest concentrations of PFAS identified during Phase I is necessary, or if a monitoring well is already in place for this purpose, in order to answer the question "Are there monitoring wells that can be sampled to establish EPCs in places where the greatest PFAS concentrations in groundwater were identified during Phase I RI activities?"

Exhibit 4-2. Question 2: Locations of Highest PFAS Concentrations in Groundwater – Monitoring Well Data Gap Analysis

AOC	Data Gap?	VAP Location or MW(s) Representative of the Highest Concentrations of PFAS Detected During Phase I	Sampling Location Reference
AOCs 20 and 21	No – Monitoring well in place	• Existing monitoring well MW-02A in AOC 20 (screened from 18 to 33 feet bgs, where PFAS6 was detected at 648 ng/L in 2019) is representative of the greatest concentration of PFAS in groundwater in AOCs 20 and 21.	Figure 4-2

AOC	Data Gap?	VAP Location or MW(s) Representative of the Highest Concentrations of PFAS Detected During Phase I	Sampling Location Reference
		• The highest PFAS6 concentration (304 ng/L) detected in AOC 21 is at 21VP-19-01 (33 to 37 feet bgs). The PFAS mixture at this location is similar to that at AOC 20, and the concentration of PFAS is lower. MW-02A is adjacent to this area and provides good representation of the greatest PFAS in groundwater detected in the area.	
AOC 30	Yes – Vertical Aquifer Profile/Monitoring well installation proposed	• VAP locations A3VP-24-01 and A3VP-24-02 are proposed to evaluate PFAS concentrations downgradient of the former Drum Storage Areas. Monitoring wells A3MW-24-01 and A3MW-24-02 will be installed and sampled at those locations based on the results of the VAP sampling.	Figure 4-5
AOC 31	Yes – Monitoring well installation proposed	• Monitoring well 31MW-24-01 is proposed at supplemental sampling VAP location AFT-B-4 (highest concentration of PFAS detected in/adjacent to AOC 31; PFAS6 was detected at 22,900 ng/L at 88 to 92 feet bgs). One monitoring well was already installed in this area during the 2022 supplemental sampling work, in the center of the former FTA (31MW-21-01). This monitoring well will be sampled as part of Phase II.	Figure 4-4 and Figure 1-3
AOC 50	Yes – Vertical Aquifer Profile/Monitoring well installation proposed	• VAP 50VP-24-01 is proposed to evaluate PFAS concentrations in groundwater immediately downgradient of the former airfield fire station. Monitoring well 50MW-24-01 will be installed at this location based on the results of the VAP sampling. • Monitoring well 50MW-24-02 is to be installed at supplemental Phase I VAP location 50VP-22-02 (highest PFAS6 concentration 23,900 ng/L	Figure 4-6

AOC	Data Gap?	VAP Location or MW(s) Representative of the Highest Concentrations of PFAS Detected During Phase I	Sampling Location Reference
		at 78 to 82 feet bgs, with PFAS concentrations 1,000 times greater than the SSSLs down to boring termination at 141 feet bgs). The proposed well will be installed in this same area, within about 10 lateral feet of 50VP-22-02. This location is in the middle of the former MAAF, downgradient of the former MAAF fire station.	

4.3 Data Gap Question 3

During the Phase I RI, soil and groundwater samples were collected from multiple depths at AOCs to determine the migration pathway of PFAS in the environment. Surface water and sediment samples were collected along the Nashua River and from smaller surface water bodies to determine if PFAS in groundwater is discharging to surface water. Particularly downgradient of AOC 20, the PFAS fingerprint in surface water has a similar mixture to that of the upgradient groundwater. Otherwise, the PFAS fingerprint in the Nashua River that flows into Area 3 is similar to what leaves Area 3, but with the portion of PFOS and PFHxS, in particular, having increased. These PFAS are the most common in groundwater across MAAF, and the increased portion of the PFAS fingerprint in the Nashua River along the MAAF indicates that groundwater from MAAF is likely discharging to this surface water body.

Exhibit 4-3 below summarizes these preliminary findings and informs decisions about whether additional investigation is required based on the question, “Have the migration pathways of PFAS from Area 3 to receptors been assessed?”

Exhibit 4-3. Migration Pathway Data Gap Analysis

AOC	Have the migration pathways of PFAS to potential receptors been assessed?		How do the data support identification of the migration pathway(s) or what additional data are needed?	Sampling Location Reference
AOC 20 and AOC 21	Groundwater Aquifer (Vertical Extent)	No – Monitoring well installation proposed	• Exceedances of the SSSLs in groundwater were present throughout overburden groundwater in VAP samples collected during Phase I. The vertical extent of PFAS in groundwater will be confirmed through installation and sampling of bedrock monitoring wells 20MW-24-01BR and 20MW-24-02BR, to be co-located with existing overburden monitoring wells MW-02A and 20VP-19-04, respectively.	Figure 4-2

AOC	Have the migration pathways of PFAS to potential receptors been assessed?		How do the data support identification of the migration pathway(s) or what additional data are needed?	Sampling Location Reference
	Discharge Location(s)/ Downgradient Receptors	Yes and no – Staff gauge installation proposed	• Discharge of groundwater to the Nashua River has been assessed based on hydrogeologic data, PFAS detections in groundwater and surface water, and the fingerprint of PFAS detected in both. • Surface water sample UP-19-01 was collected in the unnamed pond north of AOC 20 during the Phase I RI. PFAS was detected below the surface water SSSLs. • Three staff gauges (NRSG-01, NRSG-02, and NRSG-03) will be installed in the Nashua River to measure hydraulic gradients and groundwater flow direction adjacent to AOCs 20 and 21.	Figure 4-7 and Figure 4-1
	Potential Upgradient/ Offsite Sources	Yes	• Existing shallow bedrock monitoring wells MW-06 and MW-07 were non-detect for PFAS.	Figure 4-2
AOC 30	Groundwater Aquifer (Vertical Extent)	No – Monitoring well installation proposed	• Exceedances of the SSSLs in groundwater were present throughout overburden groundwater in VAP samples collected during Phase I. The vertical extent of PFAS in groundwater will be confirmed through installation and sampling of monitoring well A3MW-24-02 across the Nashua River from AOC 30 along Fitchburg Road.	Figure 4-5
	Discharge Location(s)/ Downgradient Receptors	Yes and no – VAP, monitoring well, and staff gauge installation proposed	• Discharge of groundwater to the Nashua River has been assessed based on hydrogeologic data, PFAS detections in groundwater and surface water, and the fingerprint of PFAS detected in both. • VAP 30VP-24-01 will be advanced at the northwestern end of the airfield to assess downgradient migration of PFAS toward the Nashua River. Overburden monitoring well 30MW-24-01 will be installed at the interval with highest PFAS concentrations, identified from VAP sample results. • Two staff gauges, NRSG-05 and NRSG-06, will be installed in the Nashua River to measure hydraulic gradients and groundwater flow direction adjacent to AOC 30. • A3VP-24-03 and A3MW-24-03 (co-located) and A3VP-24-05 and A3MW-24-05 (co-located) will be installed on the east side of the Nashua River along Route 2A/Fitchburg Road to the northeast of AOC 30 to assess for potential underflow and confirm groundwater flow direction offsite. These monitoring wells will help to confirm if the Nashua River is a natural groundwater divide.	Figure 4-5, Figure 4-1, and Figure 4-6
	Potential Upgradient/ Offsite Sources	Yes and no – VAP and monitoring well installation proposed	• 30VP-19-01, 30VP-19-02, and 30VP-19-05 (upgradient of the Drum Storage Areas A and B to the north and northeast) were advanced during the Phase I investigation. All sample intervals at 30VP-19-05 exceeded the PFAS6 SSSL, increasing with depth. These exceedances are likely from an upgradient source of PFAS, and the following will be performed to assess the origin:	Figure 4-5

AOC	Have the migration pathways of PFAS to potential receptors been assessed?		How do the data support identification of the migration pathway(s) or what additional data are needed?	Sampling Location Reference
			- A3VP-24-02 and A3MW-24-02 (co-located) will be installed along Route 2A/Fitchburg Road to the northwest of AOC 30 to assess the extent of PFAS in groundwater and confirm groundwater flow direction. The Nashua River may function as a natural groundwater divide between the MAAF and this area of Ayer. - A3VP-24-04 and A3MW-24-04 (co-located) are proposed for installation in the parking/storage area between DWW Motorsports and Splash Products, Inc. along Route 2A/Fitchburg Road to assess the extent of PFAS in upgradient groundwater and confirm groundwater flow direction offsite. These properties are northeast of AOC 30.	
AOC 31	Groundwater Aquifer (Vertical Extent)	No – Monitoring well installation proposed	• Exceedances of the SSSLs in groundwater were present throughout overburden groundwater in VAP samples collected during Phase I. The vertical extent of PFAS in groundwater will be confirmed through installation and sampling of bedrock monitoring well 31MW-24-01BR at the western (downgradient) edge of the airfield at AOC 31.	Figure 4-4
	Discharge Location(s)/ Downgradient Receptors	Yes and no – Staff gauge and monitoring well installation proposed	• Discharge of groundwater to the Nashua River has been assessed based on hydrogeologic data and PFAS detections in Phase I VAP samples and the fingerprint of PFAS detected in surface water. • Staff gauge NRSG-04 will be installed in the Nashua River to measure hydraulic gradients and groundwater flow direction adjacent to AOC 31. • VAP 31VP-19-05, directly west of AOC 31 and on the other side of the Nashua River, was below the SSSLs for PFAS during Phase I, indicating underflow of PFAS above the SSSLs to this location is not occurring. • VAP A3VP-24-01, overburden monitoring well A3MW-24-01, and bedrock well A3MW-24-01BR will be installed on the western side of the Nashua River northwest of AOC 31 to assess underflow and groundwater flow directions/gradients.	Figure 4-1 and Figure 4-4
AOC 50	Groundwater Aquifer (Vertical Extent)	No – VAP and monitoring well installation proposed	• Exceedances of the SSSLs in groundwater were present throughout overburden groundwater in VAP samples collected during Phase I. 50VP-24-01 and 50MW-24-01 (northeast/ upgradient of 50VP-22-01 and 50VP-22-02) will be installed to assess the extent and concentrations of PFAS adjacent to the former MAAF fire station at AOC 50.	Figure 4-6

AOC	Have the migration pathways of PFAS to potential receptors been assessed?		How do the data support identification of the migration pathway(s) or what additional data are needed?	Sampling Location Reference
	Discharge Location(s)/ Downgradient Receptors	Yes	• Discharge of groundwater to the Nashua River has been assessed based on hydrogeologic data and PFAS detections in Phase I VAP samples and the fingerprint of PFAS detected in surface water. • Two surface water/sediment samples, AFW-19-01 and AFW-19-02, were taken from the unnamed wetland west of the airfield during the Phase I RI. Neither sample exceeded SSSLs for surface water.	Figure 4-7
	Potential Upgradient/ Offsite Sources	No – Staff gauge, VAP and monitoring well installation proposed	• Staff gauge JBSG-01 will be installed near James Brook to measure hydraulic gradients and groundwater flow direction adjacent to AOC 50. • A3VP-24-06 and A3MW-24-06 are proposed to be installed in the lot of AVS, Inc. on the eastern side of the site boundary west of Route 2A/Fitchburg Road to assess the extent of PFAS in upgradient groundwater and confirm groundwater flow direction.	Figure 4-1

4.4 Data Gap Question 4

It is anticipated that additional investigation activities (i.e., Stage 2) will be required after the completion of the Stage 1 investigation to complete the delineation of the nature and extent of Area 3-related PFAS impacts. The Stage 2 investigation will include a review of the data from Phase I and Phase II Stage 1 to ensure the RI data will be sufficient, in terms of sample locations and sample quantity (e.g., a minimum of 10 data points to calculate statistical estimates of average exposure concentrations for soil), to conduct an HHRA and SLERA after the completion of Stage 2.

5 Proposed Remedial Investigation Activities

This section presents the comprehensive project approach, methods, and operational procedures to be used for the Area 3 Phase II PFAS RI. Detailed descriptions are presented in the Area 3 PFAS QAPP (**Appendix A**). Proposed locations for sampling are discussed staring in **Section 5.2 and 5.3**.

5.1 Methodology

Field activities will be conducted in accordance with the following TGIs, which are included in the Area 3 PFAS QAPP (**Appendix A**):

- TGI – PFAS Field Sampling (all media) Guidance;
- TGI – PFAS Sampling Procedures and Low-Flow Groundwater Purging for Monitoring Wells;
- TGI – Equipment and Reagent Blank Sample Collection for PFAS Analysis;
- TGI – Utility Location;
- TGI – PFAS Drilling and Well Installation;
- TGI – Monitoring Well Development;
- TGI – Manual Water-Level Monitoring;
- TGI – In-Situ and Ex-Situ Water Quality Parameters;
- TGI – Sample Chain of Custody;
- TGI – Investigation-Derived Waste Handling and Storage;
- TGI – Groundwater and Soil Sampling Equipment Decontamination;
- TGI – Soil Description;
- TGI – Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis;
- TGI – Vertical Aquifer Profiling;
- TGI – Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells; and
- TGI – Solid Slug Testing.

A summary of the proposed field activities is provided below. Details regarding the methodology of the proposed field activities are provided in the Area 3 PFAS QAPP (**Appendix A**).

- **Site Preparation:** Conducted before any intrusive activities are conducted. Preparation activities will include (but are not limited to) notifying the Massachusetts Digsafe system, clearing each drilling location of utilities with ground-penetrating radar, conducting a detailed visual inspection of the site and reviewing existing plans, clearing vegetation, and using soft dig methods to a depth of 5 feet bgs.
- **Soil Sampling:** Soil samples will be collected from AOC 21, AOC 30, and AOC 50. Soil descriptions will be recorded in accordance with the Unified Soil Classification System. The following will be recorded from each soil core at a minimum: depth interval, recovery, particle size (Udden-Wentworth), sorting, angularity/plasticity/dilatancy, principal and minor components, moisture, consistency/density, and color. Each recovered soil core will be photographed.
- **Vertical Groundwater Profiling:** Shallow VAP location methods will be installed using direct-push methods, and it is anticipated that deeper VAP locations will need to be installed using sonic drilling methods. Most VAP

locations will be installed prior to the installation of permanent monitoring wells at their respective locations, as the VAP data are needed to assess concentrations in the respective area and determine the appropriate well screen interval(s) for permanent monitoring wells.

- **Overburden Monitoring Well Installation:** Overburden monitoring wells will be installed using sonic drilling techniques. Select overburden well construction (screen interval) details have already been determined based on previously collected groundwater data. However, the screen intervals on most proposed overburden well locations will be determined following the installation of VAP locations.
- **Bedrock Monitoring Well Installation, including Borehole Geophysics and Packer Testing:** Bedrock monitoring well installation will generally occur after the installation of VAP locations and overburden monitoring wells. The construction details of bedrock wells will be determined based on borehole geophysics and packer testing.
- **Monitoring Well Development:** Well development will be completed following the installation of monitoring wells, using a submersible pump and surge block. Open bedrock borehole will be initially developed with the drill rig using air-lift methods.
- **Slug Testing:** Slug testing will be conducted at each new monitoring well location to estimate the hydraulic conductivities. A solid slug of calibrated/known volume will be used to conduct rising and falling head tests.
- **Groundwater Sampling and Water Level Measurements:** Groundwater samples will be collected during the installation of VAP borings. Groundwater samples and synoptic water levels will also be collected from all newly installed monitoring wells, in addition to a subset of existing monitoring wells in each investigation area during the spring (April/May; higher water table) and fall (October/November; lower water table).
- **Surface Water Sampling:** Surface water will be collected from locations that were previously sampled in 2019. Surface water samples will be collected from immediately below the water surface using the procedures appropriate given site conditions and may include direct collection in the sample jar and/or use of a peristaltic pump.

5.2 Former Wastewater Treatment Plant Area (Western Portion of Area 3 – AOCs 20 and 21)

This section details the proposed investigation activities at AOCs 20 and 21, including installation of additional soil borings and monitoring wells and the sampling of soil, overburden groundwater, and bedrock groundwater. Proposed groundwater investigation locations are shown on **Figure 4-1 and Figure 4-2,** and discussed in **Exhibit 4-3**.

5.2.1 Soil Sampling

Data gaps identified in **Exhibit 4-1** above will be addressed through the installation of 3 additional soil borings. These locations are shown on **Figure 4-8**, along with previously installed soil borings and a summary of PFAS detected in relation to the SSSLs. **Exhibit 5-1** below details the proposed Phase II RI locations.

Exhibit 5-1. Proposed Soil Sampling Locations – AOCs 20 and 21

Figure	Data Gap to be Addressed	Proposed Location IDs	Location	Estimated Depth to Groundwater (feet bgs)	Proposed Sampling Intervals (feet bgs)
4-8	Sample soils to bound SSSL exceedances identified during the SI and Phase I sampling.	21SB-26-01 to 21SB-26-03	AOC 21	10	0 to 0.5, 0.5 to 3, 3 to 7, and 7 to Water Table

Note:
* If the water table is encountered at a depth shallower than the bottom depth of these intervals, the deepest sample will end at the water table depth.

5.2.2 Groundwater Investigation

AOCs 20 and 21 data gaps identified in **Exhibit 4-2** will be addressed through installation of two additional bedrock monitoring wells. These locations are shown on **Figure 4-2**. **Exhibit 5-2** below includes the proposed Phase II RI locations, associated Phase I locations, and proposed well screen depths, if applicable. Information on the bedrock well installation approach is provided in **Section 5.4**.

Exhibit 5-2. Proposed Groundwater Investigation Locations – AOCs 20 and 21

Figure	Data Gap to be Addressed	Proposed Location IDs	Location Type	Reference Location(s)	Screen Interval (feet bgs)
4-2	Confirm the vertical extent of PFAS in groundwater and the vertical hydraulic gradient in bedrock.	20MW-24-01BR	MW (BR)	MW-02A	TBD
		20MW-24-02BR	MW (BR)	PZ-5 / 20VP-19-04	TBD

Notes:
MW (BR) = bedrock monitoring well
TBD = to be determined

In addition to collecting groundwater samples from the new proposed bedrock monitoring wells **(Exhibit 5-2**), a total of 11 existing monitoring wells will be sampled, as detailed in **Table 5-1**. These locations will be sampled twice, and synoptic water levels at each location will be measured twice, once in fall and once in spring.

5.3 Former Airfield Area (Eastern Portion of Area 3 – AOCs 30, 31, and 50)

This section details the proposed investigation activities at AOCs 30, 31, and 50, including installation of new investigation locations (VAPs, soil borings, monitoring wells, and stream gauges) and the sampling of soil, overburden groundwater, and bedrock groundwater. Proposed soil boring locations for AOC 50 are shown on **Figure 4-10**. All proposed groundwater investigation locations are shown on **Figure 4-1** and are depicted with more detail on **Figure 4-3 through Figure 4-6**. All proposed surface water sampling locations are shown on **Figure 4-7**.

5.3.1 Soil Sampling

Data gaps identified in **Exhibit 4-1** above will be addressed through the installation of 12 additional soil borings. These locations are shown on **Figures 4-9** and **4-10**, along with previously installed soil borings and a summary of PFAS detected in relation to the SSSLs. **Exhibit 5-3** below details the proposed Phase II RI locations.

Exhibit 5-3. Proposed Soil Sampling Locations – AOCs 30 and 50

Figure	Data Gap to be Addressed	Proposed Location IDs	Location	Estimated Depth to Groundwater (feet bgs)	Proposed Sampling Intervals (feet bgs)
4-9	Sample soils to bound SSSL exceedances identified during the SI and Phase I sampling.	30SB-26-01 to 30SB-26-04	AOC 30; Areas A and B	60	0 to 0.5, 0.5 to 3, 3 to 7, and 7 to 15
4-10	Sample soils to bound SSSL exceedances identified during the SI and Phase I sampling.	50SB-24-01 to 50SB-24-08	AOC 50; adjacent to the former MAAF fire station	60	0 to 0.5, 0.5 to 3, 3 to 7, and 7 to 15

Note:
* If the water table is encountered at a depth shallower than the bottom depth of these intervals, the deepest sample will end at the water table depth.

5.3.2 Groundwater Investigation

AOCs 30, 31, and 50 data gaps identified in **Exhibits 4-2** and **4-3** above will be addressed through installation and sampling of 8 additional VAPs, 10 additional overburden monitoring wells, 2 additional bedrock monitoring wells, and 7 additional staff gauges. These locations are shown on **Figure 4-1 and Figure 4-3 through Figure 4-6**. **Exhibit 5-4** below includes the proposed Phase II RI locations, associated Phase I locations, and proposed well screen depths, if identified based on existing VAP data.

***Exhibit 5-4. Proposed Groundwater Investigation Locations* – AOCs 30, 31, and 50**

Figure	Data Gap to be Addressed	Proposed Location ID	Location Type	Reference Location(s)	Screen Interval (feet bgs)
4-6	Confirm the extent of PFAS concentrations in groundwater to the northeast of AOC 30 and confirm if PFAS (if present) is flowing towards the MAAF from offsite sources. Install monitoring well to confirm concentrations and groundwater flow direction.	A3VP-24-05	VAP	East of 30VP-19-05, north of the former hangars	--
		A3MW-24-05	MW (OB)		TBD
		A3VP-24-03	VAP	Northwest of 30VP-19-05	--
		A3MW-24-03	MW (OB)		TBD
		A3VP-24-04	VAP	Northeast of 30VP-19-05	--
		A3MW-24-04	MW (OB)		TBD
4-5	Confirm the extent of PFAS concentrations in groundwater to the west of AOC 30, at the far northwest end of the MAAF runway. Install monitoring well to confirm concentrations and groundwater flow direction.	30VP-24-01	VAP	West of 30VP-19-04	--
		30MW-24-01	MW (OB)		TBD
4-5	Assess if migration to offsite receptors across the Nashua River to the northwest of MAAF is occurring; confirm groundwater flow direction.	A3VP-24-02	VAP	None	--
		A3MW-24-02	MW (OB)		TBD
4-4	Assess if migration to offsite receptors across the Nashua River is occurring west of AOC 31; confirm groundwater flow direction.	A3VP-24-01	VAP	None	--
		A3MW-24-01	MW (OB)		TBD
	Confirm the vertical extent of PFAS in groundwater	A3MW-24-01BR	MW (BR)		TBD
4-4	Install shallow overburden monitoring well to confirm PFAS concentrations in groundwater where it was detected at the highest concentrations at AOC 31 during Phase I.	31MW-24-01	MW (OB)	AFT-B-4, directly hydraulically downgradient of AOC 31	85-95

Figure	Data Gap to be Addressed	Proposed Location ID	Location Type	Reference Location(s)	Screen Interval (feet bgs)
	Confirm the vertical extent of PFAS in groundwater and the vertical hydraulic gradient in bedrock.	31MW-24-01BR	MW (BR)		TBD
4-1	Assess PFAS concentrations and groundwater flow direction to the east of the MAAF.	A3VP-24-06	VAP	None	--
		A3MW-24-06	MW (OB)		TBD
4-6	Install shallow overburden monitoring well to confirm PFAS concentrations in groundwater where it was detected at the highest concentration at AOC 50 during Phase I, downgradient of the former MAAF fire station.	50MW-24-02	MW (OB)	50VP-22-02	75-85
4-6	Assess PFAS concentrations in groundwater immediately downgradient of the former fire station. Install overburden well at the depth of the highest PFAS concentration detected in the VAP boring.	50VP-24-01 / 50MW-24-01	VAP / MW (OB)	None	TBD
4-1	Confirm surface water elevations to assess groundwater flow directions and vertical hydraulic gradients.	NRSG-01	Staff gauge	NR-19-09	--
		NRSG-02		NR-19-02	
		NRSG-03		NR-19-05	
		NRSG-04		NR-19-07	
		NRSG-05		NR-19-11	
		NRSG-06		NR-19-13	
		JBSG-01		None	

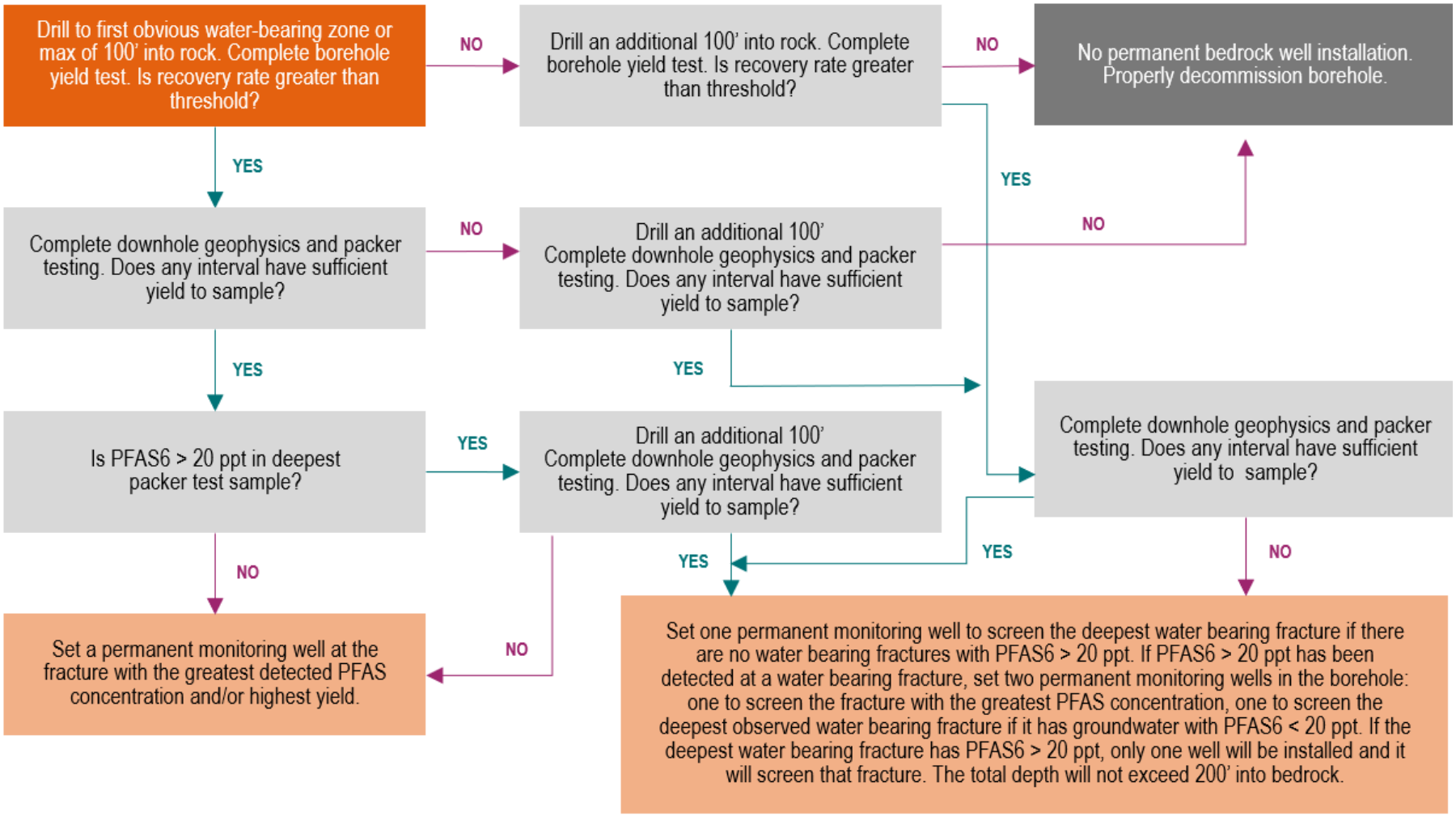
Notes:
-- = not applicable
MW (OB) – overburden monitoring well

In addition to collecting groundwater samples from the new proposed overburden and bedrock monitoring wells, a total of 36 existing monitoring wells will be sampled, as detailed in **Table 5-1**. These locations will be sampled twice, and synoptic water levels at each location will be measured twice, once in fall and once in spring.

5.4 Bedrock Well Installation Approach

Bedrock monitoring wells are proposed to be installed in AOC 20, AOC 31, and west of the Nashua River adjacent to AOC 31 (A3MW-24-01BR). The bedrock well installation approach is defined in **Exhibit 5-5** below, and additional details on the installation methodology are provided in the Area 3 PFAS QAPP (**Appendix A**).

Exhibit 5-5. Bedrock Well Installation Flow Chart



Notes:
' = foot/feet
> = greater than
< = less than

Additional information on the approximate bedrock elevations and target drilling depths is included in **Exhibit 5-6** below. These details will be modified based on field conditions.

Exhibit 5-6. Proposed Bedrock Monitoring Wells

Location	Location ID	Ground Surface Elevation (estimated) feet NAVD88	Bedrock Surface Elevation (estimated) feet NAVD88	Target Drilling Depth (estimated) feet NAVD88[a]	Target Drilling Depth (estimated) feet[b]
AOC 20	20MW-24-01BR	239	110	5	234
	20MW-24-02BR	223	99	-6	229
AOC 31	31MW-24-01BR	267	82	-23	290
Off-base	A3MW-24-01BR	252	166	61	191

Notes:
1. Bedrock surface elevations are estimated based on available information. Target drilling depths will be adjusted based on field observations. The target drilling depths shown above are an estimated 100 feet into bedrock, the "max" indicated in the first step of **Exhibit 5-5** above.
2. Target drilling depths assume that permanent well casing will be grouted 5 feet into competent rock.
[a] Location contingent on overburden groundwater monitoring results.
[b] Feet below ground surface.

NAVD88 = North American Vertical Datum of 1988

5.5 Surface Water and Sediment Assessment

Surface water and sediment data collected during Phase I activities indicated that PFAS was present in Area 3 surface water bodies. While the quantity and locations of Phase I surface water and sediment samples are adequate for risk assessment purposes, another round of surface water sampling was deemed necessary to provide data concurrent with groundwater samples. All surface water samples will be collected from locations that were sampled in 2019. As detailed in **Exhibit 5-7** below and shown on **Figure 4-7**, a total of 18 surface water samples are proposed from the water bodies listed below. The surface water sampling will consist of one round of sampling.

Exhibit 5-7. Area 3 Surface Water Proposed Sampling Locations

Surface Water Body	Location ID
Unnamed (AOC 20)	UP-19-01
N/A (AOC 21)	US-19-01
AOC 50	AFW-19-01 and AFW-10-02
Nashua River	NR-19-01 through NR-10-14

6 Reporting

After completion of the first stage of Area 3 Phase II PFAS RI field activities, a Stage 1 Field Investigation Report and Stage 2 Work Plan Addendum will be prepared. The Stage 1 Field Investigation Report will present and evaluate the efficacy of the data for meeting the stated Stage 1 Area 3 Phase II PFAS RI objectives. The Stage 2 Work Plan Addendum will include scope that builds off of the findings of the first stage, completes delineation, and provides data required to complete an HHRA and a SLERA. The RI Report will be prepared upon the conclusion of the Stage 2 investigation in accordance with the USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA 1988).

7 Project Schedule

The anticipated project schedule is presented below in **Exhibit 7-1**.

Exhibit 7-1. Anticipated Project Schedule

Task	Date
Army Submits Draft WP to USEPA/MassDEP	Summer 2025
USEPA/MassDEP Review of Draft WP	Fall 2025
Army Issues Response Letter to USEPA/MassDEP Comments on Draft WP	
USEPA/MassDEP Review of Response Letter	Fall 2025
Army Submits Draft Final WP to USEPA/MassDEP	Fall 2025
USEPA/MassDEP Review of Draft Final WP	Fall 2025
Army Submits Final WP	Winter 2025/2026
Field Work (tentative)	
USEPA/MassDEP/Army Meeting to discuss analytical data and placement of permanent monitoring wells	Summer/Fall 2026
Submit Draft Stage 1 Area 3 Phase II RI Field Investigation Report (pending field work)	Winter 2026/2027

8 References

ABB-ES. 1993. Final Site Investigation Report, Fort Devens SI, Groups 3, 5 and 6. April.

Adamson, D.T., A. Nickerson, P.R. Kulkarni, C.P. Higgins, J. Popovic, J. Field, A. Rodowa, C. Newell, P. DeBlanc, and J.J. Kornuc. 2020. Mass-based, field-scale demonstration of PFAS retention within AFFF-associated source areas. *Env. Sci. Tech.* 54(24), pp.15768-15777.

Anderson, R., G. Hunter, C. Long, R.C. Porter, and J.K. Anderson. 2016. Occurrence of select perfluoroalkyl substances at U.S. Air Force aqueous film-forming foam release sites other than fire-training areas: Field-validation of critical fate and transport properties. *Chemosphere* 150:678-685. Available online: https://doi.org/10.1016/j.chemosphere.2016.01.014.

Anderson, R.H., D.T. Adamson, and H.F. Stroo. 2019. Partitioning of poly-and perfluoroalkyl substances from soil to groundwater within aqueous film-forming foam source zones. *J. Cont. Hydro.* 220:59-65.

ANL. 1992. Final Master Environmental Plan (MEP) for Fort Devens, Massachusetts. April.

ANL. 2024. Derivation of PFAS Ecological Screening Values, Update. Environmental Sciences Division, Argonne National Laboratory, October.

BERS-Weston. 2018a. Draft Site Inspection Report for Per- and Polyfluoroalkyl Substances (PFAS) at Area of Contamination (AOC) 76 – Devens Fire Department, Former Fort Devens Army Installation, Devens, MA. April.

BERS-Weston. 2018b. Final Site Inspection Report for Per-and Polyfluoroalkyl Substances (PFAS) at Former Fort Devens Army Installation, Devens, MA. May.

DoD. 2023. Office of the Assistant Secretary of Defense. Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July. Available online at: https://www.acq.osd.mil/eie/eer/ecc/pfas/tf/policies.html.

DoD. 2024. Office of the Assistant Secretary of Defense. PFAS 101: Regional Screening Levels used in DoD Cleanups. March. Available online at: https://www.acq.osd.mil/eie/eer/ecc/pfas/pfas101/rsl.html.

DoD. 2025. Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. January 17, 2025 Memorandum. Available online: https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/policies/Memo-for-Investigating-DoD-PFAS-Cleanup.pdf.

DoD and DOE. 2023. Department of Defense and Department of Energy Quality Systems Manual for Environmental Laboratories. Version 6.0. December 13. Available online at: https://www.denix.osd.mil/edqw/denix-files/sites/43/2024/01/QSM-Version-6.0-FINAL-Dec-13-2023.pdf.

GZA. 2011a. Final Report Geothermal Pathfinder Well, USARC (Building 1410), Devens, Massachusetts. Prepared for United States Army Corp of Engineers, Concord, Massachusetts. May.

GZA. 2011b. Final Report Geothermal Pathfinder Well, Ayer, MA AFRC Training Building, Ayer, Massachusetts. Prepared for United States Army Corp of Engineers, Concord, Massachusetts. August.

HLA. 2000a. Final Remedial Investigation Report Area of Contamination (AOC) 50, Devens, Massachusetts.

HLA. 2000b. Final Remedial Investigation Report Area of Contamination (AOC) 57, Devens, Massachusetts. June.

ITRC. 2020a. History and Use of Per- and Polyfluoroalkyl Substances (PFAS) found in the Environment. Fact Sheet. August. Available online at: History and Use of Per- and Polyfluoroalkyl Substances (PFAS) found in the Environment (itrcweb.org).

ITRC. 2020b. PFAS Technical and Regulatory Guidance Document. September. Available online at: PFAS — Per- and Polyfluoroalkyl Substances (itrcweb.org).

KGS. 2017. Final Base-Wide Preliminary Assessment for Evaluation of Perfluoroalkyl Substances, Former Fort Devens Army Installation BRAC Legacy Sites, Devens, Massachusetts. September.

KGS. 2019. Area 3 Field Sampling Plan (FSP) Addendum to Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS). Former Fort Devens Army Installation, Devens, Massachusetts. Draft Final. October.

KGS. 2020. Final Remedial Investigation Work Plan for Per and Polyfluoroalkyl Substances (PFAS) and Uniform Federal Policy for Quality Assurance Project Plan for the Remedial Investigation of Per- and Polyfluoroalkyl Substances, Former Fort Devens Army Installation. December.

KGS. 2021. Area 3 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation, Former Fort Devens Army Installation, Devens, MA. February.

KGS. 2022. Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS) Area 3 Field Sampling Plan Addendum No.1, Former Fort Devens Army Installation, Devens, MA. April.

Kopera, J.P., S.B. Mabee, and D.C. Powers. 2006: Office of the Massachusetts State Geologist, Open-File Report OFR-06-03, scale 1:24,000.

MassDEP. 2020. Fact Sheet: Interim Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. October.

NRWA. 2008. Devens Open Space and Recreation Plan: 2008-2013. Prepared by MWRA in association with Montachusett Regional Planning Commission and Massachusetts Development Finance Agency. January.

S-A JV. 2023. Area 1 Phase II Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances, Former Fort Devens Army Installation, Devens, Massachusetts. September.

Sepulvado, J.G., A.C. Blaine, A.C., L.S. Hundal, and C.P. Higgins. 2011. Occurrence and fate of perfluorochemicals in soil following the land application of municipal biosolids. *Env. Sci. Technol.* 45(19):8106-8112.

Stahl, T., R.K. Riebe, S. Falk, K. Failing, and H. Brunn. 2013. Long-term lysimeter experiment to investigate leaching of perfluoroalkyl substances (PFASs) and the carry-over from soil to plants: results of a pilot study. *J. Agri. Food Chem*. 61 (8):1784-1793.

U.S. Geological Survey. 1994. Water-Resources Investigations Report 93-4115. Yields of Bedrock Wells in Massachusetts. Available online at: https://pubs.usgs.gov/wri/1993/4115/report.pdf.

USEPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. EPA/540/G-89/004. October.

USEPA. 2000. Data Quality Objectives Process for Hazardous Waste Site Investigations. EPA QA/G-4HW. Final. EPA/600/R-00/007. January.

USEPA. 2016. Lifetime Health Advisories and Health Effects Support Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate. EPA-HQ-OW-2014-0138; FRL-9946-91-OW. Federal Register/ Vol. 81. No. 101. May 25. Available online at: https://www.govinfo.gov/content/pkg/FR-2016-05-25/pdf/201612361.pdf.

USEPA. 2018. Memorandum: Site Specific Screening Levels for PFOA, PFOS, and PFBS for the Fort Devens NPL Site. USEPA Region 1. February 28.

USEPA. 2023. Regional Screening Level (RSL). November.

USEPA. 2024a. PFAS National Primary Drinking Water Regulation. 89 FR 32532. Available online at: https://www.federalregister.gov/documents/2024/04/26/2024-07773/pfas-national-primary-drinking-water-regulation. 26 April.

USEPA.2024b. Regional Screening Level (RSL) Calculator. Available online at: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.

USEPA. 2024c. Fact Sheet, Final Recommended Aquatic Life Criteria and Benchmarks for Select PFAS. United States Environmental Protection Agency, Office of Water, September.

USEPA Region 1. 2018. Memorandum: Site Specific Screening Levels for PFOA, PFOS, and PFBS for the Fort Devens NPL Site. February 28.

USEPA Region 1. 2022. Site-specific Screening Levels for PFOA, PFOS, PFBS, PFNA, PFHxS, HFPO-DA, PFBA, and PFHxA for the Fort Devens NPL Site. USEPA Region 1. June. Included with USEPA comments on the Draft Devens Phase II PFAS Remedial Investigation Work Plan – Area 1.

USEPA Region 1. 2023. Site-specific Screening Levels for PFOA, PFOS, PFBS, PFNA, PFHxS, HFPO-DA, PFBA, and PFHxA for the Fort Devens NPL Site. USEPA Region 1. June. Included with USEPA comments on the Draft Final Devens Phase II PFAS Remedial Investigation Work Plan – Area 1.

VHB. 1994. Devens Reuse Plan. Prepared for the Boards of Selectmen of the Towns of Ayer, Harvard, and Lancaster.

Tables

Table 1-1a
Human Health Risk-based Screening Levels for Groundwater and Soil as of April 2025
Area 3 Phase II Remedial Investigation Work Plan for PFAS - Stage 1
Former Fort Devens Army Installation
Devens, Massachusetts

PFAS	Abbreviation	CASRN	DoD Screening Level (ASD 2025)					
			Groundwater (Tap Water)			Residential Soil		
			µg/L	ng/L	Basis	mg/kg	µg/kg	Basis
Perfluorooctanoic acid	PFOA	335-67-1	4.0E-03	4.0	b	7.0E-05	0.07	c
Perfluorooctanesulfonic acid	PFOS	1763-23-1	4.0E-03	4.0	b	6.3E-04	0.63	a
Perfluorobutanesulfonic acid	PFBS	375-73-5	6.0E-01	600	a	1.9E+00	1900	a
Perfluorononanoic acid	PFNA	375-95-1	5.9E-03	5.9	a	1.9E-02	19	a
Perfluorohexanesulfonic acid	PFHxS	355-46-4	1.0E-02	10	b	1.3E-01	130	a
Hexafluoropropylene oxide dimer acid	HFPO-DA (GenX)	13252-13-6	1.5E-03	1.5	a	2.3E-02	23	a
Perfluorobutanoic acid	PFBA	375-22-4	1.8E+00	1800	a	7.8E+00	7800	a
Perfluorohexanoic acid	PFHxA	307-24-4	9.9E-01	990	a	3.2E+00	3200	a
Perfluorodecanoic acid	PFDA	335-76-2	5.2E-04	0.52	c	6.0E-05	0.06	c
Perfluoropropanoic acid	PFPrA	422-64-0	9.8E-01	980	a	3.9E+00	3900	a
bis(Trifluoromethylsulfonyl)amine	TFSI	82113-65-3	5.9E-01	590	a	2.3E+00	2300	a

Notes:
(a) Screening level is the USEPA Regional Screening Level based on a noncancer hazard quotient of 0.1 (November 2024).
(b) Screening level is the Maximum Contaminant Level (MCL) (ASD 2025).
(c) Screening level is the analytical method's pooled method detection limit (MDL) (ASD 2025).

Abbreviations and Acronyms:
µg/L - micrograms per liter
µg/kg - micrograms per kilogram
ASD - Assistant Secretary of Defense
CASRN - Chemical Abstracts Service Registry Number
DoD - Department of Defense
mg/kg - milligrams per kilogram
ng/L - nanograms per liter
PFAS - per- and polyfluoroalkyl substances
USEPA - United States Environmental Protection Agency

References:
ASD 2025. Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. January 17, 2025 Memorandum. Available online: https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/policies/Memo-for-Investigating-DoD-PFAS-Cleanup.pdf.
USEPA 2024. Regional Screening Levels. November. Available online: https://www.epa.gov/risk/regional-screening-levels-rsls.

Table 1-1b
Human Health Risk-based Screening Levels for Surface Water, Sediment, and Fish Tissue as of April 2025
Area 3 Phase II Remedial Investigation Work Plan for PFAS - Stage 1
Former Fort Devens Army Installation
Devens, Massachusetts

PFAS	Abbreviation	CASRN	Human Health Risk-based Screening Levels [1]							
			Recreator Surface Water [2]			Recreator Sediment [3]			Angler Fish Tissue [4]	
			µg/L	ng/L	Basis	mg/kg	µg/kg	Basis	mg/kg	Basis
Perfluorooctanoic acid	PFOA	335-67-1	2.6E-04	0.26	a	8.0E-05	0.08	a	3.7E-07	a
Perfluorooctanesulfonic acid	PFOS	1763-23-1	1.0E-02	10	b	3.1E-03	3	b	3.1E-05	b
Perfluorobutanesulfonic acid	PFBS	375-73-5	3.0E+01	30400	b	9.1E+00	9140	b	9.2E-02	b
Perfluorononanoic acid	PFNA	375-95-1	2.9E-01	287	b	9.1E-02	91	b	9.2E-04	b
Perfluorohexanesulfonic acid	PFHxS	355-46-4	1.9E+00	1930	b	6.1E-01	609	b	6.1E-03	b
Hexafluoropropylene oxide dimer acid	HFPO-DA (GenX)	13252-13-6	3.2E-02	32	b	1.1E-01	110	b	9.2E-04	b
Perfluorobutanoic acid	PFBA	375-22-4	8.2E+01	81900	b	3.7E+01	36500	b	3.1E-01	b
Perfluorohexanoic acid	PFHxA	307-24-4	4.9E+01	49200	b	1.5E+01	15200	b	1.5E-01	b
Perfluorodecanoic acid	PFDA	335-76-2	5.2E-04	0.52	c	6.1E-05	0.06	b	6.1E-07	b
Perfluoropropanoic acid	PFPrA	422-64-0	4.7E+01	47100	b	1.8E+01	18300	b	1.5E-01	b
bis(Trifluoromethylsulfonyl)amine	TFSI	82113-65-3	2.8E+01	28300	b	1.1E+01	11000	b	9.2E-02	b

Notes:
1. Human health risk-based screening levels for the select PFAS included on the ASD's PFAS 101 website (https://www.acq.osd.mil/eie/eer/ecc/pfas/pfas101/rsl.html) were calculated using the USEPA Regional Screening Level (RSL) online calculator.
Screening levels were rounded to two significant figures, to be consistent with published RSL tables (https://www.epa.gov/risk/regional-screening-levels-rsls).
The recreator and angler exposure parameters are consistent with those used by USEPA Region 1 to calculate Former Fort Devens site-specific screening levels in June 2023.

2. Surface water screening levels were calculated using a recreator exposure frequency (EF) of 45 days/year, exposure time (ET) of 1 hour/event, event frequency (EV) of 1 event/day, child skin surface area (SSA) of 1,979 cm^2/event, and adult SSA of 4,780 cm^2/event.

3. Sediment screening levels were calculated using a recreator EF of 75 days/year, ET of 1 hour/event, EV of 1 event/day, child SSA of 1,979 cm^2/event, and adult SSA of 4,780 cm^2/event.
4. Fish tissue screening levels were calculated using an adult fish ingestion rate of 21,000 mg/day and a child ingestion rate of 5,100 mg/day (USEPA 2014).

(a) Screening level is based on a target cancer risk of 1×10^{-6}.
(b) Screening level is based on a target noncancer hazard quotient of 0.1.
(c) Screening level is the analytical method's pooled method detection limit (MDL) (ASD 2025).

Abbreviations and Acronyms:
µg/L - micrograms per liter
µg/kg - micrograms per kilogram
ASD - Assistant Secretary of Defense
CASRN - Chemical Abstracts Service Registry Number
cm^2 - square centimeters
mg - milligrams
mg/kg - milligrams per kilogram
ng/L - nanograms per liter
PFAS - per- and polyfluoroalkyl substances
USEPA - United States Environmental Protection Agency

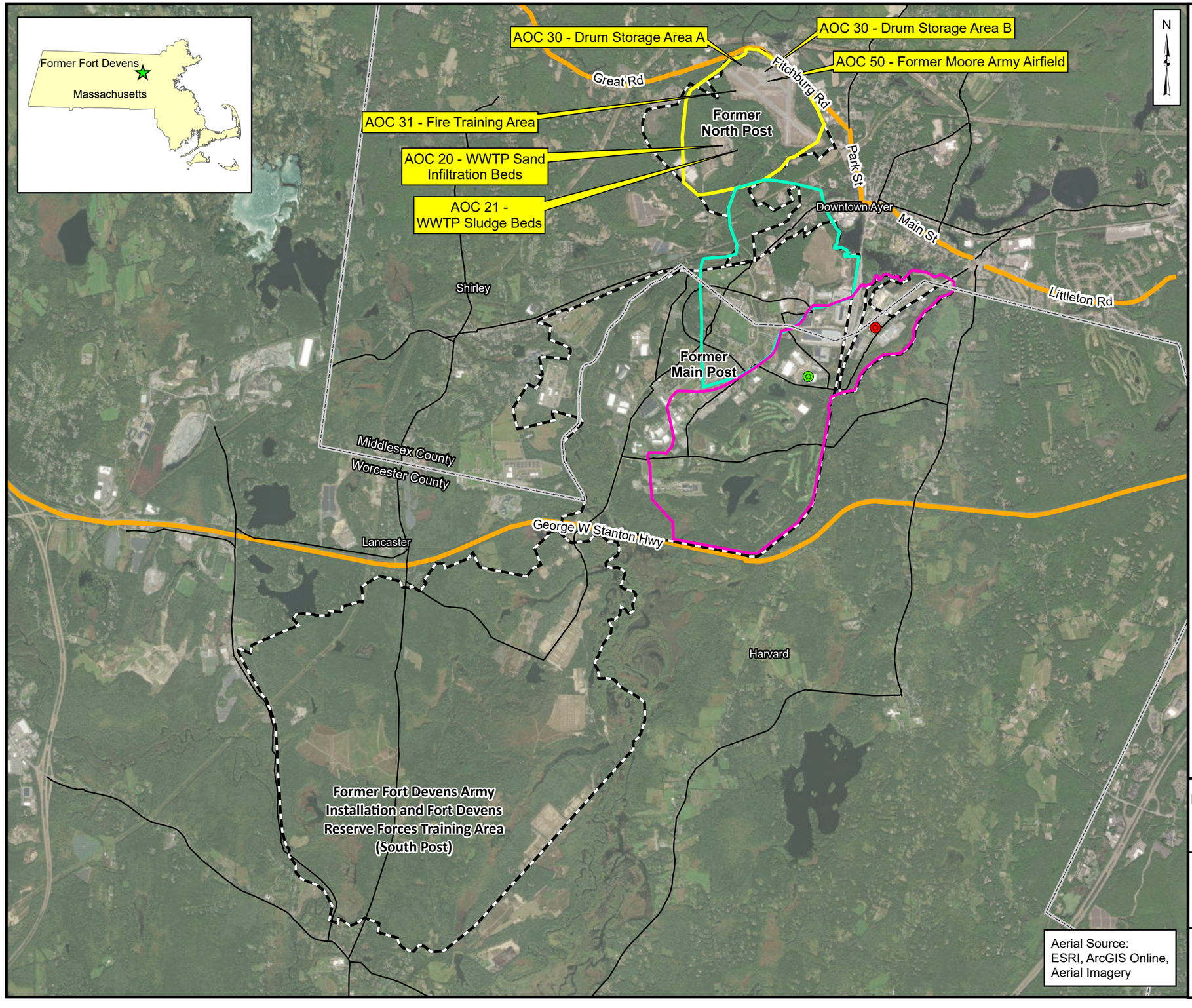
References:
ASD 2025. Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. January 17, 2025 Memorandum.
Available online: https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/policies/Memo-for-Investigating-DoD-PFAS-Cleanup.pdf.
USEPA 2014. Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010), Final Report. EPA-820-R-14-002. April.
Available online: vhttps://www.epa.gov/sites/default/files/2015-01/documents/fish-consumption-rates-2014.pdf.

Table 5-1
Existing Monitoring Wells to be Sampled
Area 3 Phase II Remedial Investigation Work Plan for PFAS - Stage 1
Former Fort Devens Army Installation
Devens, Massachusetts

Associated Area	Location ID	Ground Surface Elevation (ft NAVD88)	Top of Casing Elevation (ft NAVD88)	Screen Interval Depth (ft bgs)	Screen Interval Elevation (ft NAVD88)
Wastewater Treatment Plant Sand Infiltration Beds (AOC 20)	MW-01A	218.71	221.40	18 - 33	200.71 - 185.71
	MW-02A	223.65	225.30	18 - 33	205.65 - 190.65
	MW-04	214.72	217.30	7 - 22	207.72 - 192.72
	MW-06	231.71	233.90	14 - 29	217.71 - 202.71
	MW-07	241.20	242.50	20.5 - 35.5	220.7 - 205.7
	MW-WC1A	209.69	212.50	6.45 - 17.95	203.24 - 191.74
	MW-WC2	210.40	217.10	5.4 - 19.9	205 - 190.5
	PZ-1	272.10	274.60	70 - 75	202.1 - 197.1
	PZ-2	272.10	275.10	95 - 100	177.1 - 172.1
	PZ-5	224.30	227.20	25 - 30	199.3 - 194.3
	PZ-6	218.90	221.80	15 - 20	203.9 - 198.9
Firefighting Training Area (AOC 31)	31-MW-21-01	267.33	270.16	60 - 70	207.33 - 197.33
	G6M-18-01	264.58	264.24	116 - 126	148.58 - 138.58
	G6M-18-02	266.64	268.33	123.95 - 133.95	142.69 - 132.69
Former Moore Army Airfield (AOC 50)	G6M-01-01X	263.62	265.67	130 - 150	133.62 - 113.62
	G6M-02-01X	263.12	262.44	80 - 95	183.12 - 168.12
	G6M-02-06X	204.72	209.73	55 - 65	149.72 - 139.72
	G6M-02-07X	207.74	210.72	30 - 40	177.74 - 167.74
	G6M-02-08X	222.72	224.23	60 - 70	162.72 - 152.72
	G6M-02-09X	262.66	264.10	90 - 105	172.66 - 157.66
	G6M-02-13X	263.81	263.61	110 - 120	153.81 - 143.81
	G6M-03-11X	260*	Unknown	115 - 130	145* - 130*
	G6M-04-03X	264.78	264.29	85 - 95	179.78 - 169.78
	G6M-04-06X	262.20	263.97	95 - 105	167.2 - 157.2
	G6M-04-08X	203.20	209.55	80 - 90	123.2 - 113.2
	G6M-04-10X	222.46	224.22	52 - 62	170.46 - 160.46
	G6M-04-11X	228.27	229.47	35 - 45	193.27 - 183.27
	G6M-04-13X	224.17	225.88	30 - 40	194.17 - 184.17
	G6M-04-14X	208.51	210.61	80 - 90	128.51 - 118.51
	G6M-13-02X	264.03	263.82	115 - 125	149.03 - 139.03
	G6M-13-03X	264.78	264.37	80 - 90	184.78 - 174.78
	G6M-13-05X	223.86	225.00	45 - 55	178.86 - 168.86
	G6M-92-10X	222.40	225.08	9 - 19	213.4 - 203.4
	G6M-93-13X	222.90	224.83	9 - 19	213.9 - 203.9
	G6M-95-20X	222.51	224.61	18 - 23	204.51 - 199.51
	G6M-96-22A	216.30	217.59	40 - 50	176.3 - 166.3
	G6M-96-22B	216.40	217.56	65.5 - 70.5	150.9 - 145.9
	G6M-96-25A	223.28	225.52	9 - 18.7	214.28 - 204.58
	G6M-96-25B	223.89	225.64	48 - 58	175.89 - 165.89
	G6M-96-26A	222.83	224.56	8 - 18	214.83 - 204.83
	G6M-96-26B	222.89	224.40	68 - 78	154.89 - 144.89
	G6M-97-09B	257.30	260.05	71.5 - 81.5	185.8 - 175.8
	G6P-97-05X	234.59	236.72	33 - 43	201.59 - 191.59
	MW-6	263.59	265.20	125 - 135	138.59 - 128.59
	MW-7 (IT)	238.20	234.00	22 - 32	216.2 - 206.2
	XSA-12-96X	266.56	269.99	120 - 130	146.56 - 136.56
	XSA-12-98X	204.14	209.61	60 - 70	144.14 - 134.14

Acronyms and Abbreviations:
AOC = Area of Contamination
ft bgs = feet below ground surface
ft NAVD88 = feet North American Vertical Datum 1988
ID = Identification

Figures



LEGEND

- FORMER FORT DEVENS BOUNDARY
- COUNTY LINE
- HIGHWAY
- MAJOR ROAD
- PFAS AREA 1
- PFAS AREA 2
- PFAS AREA 3
- DEVENS PATHFINDER WELL
- AYER PATHFINDER WELL

NOTES:
AOC = AREA OF CONTAMINATION
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
WWTP = WASTEWATER TREATMENT PLANT

0 1 2
Miles

Aerial Source:
ESRI, ArcGIS Online,
Aerial Imagery

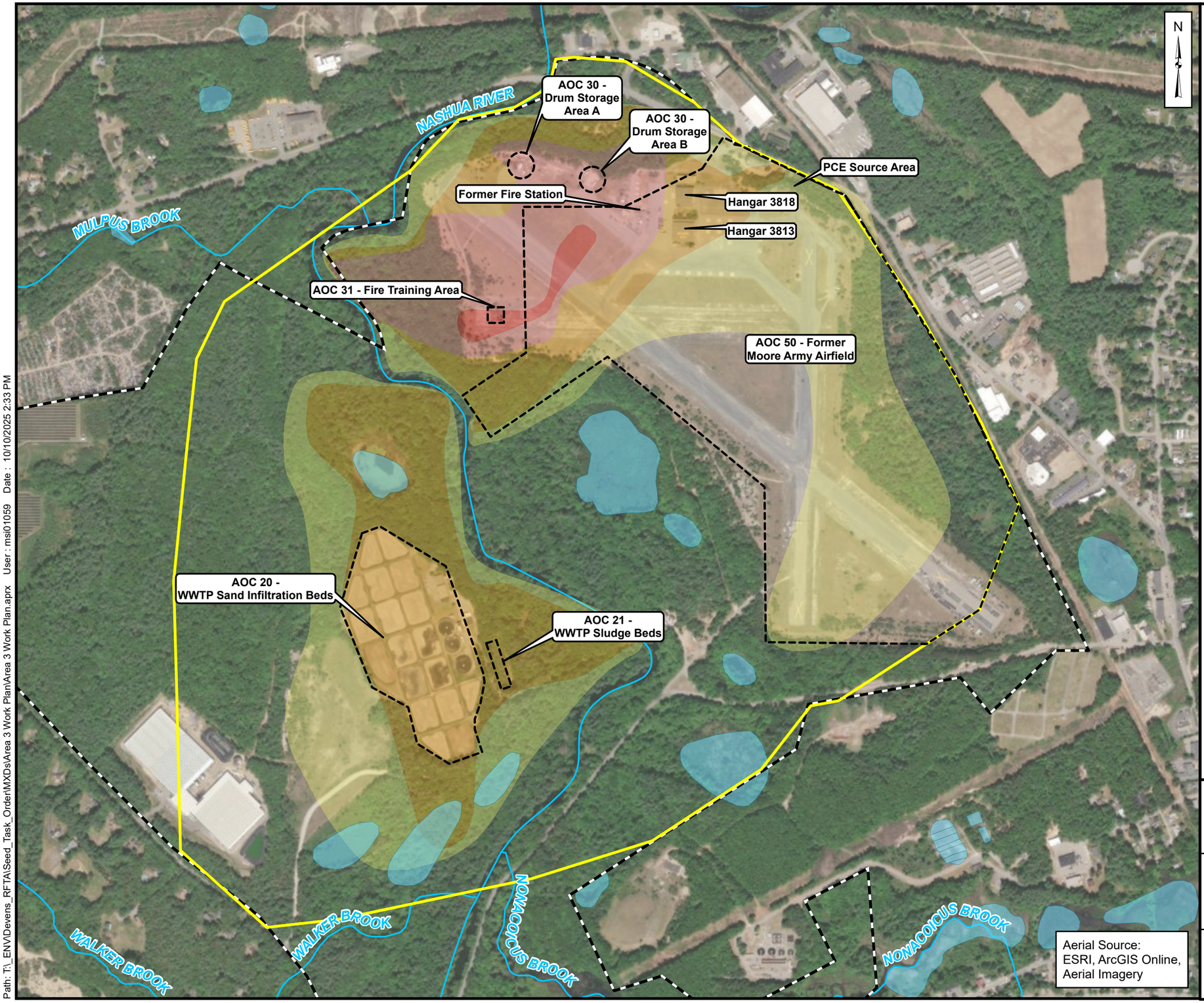
PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SITE LOCATION

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 1-1

T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx 6/10/2024 1:36 PM User Name: msi01059



N

LEGEND

- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- AOC AREA
- APPROXIMATE EXTENT OF THE AREA EXCEEDING THE SSSLs
- APPROXIMATE EXTENT OF THE AREA >10X SSSLs
- APPROXIMATE EXTENT OF THE AREA >100X SSSLs
- APPROXIMATE EXTENT OF THE AREA >1000X SSSLs
- STREAM
- WATERBODY

NOTES:
> = GREATER THAN
AOC = AREA OF CONTAMINATION
PCE = TETRACHLOROETHENE
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
SSSL = SITE-SPECIFIC SCREENING LEVEL
WWTP = WASTEWATER TREATMENT PLANT
X = TIMES

0 500 1,000
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

PFAS PHASE II REMEDIAL INVESTIGATION - AREA 3

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 1-2

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msl01059 Date : 10/10/2025 2:33 PM

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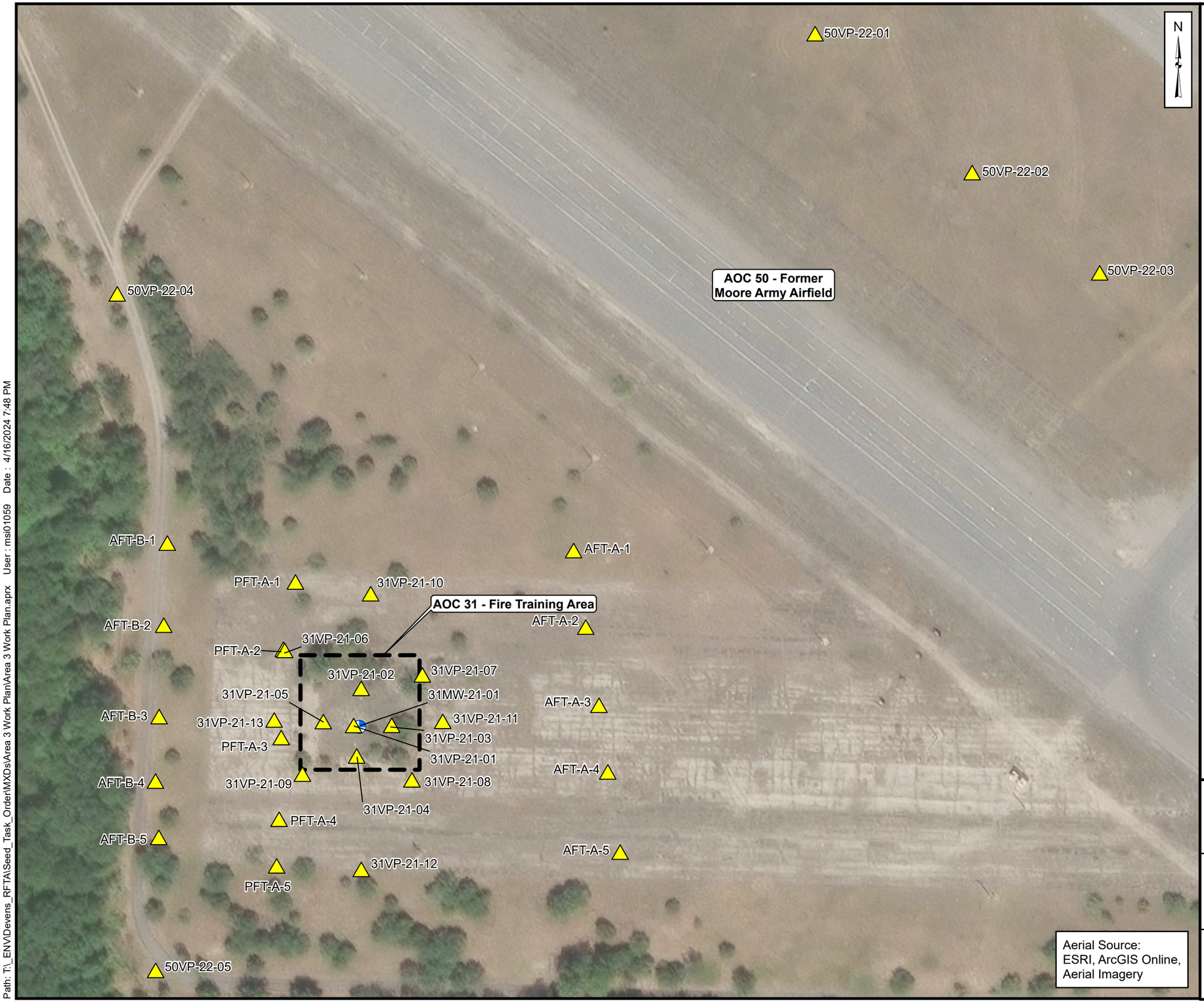

LEGEND

- AOC AREA
- MONITORING WELL
- VERTICAL AQUIFER PROFILE/GRAB GROUNDWATER SAMPLE

NOTE:
AOC = AREA OF CONTAMINATION

0 100 200
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER SUPPLEMENTAL SAMPLING LOCATIONS - AOC 31 AND AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 1-3

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msi01059 Date : 4/16/2024 7:48 PM

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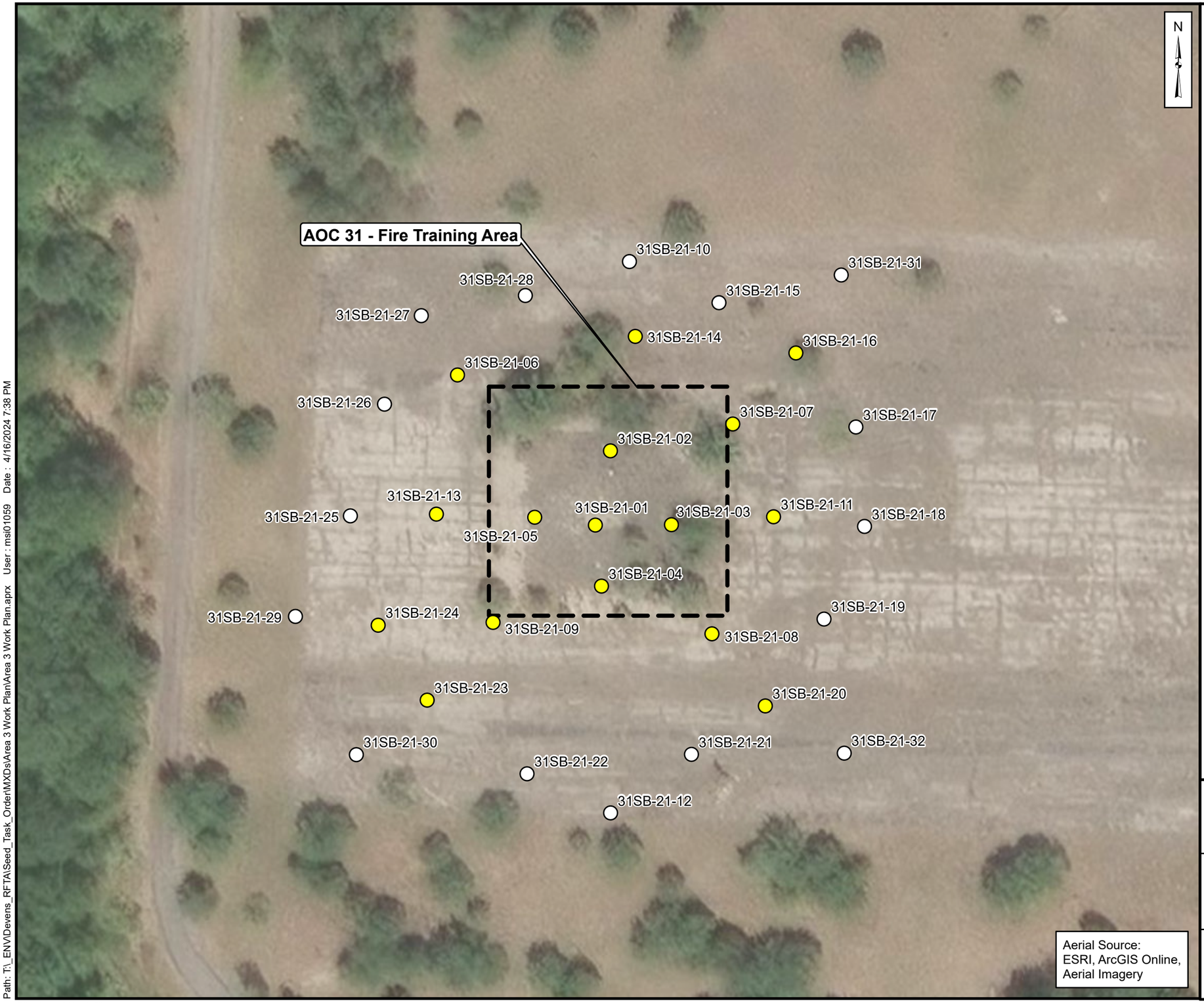

LEGEND

- AOC AREA
- COMPLETED SOIL BORING BELOW SSSL
- COMPLETED SOIL BORING ABOVE SSSL

NOTES:
AOC = AREA OF CONTAMINATION
SSSL = SITE-SPECIFIC SCREENING LEVEL

0 50 100
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL SUPPLEMENTAL SAMPLING RESULTS - AOC 31

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 1-4

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msi01059 Date : 4/16/2024 7:38 PM

File: Area 3 Work Plan.mxd

LEGEND

- AOC AREA
- COMPLETED SOIL BORING BELOW SSSL
- COMPLETED SOIL BORING ABOVE SSSL

NOTES:
AOC = AREA OF CONTAMINATION
SSSL = SITE-SPECIFIC SCREENING LEVEL

0 75 150
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL SUPPLEMENTAL SAMPLING RESULTS - AOC 50

SERES Engineering & Services, LLC
ARCADIS
a joint venture

Figure
1-5

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msi01059 Date : 4/16/2024 7:40 PM

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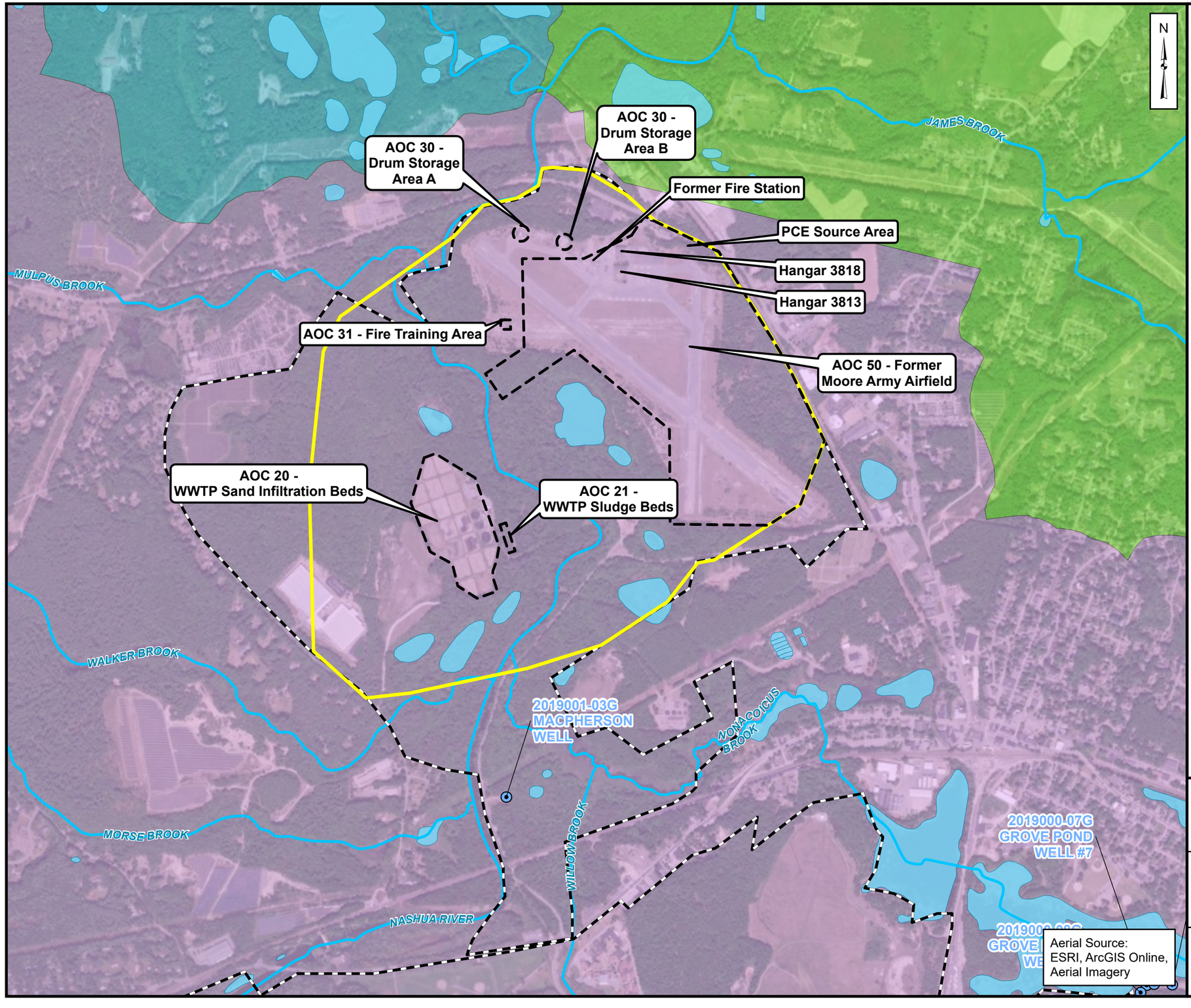


LEGEND

- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- AOC AREA
- STREAM
- WATERBODY
- WATER SUPPLY WELL

WATERSHED BOUNDARY

- MULPUS BROOK-NASHUA RIVER
- UNKETY BROOK-NASHUA RIVER
- WITCH BROOK-SQUANNACOOK RIVER

NOTES:
AOC = AREA OF CONTAMINATION
PCE = TETRACHLOROETHENE
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
WWTP = WASTEWATER TREATMENT PLANT

0 0.25 0.5
Miles

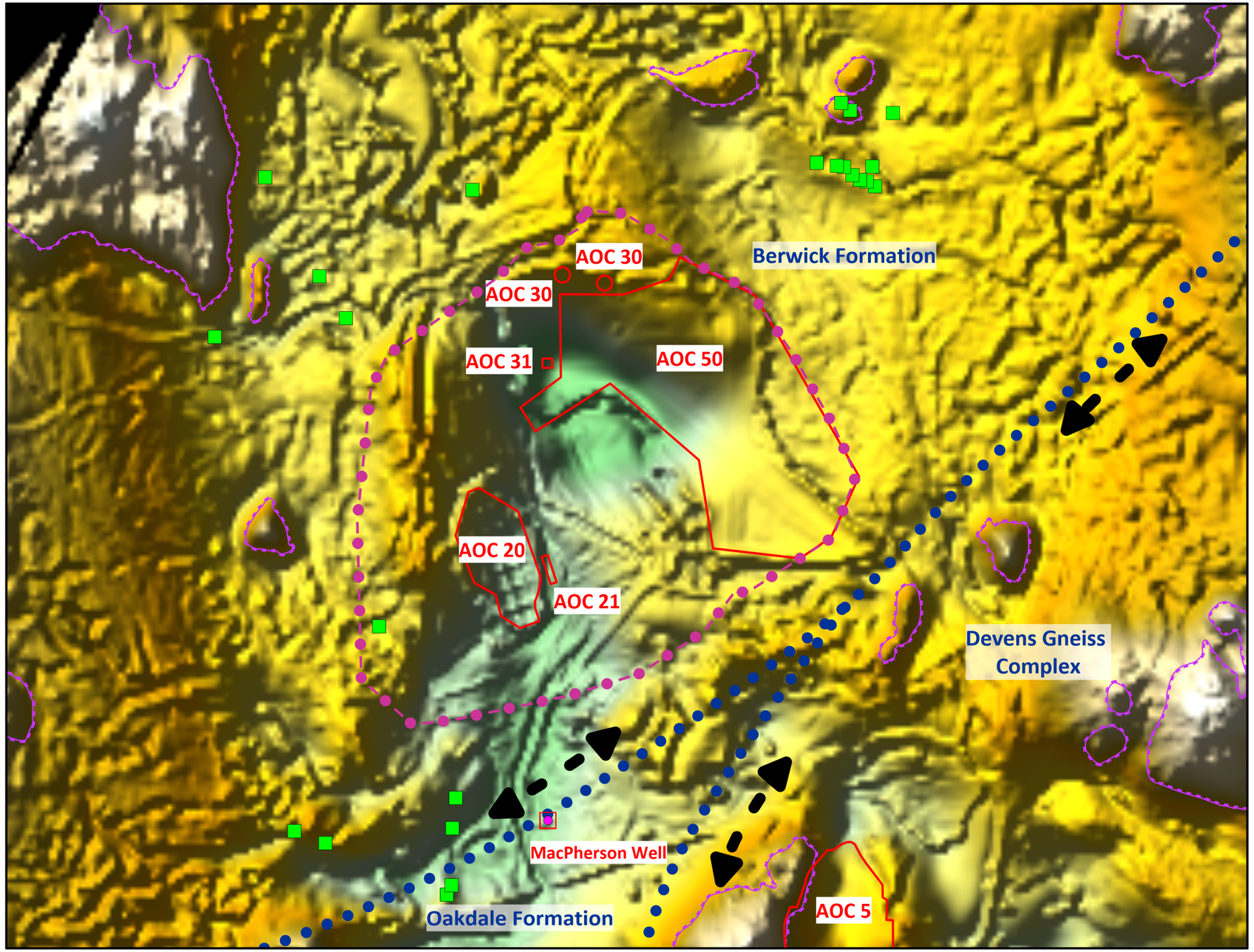
PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

LOCAL-SCALE WATERSHEDS

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 2-1

T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx 10/10/2025 2:33 PM User Name: msi01059



N

Bedrock Elevation (ft amsl)

600
550
500
450
400
350
300
250
200
150
100
50
0

SCALE:FEET

0 1400 2800

NOTES:

FT AMSL = FEET ABOVE MEAN SEA LEVEL
AOC = AREA OF CONTAMINATION
PFAS = PER- AND POLYFLUOURALKYL SUBSTANCES

SOURCE (BEDROCK CONTACTS): PRELIMINARY FRACTURE CHARACTERIZATION MAP OF THE AYER QUADRANGLE MASSACHUSETTS HYDROSTRUCTURAL DOMAIN MAP SHEET 1

LEGEND

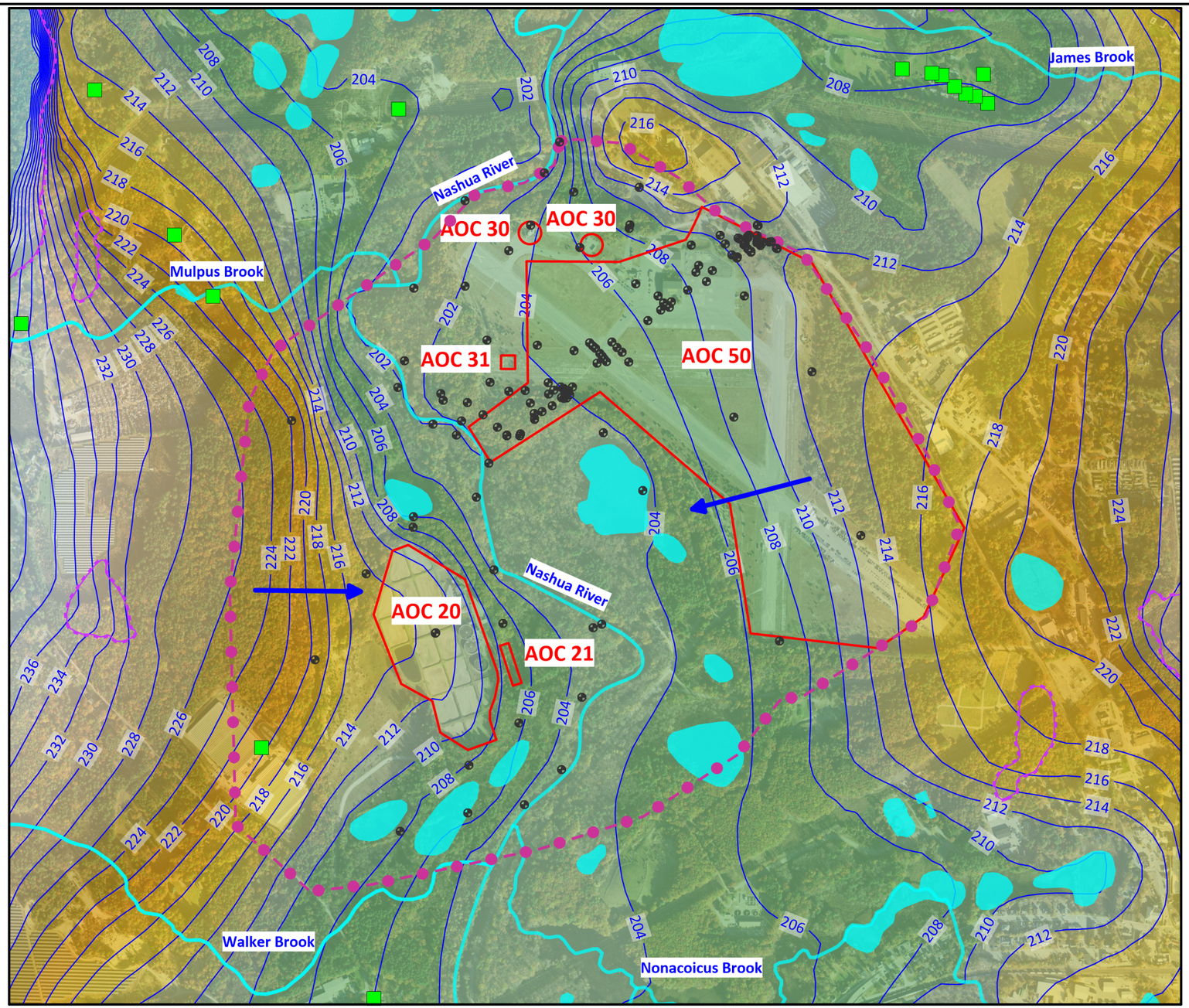
- APPROXIMATE BEDROCK CONTACT
- SHALLOW OR EXPOSED BEDROCK
- AREA OF CONTAMINATION (AOC)
- PFAS AREA 3 BOUNDARY
- DOMINANT STRUCTURAL ALIGNMENT (STRIKE)
- COMMUNITY PRODUCTION WELL
- PRIVATE RESIDENTIAL WELL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

REGIONAL BEDROCK SURFACE

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE 2-2



N

Groundwater Elevation
(ft amsl)

258
254
250
246
242
238
234
230
226
222
218
214
210
206
202
198

SCALE:FEET

0 1000 2000

NOTES:

FT AMSL = FEET ABOVE MEAN SEA LEVEL
AOC = AREA OF CONTAMINATION
PFAS = PER- AND POLYFLUOURALKYL SUBSTANCES

LEGEND

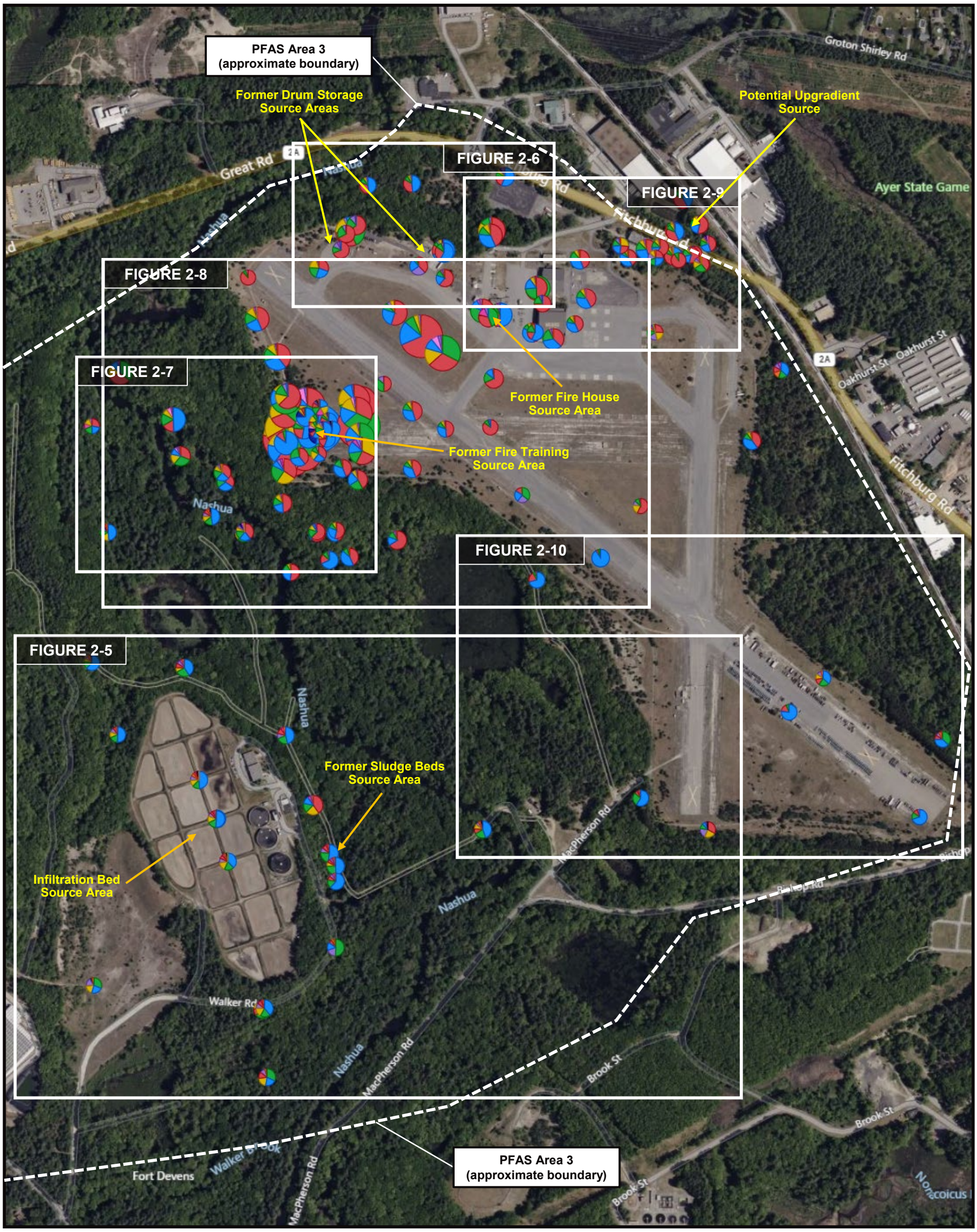
- SIMULATED GROUNDWATER ELEVATION CONTOUR (ft amsl)
- SHALLOW OR EXPOSED BEDROCK
- AREA OF CONTAMINATION (AOC)
- PFAS AREA 3 BOUNDARY
- INFERRED GROUNDWATER FLOW DIRECTION
- AREA 3 MONITORING WELL
- STREAM
- WATERBODY
- PRIVATE RESIDENTIAL WELL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SIMULATED OVERBURDEN WATER-LEVEL ELEVATION CONTOURS

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-3



PFAS 6:2 FtS · 8:2 FtS · EtFOSAA · MeFOSAA · PFBS · PFDA · PFDoA · PFHpA · PFHxA · PFHxS · PFNA · PFOA · PFOS · PFTA · PFTrDA · PFUnA

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE SSSLS.
2. THE SIZE OF THE PIE CHART IS PROPORTIONAL TO THE SUM OF THE PFAS CONCENTRATIONS. LARGER PIE CHARTS INDICATE HIGHER TOTAL PFAS CONCENTRATIONS WHEN COMPARED TO SMALLER PIE CHARTS.
3. ANAYLYTES BOLDED IN LIST ON RIGHT ARE INCLUDED IN EITHER PFAS6 AND/OR HAVE DOD ACCEPTED RSLS.
4. DOD = DEPARTMENT OF DEFEFENSE
5. FT = FEET
6. RSL = REGIONAL SCREENING LEVEL
7. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
8. PFAS6 = PFOS, PFOA, PFNA, PFHxS, PFHpA, PFDA
9. SSSL = SITE-SPECIFIC SCREENING LEVEL

ANALYTE ACRONYMS

1. 6:2 FtS = 6:2 fluorotelomer sulfonate
2. 8:2 FtS = 8:2 fluorotelomer sulfonic acid
3. EtFOSAA = N-ethyl perfluorooctane sulfonamidoacetic acid
4. MeFOSAA = N-methylperfluorooctane sulfonamidoacetic acid
5. **PFBS = perfluorobutanesulfonic acid**
6. **PFDA = perfluorodecanoic acid**
7. **PFDoA = perfluorododecanoic acid**
8. **PFHpA = perfluoroheptanoic acid**
9. **PFHxA = perfluorohexanoic acid**
10. **PFHxS = perfluorohexanesulfonic acid**
11. **PFNA = perfluorononanoic acid**
12. **PFOA = perfluorooctanoic acid**
13. **PFOS = perfluorooctanesulfonic acid**
14. **PFTA = perfluorotetradecanoic acid**
15. PFTrDA = perfluorotridecanoic acid
16. **PFUnA = perfluoroundecanoic acid**

Approx. 500 ft

N

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – AREA 3 KEY MAP

SERES Engineering & Services, LLC · ARCADIS a joint venture

FIGURE 2-4

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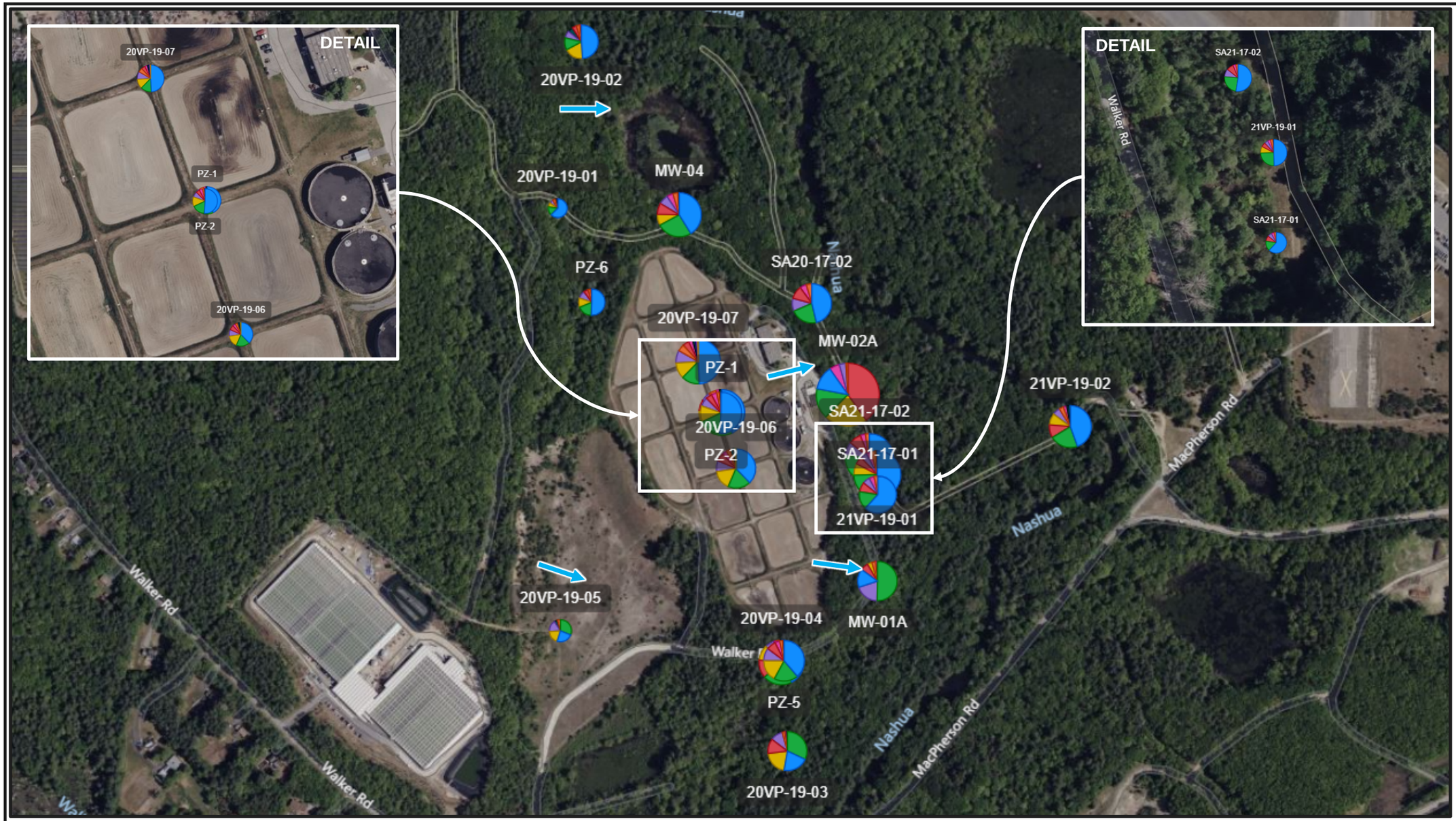

NOTES

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3. ANALTYE ACRONYMS ARE SHOWN ON FIGURE 2-4 FOR REFERENCE.
4. FT = FEET
5. MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
6. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

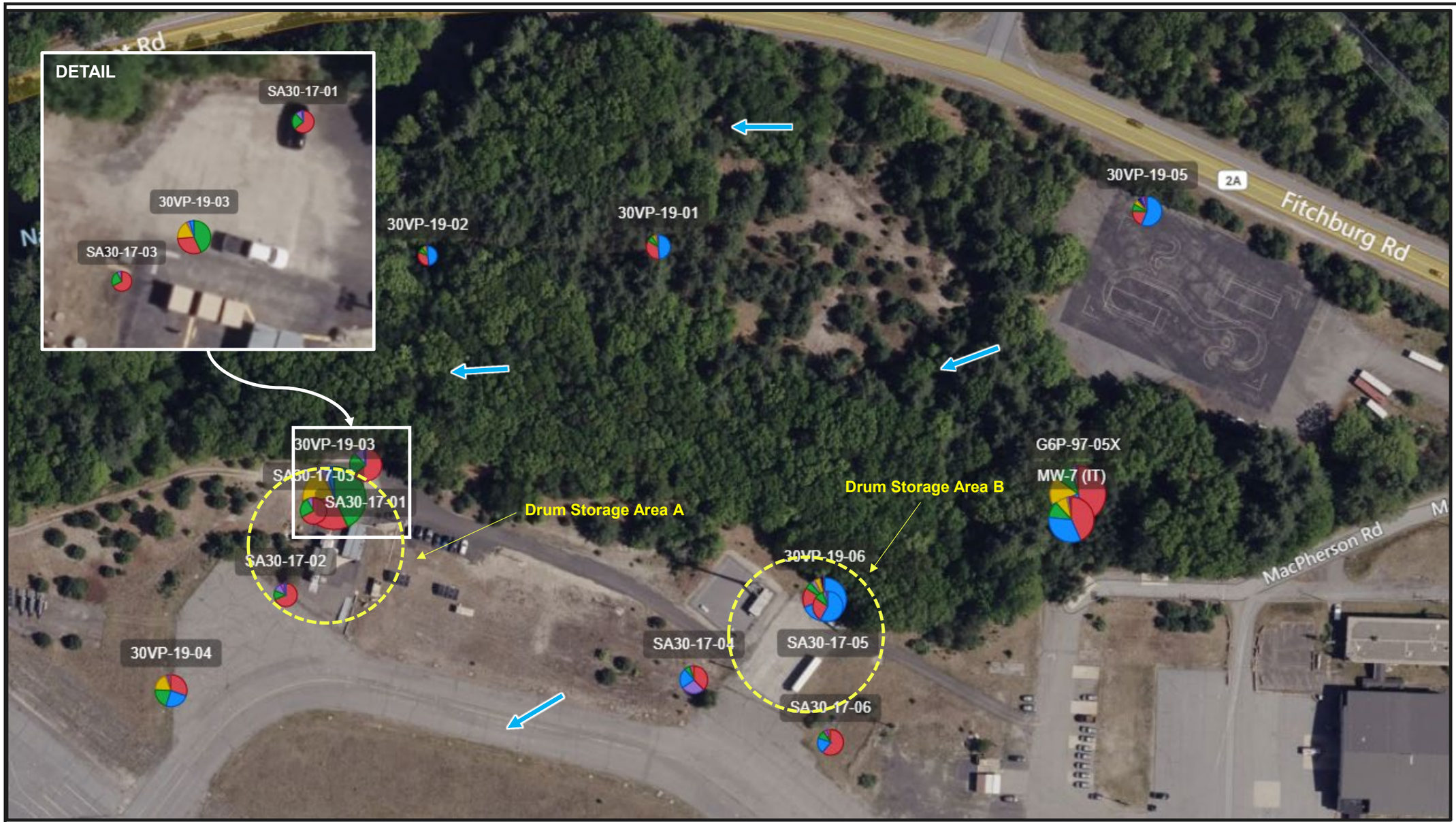
→ INTERPRETED GROUNDWATER FLOW DIRECTION (TO BE CONFIRMED)

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – AOC 20 AND AOC 21

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-5



NOTES

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4. FT = FEET
5. MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
6. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

→ INTERPRETED GROUNDWATER FLOW DIRECTION (TO BE CONFIRMED)

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – AOC 30

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-6

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE MMCLS AND/OR SSSLS.
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3. ANALTYE ACRONYMS ARE SHOWN ON FIGURE 2-4 FOR REFERENCE.
4. FT = FEET
5. MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
6. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

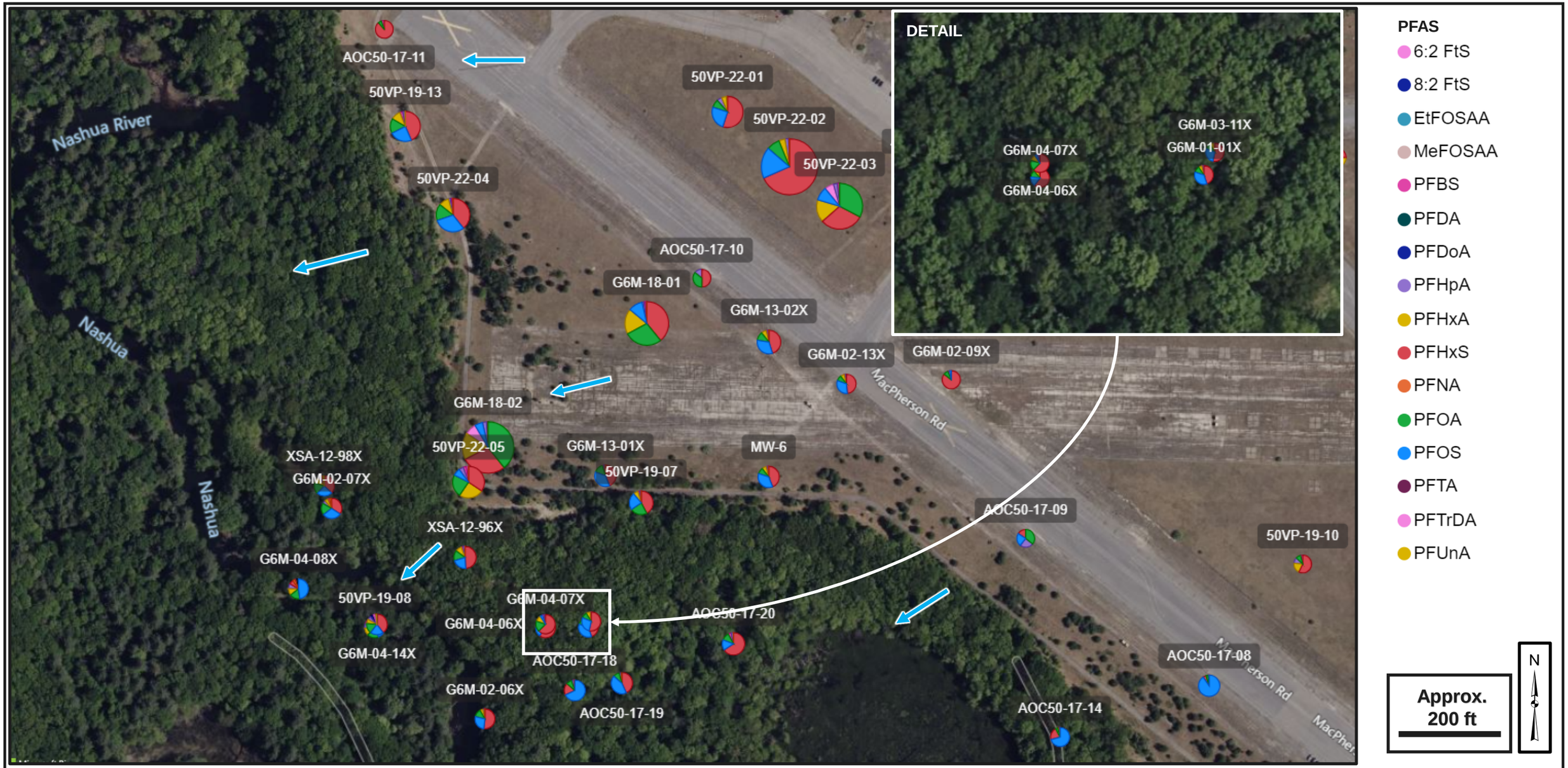
→ INTERPRETED GROUNDWATER FLOW DIRECTION (TO BE CONFIRMED)

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – AOC 31

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-7



NOTES

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6. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

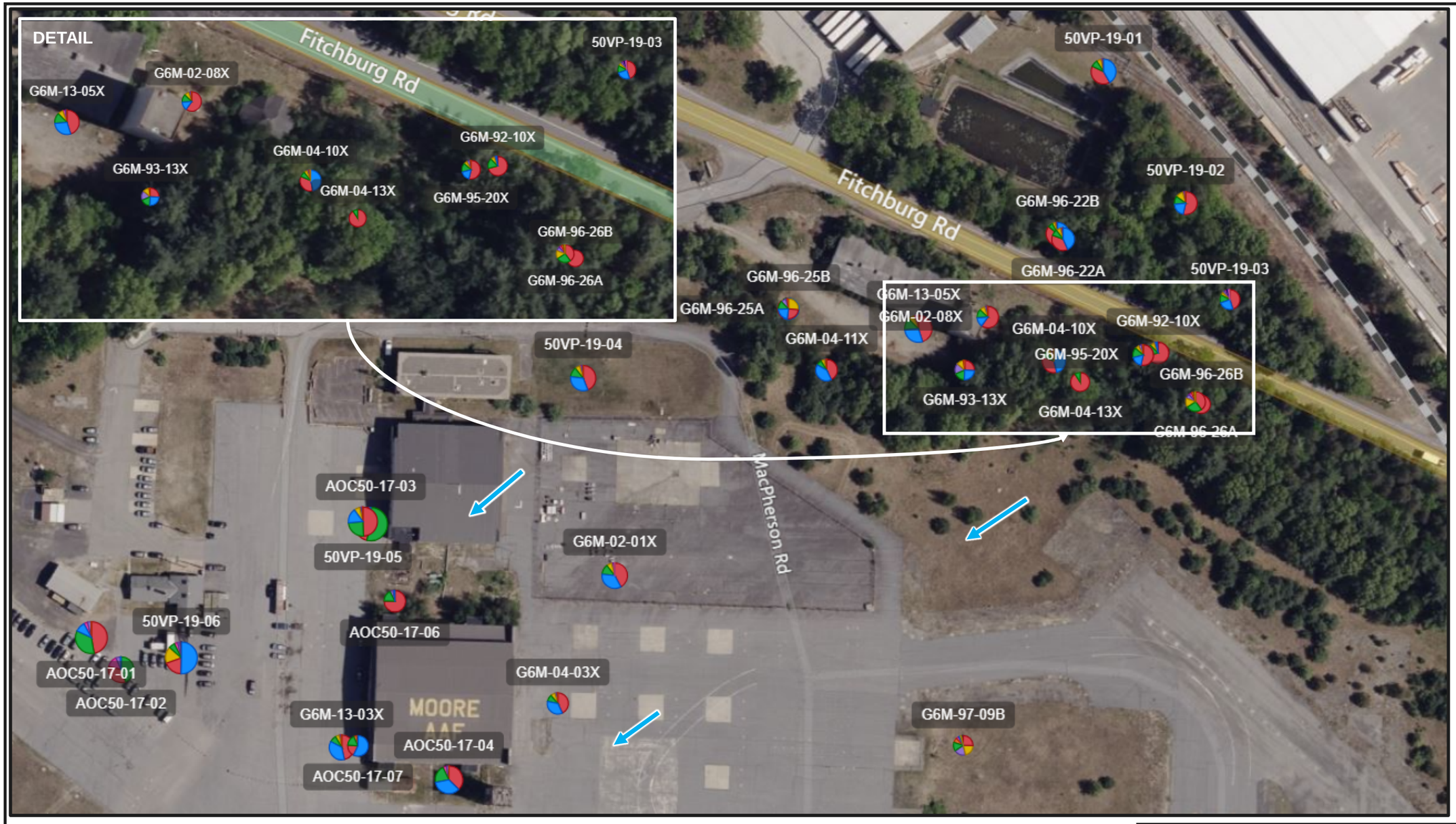
→ INTERPRETED GROUNDWATER FLOW DIRECTION (TO BE CONFIRMED)

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – WESTERN PORTION OF AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-8



NOTES

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4. FT = FEET
5. MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
6. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

→ INTERPRETED GROUNDWATER FLOW DIRECTION (TO BE CONFIRMED)

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – NORTHERN PORTION OF AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-9

PFAS

- 6:2 FtS
- 8:2 FtS
- EtFOSAA
- MeFOSAA
- PFBS
- PFDA
- PFDoA
- PFHpA
- PFHxA
- PFHxS
- PFNA
- PFOA
- PFOS
- PFTA
- PFTrDA
- PFUnA

Approx. 200 ft

N

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE MMCLS AND/OR SSSLS.
2. THE SIZE OF THE PIE CHART IS PROPORTIONAL TO THE SUM OF THE PFAS CONCENTRATIONS. LARGER PIE CHARTS INDICATE HIGHER TOTAL PFAS CONCENTRATIONS WHEN COMPARED TO SMALLER PIE CHARTS.
3. ANALTYE ACRONYMS ARE SHOWN ON FIGURE 2-4 FOR REFERENCE.
4. FT = FEET
5. MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
6. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

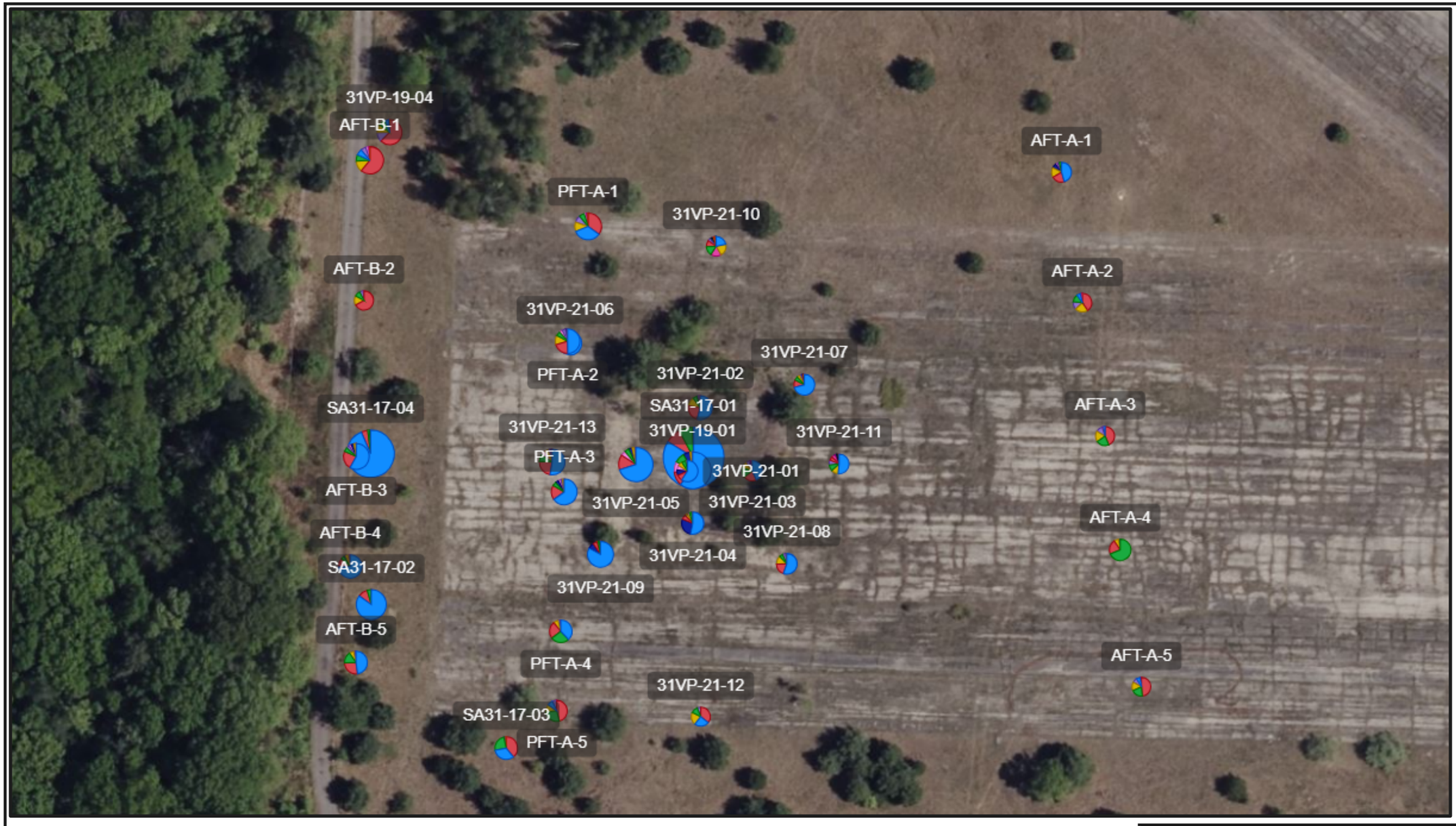
→ INTERPRETED GROUNDWATER FLOW DIRECTION (TO BE CONFIRMED)

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – SOUTHERN PORTION OF AOC 50

SERES Engineering & Services, LLC | ARCADIS a joint venture

FIGURE
2-10



NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE MMCLS AND/OR SSSLS.
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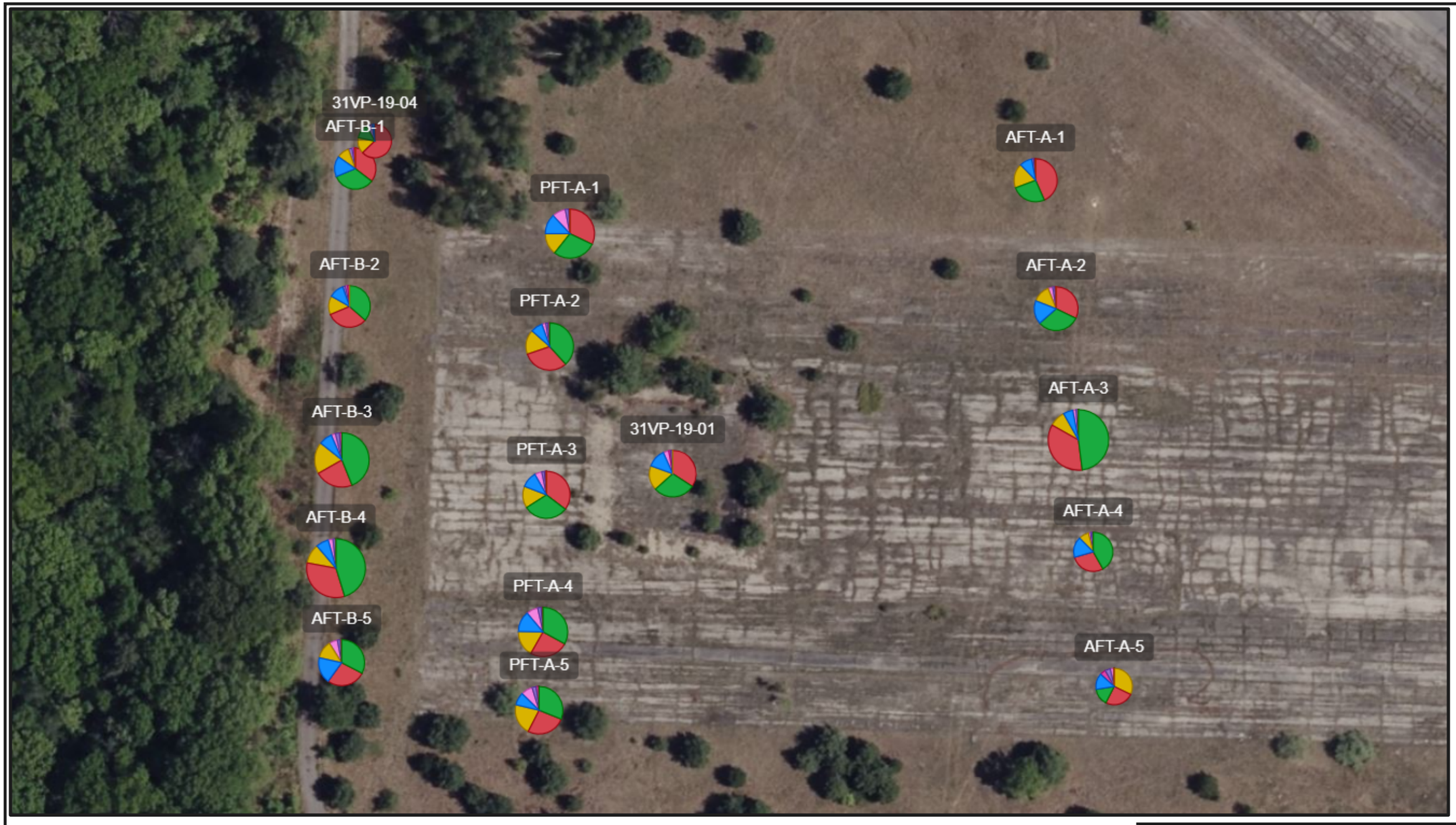
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – AOC 31 SHALLOW (0-77 FEET)

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-11



NOTES

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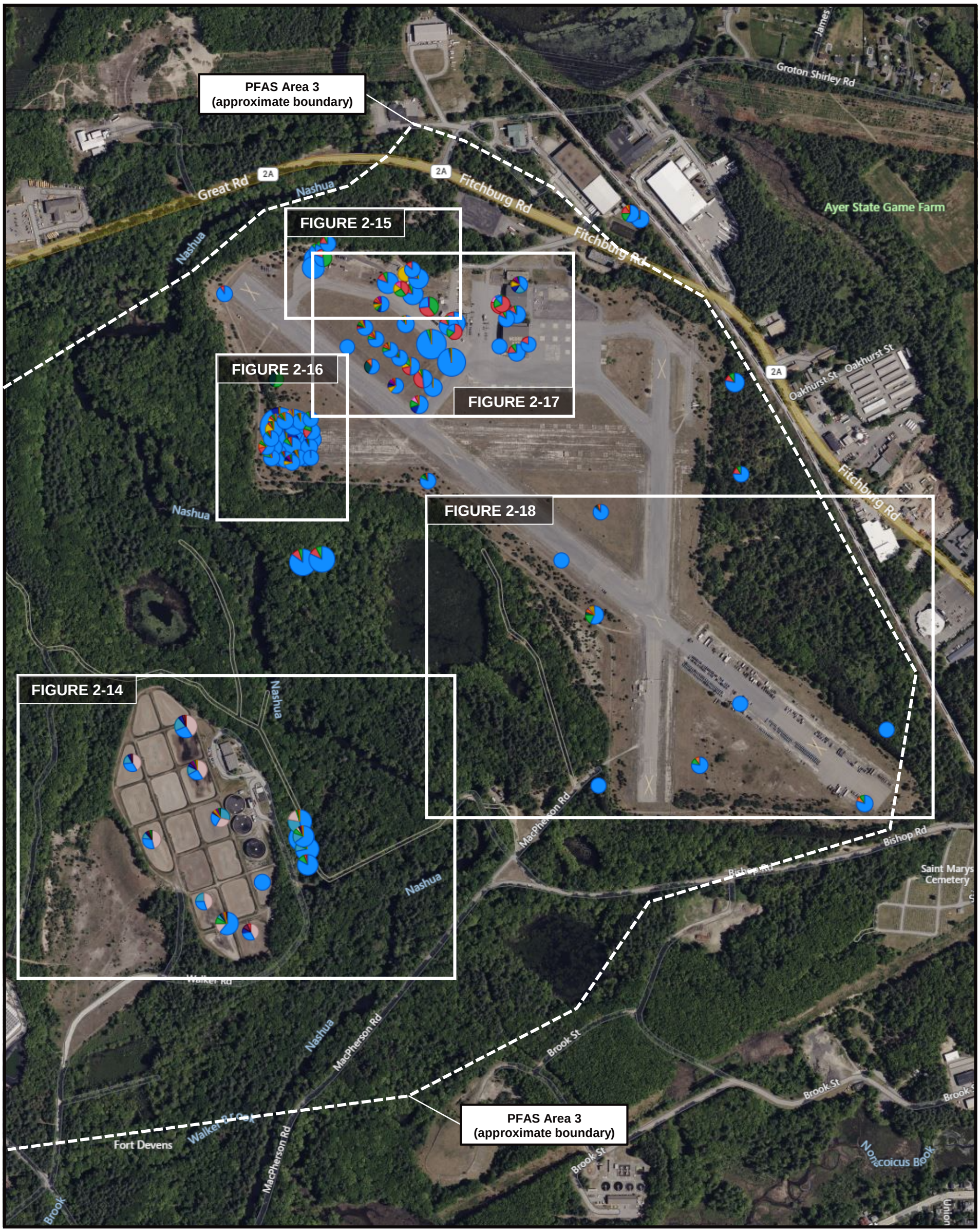
3. ANALTYE ACRONYMS ARE SHOWN ON FIGURE 2-4 FOR REFERENCE.
4. FT = FEET
5. MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
6. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
7. SSSL = SITE-SPECIFIC SCREENING LEVEL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER PFAS FINGERPRINTS – AOC 31 DEEP (78-196 FEET)

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-12



PFAS 6:2 FtS · 8:2 FtS · EtFOSAA · MeFOSAA · PFBS · PFDA · PFDoA · PFHpA · PFHxA · PFHxS · PFNA · PFOA · PFOS · PFTA · PFTrDA · PFUnA

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE SSSLS.
2. THE SIZE OF THE PIE CHART IS PROPORTIONAL TO THE SUM OF THE PFAS CONCENTRATIONS. LARGER PIE CHARTS INDICATE HIGHER TOTAL PFAS CONCENTRATIONS WHEN COMPARED TO SMALLER PIE CHARTS.
3. ANAYLYTES BOLDED IN LIST ON RIGHT ARE INCLUDED IN EITHER PFAS6 AND/OR HAVE DOD ACCEPTED RSLS.
4. DOD = DEPARTMENT OF DEFEFENSE
5. FT = FEET
6. RSL = REGIONAL SCREENING LEVEL
7. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
8. PFAS6 = PFOS, PFOA, PFNA, PFHxS, PFHpA, PFDA
9. SSSL = SITE-SPECIFIC SCREENING LEVEL

ANALYTE ACRONYMS

1. 6:2 FtS = 6:2 fluorotelomer sulfonate
2. 8:2 FtS = 8:2 fluorotelomer sulfonic acid
3. EtFOSAA = N-ethyl perfluorooctane sulfonamidoacetic acid
4. MeFOSAA = N-methylperfluorooctane sulfonamidoacetic acid
5. **PFBS = perfluorobutanesulfonic acid**
6. **PFDA = perfluorodecanoic acid**
7. **PFDoA = perfluorododecanoic acid**
8. **PFHpA = perfluoroheptanoic acid**
9. **PFHxA = perfluorohexanoic acid**
10. **PFHxS = perfluorohexanesulfonic acid**
11. **PFNA = perfluorononanoic acid**
12. **PFOA = perfluorooctanoic acid**
13. **PFOS = perfluorooctanesulfonic acid**
14. **PFTA = perfluorotetradecanoic acid**
15. PFTrDA = perfluorotridecanoic acid
16. **PFUnA = perfluoroundecanoic acid**

Approx. 500 ft

N

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL PFAS FINGERPRINTS – AREA 3 KEY MAP

SERES Engineering & Services, LLC · ARCADIS a joint venture

FIGURE **2-13**

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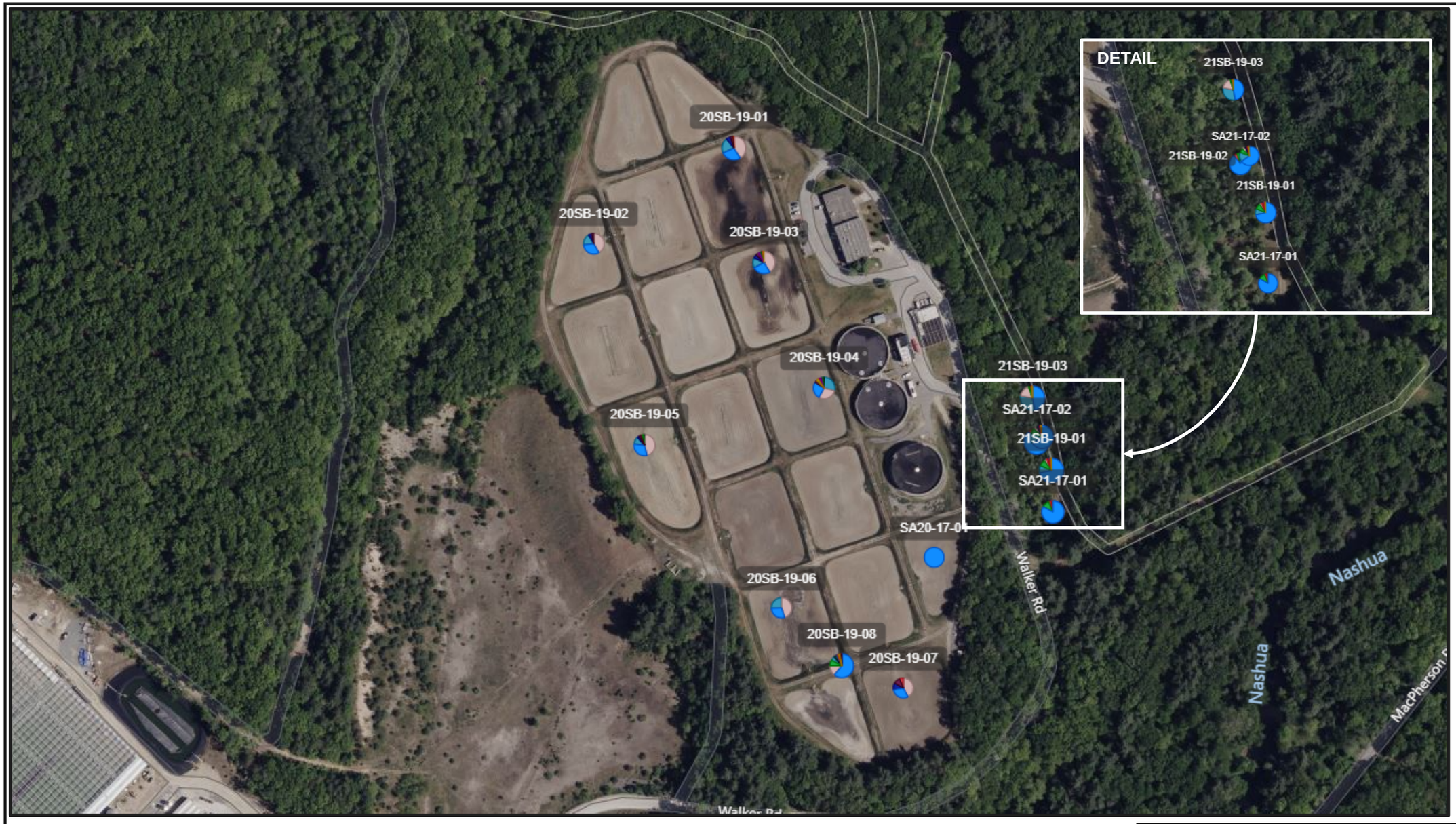

PFAS

- 6:2 FtS
- 8:2 FtS
- EtFOSAA
- MeFOSAA
- PFBS
- PFDA
- PFDoA
- PFHpA
- PFHxA
- PFHxS
- PFNA
- PFOA
- PFOS
- PFTA
- PFTrDA
- PFUnA

Approx. 200 ft

N

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE SSSLS.
2. THE SIZE OF THE PIE CHART IS PROPORTIONAL TO THE SUM OF THE PFAS CONCENTRATIONS. LARGER PIE CHARTS INDICATE HIGHER TOTAL PFAS CONCENTRATIONS WHEN COMPARED TO SMALLER PIE CHARTS.
3. ANALTYE ACRONYMS ARE SHOWN ON FIGURE 2-13 FOR REFERENCE.
4. FT = FEET
5. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
6. SSSL = SITE-SPECIFIC SCREENING LEVEL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL PFAS FINGERPRINTS – AOC 20 AND AOC 21

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-14

PFAS

- 6:2 FtS
- 8:2 FtS
- EtFOSAA
- MeFOSAA
- PFBS
- PFDA
- PFDoA
- PFHpA
- PFHxA
- PFHxS
- PFNA
- PFOA
- PFOS
- PFTA
- PFTrDA
- PFUnA

Approx. 50 ft

N

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE SSSLS.
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3. ANALTYE ACRONYMS ARE SHOWN ON FIGURE 2-13 FOR REFERENCE.
4. FT = FEET
5. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
6. SSSL = SITE-SPECIFIC SCREENING LEVEL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL PFAS FINGERPRINTS – AOC 30

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-15

PFAS

6:2 FtS · 8:2 FtS · EtFOSAA · MeFOSAA · PFBS · PFDA · PFDoA · PFHpA · PFHxA · PFHxS · PFNA · PFOA · PFOS · PFTA · PFTrDA · PFUnA

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE SSSLS.
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4. FT = FEET
5. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
6. SSSL = SITE-SPECIFIC SCREENING LEVEL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL PFAS FINGERPRINTS – AOC 31

SERES Engineering & Services, LLC · ARCADIS a joint venture

FIGURE
2-16

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PFAS

- 6:2 FtS
- 8:2 FtS
- EtFOSAA
- MeFOSAA
- PFBS
- PFDA
- PFDoA
- PFHpA
- PFHxA
- PFHxS
- PFNA
- PFOA
- PFOS
- PFTA
- PFTrDA
- PFUnA

Approx. 100 ft

N

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE SSSLS.
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4. FT = FEET
5. PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
6. SSSL = SITE-SPECIFIC SCREENING LEVEL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL PFAS FINGERPRINTS – NORTHERN PORTION OF AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-17

PFAS

- 6:2 FtS
- 8:2 FtS
- EtFOSAA
- MeFOSAA
- PFBS
- PFDA
- PFDoA
- PFHpA
- PFHxA
- PFHxS
- PFNA
- PFOA
- PFOS
- PFTA
- PFTrDA
- PFUnA

Approx. 200 ft

N

NOTES

1. A PIE CHART SHOWING THE MAXIMUM PFAS MIXTURE AT EACH SAMPLED LOCATION IS SHOWN REGARDLESS OF CONCENTRATION DETECTED. PIE CHARTS ARE SHOWN AT LOCATIONS THAT EXCEED AND DO NOT EXCEED THE SSSLS.
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4. FT = FEET
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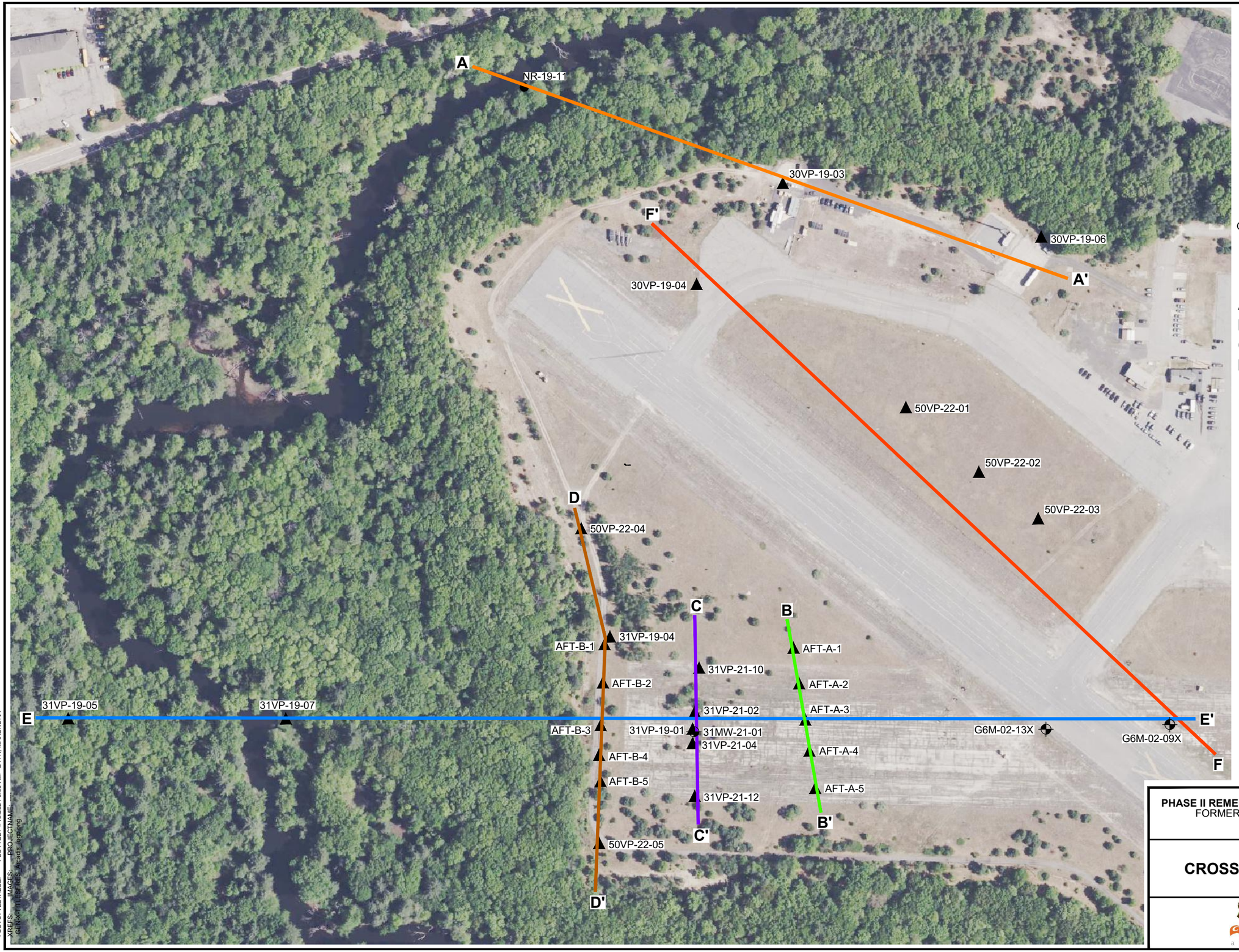
6. SSSL = SITE-SPECIFIC SCREENING LEVEL

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

SOIL PFAS FINGERPRINTS – SOUTHERN PORTION OF AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-18



LEGEND

G6M-02-13X	MONITORING WELL
NR-19-11	SURFACE WATER SAMPLE
50VP-22-01	VERTICAL AQUIFER PROFILE
A — A'	AOC 30 TRANSECT LINE
B — B'	AOC 31 TRANSECT LINE
C — C'	AOC 31 TRANSECT LINE
D — D'	AOC 31 TRANSECT LINE
E — E'	AOC 31 TRANSECT LINE
F — F'	AOC 50 TRANSECT LINE

NOTES:

1. ONLY INVESTIGATION LOCATIONS PRESENT ON CROSS SECTIONS INCLUDED IN FIGURE
2. AOC = AREA OF CONTAMINATION
3. FT = FEET
4. IN = INCH

0 200' 400'

APPROXIMATE SCALE 1 in. = 200 ft.

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION LOCATION MAP

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-19

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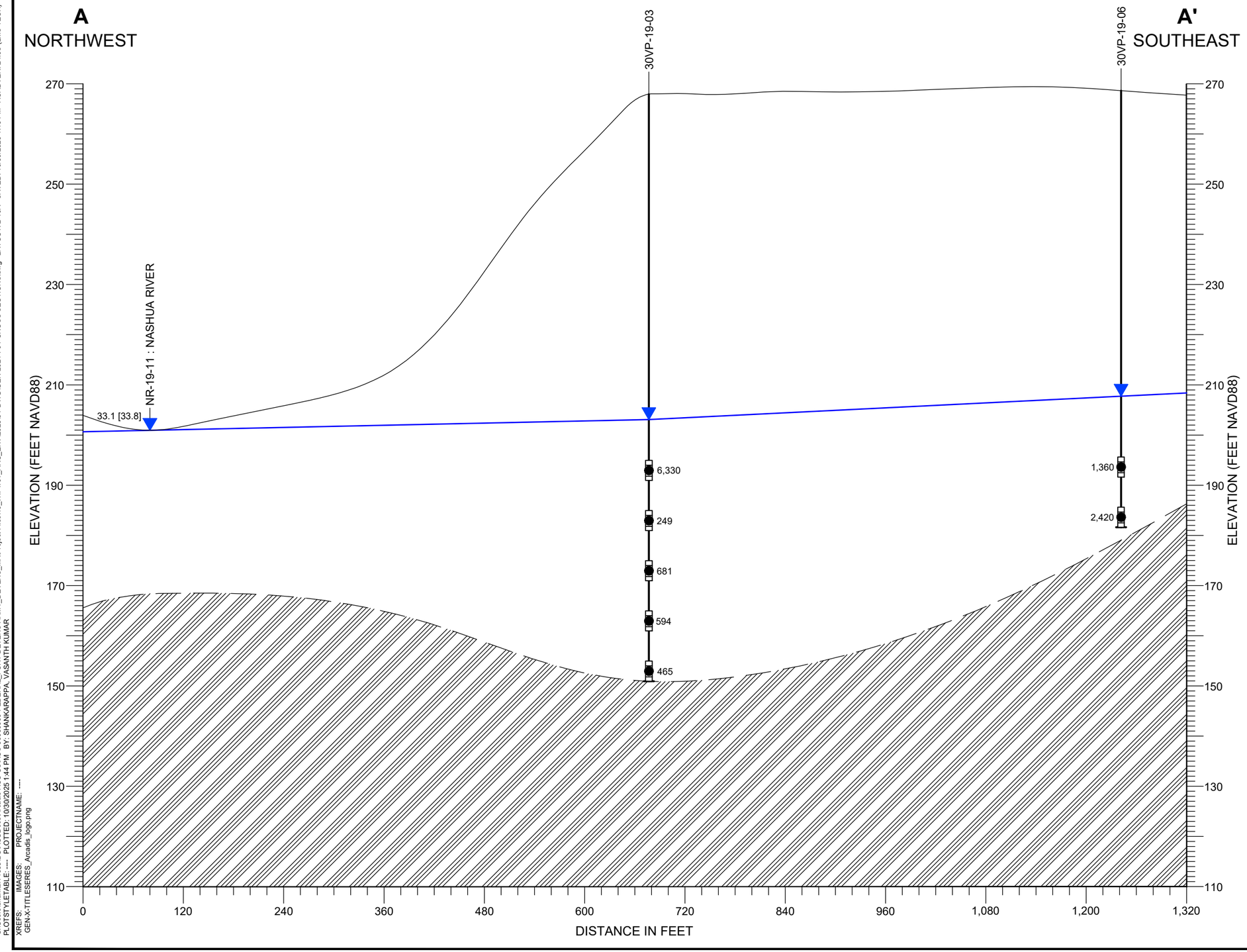


LEGEND

- WELL/BORING ID (30VP-19-06)
- EXISTING GROUND SURFACE
- BORING
- DEPTH TO WATER
- BEDROCK SURFACE (ESTIMATED BASED ON DRILLING REFUSAL)
- SCREEN INTERVAL
- 6,330 — Sum of PFOS + PFOA+ PFDA + PFHpA + PFHxS + PFNA (ng/L)
- TOTAL BORING DEPTH
- BEDROCK

NOTES:

1. AOC = AREA OF CONTAMINATION
2. DUPLICATE CONCENTRATIONS ARE INCLUDED IN PARENTHESIS
3. ID = IDENTIFICATION
4. NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
5. ng/L = NANOGRAM PER LITER
6. PFDA = PERFLUORODECANOIC ACID
7. PFHpA = PERFLUOROHEPTANOIC ACID
8. PFHxS = PERFLUOROHEXANESULFONIC ACID
9. PFNA = PERFLUORONANOIC ACID
10. PFOS = PERFLUOROOCTANESULFONIC ACID
11. PFOA = PERFLUOROOCTANOIC ACID
12. PFAS6 = PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA

0 120' 240'
HORIZONTAL SCALE

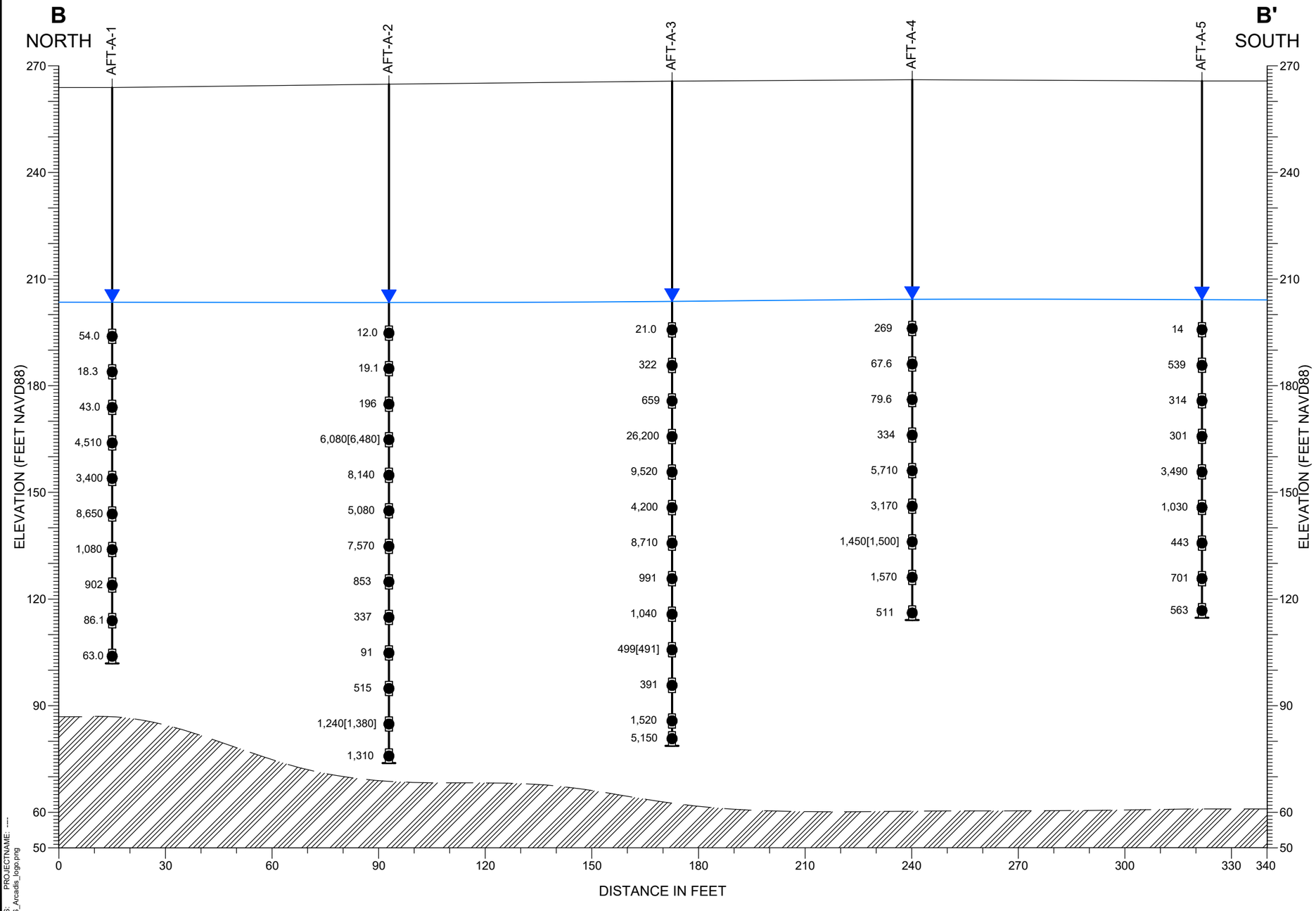
0 20' 40'
VERTICAL SCALE

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION A-A'
PFAS6 CONCENTRATIONS - AOC 30

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-19a



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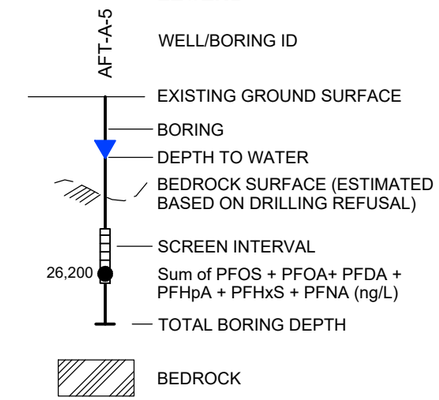

NOTES:

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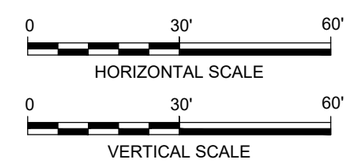
7. PFHpA = PERFLUOROHEPTANOIC ACID
8. PFHxS = PERFLUOROHEXANESULFONIC ACID
9. PFNA = PERFLUORONANOIC ACID
10. PFOS = PERFLUOROOCTANESULFONIC ACID
11. PFOA = PERFLUOROOCTANOIC ACID
12. PFAS6 = PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA



PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION B-B'
PFAS6 CONCENTRATIONS - AOC 31

SERES
ARCADIS
a joint venture

FIGURE
2-19b

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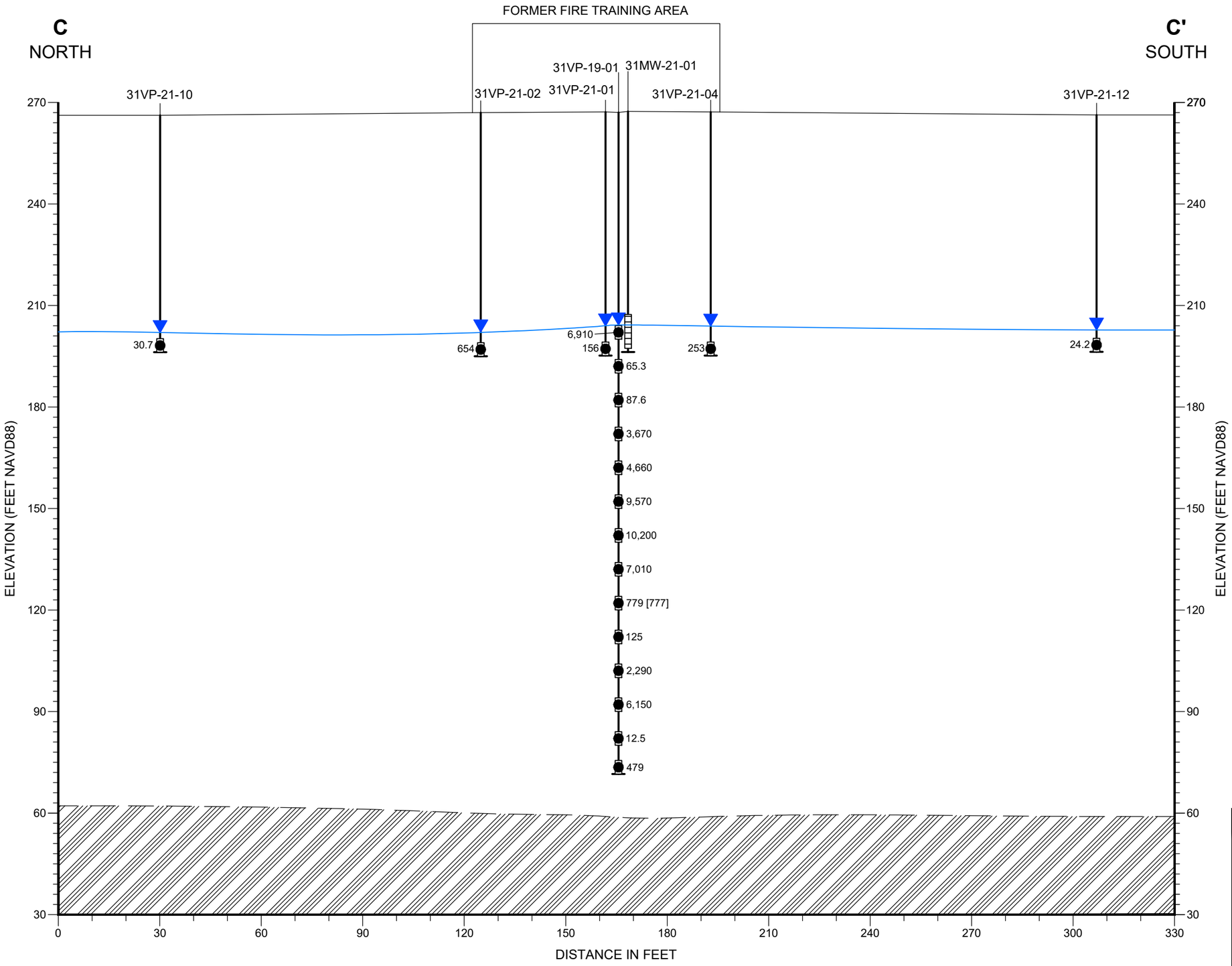

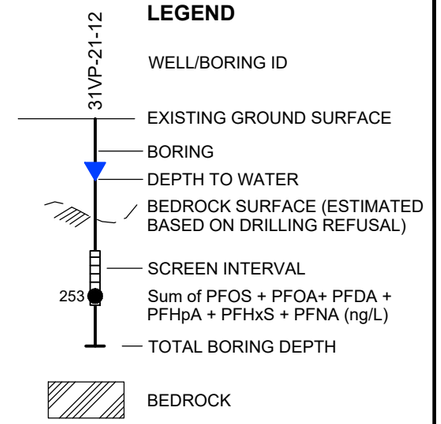

NOTES:

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3. ID = IDENTIFICATION
4. NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
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7. PFHpA = PERFLUOROHEPTANOIC ACID
8. PFHxS = PERFLUOROHEXANESULFONIC ACID
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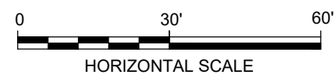
10. PFOS = PERFLUOROOCTANESULFONIC ACID
11. PFOA = PERFLUOROOCTANOIC ACID
12. PFAS6 = PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA



PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION C-C'
PFAS6 CONCENTRATIONS - AOC 31

SERES Engineering & Sciences, LLC
ARCADIS a joint venture

FIGURE
2-19c

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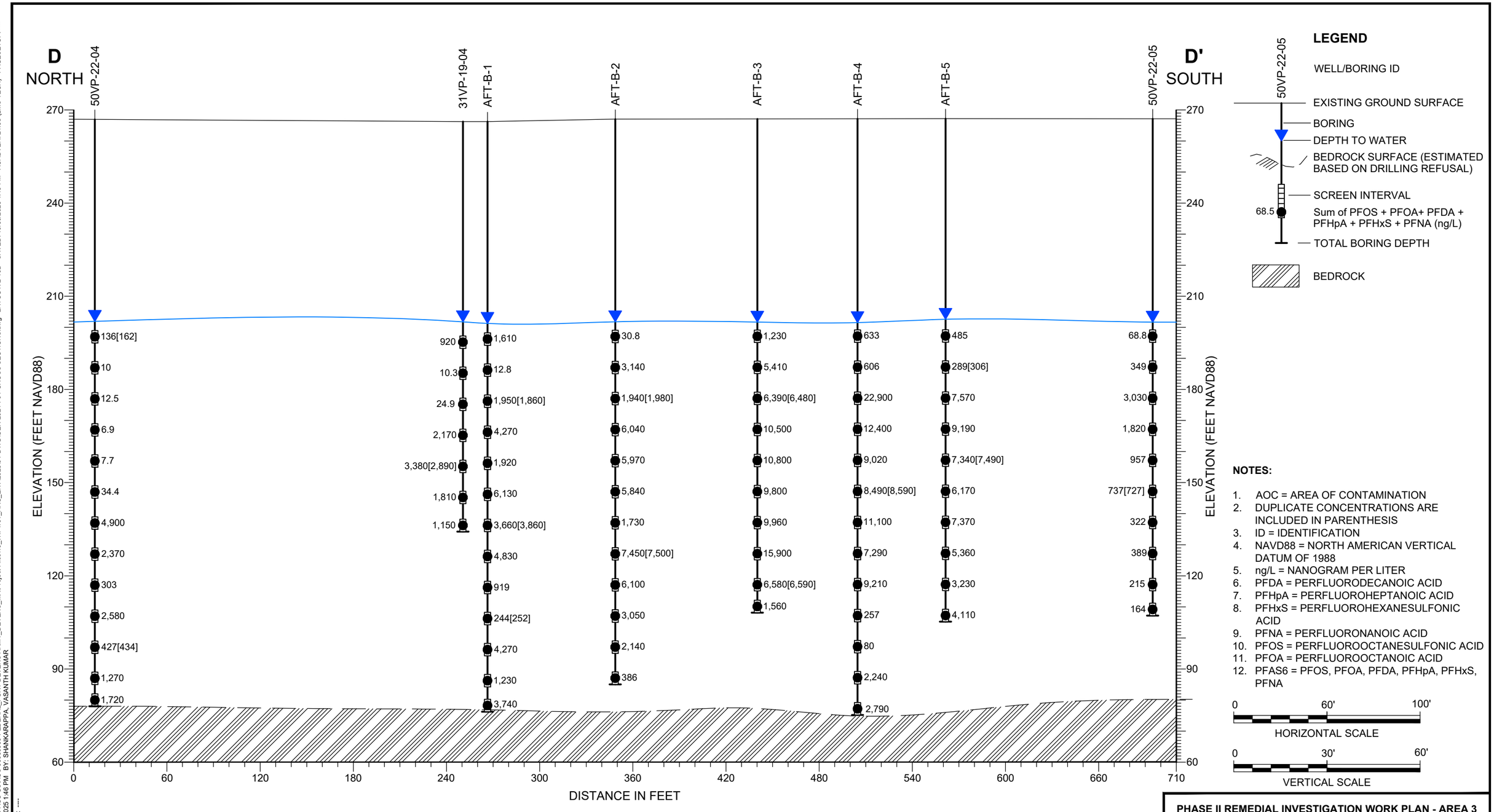

LEGEND

- WELL/BORING ID
- EXISTING GROUND SURFACE
- BORING
- DEPTH TO WATER
- BEDROCK SURFACE (ESTIMATED BASED ON DRILLING REFUSAL)
- SCREEN INTERVAL
- Sum of PFOS + PFOA+ PFDA + PFHpA + PFHxS + PFNA (ng/L)
- TOTAL BORING DEPTH
- BEDROCK

NOTES:

1. AOC = AREA OF CONTAMINATION
2. DUPLICATE CONCENTRATIONS ARE INCLUDED IN PARENTHESIS
3. ID = IDENTIFICATION
4. NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
5. ng/L = NANOGRAM PER LITER
6. PFDA = PERFLUORODECANOIC ACID
7. PFHpA = PERFLUOROHEPTANOIC ACID
8. PFHxS = PERFLUOROHEXANESULFONIC ACID
9. PFNA = PERFLUORONANOIC ACID
10. PFOS = PERFLUOROOCTANESULFONIC ACID
11. PFOA = PERFLUOROOCTANOIC ACID
12. PFAS6 = PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA

0 60' 100'
HORIZONTAL SCALE

0 30' 60'
VERTICAL SCALE

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION D-D'
PFAS6 CONCENTRATIONS - AOC 31

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-19d

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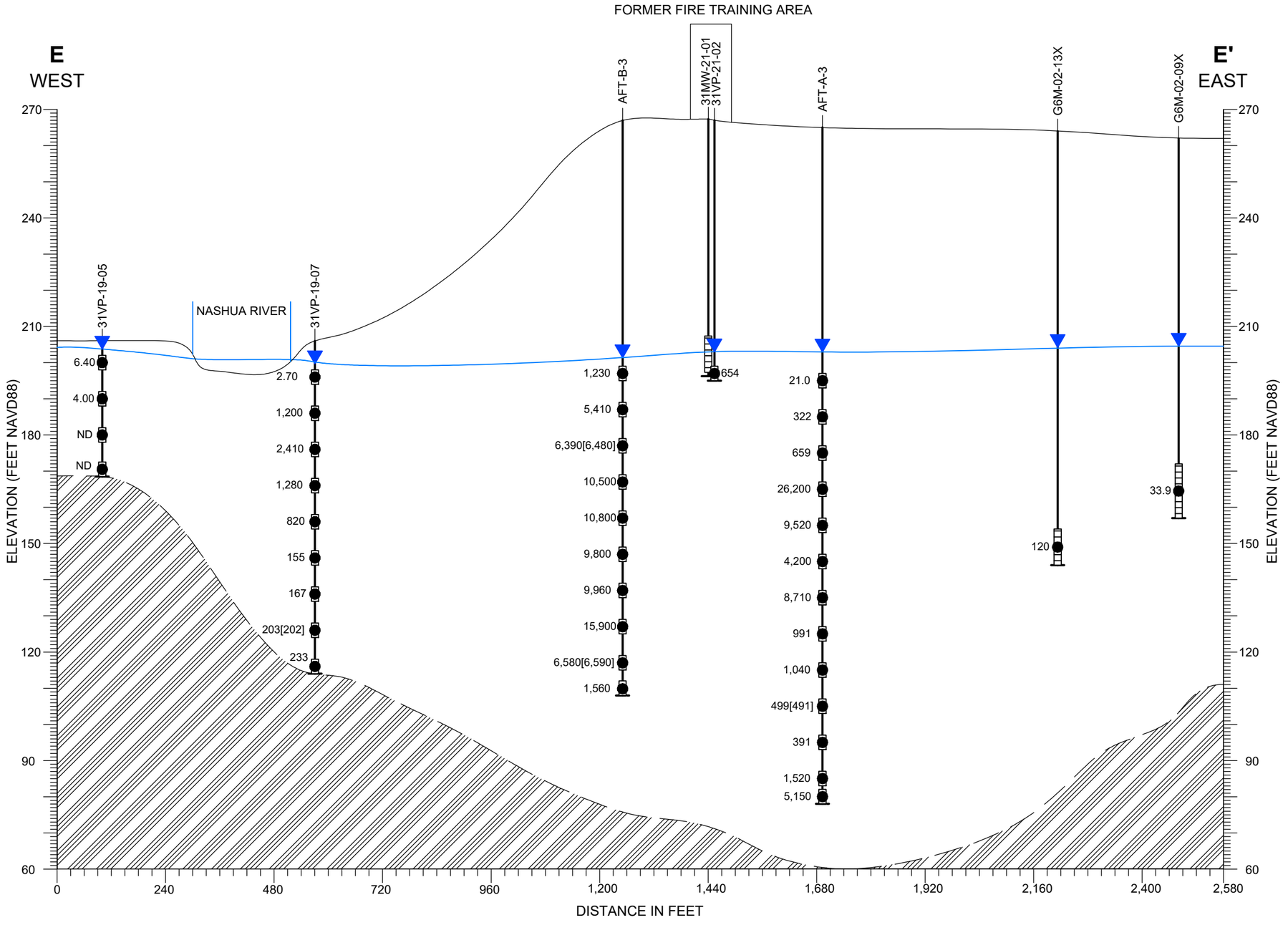
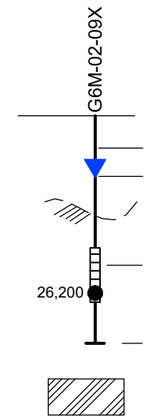
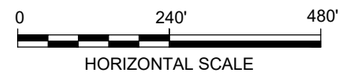


LEGEND



NOTES:

1. AOC = AREA OF CONTAMINATION
2. DUPLICATE CONCENTRATIONS ARE INCLUDED IN PARENTHESIS
3. ID = IDENTIFICATION
4. NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
5. ng/L = NANOGRAM PER LITER
6. PFDA = PERFLUORODECANOIC ACID
7. PFHpA = PERFLUOROHEPTANOIC ACID
8. PFHxS = PERFLUOROHEXANESULFONIC ACID
9. PFNA = PERFLUORONANOIC ACID
10. PFOS = PERFLUOROOCTANESULFONIC ACID
11. PFOA = PERFLUOROOCTANOIC ACID
12. PFAS6 = PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA



PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION E-E'
PFAS6 CONCENTRATIONS - AOC 31

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FIGURE
2-19e

F

SOUTHEAST

F'

NORTHWEST

G6M-02-09X
50VP-22-03
50VP-22-02
50VP-22-01
30VP-19-04

ELEVATION (FEET NAVD88)

270
250
230
210
190
170
150
130
110
100

33.9
3,900
11,400
3,360
2,060
116[142]
ND
1,200
113
15
23,900
1,900
10,100
3,810
4,430
4,260
4,860
231
2,580
325
417
790
900
1,160
1,750[1,690]
1,890
20.1[20.1]
20.0
ND
28.6
210
513
645

0
140
280
420
560
700
840
980
1,120
1,260
1,400
1,500

DISTANCE IN FEET

LEGEND

30VP-19-04 — WELL/BORING ID

EXISTING GROUND SURFACE

BORING

DEPTH TO WATER

BEDROCK SURFACE (ESTIMATED BASED ON DRILLING REFUSAL)

SCREEN INTERVAL

20.0 — Sum of PFOS + PFOA+ PFDA + PFHpA + PFHxS + PFNA (ng/L)

TOTAL BORING DEPTH

BEDROCK

NOTES:

1. AOC = AREA OF CONTAMINATION
2. DUPLICATE CONCENTRATIONS ARE INCLUDED IN PARENTHESIS
3. ID = IDENTIFICATION
4. NAVD88 = NORTH AMERICAN VERTICAL DATUM OF 1988
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8. PFHxS = PERFLUOROHEXANESULFONIC ACID
9. PFNA = PERFLUORONANOIC ACID
10. PFOS = PERFLUOROOCTANESULFONIC ACID
11. PFOA = PERFLUOROOCTANOIC ACID
12. PFAS6 = PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA

0 — 140' — 280'

HORIZONTAL SCALE

0 — 20' — 40'

VERTICAL SCALE

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION F-F'
PFAS6 CONCENTRATIONS - AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-19f

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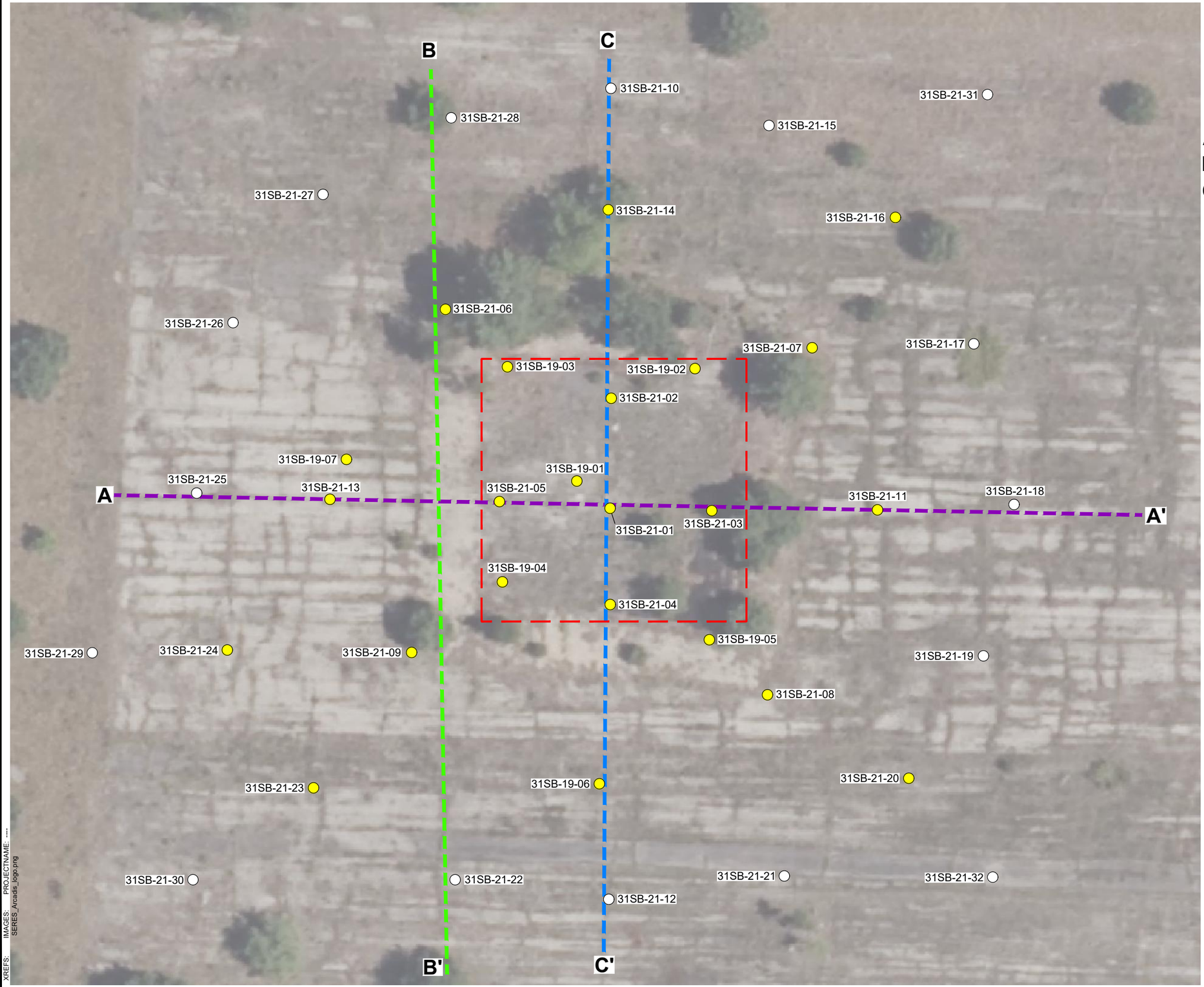

LEGEND

- COMPLETED SOIL BORING BELOW SSSL
- COMPLETED SOIL BORING ABOVE SSSL
- A – – – A' TRANSECT LINE
- B – – – B' TRANSECT LINE
- C – – – C' TRANSECT LINE
- FORMER FIRE TRAINING AREA

NOTES:

1. AOC = AREA OF CONTAMINATION
2. FT = FEET
3. IN = INCHES
4. SSSL = SITE-SPECIFIC SCREENING LEVELS

0 30' 60'

Approximate Scale: 1 in. = 30 ft.

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION LOCATION MAP - AOC 31

SERES Engineering & Services, LLC
ARCADIS a joint venture

FIGURE
2-20

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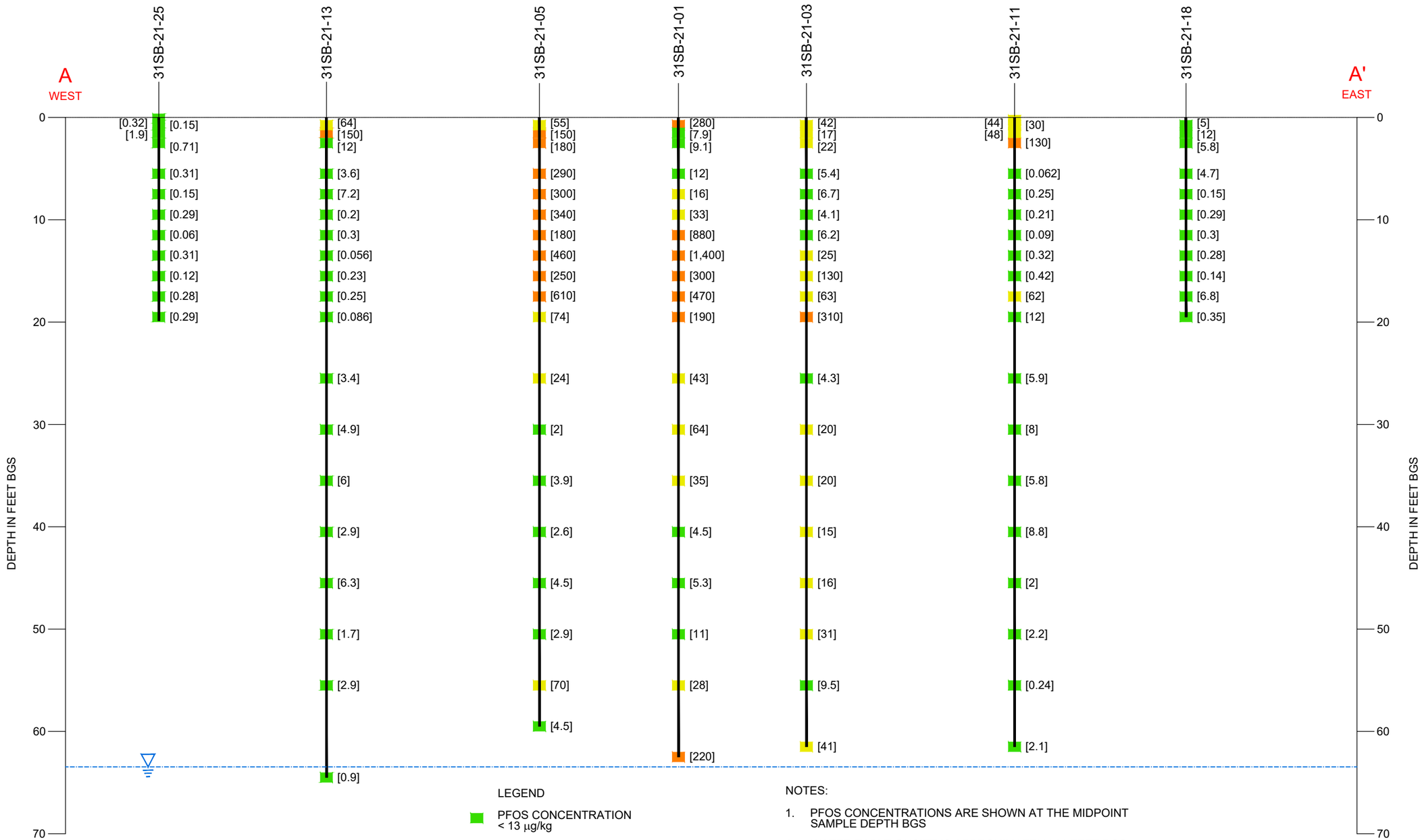

KEY PLAN
SHOWING CROSS SECTION A-A'

LEGEND

- PFOS CONCENTRATION < 13 µg/kg
- PFOS CONCENTRATION 13 - 130 µg/kg
- PFOS CONCENTRATION > 130 µg/kg
- WATER TABLE
- [0.32] PFOS CONCENTRATION AT SAMPLE DEPTH IN µg/kg

NOTES:

1. PFOS CONCENTRATIONS ARE SHOWN AT THE MIDPOINT SAMPLE DEPTH BGS
2. WATER TABLE ONSITE IS APPROXIMATELY 64 FEET BGS BASED ON SPRING 2022 WATER LEVELS
3. µg/kg = MICROGRAMS PER KILOGRAM
4. BGS = BELOW GROUND SURFACE
5. PFOS = PERFLUOROOCTANE SULFONATE
6. > = GREATER THAN
7. < = LESSER THAN

0 25' 50'
HORIZONTAL GRAPHIC SCALE

0 10' 20'
VERTICAL GRAPHIC SCALE

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION A-A'
PFOS CONCENTRATIONS

SERES
ARCADIS
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FIGURE
2-20a

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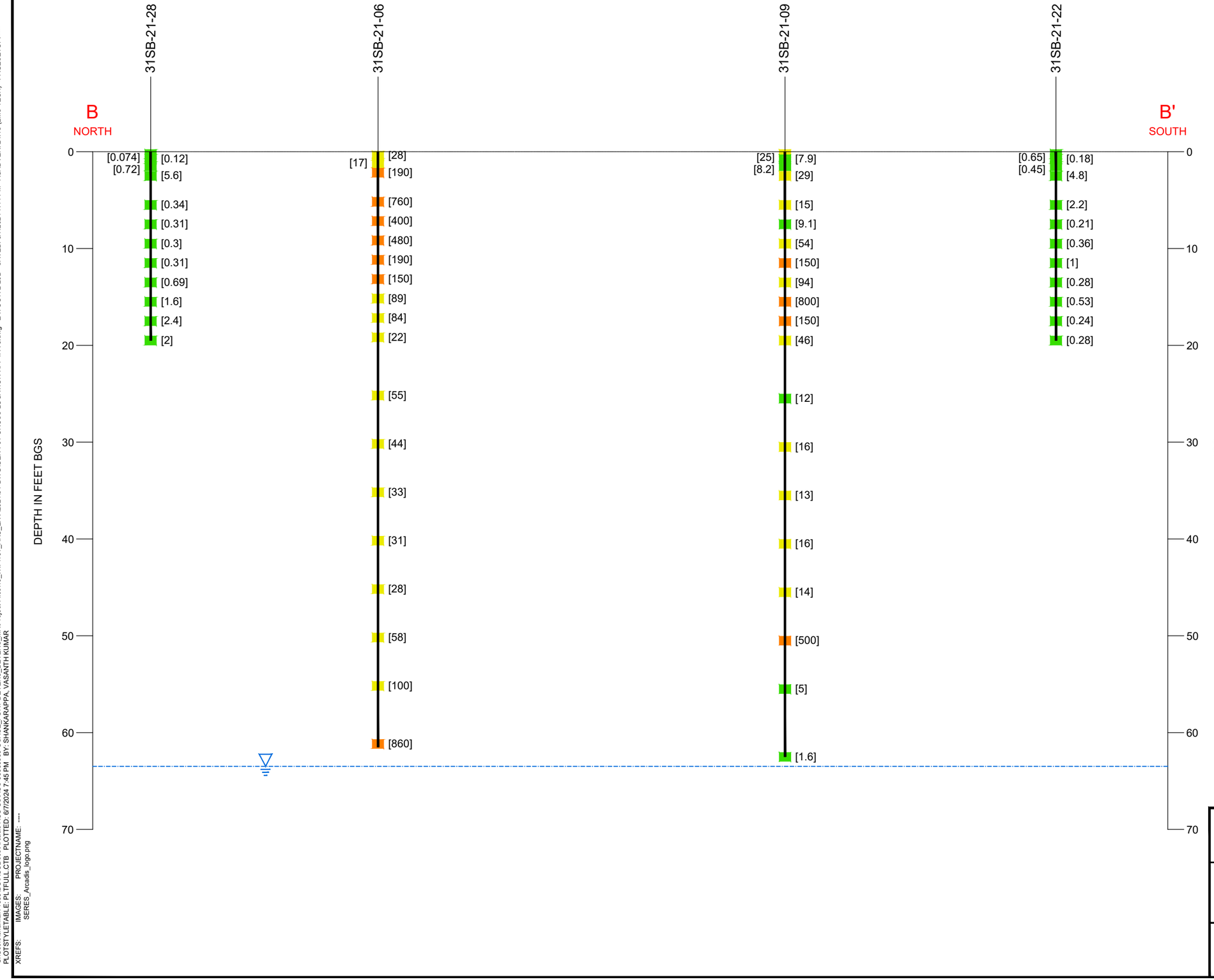

KEY PLAN
SHOWING CROSS SECTION B-B'

LEGEND

- PFOS CONCENTRATION < 13 µg/kg
- PFOS CONCENTRATION 13 - 130 µg/kg
- PFOS CONCENTRATION > 130 µg/kg
- WATER TABLE
- [0.32] PFOS CONCENTRATION AT SAMPLE DEPTH IN µg/kg

NOTES:

1. PFOS CONCENTRATIONS ARE SHOWN AT THE MIDPOINT SAMPLE DEPTH BGS
2. WATER TABLE ONSITE IS APPROXIMATELY 64 FEET BGS BASED ON SPRING 2022 WATER LEVELS
3. µg/kg = MICROGRAMS PER KILOGRAM
4. BGS = BELOW GROUND SURFACE
5. PFOS = PERFLUOROOCTANE SULFONATE
6. > = GREATER THAN
7. < = LESSER THAN

0 25' 50'
HORIZONTAL GRAPHIC SCALE

0 10' 20'
VERTICAL GRAPHIC SCALE

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION B-B'
PFOS CONCENTRATIONS

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ARCADIS a joint venture

FIGURE
2-20b

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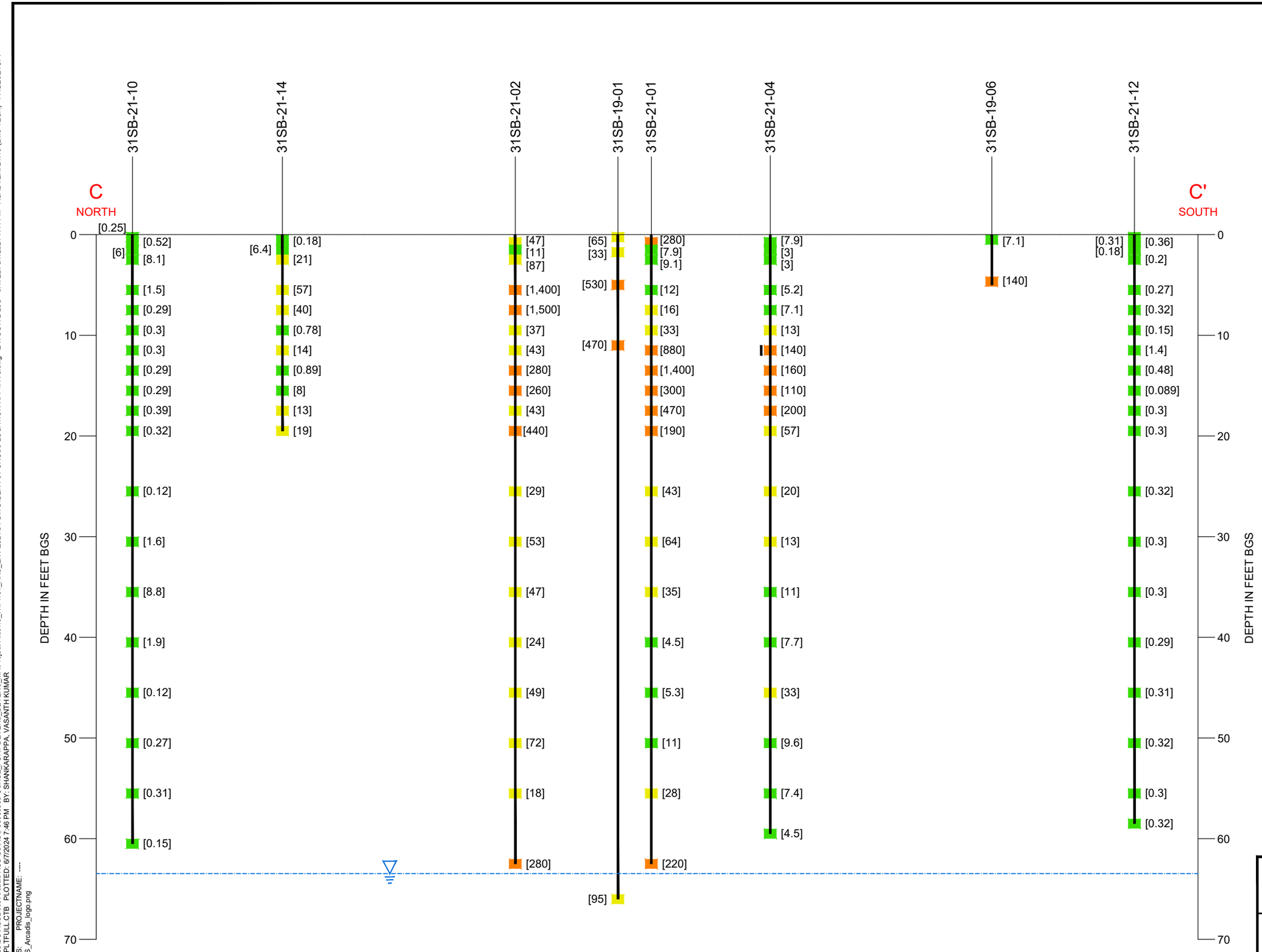

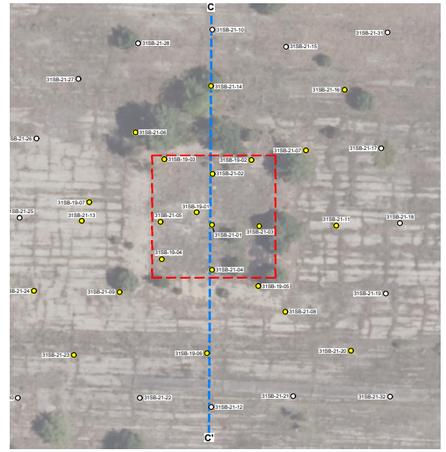

KEY PLAN
SHOWING CROSS SECTION C-C'

LEGEND

- PFOS CONCENTRATION < 13 µg/kg
- PFOS CONCENTRATION 13 - 130 µg/kg
- PFOS CONCENTRATION > 130 µg/kg
- WATER TABLE
- [0.32] PFOS CONCENTRATION AT SAMPLE DEPTH IN µg/kg

NOTES:

1. PFOS CONCENTRATIONS ARE SHOWN AT THE MIDPOINT SAMPLE DEPTH BGS
2. WATER TABLE ONSITE IS APPROXIMATELY 64 FEET BGS BASED ON SPRING 2022 WATER LEVELS
3. µg/kg = MICROGRAMS PER KILOGRAMS
4. BGS = BELOW GROUND SURFACE
5. PFOS = PERFLUOROOCTANE SULFONATE
6. > = GREATER THAN
7. < = LESSER THAN

0 25' 50'
HORIZONTAL GRAPHIC SCALE

0 10' 20'
VERTICAL GRAPHIC SCALE

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

CROSS SECTION C-C'
PFOS CONCENTRATIONS

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FIGURE
2-20c

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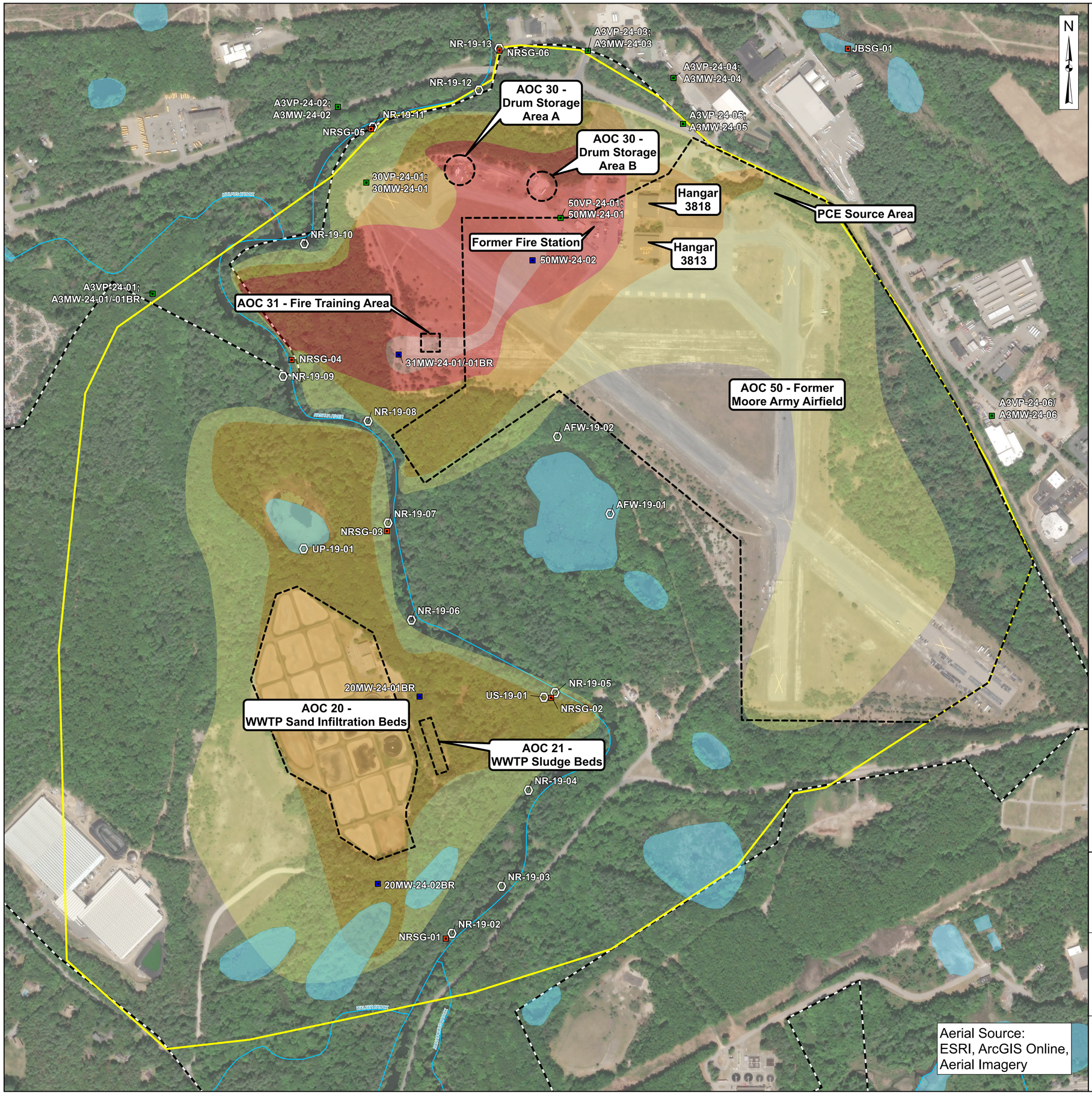

LEGEND

- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- AOC AREA
- STREAM
- WATERBODY
- APPROXIMATE EXTENT OF THE AREA EXCEEDING THE SSSLs
- APPROXIMATE EXTENT OF THE AREA >10X SSSLs
- APPROXIMATE EXTENT OF THE AREA >100X SSSLs
- APPROXIMATE EXTENT OF THE AREA >1000X SSSLs

PROPOSED SAMPLE LOCATIONS

- VERTICAL AQUIFER PROFILE AND MONITORING WELL
- MONITORING WELL
- STAFF GAUGE
- SURFACE WATER

NOTES:
> = GREATER THAN
AOC = AREA OF CONTAMINATION
PCE = TETRACHLOROETHENE
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
SSSL = SITE-SPECIFIC SCREENING LEVELS
WWTP = WASTEWATER TREATMENT PLANT
X = TIMES

0 1,000 2,000
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

PROPOSED GROUNDWATER INVESTIGATION LOCATIONS OVERVIEW

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a joint venture

Figure
4-1

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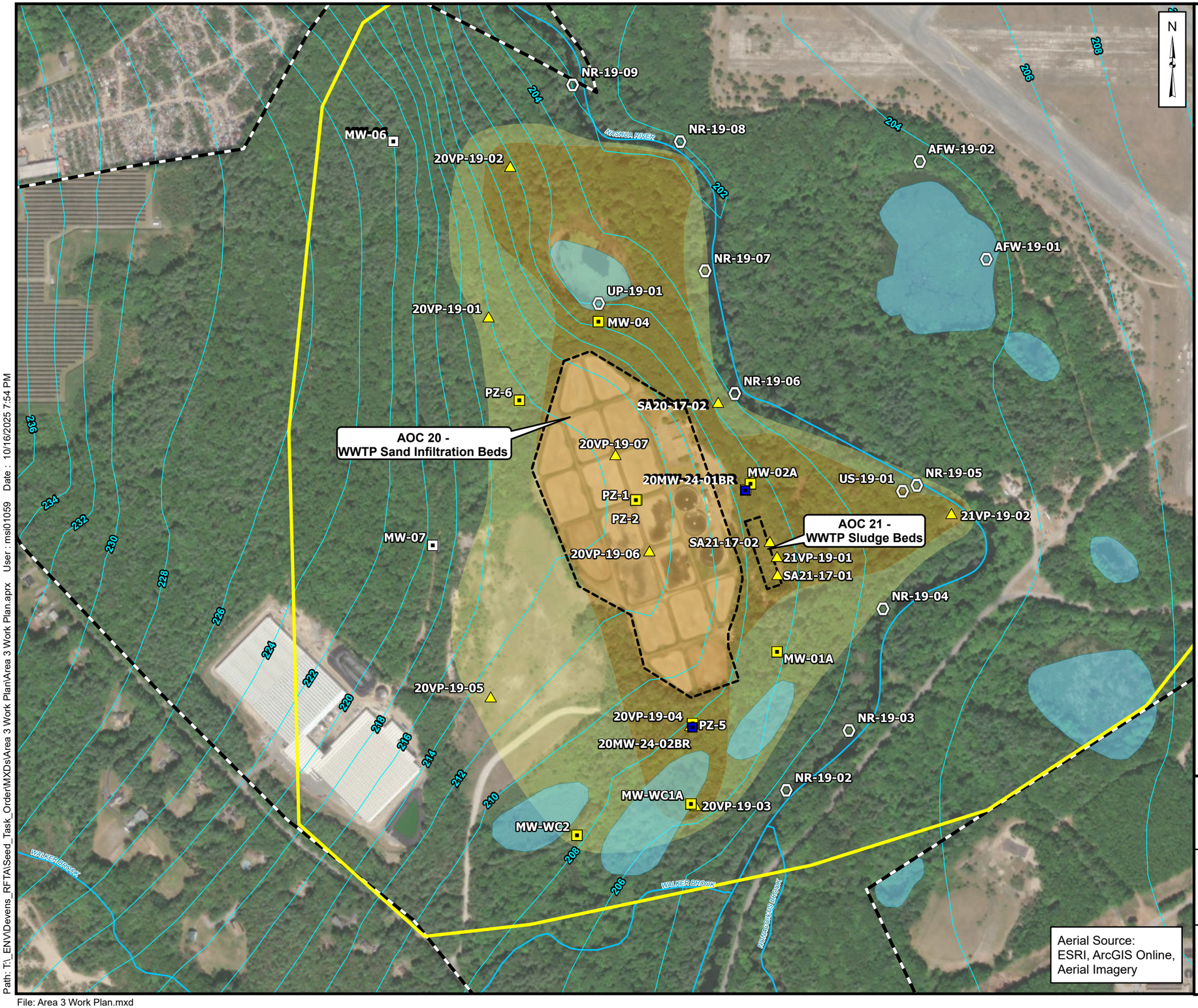

LEGEND

- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- AOC AREA
- MODELED GROUNDWATER CONTOURS
- STREAM
- WATERBODY
- APPROXIMATE EXTENT OF THE AREA EXCEEDING THE SSSLs
- APPROXIMATE EXTENT OF THE AREA >10X SSSLs

PROPOSED SAMPLE LOCATIONS

- MONITORING WELL
- SURFACE WATER

HISTORICAL PFAS INVESTIGATION LOCATIONS

- VAP LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)
- VAP LOCATION BELOW MMCL AND/OR SSSL
- MONITORING WELL LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)
- MONITORING WELL LOCATION BELOW MMCL AND/OR SSSL

NOTES:
> = GREATER THAN
AOC = AREA OF CONTAMINATION
MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
PCE = TETRACHLOROETHENE
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
SSSL = SITE-SPECIFIC SCREENING LEVELS
VAP = VERTICAL AQUIFER PROFILE
WWTP = WASTEWATER TREATMENT PLANT
X = TIMES

0 500 1,000
Feet

Aerial Source:
ESRI, ArcGIS Online,
Aerial Imagery

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER INVESTIGATION LOCATIONS – WESTERN PORTION OF AREA 3 (AOC 20 AND AOC 21)

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ARCADIS a joint venture

Figure 4-2

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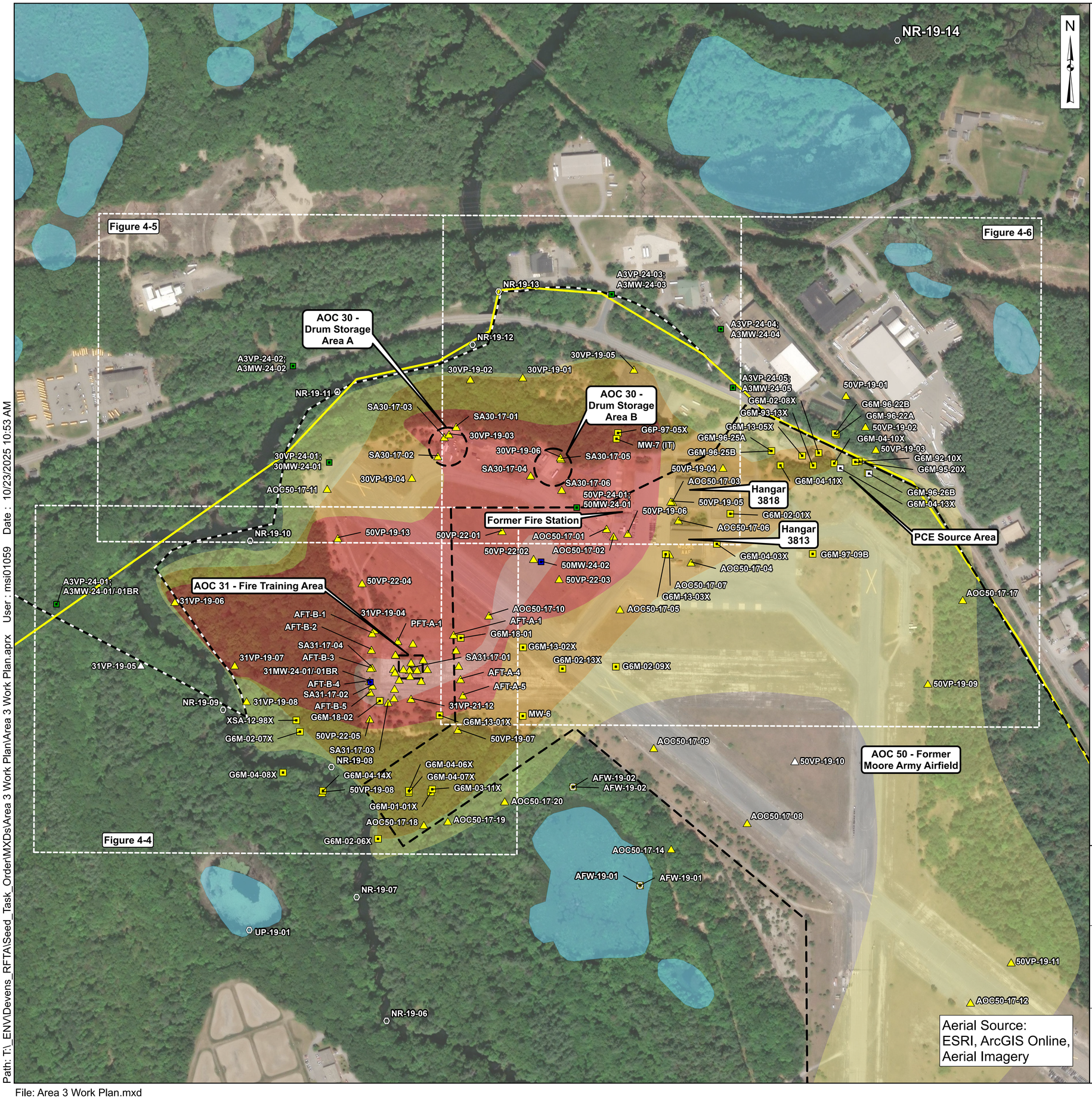

LEGEND

- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- AOC AREA
- STREAM
- WATERBODY
- APPROXIMATE EXTENT OF THE AREA EXCEEDING THE SSSLs
- APPROXIMATE EXTENT OF THE AREA >10X SSSLs
- APPROXIMATE EXTENT OF THE AREA >100X SSSLs
- APPROXIMATE EXTENT OF THE AREA >1000X SSSLs

PROPOSED SAMPLE LOCATIONS

- VERTICAL AQUIFER PROFILE (VAP) AND MONITORING WELL
- MONITORING WELL
- SURFACE WATER

HISTORICAL PFAS INVESTIGATION LOCATIONS

- VAP LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)
- VAP LOCATION BELOW MMCL AND/OR SSSL
- MONITORING WELL LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)
- MONITORING WELL LOCATION BELOW MMCL AND/OR SSSL

NOTES:
> = GREATER THAN
AOC = AREA OF CONTAMINATION
MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
PCE = TETRACHLOROETHENE
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
SSSL = SITE-SPECIFIC SCREENING LEVELS
VAP = VERTICAL AQUIFER PROFILE
WWTP = WASTEWATER TREATMENT PLANT
X = TIMES

0 500 1,000
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER INVESTIGATION LOCATIONS – EASTERN PORTION OF AREA 3 (AOC 30, AOC 31, AND AOC 50) - KEY MAP

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ARCADIS a joint venture

Figure 4-3

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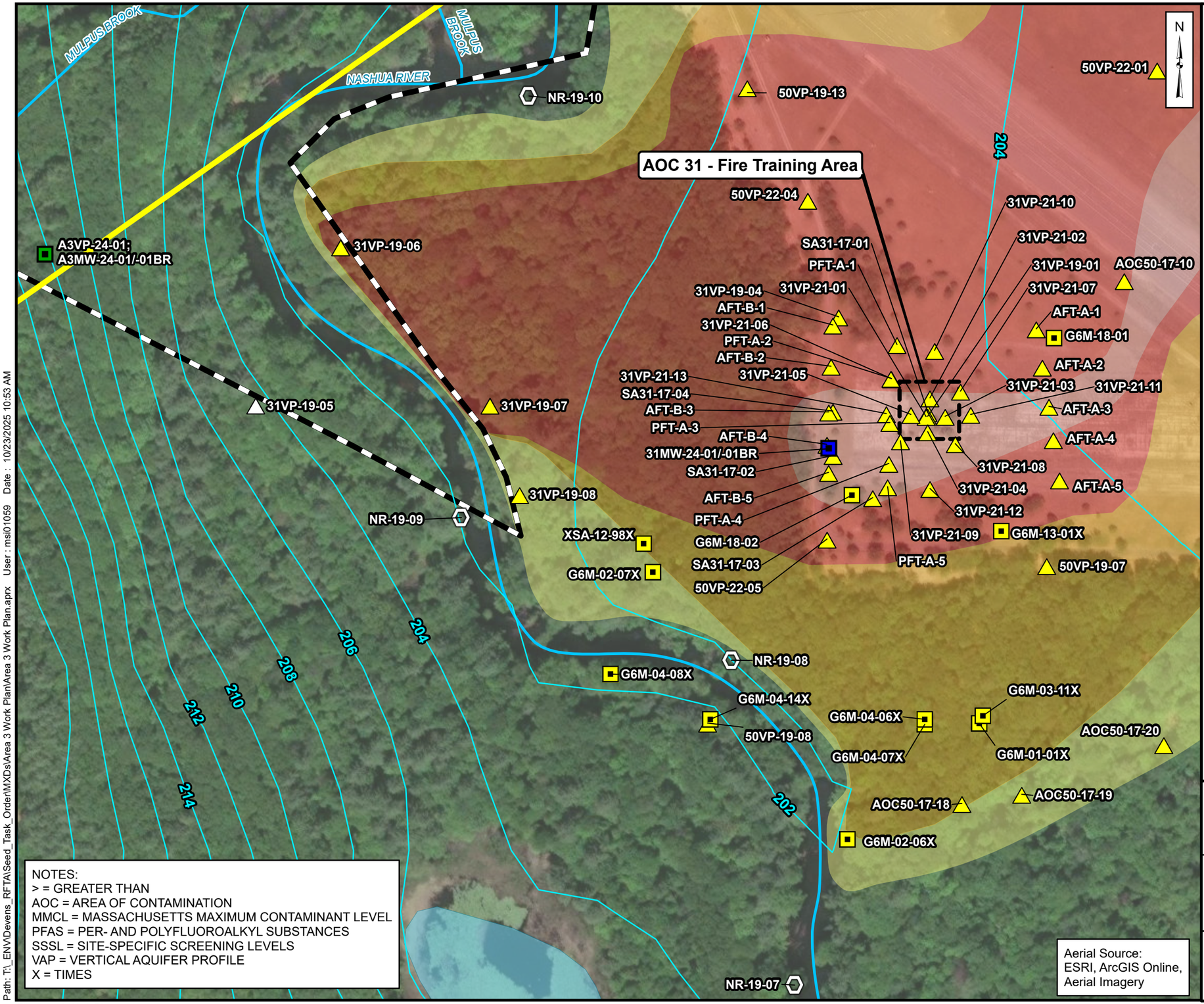
File: Area 3 Work Plan.mxd



NOTES:
> = GREATER THAN
AOC = AREA OF CONTAMINATION
MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
SSSL = SITE-SPECIFIC SCREENING LEVELS
VAP = VERTICAL AQUIFER PROFILE
X = TIMES

Aerial Source:
ESRI, ArcGIS Online,
Aerial Imagery

LEGEND

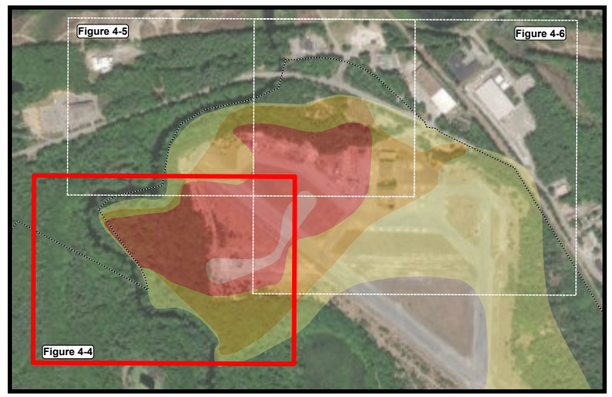
- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- STREAM
- AOC AREA
- MODELED GROUNDWATER CONTOURS
- APPROXIMATE EXTENT OF THE AREA EXCEEDING THE SSSLs
- APPROXIMATE EXTENT OF THE AREA >10X SSSLs
- APPROXIMATE EXTENT OF THE AREA >100X SSSLs
- APPROXIMATE EXTENT OF THE AREA >1000X SSSLs

PROPOSED SAMPLE LOCATIONS

- VERTICAL AQUIFER PROFILE AND MONITORING WELL
- MONITORING WELL
- SURFACE WATER

HISTORICAL PFAS INVESTIGATION LOCATIONS

- VAP LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)
- MONITORING WELL LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)



0 200 400
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER INVESTIGATION LOCATIONS – AOC 31

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 4-4

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File: Area 3 Work Plan.mxd

NOTES:
> = GREATER THAN
AOC = AREA OF CONTAMINATION
MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
SSSL = SITE-SPECIFIC SCREENING LEVELS
VAP = VERTICAL AQUIFER PROFILE
X = TIMES

SQUANNACOOK RIVER
MULPUS BROOK
NASHUA RIVER

202
204
206
208
210
212
214
216

NR-19-13
NR-19-12
NR-19-11
NR-19-10

A3VP-24-03; A3MW-24-03
A3VP-24-04; A3MW-24-04
A3VP-24-02; A3MW-24-02
30VP-24-01; 30MW-24-01
50VP-24-01; 50MW-24-01

30VP-19-05
30VP-19-02
30VP-19-01
30VP-19-03
30VP-19-04
30VP-19-06
50VP-19-04
50VP-19-05
50VP-19-13
50VP-22-01
50VP-22-02
50VP-22-04
50VP-22-03
50MW-24-02
31VP-19-06

AOC 30 - Drum Storage Area A
AOC 30 - Drum Storage Area B
Former Fire Station
Hangar 3818
Hangar 3813

SA30-17-01
SA30-17-02
SA30-17-03
SA30-17-04
SA30-17-05
SA30-17-06

G6P-97-05X
MW-7 (IT)
G6M-02-01X
G6M-04-03X
G6M-13-03X

AOC50-17-01
AOC50-17-02
AOC50-17-03
AOC50-17-04
AOC50-17-05
AOC50-17-06
AOC50-17-07
AOC50-17-10
AOC50-17-11

Aerial Source:
ESRI, ArcGIS Online,
Aerial Imagery

N

LEGEND

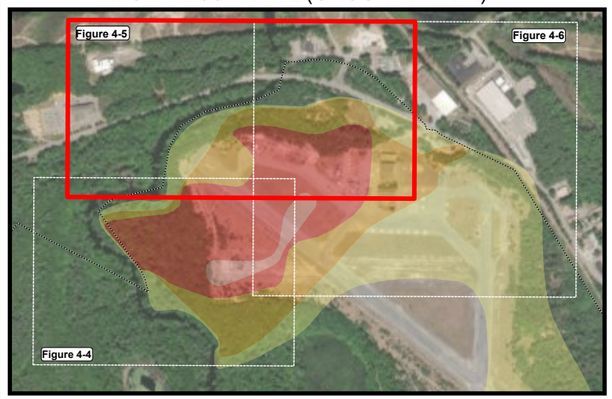
- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- STREAM
- AOC AREA
- MODELED GROUNDWATER CONTOURS
- APPROXIMATE EXTENT OF THE AREA EXCEEDING THE SSSLs
- APPROXIMATE EXTENT OF THE AREA >10X SSSLs
- APPROXIMATE EXTENT OF THE AREA >100X SSSLs
- APPROXIMATE EXTENT OF THE AREA >1000X SSSLs

PROPOSED SAMPLE LOCATIONS

- VERTICAL AQUIFER PROFILE AND MONITORING WELL
- MONITORING WELL
- SURFACE WATER

HISTORICAL PFAS INVESTIGATION LOCATIONS

- VAP LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)
- MONITORING WELL LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)



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PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER INVESTIGATION LOCATIONS – AOC 30

SERES Engineering & Services, LLC
ARCADIS
a joint venture

Figure 4-5

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msl01059 Date : 10/23/2025 10:50 AM
File: Area 3 Work Plan.mxd

NOTES:
> = GREATER THAN
AOC = AREA OF CONTAMINATION
MMCL = MASSACHUSETTS MAXIMUM CONTAMINANT LEVEL
PCE = TETRACHLOROETHENE
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
SSSL = SITE-SPECIFIC SCREENING LEVELS
VAP = VERTICAL AQUIFER PROFILE
X = TIMES

NR-19-13
NR-19-12
NASHUA RIVER
A3VP-24-03; A3MW-24-03
A3VP-24-04; A3MW-24-04
A3VP-24-05; A3MW-24-05
202
204
206
208
210
212
214
216
30VP-19-05
30VP-19-02
30VP-19-01
AOC 30 - Drum Storage Area A
AOC 30 - Drum Storage Area B
SA30-17-01
30VP-19-03
SA30-17-03
SA30-17-02
30VP-19-06
SA30-17-05
G6P-97-05X
MW-7 (IT)
SA30-17-04
SA30-17-06
AOC50-17-03
50VP-19-04
50VP-19-05
50VP-24-01; 50MW-24-01
Former Fire Station
AOC50-17-06
G6M-02-01X
AOC50-17-01
AOC50-17-02
50VP-19-06
50VP-22-01
50VP-22-02
50MW-24-02
50VP-22-03
G6M-13-03X
AOC50-17-07
AOC50-17-04
G6M-04-03X
G6M-97-09B
AOC50-17-05
AOC50-17-10
AFT-A-1
G6M-18-01
AFT-A-2
AFT-A-3
AFT-A-4
AFT-A-5
G6M-13-01X
MW-6
G6M-13-02X
G6M-02-09X
G6M-02-13X
AOC 50 - Former Moore Army Airfield
Hangar 3818
Hangar 3813
G6M-13-05X
G6M-96-25A
G6M-96-25B
G6M-04-11X
G6M-96-22A
G6M-96-22B
50VP-19-01
G6M-04-10X
50VP-19-02
G6M-95-20X
50VP-19-03
G6M-92-10X
G6M-96-26A
G6M-96-26B
PCE Source Area
G6M-04-13X
G6M-02-08X
G6M-93-13X
AOC50-17-17
50VP-19-09
210
212
214

Aerial Source:
ESRI, ArcGIS Online,
Aerial Imagery

LEGEND

- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- STREAM
- AOC AREA
- MODELED GROUNDWATER CONTOURS
- APPROXIMATE EXTENT OF THE AREA EXCEEDING THE SSSLs
- APPROXIMATE EXTENT OF THE AREA >10X SSSLs
- APPROXIMATE EXTENT OF THE AREA >100X SSSLs
- APPROXIMATE EXTENT OF THE AREA >1000X SSSLs

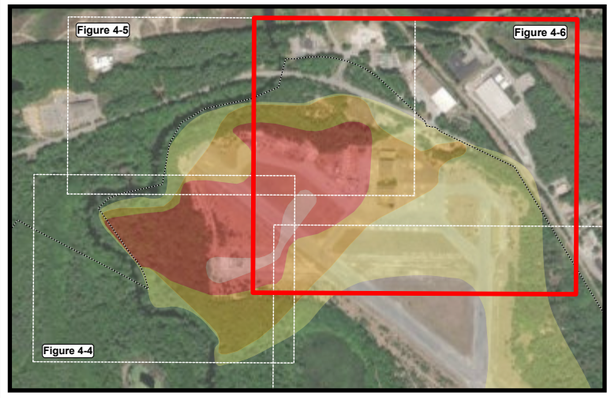
PROPOSED SAMPLE LOCATIONS

- VERTICAL AQUIFER PROFILE AND MONITORING WELL
- MONITORING WELL
- SURFACE WATER

HISTORICAL PFAS INVESTIGATION LOCATIONS

- VAP LOCATION EXCEEDING THE MMCL AND/ OR SSSL (GROUNDWATER)
- MONITORING WELL LOCATION EXCEEDING THE MMCL AND/OR SSSL (GROUNDWATER)
- MONITORING WELL LOCATION BELOW MMCL AND/OR SSSL

N



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Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

GROUNDWATER INVESTIGATION LOCATIONS – AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 4-6

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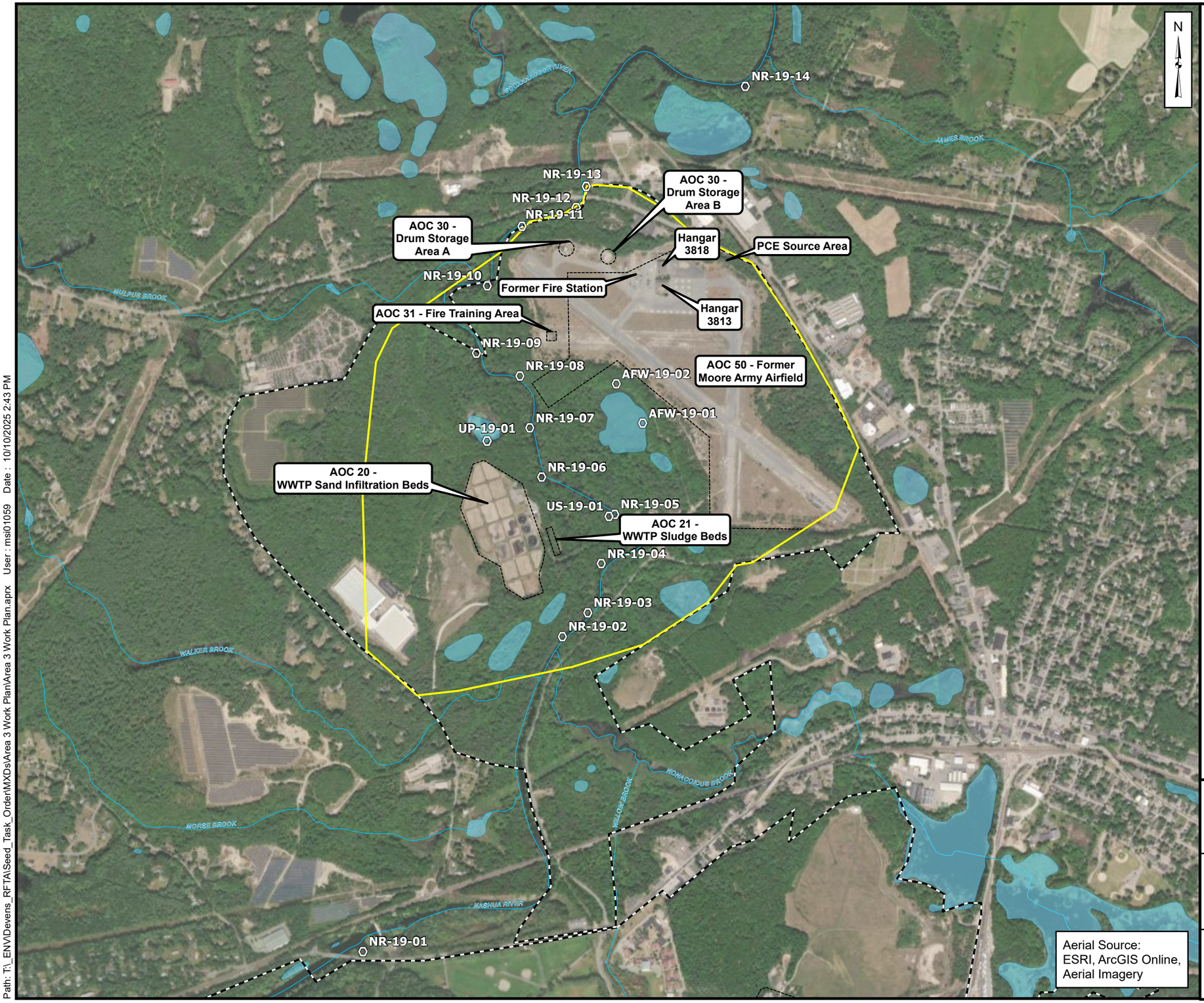

LEGEND

- FORMER FORT DEVENS BOUNDARY
- PFAS AREA 3
- AOC AREA
- STREAM
- WATERBODY
- PROPOSED SURFACE WATER SAMPLE LOCATIONS, PREVIOUSLY SAMPLED FOR SURFACE WATER AND SEDIMENT

NOTES:
AOC = AREA OF CONTAMINATION
PCE = TETRACHLOROETHENE
PFAS = PER- AND POLYFLUOROALKYL SUBSTANCES
WWTP = WASTEWATER TREATMENT PLANT

0 0.25 0.5
Miles

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

PROPOSED SURFACE WATER SAMPLE LOCATIONS

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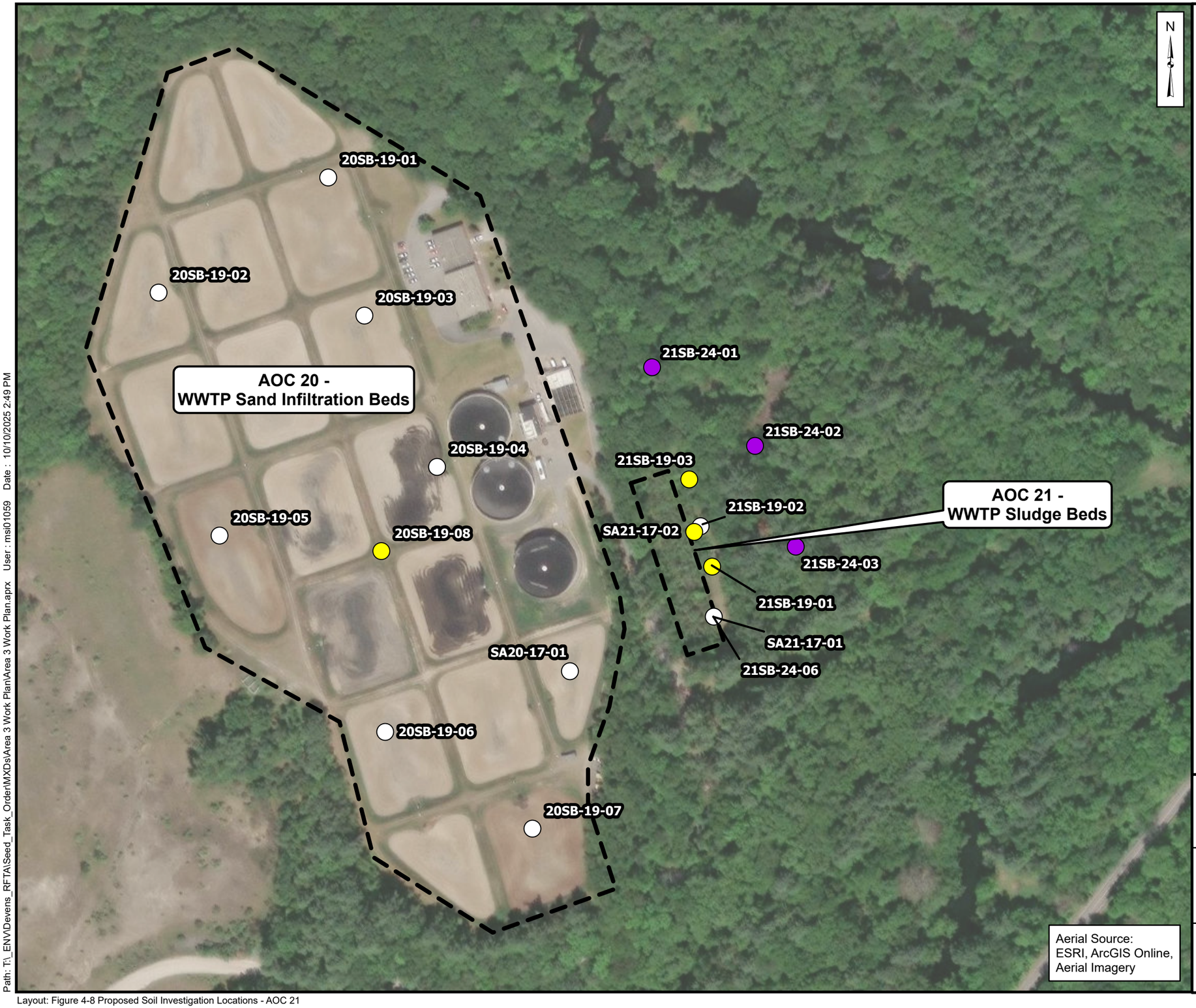
Figure 4-7

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msi01059 Date : 10/10/2025 2:43 PM

File: Area 3 Work Plan.mxd



LEGEND

AOC AREA

PROPOSED SOIL INVESTIGATION LOCATIONS

SOIL BORING

HISTORICAL PFAS INVESTIGATION LOCATIONS

COMPLETED SOIL BORING BELOW SSSL

COMPLETED SOIL BORING ABOVE SSSL

NOTES:
AOC = AREA OF CONTAMINATION
SSSL = SITE-SPECIFIC SCREENING LEVELS
WWTP = WASTEWATER TREATMENT PLANT

0 250 500
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

Proposed Soil Investigation Locations - AOC 21

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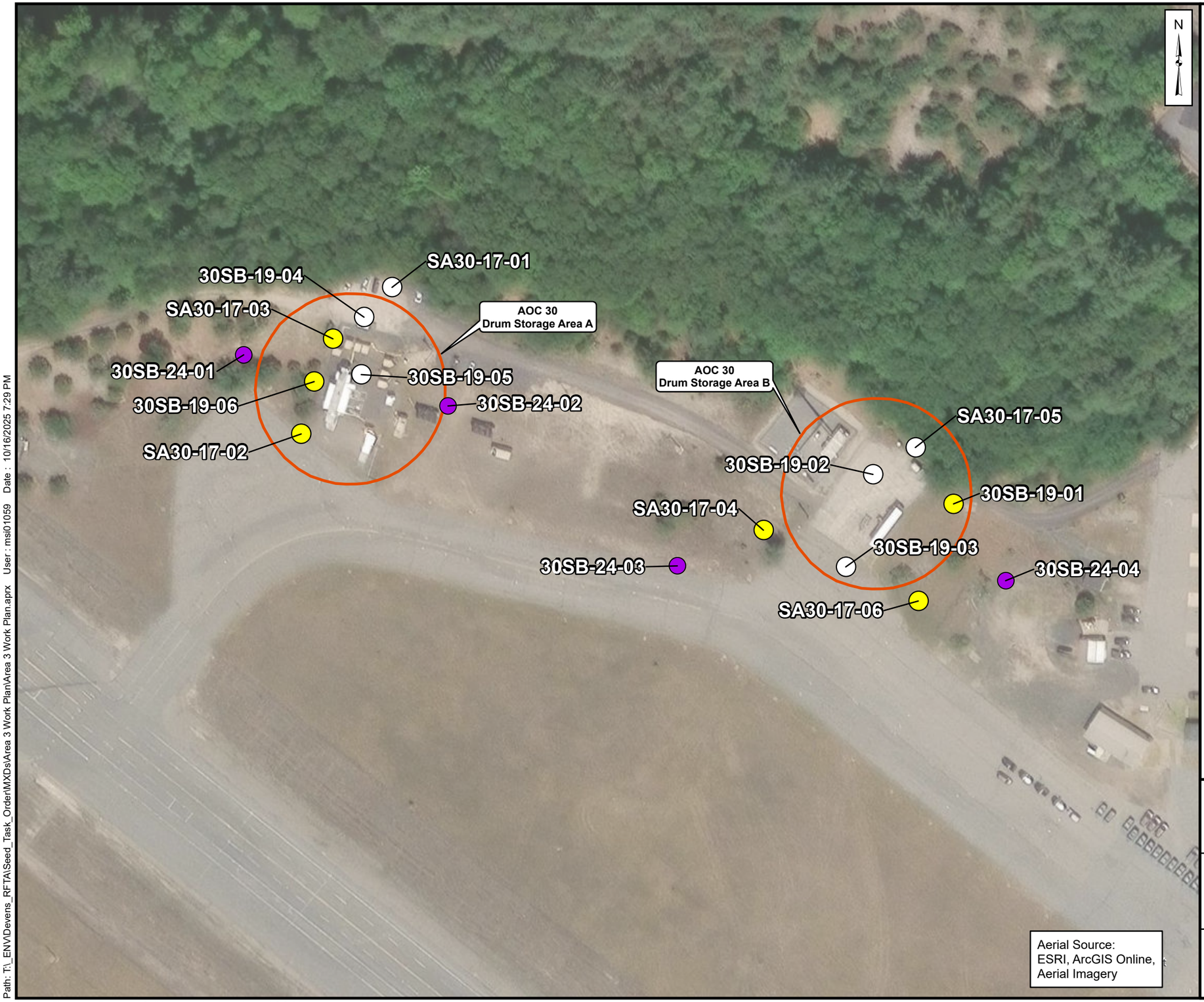
Figure 4-8

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msl01059 Date : 10/10/2025 2:49 PM

Layout: Figure 4-8 Proposed Soil Investigation Locations - AOC 21



LEGEND

PROPOSED SOIL INVESTIGATION LOCATIONS

- SOIL BORING

HISTORICAL PFAS INVESTIGATION LOCATIONS

- COMPLETED SOIL BORING BELOW SSSL
- COMPLETED SOIL BORING ABOVE SSSL

NOTES:
AOC = AREA OF CONTAMINATION
SSSL = SITE-SPECIFIC SCREENING LEVELS

0 100 200
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

PROPOSED SOIL INVESTIGATION LOCATIONS – AOC 30

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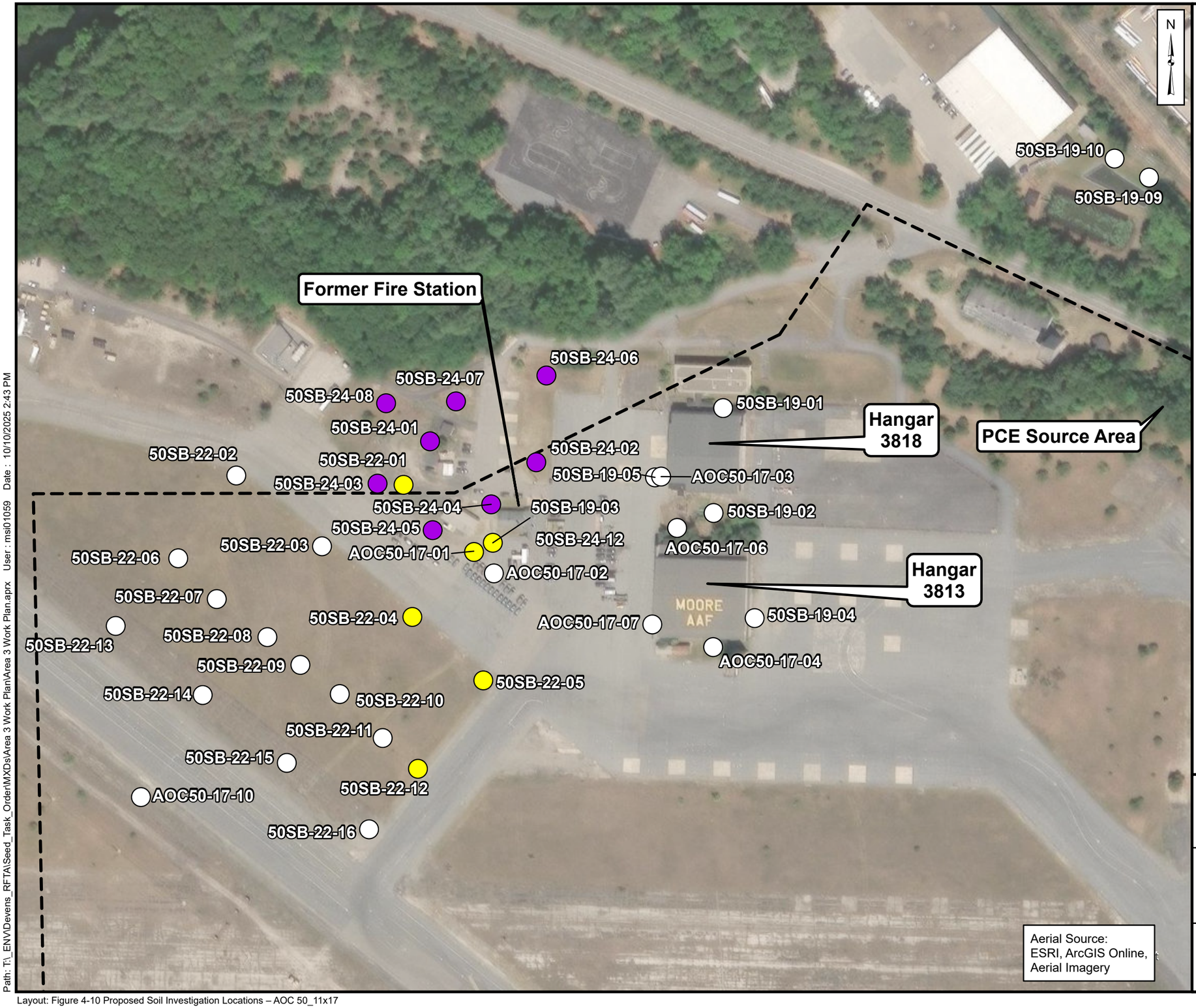
Figure
4-9

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msl01059 Date : 10/16/2025 7:29 PM

Layout: Figure 4-9 Proposed Soil Investigation Locations - AOC 30



LEGEND

AOC AREA

PROPOSED SOIL INVESTIGATION LOCATIONS

SOIL BORING

HISTORICAL PFAS INVESTIGATION LOCATIONS

COMPLETED SOIL BORING BELOW SSSL

COMPLETED SOIL BORING ABOVE SSSL

NOTES:
AOC = AREA OF CONTAMINATION
PCE = TETRACHLOROETHENE
SSSL = SITE-SPECIFIC SCREENING LEVELS

0 175 350
Feet

PHASE II REMEDIAL INVESTIGATION WORK PLAN - AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

PROPOSED SOIL INVESTIGATION LOCATIONS – AOC 50

SERES Engineering & Services, LLC
ARCADIS a joint venture

Figure 4-10

Path: T:_ENV\Devens_RFTA\Seed_Task_Order\MXDs\Area 3 Work Plan\Area 3 Work Plan.aprx User : msl01059 Date : 10/10/2025 2:43 PM

Layout: Figure 4-10 Proposed Soil Investigation Locations – AOC 50_11x17

Appendix A

Quality Assurance Project Plan

DRAFT FINAL

VERSION 0

UNIFORM FEDERAL POLICY FOR QUALITY ASSURANCE PROJECT PLAN

PHASE II REMEDIAL INVESTIGATION FOR PER- AND POLYFLUOROALKYL SUBSTANCES – STAGE 1

AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

NOVEMBER 2025

Contract No. W912WJ-19-D-0014
Contract Delivery Order No. W912WJ-23-F-0118

UNIFORM FEDERAL POLICY FOR QUALITY ASSURANCE PROJECT PLAN

PHASE II REMEDIAL INVESTIGATION FOR PER- AND POLYFLUOROALKYL SUBSTANCES – STAGE 1

AREA 3
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

NOVEMBER 2025

Contract No. W912WJ-19-D-0014
Contract Delivery Order No. W912WJ-23-F-0118

Prepared For:

UNITED STATES ARMY CORPS OF ENGINEERS, NEW ENGLAND DISTRICT
696 Virginia Road
Concord, Massachusetts 01742

Prepared By:

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Introduction

The SERES-Arcadis Joint Venture (JV), Limited Liability Company (LLC)[1] (hereafter referred to as the S-A JV) has prepared this Quality Assurance Project Plan (QAPP) under Contract No. W912WJ-19-D-0014, Task Order No. W912WJ-23-F-0118. The QAPP was prepared consistent with the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) on behalf of the United States (U.S.) Army Corps of Engineers (USACE) to conduct a Comprehensive Environmental Response, Compensation, and Liability Act- (CERCLA-) compliant Remedial Investigation (RI) to investigate areas at the Former Fort Devens Army Installation (Devens) located in Devens, Massachusetts, that may have been impacted by per- and polyfluoroalkyl substances (PFAS), including constituents of aqueous film-forming foam (AFFF).

This QAPP pertains to investigation in the following locations in the former North Post area of Devens:

- AOC 20 Wastewater Treatment Plant (WWTP) Sand Filter Beds
- AOC 21 WWTP Sludge Drying Beds
- AOC 50 Former Moore Army Airfield (MAAF)
- AOC 30 MAAF Drum Storage Area
- AOC 31 MAAF Fire Training Area (FTA)

This QAPP was prepared in accordance with the following documents:

- EM 385-1-1, Safety and Health Requirements Manual (USACE 2014);
- United States Environmental Protection Agency (USEPA) guidance document 505-F-03-001, Intergovernmental Data Quality Task Force, Uniform Federal Policy for Implementing Environmental Quality Systems (USEPA 2005a);
- USEPA's Guidance for Quality Assurance Project Plans, CIO 2106-G-05 (USEPA 2012); and
- Other guidance documents as appropriate.

UFP-QAPP Worksheets are developed to systematically document the planning process, sampling rationale, sampling protocols, quality assurance (QA)/quality control (QC) procedures, and other relevant components. This QAPP was developed with the understanding that unanticipated conditions may dictate a change in the plan as currently written.

Staff who will be participating in project and field efforts are required to read this plan and understand the objectives of the work to be performed, as well as the procedures to be used for conducting the field investigation, performing the laboratory analyses, and evaluating and reporting the data that are collected. In addition, key personnel are responsible for mentoring assigned staff in aspects of this QAPP potentially impacting their assigned work to ensure project activities are executed in accordance with the plan.

The Area 3 Phase II investigation will be performed in two stages (Stages 1 and 2). This QAPP includes the methodology and proposed plan to execute the first stage of the Phase II investigation. The objectives of Stage 1 are:

1. Characterize the areas greatest concentrations of PFAS at Area 3 to assess maximum exposure point concentrations (EPCs) in the impacted media; and

[1] The SERES-Arcadis JV is composed of protégé firm SERES Engineering & Services, LLC (SERES) and its mentor Arcadis U.S., Inc. (Arcadis).

2. Identify/confirm potential exposure pathways for PFAS.

In 2016, an installation-wide Preliminary Assessment (PA) of PFAS at Devens identified Study Areas (SAs) and Areas of Contamination (AOCs) where there was a potential for the use, storage, or disposal of AFFF. The constituents of AFFF are collectively referred to as PFAS. In 2018, a site inspection (SI) conducted at Devens to determine the presence or absence of PFOS and PFOA at potential source areas confirmed the presence of PFAS in groundwater, soil, surface water, and sediment in the former North Post area and recommended further investigation in an RI (BERS-Weston Services, JVA, LLC [BERS-Weston] 2018). To expedite field investigations in support of the RI, the identified Devens AOCs and public water supply well areas were grouped into three areas (Areas 1, 2, and 3). The three areas were designated for sequencing of field activities and do not reflect prioritization. Area 3 includes AOCs in the North Post area of Devens.

The Area 3 Phase II PFAS RI Work Plan – Stage 1 (Area 3 Phase II PFAS RI WP) addresses collection of soil, groundwater, and surface water data in Area 3 of the former Fort Devens. The WP presents the CSM including potential receptors and exposure pathways and the rationale for the number and locations of proposed RI samples. This QAPP provides brief summaries of the WP elements, but its primary purpose is to outline the analytical parameters.

The objective of this QAPP is to generate project data that are technically valid, legally defensible, and useful in meeting the Stage 1 project objectives, as well as to integrate the technical and QC requirements for future investigation activities. The RI will collect data sufficient to meet USACE and regulatory requirements and support remedial alternative decisions, if needed, for the PFAS-impacted sites in Area 3 of the former Fort Devens. The technical approach for the RI is designed to achieve the data quality objectives (DQOs) presented in the Area 3 Phase II PFAS RI WP and in **Worksheet #11**. This QAPP addresses four primary elements:

- Project management;
- Measurement and data acquisition;
- Assessment and oversight; and
- Data validation and usability.

The above elements incorporate quality assurance/quality control (QA/QC) requirements cited within the following documents:

- USEPA Requirements for Quality Assurance Project Plans, USEPA QA/R-5 (USEPA 2001);
- USEPA Guidance on Systematic Planning Using the Data Quality Objectives Process, QA/G-4 (USEPA 2006);
- USEPA Uniform Federal Policy for Quality Assurance Project Plans, Final Version (USEPA 2005b);
- USEPA Guidance for Quality Assurance Project Plans, CIO-2106-G-05 (USEPA 2012);
- U.S. Department of Defense (DoD) Quality Systems Manual, Version 5.4 (DoD 2021a) or later;
- DoD General Data Validation Guidelines, November 2019, Revision 1 (DoD 2019); and
- DoD Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24 (DoD 2022).

The optimized UFP-QAPP workbook format used for this QAPP implements the systematic planning process and was developed via collaboration between the USEPA, DoD, and the Department of Energy. In 2010, a subgroup composed of members from the participating agencies reviewed and optimized the UFP-QAPP workbook in close coordination with USEPA's 2012 update of QA/G5, Guidance for Quality Assurance Project Plans. The information contained in the worksheets captures the elements that would otherwise be included in related project planning documents, such as a Sampling and Analysis Plan and Field Sampling Plan. Table I is a crosswalk between the optimized UFP-QAPP worksheet numbers and titles and the USEPA's QAPP Guidance (USEPA 2012).

The following attachments are provided to supplement the information presented in this QAPP:

Attachment A Field Standard Operating Procedures

Attachment B Field Forms

Attachment C Laboratory Standard Operating Procedures and Certifications

Table I: Crosswalk: UFP-QAPP Workbook to 2106-G-05 QAPP

Worksheet Number(s)	Worksheet Title	CIO 2106-G-05 QAPP Guidance Section	
		Section	Title
1, 2	Title and Approval Pages	2.2.1	Title, Version, and Approval/Sign-Off
3, 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7, 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
10	Conceptual Site Model	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations Table	Chapter 3	QAPP Elements for Evaluating Existing Data
14, 16	Project Tasks and Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits and Laboratory-Specific Detection/ Quantitation Limits	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods/ Standard Operating Procedures (SOPs)	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements

Worksheet Number(s)	Worksheet Title	CIO 2106-G-05 QAPP Guidance Section	
		Section	Title
19, 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field Quality Control Samples Summary Table	2.3.5	Quality Control Requirements
21	Project Sampling SOP References Table	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration, and Maintenance Requirements, Supplies and Consumables
23	Analytical Standard Operating Procedures	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration, and Maintenance Requirements, Supplies and Consumables
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration, and Maintenance Requirements, Supplies and Consumables
26, 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Analytical Quality Control and Corrective Action
29	Project Documents and Records	2.3.8	Documentation and Records Requirements
31, 32, 33	Assessments and Corrective Action	2.4	Assessments and Data Review (Check)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

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Acronyms and Abbreviations

%	percent
ºC	degrees Celsius
%	percent
%R	percent recovery
µg/kg	microgram per kilogram
µS/cm	microSiemens per centimeter
ABB	ABB Environmental Services, Inc
AFFF	aqueous film-forming foam
amu	atomic mass unit
AOC	Area of Contamination
Army	United States Army
ASD	Office of the Assistant Secretary of Defense
ASTM	American Society of Testing & Materials
BA	Bachelor of Arts
BCEE	Board Certified Environmental Engineer
BEC	Base Realignment and Closure Environmental Coordinator
BERS-Weston	BERS-Weston Services, JVA, LLC
bgs	below ground surface
BRA	baseline risk assessment
BRAC	Base Realignment and Closure
BS	Bachelor of Science
CA	corrective action
CAS	Chemical Abstract Service
CCV	continuing calibration verification
CENAE	United States Army Corps of Engineers, New England District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfr	code of federal regulation
cfs	cubic feet per second
cm	centimeter
COR	Contracting Officer's Representative
CSM	conceptual site model
CSP	Certified Safety Professional
Devens	Former Fort Devens Army Installation
DL	detection limit
DO	dissolved oxygen
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DPT	direct-push technology
DQCR	daily quality control report
DQI	data quality indicator
DQO	data quality objective
EDD	electronic data deliverable
EIS	extracted internal standard
ELAP	Environmental Laboratory Accreditation Program
EPC	exposure point concentration
eV	electron volt

FEMA	Federal Emergency Management Agency
FTA	Firefighting Training Area
FS	feasibility study
g/kg	grams per kilogram
gpm	gallons per minute
gpm/foot	gallons per minute per foot
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HFPO-DA	hexafluoropropylene oxide dimer acid
HHRA	human health risk assessment
HTRW	hazardous, toxic, and radioactive waste
ICAL	initial calibration
ICP-OES	inductively coupled plasma-optical emission spectrometer
ICV	initial calibration verification
ID	Identification
IDA	isotope dilution analyte
IDW	investigation-derived waste
Inc.	Incorporated
ISC	internal standard calibration
ITRC	Interstate Technology Regulatory Council
JV	joint venture
KGS	KOMAN Government Solutions, LLC
LC/MS/MS	liquid chromatography with tandem mass spectrometry
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LHA	Lifetime Health Advisory
LLC	Limited Liability Company
LOD	limit of detection
LOQ	limit of quantitation
MA	Massachusetts
MAAF	Moore Army Airfield
MassDEP	Massachusetts Department of Environmental Protection
MB	method blank
MBA	Master of Business Administration
MCL	maximum contaminant level
MCP	Massachusetts Contingency Plan
MDL	method detection limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
ml	milliliter
MPC	measurement performance criteria
MS	matrix spike
MSc	Master of Science
MSD	matrix spike duplicate
mV	millivolt
NA	not applicable/not available
NAD 83	North American Datum of 1983

NAVD 88	North American Vertical Datum of 1988
ng/g	nanogram per gram
ng/L	nanogram per liter
NIS	non-extracted internal standard
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PA	preliminary assessment
Pace	Pace Analytical Services, LLC
PAL	project action limit
PCE	tetrachloroethylene
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances
PFAS6	PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonate
PFDA	perfluorodecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanic acid
PFOS	perfluorooctane sulfonic acid
PFPrA	perfluoropropanoic acid
PG	Professional Geologist
PID	photoionization detector
PM	Project Manager
POC	point of contact
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance project plan
QA/QC	quality assurance /quality control
QC	quality control
QSM	quality systems manual
RAGS	Risk Assessment Guidance for Superfund
RCA	root cause analysis
RCRA	Resource Conservation and Recovery Act
RF	response factor
RI	remedial investigation
RPD	relative percent difference
RSD	relative standard deviation
RSE	relative standard error
RSL	Regional Screening Levels
RT	retention time
SA	Study Area
S-A JV	Seres-Arcadis JV
SI	site inspection
SL	screening level
SLERA	screening level ecological risk assessment

SOP	standard operating procedure
SSSL	site-specific screening level
STSC	Safety Trained Supervisor Construction
TBD	to be determined
TFSI	bis(trifluoromethylsulfonyl)amine
TGI	Technical Guidance Instruction
TOC	total organic carbon
T&R	transformation and reduction
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
U.S.	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VAP	vertical aquifer profiling
WP	work plan
WWTP	Wastewater Treatment Plant

QAPP Worksheets #1 & 2: Title and Approval Pages

(Uniform Federal Policy for Quality Assurance Project Plans [UFP-QAPP] Manual Section 2.1) (USEPA 2106-G-05 Section 2.2.1)

This worksheet identifies the principal points of contact for all organizations having decision authority in the project and documents their commitment to implement the UFP-Quality Assurance Project Plan (QAPP). Signatories usually include the Project Manager (PM) and Quality Assurance (QA) Manager, and individuals with approval or oversight authority. Signatures indicate that officials have reviewed the UFP-QAPP and concur with the implementation as written. It is the lead organization's responsibility to make sure all signatures are in place before work begins.

1. Project Identifying Information:
    a. Site Name/Project Name: Area 3 Phase II Remedial Investigation for Per- and Polyfluoroalkyl Substances – Stage 1
    b. Site Location: Former Fort Devens Army Installation (Fort Devens), Devens, Massachusetts
    c. Contract/Work Assignment Number: W912WJ-19-D-0014/W912WJ-23-F-0118
    d. Lead Organization: U.S. Environmental Protection Agency (USEPA) Region 1 and U.S. Army Corps of Engineers (USACE)
    e. Geographical Corps District: New England District
2. Department of Defense Organization(s):
    a. U.S. Army (Army), Base Realignment and Closure (BRAC)
        i. Name: Thomas Lineer
        ii. Title: BRAC Environmental Coordinator (BEC)
    b. USACE, New England District (CENAE)
        i. Name: Penelope Reddy
        ii. Title: USACE PM

        iii. Signature: _____ Date: _____
3. Contractor: SERES-Arcadis JV (S-A JV)
    a. S-A JV PM
        i. Name: Andy Vitolins, Professional Geologist (PG)
        ii. Title: S-A JV PM

        iii. Signature: _____ Date: _____

4. Federal Regulatory Agency: USEPA Region I
5. State/Territory Regulatory Agency: Massachusetts Department of Environmental Protection (MassDEP)
6. Other Stakeholders:
    a. Restoration Advisory Board
    b. Local Residents and Businesses
7. Plans and reports from previous investigations in the following table:

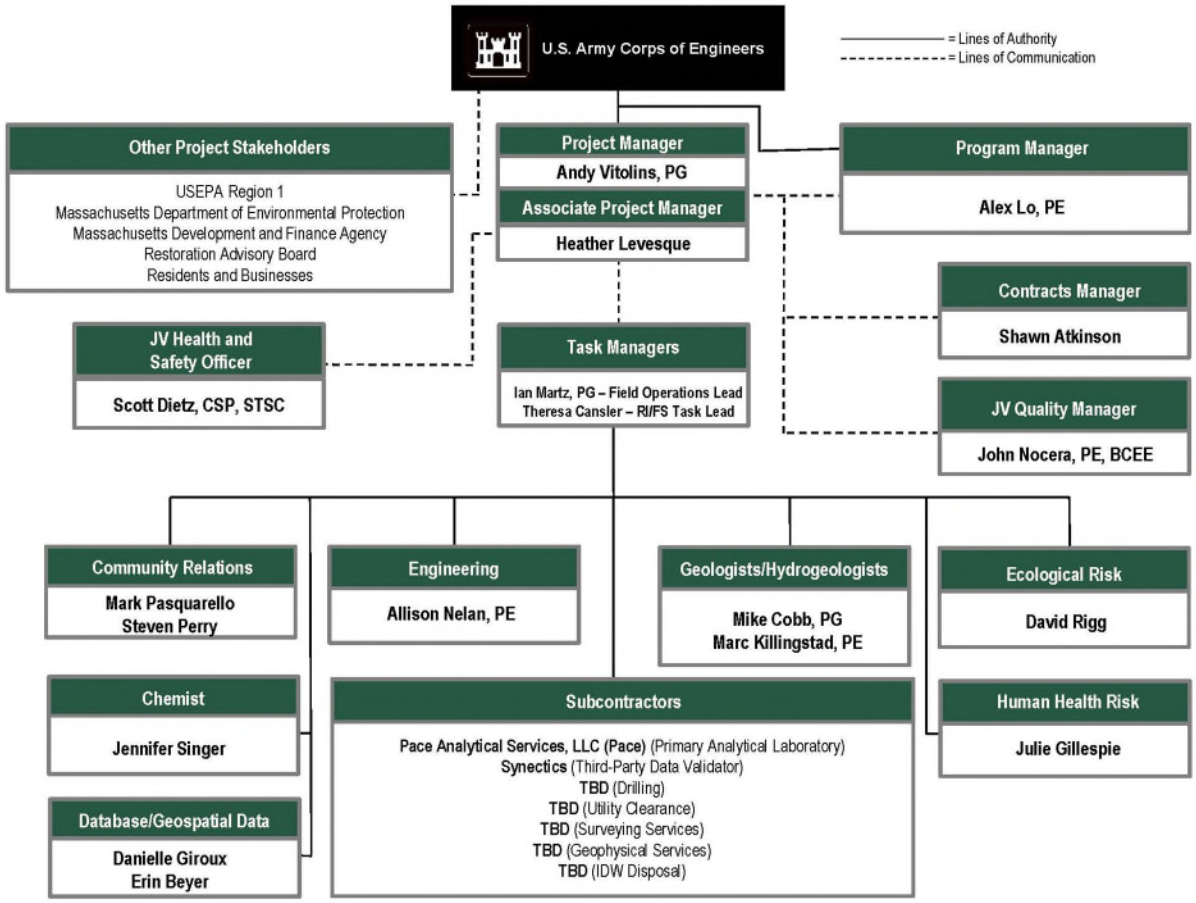
Date	Report Title	Author
April 1993	Final Site Investigation Report, Fort Devens, Groups 3, 5, and 6.	ABB Environmental Services, Inc. (ABB-ES)
August 2017	Final Base-Wide Preliminary Assessment for Evaluation of Perfluoroalkyl Substances, Former Fort Devens Army Installation BRAC Legacy Sites, Devens, Massachusetts.	KOMAN Government Solutions, LLC (KGS)
May 2018	Final Site Inspection Report for Per- and Polyfluoroalkyl Substances (PFAS) at Former Fort Devens Army Installation, Devens, MA.	BERS-Weston Services, JVA, LLC (BERS-Weston)
February 2021	Area 3 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation. Former Fort Devens Army Installation, Devens, MA.	KGS

Scoping Session:	USACE Kickoff Meeting: April 2020 Technical Project Planning Meetings: Biweekly since kickoff.	

QAPP Worksheets #3 & 5: Project Organization and QAPP Distribution

(UFP-QAPP Manual Sections 2.3 and 2.4)
(USEPA 2106-G-05 Sections 2.2.3 and 2.2.4)

This worksheet identifies key project personnel, as well as lines of authority and lines of communication among the Department of Defense (DoD) organization, prime contractor, subcontractors, and regulatory agencies. A list of QAPP recipients along with their contact information is provided in the table below.



Distribution List for Area 3 Phase II PFAS RI QAPP

Project Delivery Team and QAPP Recipients	Title	Organization	Telephone Number	Email Address
Alex Lo	Program Manager	S-A JV	(843) 388-7804	ahlo@seres-es.com
John Nocera	Corporate Quality Manager	S-A JV	(251) 405-4560	john.nocera@arcadis.com
Scott Dietz	Health and Safety Officer	S-A JV	(240) 344-5892	scott.dietz@arcadis.com
Andy Vitolins	PM	S-A JV	(518) 461-3145	andy.vitolins@arcadis.com
Heather Levesque	Associate PM	S-A JV	(619) 370-0374	halevesque@seres-es.com
Ian Martz	Field Operations Lead	S-A JV	(978) 322-4526	ian.martz@arcadis.com
Theresa Cansler	RI/FS Task Lead	S-A JV	(757) 873-4355	theresa.cansler@arcadis.com
Jennifer Singer	Project Chemist	S-A JV	(716) 667-6664	jennifer.singer@arcadis.com
Penelope Reddy	PM	USACE	(978) 318-8160	penelope.reddy@usace.army.mil
Michael Kulbersh	Project Hydrogeologist	USACE	(978) 318-8088	michael.r.kulbersh@usace.army.mil
Brent Smith	Project Geologist	USACE	(978) 318-8233	brent.l.smith@usace.army.mil
Yixian Zhang	Project Chemist	USACE	(978) 318-8730	yixian.zhang@usace.army.mil
Cheryl Montgomery	Project Ecological Risk Assessor	USACE	(978) 318-8088	cheryl.r.montgomery@usace.army.mil
Amy Rosenstein	Project Human Health Risk Assessor	USACE	(978) 318-8055	amy.b.rosenstein@usace.army.mil
Thomas Lineer	BEC	Army	(703) 545-2487 (Office) (703) 371-6785 (Mobile)	thomas.a.lineer.civ@army.mil
Shawn Lowry	Remedial PM	USEPA Region 1	(617) 918-1459	lowry.shawn@epa.gov
Joanne Dearden	Federal Sites Program PM	MassDEP	(781) 407-1595	joanne.dearden@state.ma.us
Kathy Smith	Laboratory PM	Pace Analytical Services, LLC (Pace)	(803) 683-9550 (Office) (912) 465-7901 (Mobile)	kathy.smith@pacelabs.com
Jessica Beskind	Data Validation PM	Synectics	(916) 737-4031	jessica.beskind@synetics.net
Evin McKinney	Data Validation Senior Scientist	Synectics	(916) 737-4016 (Office) (916) 508-9467 (Mobile)	evin.mckinney@synectics.net

QAPP Worksheets #4, 7, & 8: Personnel Qualifications and Sign-off Sheet

(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(USEPA 2106-G-05 Sections 2.2.1 and 2.2.7)

This worksheet identifies the key project personnel for the contractor performing tasks defined in this QAPP, which includes the prime contractor and laboratories.

ORGANIZATION: SERES-Arcadis JV

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications for the Project Title/Role[1]	Signature/Date[2]
Alex Lo, Professional Engineer (PE)	Program Manager	Bachelor of Science (BS), Geological Engineering, 27 years of experience managing hazardous, toxic, and radioactive waste (HTRW) investigation, remediation, construction and Military Munitions and Response Program responses, and 22 years of experience working at government installations.	• Licensed Professional Engineer • Occupational Safety and Health Administration (OSHA) Initial 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER), Annual 8-Hour Refreshers	Signature on file
Andy Vitolins, PG	PM	Master of Science (MSc), Environmental Science, Bachelor of Arts (BA), Geological Sciences, 24 years of experience. Experienced in the management of numerous comprehensive investigation and remediation projects throughout the eastern United States under federal and state environmental programs.	• OSHA Initial 40-Hour HAZWOPER • OSHA 8-Hour HAZWOPER Refresher • Construction Safety Awareness and Site Supervisor Safety Training • Arcadis Certified Federal PM	Signature on file
John Nocera, PE, Board Certified Environmental Engineer (BCEE)	Corporate Quality Manager	Master of Engineering (ME) and Bachelor of Engineering (BE), 31 years of experience in environmental investigation and remedial design for USACE.	• OSHA Initial 40-Hour HAZWOPER • USACE Construction Quality Management for Contractors	Signature on file

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications for the Project Title/Role[1]	Signature/Date[2]
Shawn Atkinson	Federal Contracts Manager	Master of Business Administration (MBA), BS, Management, 12 years of experience managing both cost and fixed-price contracts for DoD, civilian agencies, and federal contractors. Solid understanding of the Federal Acquisition Regulation, various contract types and vehicles, and the entire acquisition process.	• Certified Professional Contracts Manager • Previously held Defense Acquisition Workforce Improvement Act Level III certification	Signature on file
Scott Dietz, Certified Safety Professional (CSP), Safety Trained Supervisor Construction (STSC)	Health and Safety Officer	BS, 28 years of industrial hygiene/environmental, occupational health and safety experience.		Signature on file
Jennifer Singer	Project Chemist	MSc, Environmental Pollution Control, BS, Biochemistry, 21 years of project chemistry experience in coordination with the Air Force Civil Engineer Center, USACE, and USEPA.		Signature on file
Allison Nelan, PE	Senior Environmental Engineer	BS, Environmental Engineering, 10 years of experience, specializing in preparing conceptual site models and evaluating remedial technologies. Diverse background in the remediation of contaminated soil and groundwater.	• OSHA Initial 40-Hour HAZWOPER • OSHA 8-Hour HAZWOPER Refresher	Signature on file
Mike Cobb, PG	Geologist	MSc/BS, Geology, 15 years of professional experience with a range of geologic/hydrogeologic investigations, with an emphasis in dense non-aqueous phase liquid sites, fractured rock, and karst. Experience developing conceptual site models in an array of hydrogeologic settings, ranging from bedrock and glacial terrains, to waterfront settings. Has coordinated major subsurface investigations throughout the eastern and central United States.	• OSHA Initial 40-Hour HAZWOPER • OSHA 8-Hour HAZWOPER Refresher	Signature on file

Name	Project Title/Role	Education/Experience	Specialized Training/ Certifications for the Project Title/Role[1]	Signature/Date[2]
Marc Killingstad, PE	Hydrogeologist	Master of Civil Engineering, BS Civil Engineering, 31 years of experience, Director of the Hydrogeology Community of Practice as well as the technical lead for the Remediation Hydraulics Practice Area for Arcadis North America (NA).	• Licensed Professional Engineer • Occupational Safety and Health Administration (OSHA) Initial 40-Hour HAZWOPER, Annual 8-Hour Refreshers	Signature on file
David Rigg	Ecological Risk Assessor	MSc, Environmental Modeling and Risk Analysis, BS, Environmental Science, 30 years of experience in aquatic and terrestrial ecology, specializing in fish and wildlife impact assessments, ecological risk assessments, biological surveys, and aquatic and terrestrial community characterization. Has developed food web models to evaluate potential uptake and assess risks to various wildlife species.	• OSHA Initial 40-Hour HAZWOPER • OSHA 8-Hour HAZWOPER Refresher • USFWS Electrofishing Certification	Signature on file
Julie Gillespie	Human Health Risk Assessor	MSc, Environmental Policy, BS, Natural Resources Management, 15 years of experience conducting CERCLA human health and ecological risk assessments; provided risk assessment expertise to U.S. Army, Air Force, and Navy sites.	• OSHA Initial 40-Hour HAZWOPER • OSHA 8-Hour HAZWOPER Refresher	Signature on file

Notes:

1 Training listed is required for the project title/role only and not the personnel holding that position.
2 Signatures indicate personnel have read and agree to implement this QAPP as written (signatures required for final submittal only).

ORGANIZATION: Pace (Primary Laboratory)

Name	Project Title/Role	Education/Experience	Signature/Date[1]
Kathy Smith	Laboratory PM	Representative for project laboratory.	Signature on file
Erin Boyd	Laboratory QA Manager	Representative for project laboratory.	Signature on file

Note:

1 Signatures indicate personnel have read and agree to implement this QAPP as written (signatures required for final submittal only).

ORGANIZATION: Synectics (Data Validator)

Name	Project Title/Role	Education/Experience	Signature/Date[1]
Jessica Beskind	Data Validation PM	Representative for project data validation.	Signature on file
Evin McKinney	Data Validation Senior Scientist	Representative for project laboratory.	Signature on file

Note:

1 Signatures indicate personnel have read and agree to implement this QAPP as written (signatures required for final submittal only).

QAPP Worksheet #6: Communication Pathways

(UFP-QAPP Manual Section 2.4.2)
(USEPA 2106-G-05 Section 2.2.4)

This worksheet documents specific issues (communication drivers) that will trigger the need to communicate with other project personnel or stakeholders. It ensures there are procedures in place for providing the appropriate notifications and generating the appropriate documentation when handling important communications, including those involving regulatory interfaces, unexpected events, emergencies, non-conformances, and stop-work orders. An organizational chart is included in Worksheets #3 & #5.

Communication Driver	Organization	Name/Role	Phone Number	Procedure (Timing, Pathways, Documentation, etc.)
Program issues and modifications	CENAE	Penny Reddy *CENAE PM*	(978) 318-8160 (Office)	The CENAE PM will communicate project management decisions and QAPP modifications to the USACE Contracting Officer's Representative (COR) and the S-A JV PM, as necessary. All approved QAPP modifications will be included in the amendments to the QAPP by the S-A JV and signed within seven working days.
Project issues	S-A JV	Andy Vitolins *S-A JV PM*	(518) 250-7359 (Office) (518) 461-3145 (Mobile)	The S-A JV PM will notify the USACE Contracting Officer's Representative (COR) and PM of project issues within seven days by telephone or email.
BRAC	BEC	Thomas Lineer	(703) 545-2487 (Office) (703) 371-6785 (Mobile)	Primary point of contact (POC) for Fort Devens.
Regulatory agency interface (USEPA Region I and MassDEP)	S-A JV	Andy Vitolins *S-A JV PM* Penny Reddy *CENAE PM*	(518) 250-7359 (Office) (518) 461-3145 (Mobile) (978) 318-8160 (Office)	Communication with the USEPA will include USACE representatives. At the direction of the USACE COR or PM, the S-A JV PM may communicate directly with regulatory agency representatives by phone or email. If this occurs, the USACE COR and PM will be copied on any communications and a summary of discussion points will be provided.
Field progress reports	S-A JV	Andy Vitolins *S-A JV PM*	(518) 250-7359 (Office) (518) 461-3145 (Mobile)	The S-A JV PM will send weekly field status reports to the USACE COR and/or PM by email. Daily email updates will also be provided.
Stop work due to safety issues	S-A JV	Scott Dietz *S-A JV Federal Safety and Health Officer* Andy Vitolins *S-A JV PM*	(240) 344-5892 (Mobile) (518) 250-7359 (Office) (518) 461-3145 (Mobile)	Anyone may stop work at any time for any safety concern. Persons other than the responsible entity may also stop work for safety concerns. All stop work issues will be recorded in the daily QC report (DQCR). The S-A JV PM will notify the USACE COR and PM, by phone within 24 hours, if there is a stop work situation. Email documentation will follow within 24 hours.
QAPP changes prior to field work	S-A JV	Andy Vitolins *S-A JV PM*	(518) 250-7359 (Office) (518) 461-3145 (Mobile)	The S-A JV PM will submit documented amendments within 10 working days to the USACE COR and PM for approval.

Communication Driver	Organization	Name/Role	Phone Number	Procedure (Timing, Pathways, Documentation, etc.)
QAPP changes during project execution	S-A JV	Andy Vitolins *S-A JV PM*	(518) 250-7359 (Office) (518) 461-3145 (Mobile)	The S-A JV PM will notify and obtain approval for QAPP modifications from the USACE COR and PM. The S-A JV will include all approved QAPP modifications in the amendments to the QAPP and sign them within seven working days.
Field corrective actions	S-A JV	Andy Vitolins *S-A JV PM*	(518) 250-7359 (Office) (518) 461-3145 (Mobile)	The S-A JV PM will communicate field corrective actions within 24 hours to the USACE COR and PM by phone and email. Documentation of the corrective action will occur within seven working days.
Sample receipt variances	Pace	Kathy Smith *Pace PM*	(803) 683-9550 (Office) (912) 465-7901 (Mobile)	The laboratory PM will report all project field sample variance issues to the S-A JV Project Chemist within 24 hours of identification of the technical concern. The S-A JV PM will report all field sample variance issues to the USACE COR and PM within 24 hours (by phone followed by a confirming email) of notification from the laboratory.
Laboratory quality control variances	Pace	Kathy Smith *Pace PM*	(803) 683-9550 (Office) (912) 465-7901 (Mobile)	The laboratory PM will report all quality control (QC) issues with project field samples to the S-A JV PM and Project Chemist within 24 hours of identification of the technical concern. The S-A JV PM will report all QC issues with project field samples to the USACE COR and PM within 24 hours (by phone followed by a confirming email) of notification by the laboratory.
Data verification issues (for example, incomplete records)	S-A JV and/or Synectics	Jennifer Singer *S-A JV Project Chemist* Evin McKinney *Synectics Senior Scientist*	(716) 667-6664 (Office) (916) 737-4016 (Office) (916) 508-9467 (Mobile)	The S-A JV Project Chemist or data validator (Synectics) will report all verification issues to the S-A JV PM via email within 24 hours of identification of the technical concern. The S-A JV PM will report verification issues to the USACE COR and PM via email within 24 hours (by phone followed by a confirming email) of notification.

Communication Driver	Organization	Name/Role	Phone Number	Procedure (Timing, Pathways, Documentation, etc.)
Data validation issues (for example, non-compliance with procedures)	S-A JV and/or Synectics	Jennifer Singer *S-A JV Project Chemist* Evin McKinney *Synectics Senior Scientist*	(716) 667-6664 (Office) (916) 737-4016 (Office) (916) 508-9467 (Mobile)	The Synectics validator will report all validation issues to the S-A JV PM and Project Chemist via email within 24 hours of identification of the technical concern. The S-A JV PM will report all validation issues to the USACE COR and PM within 24 hours (by phone followed by a confirming email) of notification.
Data review corrective actions	S-A JV and/or Synectics	Jennifer Singer *S-A JV Project Chemist* Evin McKinney *Synectics Senior Scientist*	(716) 667-6664 (Office) (916) 737-4016 (Office) (916) 508-9467 (Mobile)	The S-A JV Project Chemist and/or Synectics validator, as appropriate, will determine the need for data review corrective actions and document the actions in a memorandum to the S-A JV PM. The S-A JV PM will report data review corrective actions to the USACE COR and PM within 24 hours (by phone followed by a confirming email) of notification.

Points of Contact Information

Organization/Agency and Title/Project Function	Name	Contact Information
Army		
BRAC Environmental Coordinator	Thomas Lineer	(703) 545-2487 (Office) / (703) 371-6785 (Mobile) thomas.a.lineer.civ@army.mil
CENAES		
Project PM	Penelope Reddy	(978) 318-8160 penelope.w.reddy@usace.army.mil
Project Hydrogeologist	Michael Kulbersh	(978) 318-8088 michael.r.kulbersh@usace.army.mil
Project Geologist	Brent Smith	(978) 318-8233 brent.l.smith@usace.army.mil
Project Chemist	Yixian Zhang	(978) 318-8730 (Office) yixian.zhang@usace.army.mil
Project Ecological Risk Assessor	Cheryl Montgomery	(978) 318-8088 (Office) cheryl.r.montgomery@usace.army.mil
Project Human Health Risk Assessor	Amy Rosenstein	(978) 318-8055 (Office) amy.b.rosenstein@usace.army.mil
USEPA Region 1		
Remedial PM	Shawn Lowry	(617) 918-1459 lowry.shawn@epa.gov
MassDEP		
Federal Sites Program PM	Joanne Dearden	(781) 407-1595 (Mobile) joanne.dearden@state.ma.us
S-A JV		
Program Manager	Alex Lo	(843) 388-7804 (Office) ahlo@seres-es.com
PM	Andy Vitolins, PG	(518) 250-7359 (Office) (518) 461-3145 (Mobile) andy.vitolins@arcadis.com
Associate PM	Heather Levesque	(619) 370-0374 (Mobile) halevesque@seres-es.com
Contracts Manager	Shawn Atkinson	(303) 471-3420 (Office) shawn.atkinson@arcadis.com
Corporate Quality Manager	John Nocera, PE, BCEE	(251) 405-4560 (Office) (251) 689-7760 (Mobile) john.nocera@arcadis.com
Health and Safety Officer	Scott Dietz, CSP, STSC	(240) 344-5892 (Mobile) scott.dietz@arcadis.com

Organization/Agency and Title/Project Function	Name	Contact Information
Senior Environmental Engineer	Allison Nelan, PE	(267) 685-1891 (Office) allison.nelan@arcadis.com
Ecological Risk Assessor	David Rigg	(518) 250-7379 (Office) david.rigg@arcadis.com
Hydrogeologist	Marc Killingstad, PE	(410) 923-7816 (Office) marc.killingstad@arcadis.com
Human Health Risk Assessor	Julie Gillespie	(845) 218-0749 (Office) julie.gillespie@arcadis.com
Chemist	Jennifer Singer	(716) 667-6664 (Office) jennifer.singer@arcadis.com
Geologist	Mike Cobb, PG	(207) 613-8351 (Office) (207) 712-8843 (Mobile) michael.cobb@arcadis.com
Pace		
Laboratory PM	Kathy Smith	(803) 683-9550 (Office) (912) 465-7901 (Mobile) kathy.smith@pacelabs.com
Laboratory QA Manager	Erin Boyd	(803) 227-2702 (Office) (717) 648-7433 (Mobile) erin.boyd@pacelabs.com
Synectics		
Data Validatory PM	Jessica Beskind	(916) 737-4031 (Office) jessica.beskind@synetics.net
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Emergency Numbers		
Emergency Department at UMass Memorial HealthAlliance - Clinton Hospital, Leominster Campus	Not applicable (NA)	(978) 466-2451
Devens Fire Department	NA	911 (978) 772-4600 (non-emergency)
Ambulance Service	NA	911
Work Care (S-A JV)	NA	(800) 455-6155

QAPP Worksheet #9: Project Planning Session Summary

(UFP-QAPP Manual Section 2.5.1 and Figures 9–12)
(USEPA 2106-G-05 Section 2.2.5)

A scoping meeting was held on January 31, 2024 for the Area 3 Phase II PFAS RI WP. The purpose of the meeting was to:

- Review site information;
- Review the RI objectives and proposed sampling locations;
- Discuss the general project schedule; and
- Confirm project stakeholders.

Ongoing technical project planning teleconferences are held approximately biweekly (every other week), during ongoing Devens planning teleconferences.

QAPP Worksheet #10: Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)

(USEPA 2106-G-05 Section 2.2.5)

This worksheet presents an abbreviated summary of site characteristics and history for AOCs in Area 3, located in the former North Post of Devens (**Figure 1-1 of the Area 3 Phase II PFAS RI – Stage 1Work Plan [Area 3 Phase II PFAS RI WP]**): AOCs 20 and 21, associated with the Devens wastewater treatment plant (WWTP), and AOCs 30, 31, and 50, associated with the former Moore Army Airfield (MAAF). This section also presents an abbreviated conceptual site model (CSM) for Area 3. The primary purpose of this QAPP is to outline analytical parameters being investigated (i.e., PFAS). A more detailed discussion of site characteristics, history, and the CSM is provided in the Area 3 Phase II PFAS RI WP.

10.1 Site Background and Location

The former Fort Devens is located in the Towns of Ayer and Shirley in Middlesex County and the Towns of Harvard and Lancaster in Worcester County, Massachusetts, approximately 35 miles northwest of Boston. The installation occupied approximately 9,260 acres. Fort Devens was divided into the North Post, Main Post, and South Post. Route 2 divides the South Post from the Main Post. The Nashua River runs through the North, Main, and South Posts. The area surrounding Fort Devens is primarily rural residential properties. Portions of Fort Devens have been redeveloped for commercial/industrial use.

The Devens WWTP (AOCs 20 and 21) is situated in the former North Post area of Devens, southwest of the Nashua River. The WWTP was constructed by the Army in 1942 and is still in operation by MassDevelopment. The site consists of structures to support wastewater treatment including 18 rapid infiltration beds (RIBs), three Imhoff tanks (settling tanks and sludge digestors), a dosing tank, and a support building.

The former MAAF (AOCs 30, 31, and 50) is located northeast of the Devens WWTP (**Area 3 Phase II PFAS RI WP Figure 1-2**). The main portion of the former MAAF consisted of two fixed wing runways, two rotary wing runways, a parking area for 15 rotary-wing aircraft, and aircraft hangars (Buildings 3813 and 3818) (**Area 3 Phase II PFAS RI WP Figure 1-2**). The northern part of the former MAAF, south of Route 2A/Fitchburg Road, was used for the maintenance, including a fueling system, and storage of parachutes.

All but approximately 14 acres of the former MAAF (approximately 246 acres total) were transferred to MassDevelopment for reuse in 1997. The Devens Army Installation retained approximately 9 acres of the former airfield for vehicle storage and maintenance around the Hangars, and approximately 4 acres in and around the AOC 50 Source Area for tetrachloroethylene (PCE) remediation activities. The Hangars are not occupied. Currently, the airfield (including AOCs 30, 31, and 50) is closed to aircraft traffic and is used by the Massachusetts State Police for training purposes and vehicle storage.

The former MAAF Drum Storage Area (AOC 30) comprises two locations (labeled Area “A” and Area “B” for the PFAS RI) located north of the main airfield runway at the MAAF and was used to store 55-gallon drums of hazardous waste and firefighting foam concentrate.

The former Fire Training Area (FTA; AOC 31) is a 100- by 100-foot asphalt-covered concrete pad surrounded by a 12-inch-high by 24-inch-wide earthen containment berm, located at the west end of the of the main runway. It was used for annual fire training exercises to practice extinguishing aircraft fires, using aqueous film-forming foam (AFFF).

10.2 Known or Suspected DoD-Related Releases of Aqueous Film-Forming Foam and Previous PFAS Investigations

The issuance of the Lifetime Health Advisory (LHA) for total perfluorooctane sulfonic acid (PFOS) and perfluorooctanic acid (PFOA) contamination in drinking water in 2016 (USEPA 2016) triggered the need to investigate potential sources. Since 2016, multiple investigations have been performed in response to concerns regarding the potential presence of PFAS in groundwater, soil, surface water, and sediment based on past operations at the former Fort Devens.

In 2016, a basewide Preliminary Assessment (PA; KGS 2017) was conducted to determine if there were potential historical releases of PFAS at Devens where there was a potential for the use, storage, or disposal of AFFF. The potential PFAS sources were evaluated using all available documents, interviews with current and former Devens workers, available sampling data, and findings from environmental database searches. The PA concluded that potential PFOS and PFOA impacts should be further investigated at multiple locations at Devens, including Study Area [SA] 20/21, AOC 50, SA 30, and SA 31 in the former North Post of Devens, under a site inspection (SI), pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and 40 Code of Federal Regulations (CFR) 300.420(c). USEPA and MassDEP concurred with the PA and its recommendations (KGS 2017).

The Devens WWTP was not identified as a potential release site during the PA (KGS 2017). However, it was a location of industrial and residential wastewater disposal during the operational period of Fort Devens and could be a continual source of PFAS; therefore, the USEPA requested that the Devens WWTP be included in the SI due to its historical use as a wastewater treatment facility.

The SI recommended SA 20/21, SA 30, and SA 31 be reclassified as AOCs and that further investigation be conducted at the AOCs under a remedial investigation (RI) to determine the extent of PFAS impacts to soil and groundwater (BERS-Weston 2018).

The following sections summarize the results of PFAS investigations conducted in the Area 3 AOCs during the 2017 SI and 2018-2020 RI (considered to be Phase I; KGS 2021). SI groundwater results were compared to the USEPA LHA of 70 nanograms per liter (ng/L) for PFOA and/or PFOS concentrations. RI groundwater results were compared to the USEPA LHA and the Massachusetts Contingency Plan (MCP) PFAS standard for drinking water (GW-1) of 20 ng/L for combined or individual concentrations of six PFAS (PFAS6: PFOS, PFOA, perfluorohexanesulfonic acid [PFHxS], perfluorononanoic acid [PFNA], perfluoroheptanoic acid [PFHpA], and perfluorodecanoic acid [PFDA]). SI and RI soil analytical results were compared to the MCP Method 1 S-1 Soil Category (S-1)/GW-1 standard. RI surface water and sediment sampling results were compared to USEPA Region 1 PFAS site-specific screening level (SSSLs) established for Former Fort Devens (USEPA Region 1 2018). Surface water and sediment samples collected at AOC 50 during the 2017 SI were not screened, as SSSLs had not yet been developed.

A more detailed discussion of site characteristics, history, and PFAS investigations are provided in the Area 3 Phase II PFAS RI WP.

10.2.1 Wastewater Treatment Plant (AOCs 20 and 21)

Three components of the WWTP were initially identified for PFAS investigation: Imhoff tanks (SA 19), rapid infiltration beds (SA 20), and sludge drying beds (SA 21). Because treated wastewater is applied to infiltration beds (SA 20), and sludge from the wastewater treatment process is managed in sludge drying beds (SA 21), sample locations for the SI were selected to assess PFAS impacts to soil and groundwater from potential infiltration of PFAS-impacted process water into groundwater.

The SI groundwater results indicated that all sites investigated exceeded the USEPA LHA of 70 ng/L. The SI soil samples did not exceed screening criteria. Based on results of the SI, SAs 20 and 21 were subsequently reclassified as AOCs.

During the Phase I RI, PFAS concentrations in soil and groundwater samples exceeded the USEPA LHA and the MCP GW-1 standard (20 ng/L). PFAS were detected in the surface water and sediment samples, but no concentrations exceeded the USEPA Region 1 SSSLs.

10.2.2 Former Moore Army Airfield (AOCs 30, 31, and 50)

During the SI, soil and groundwater samples were collected in areas of AOC 50 where former PFAS storage or use were suspected (i.e., former fire station area and runways/taxiways where firefighting foams may have been deployed) and at stormwater outfalls that may have directed PFAS-impacted surface runoff to areas adjacent to the former airfield. Surface water and sediment sample locations were selected at the terminus of a former stormwater outfall where PFAS-impacted surface water may have been formerly directed (BERS-Weston 2018).

At AOC 30, soil and groundwater sampling were conducted at select locations within and downgradient of the former drum storage area. Soil and groundwater samples were collected to assess for potential PFAS impacts caused by PFAS management in this area.

At AOC 31, soil and groundwater sample locations were selected to assess for potential PFAS impacts to soil and groundwater due to firefighting foam application in this area.

The SI groundwater results indicated that all sites investigated exceeded the LHA of 70 ng/L. In soil, the highest concentrations of PFAS detected across Devens were at the former MAAF sites SA 30 and 31, which included the bermed area where firefighting training was conducted. The SI noted that soil containing PFAS could continue to be a source for groundwater impacts. PFOA and PFOS were detected in sediment and surface sample at stormwater outfalls discharging from MAAF. The SI also recommended that, given that the former airfield impacts are widespread from multiple release sites, the impacts to groundwater should be evaluated as one groundwater operable unit (BERS-Weston 2018).

During the Phase I RI, PFAS concentrations in more than half of the soil and groundwater samples at AOC 50 exceeded screening standards. PFAS were detected in the surface water and sediment samples collected in the Nashua River and the unnamed wetland, but no concentrations exceeded the USEPA Region 1 SSSLs (2018).

10.3 Primary Release Mechanism/Fate and Transport Consideration

DoD-related impacts from PFAS are present in surface and subsurface soil, groundwater, and surface water at Devens.

Once PFAS compounds are released to the environment, they are subject to physical, chemical, and biological processes that influence their distribution in various environmental media. An overview of PFAS uses and presence in the environment, qualities of PFAS compounds that contribute to their persistence in

the environment, and potential routes of migration is presented in the Area 3 Phase II PFAS RI WP and is not repeated here.

10.4 Potential Receptors and Exposure Pathways

A preliminary, general understanding of potential human and ecological receptors and exposure pathways based on the current and most likely future land uses for Area 3 is presented in the Area 3 Phase II PFAS RI WP.

10.5 Key Physical Aspects of the Site

Area 3 of Devens is situated in the former North Post area of Devens, southwest of the Nashua River. The Devens WWTP consists of structures to support wastewater treatment including 18 rapid infiltration beds (AOC 20), three Imhoff tanks (settling tanks and sludge digestors), a dosing tank, and a support building.

Topography is generally flat across AOC 20, but slopes on each side in all directions. To the west of AOC 20, the topography is generally flat, but slopes steeply further west, rising with the bedrock surface. To the north and south of AOC 20 are low lying woods that gradually transition to wetland. To the east, are the four former sludge drying beds comprising AOC 21. The sludge drying beds are below ground surface within secondary contaminant (raised platform, lined). These beds are no longer in use and are overgrown with brush and small diameter trees. East of the beds the land slopes gradually towards the Nashua River, transitioning from woods to wetlands before reaching the Nashua River.

The former MAAF is located northeast of the Devens WWTP. The main portion of the former MAAF consisted of two fixed wing runways, two rotary wing runways, a parking area for 15 rotary-wing aircraft, and aircraft hangars (Buildings 3813 and 3818) (**Area 3 Phase II PFAS RI WP Figure 1-2**). The airfield is generally flat. As the airfield approaches the Nashua River towards the southwest, west, and northwest the ground slopes steeply downwards towards the Nashua River. Currently, the airfield is closed to aircraft traffic and is used by the Massachusetts State Police for training purposes and vehicle storage.

The northern part of the former MAAF, south of Route 2A/Fitchburg Road, was used for the maintenance, including a fueling system, and storage of parachutes. The Merrimack Warehouse Realty Co., Inc. currently owns the area north of Route 2A. The property is zoned commercial and is developed with a building used for the manufacture of windshield washer fluid and as a storage facility. A fire pond and detention basin is located on the property and would be used for fire suppression source water in the event of a fire.

Details of the physical characteristics of Area 3 are presented in the Area 3 Phase II PFAS RI WP.

10.6 Data Gaps

Data collected during the 2017 SI and 2018-2020 RI field activities have been reviewed, and the CSM and data screened against the DQOs established in the Area 3 Phase II PFAS RI WP and in **Worksheet #11**. Additional data is required to meet the objectives of the Area 3 PFAS RI.

In general, analytical results for samples collected during the Area 3 Phase II PFAS RI field activities will be analyzed for the 40 PFAS currently listed in Quality Systems Manual (QSM) 5.4 Table 24 for USEPA Method 1633, with results for PFOS, PFOA, PFBS, PFNA, PFHxS, PFHpA, perfluorohexanoic acid (PFHxA), and perfluorobutanoic acid (PFBA) screened against the project action limits (PALs) presented in **Worksheets #15-1** through **#15-6**.

In addition to the PALs, analytical data will be compared for informational purposes to applicable MCP PFAS standards for PFAS6 (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA) in groundwater, soil, and surface water. There is no applicable MCP standard for PFAS6 in sediment.

Because elevated levels of suspended solids in samples collected from vertical aquifer profiling (VAP) points may cause problems during sample preparation and analysis using USEPA Method 1633, VAP groundwater samples will be centrifuged before analysis. Groundwater data obtained from VAP points is not reproducible; therefore, the VAP data will used to further the understanding of nature and extent of PFAS at the site, but will not be used for future risk assessment.

QAPP Worksheet #11: Project/Data Quality Objectives

(UFP-QAPP Manual Section 2.6.1) / (USEPA 2106-G-05 Section 2.2.6)

The Data Quality Objectives (DQOs) are qualitative and quantitative statements that clarify study objectives, define the appropriate type of data, and specify the tolerable levels of potential decision errors that are used as the basis for establishing the quality and quantity of data needed to support decisions. The JV utilized the DQO guidelines established in the Data Quality Objectives Process for Hazardous Waste Site Investigations, *EPA QA/G-4 HW (January 2000) EPA/600/R-00/007* (USEPA 2000) to develop the DQOs for the Phase II RI activities for the Area 3 at former Fort Devens, as summarized in the table below.

DQO	Problem Statement	Project Goals	Information Inputs	Study Boundaries	Decision Rules	Performance Criteria	Plan for Obtaining Data
Explanation	*Define the problem that necessitates this study*	*Identify study questions*	*Identify data and information needed to answer study questions*	*Specify the spatial and temporal boundaries.*	*Define the conditions under which the data will be utilized.*	*Specify the limits on decision errors*	*Design an effective data collection strategy based on previous steps*
Former Fort Devens Army Installation Area 3 includes the following areas: • AOC 20 Wastewater Treatment Plant (WWTP) Sand Filter Beds • AOC 21 WWTP Sludge Drying Beds • AOC 50 Former Moore Army Airfield (MAAF)	Data collected during the 2017 SI (BERS-Weston 2018) and the 2018-2020 RI (KGS 2021) determined the detected concentrations for select PFAS in soil, groundwater, and surface water samples were greater than the screening levels current at the time. Because exposure pathways are potentially complete in Area 3, and some detected concentrations may pose a potential risk to human health or	The Phase II Area 3 investigation is anticipated to be completed in two stages both to complete delineation of the nature and extent of PFAS, and to collect remaining samples needed to evaluate human health or ecological risks. The following study questions apply to the Stage 1 investigation. The Stage 2 scope will be presented in a Work Plan Addendum. The goals of the Stage 1 Phase II RI associated with the presence of PFAS in Area 3 are to: • Evaluate fate and transport pathways of PFAS from identified	The information inputs required to accomplish the project goals are: • All information reviewed/gathered to date including the results of previous investigations. • Analytical data from environmental media from previous investigations and this Stage 1 Phase II RI for groundwater, soil, and surface water samples. • Geologic, hydrogeologic/	• The general areal boundaries for the investigation are Area 3. • The vertical boundaries of the study will include overburden groundwater and/or bedrock groundwater to the extent necessary to evaluate the pathways for human exposure to PFAS released from Area 3. • The temporal boundary is one year during which data will be collected.	• All samples will be collected and analyzed in accordance with the QAPP technical guidance instruction (TGI) and SOP documents included in the QAPP to ensure that subsequent decisions are made based on valid data. • Presence/ absence of PFAS will be based on the laboratory limits of detection (LODs) for PFAS presented in **Worksheet #15**.	The potential decision errors associated with this RI include: • The false presumption that PFAS are not present at concentrations greater than the applicable decision criteria, when in fact they are. • The false presumption that PFAS are present at concentrations greater than the applicable decision criteria, when in fact they are not.	The plan for obtaining the data necessary to meet the goals of the Stage 1 Phase II RI is presented in Section 4 of the Area 3 Phase II PFAS RI WP and in **Worksheet #17** of the QAPP.

DQO	Problem Statement	Project Goals	Information Inputs	Study Boundaries	Decision Rules	Performance Criteria	Plan for Obtaining Data
• AOC 30 MAAF Drum Storage Area • AOC 31 MAAF Fire Training Area (FTA)	the environment, additional investigation of soil in Area 3 under an RI phase of the CERCLA process is necessary.	source areas to areas of potential exposure. • Collect and document data that is both representative of field conditions and defensible within the precision, accuracy, representativeness, completeness and comparability parameters. This includes sufficient field samples to fully characterize field conditions and heterogeneity as well as quality control samples sufficient to demonstrate data quality. Collect legally defensible samples with a known provenance via an unbroken chain of custody maintained from sampling through analysis. To support this goal, the objectives of the Area 3 Stage 1 Phase II RI field activities are to: • Characterize the areas greatest concentrations of PFAS at Area 3 to assess maximum EPCs in the impacted media.	hydraulic, and chemical data to evaluate PFAS fate and transport. • Existing/ current toxicological data necessary to evaluate the potential risks of human and ecological exposures to PFAS in the environment.		• More specific decision rules associated with the comparison of detected PFAS in various media to human health and ecological screening levels can be found in Section 3.2.5 of the Area 3 Phase II PFAS RI WP.	The Data Usability Assessment Process will be used to limit decision errors based on field and analytical data. Project-specific MPCs, which are the criteria that collected data must meet to satisfy the DQOs, are presented in **Worksheet #12**.	

DQO	Problem Statement	Project Goals	Information Inputs	Study Boundaries	Decision Rules	Performance Criteria	Plan for Obtaining Data
		• Identify/confirm potential exposure pathways for PFAS.					

QAPP Worksheet #12: Measurement Performance Criteria

(UFP-QAPP Manual Section 2.6.2)
(USEPA 2106-G-05 Section 2.2.6)

Measurement performance criteria (MPC) for field QC sampling results are used to evaluate project data quality indicators (DQIs) such as accuracy/bias and precision. The following tables provide definition of different laboratory and field blanks that will be used as quality control measures to evaluate the site-specific DQIs. MPC are provided below by matrix and analytical group in **Worksheets #12a and #12b**.

QAPP Worksheet #12a: Measurement Performance Criteria (PFAS in Groundwater/Surface Water)

Matrix: Groundwater/Surface Water
Concentration Level: Low
Analytical Method: PFAS per USEPA Method 1633 compliant with DoD QSM 5.4 (or later versions) Table B-24
Laboratory SOP: ENV-SOP-WCOL-0158

DQIs	QC Sample of Measurement Performance Activity	MPC
Precision	Field Duplicates	Relative percent difference (RPD) ≤ 35 percent (%)
Accuracy/Bias (contamination)	Reagent or Equipment Blanks as appropriate	No target analyte concentrations ≥1/2 limit of quantitation (LOQ) or > 1/10 the amount measured in any sample or 1/10th the regulatory limit, whichever is greater
Analytical Accuracy/Bias (laboratory)	Laboratory control sample (LCS)	Percent recovery (%R) must be within the limits included in EPA Method 1633 for aqueous matrices.
Analytical Accuracy/Bias (matrix interference)	Matrix spike (MS) and matrix spike duplicate (MSD)	%R same as LCS
Analytical Precision (laboratory)	Laboratory control sample duplicate (LCSD) and MSD	RPD ≤ 30%
Analytical Accuracy/Bias (laboratory)	Extracted internal standard (EIS)	%R must be within the limits included in EPA Method 1633 for aqueous matrices.
Sensitivity Check	LOQ Verification Sample (spiked at concentration of lowest calibration standard)	Recovery within ±30% of true value

Note: The table above complies with the requirements of USEPA Method 1633 compliant with DoD QSM 5.4 Table B-24.

QAPP Worksheet #12b: Measurement Performance Criteria (PFAS in Soil)

Matrix: Soil
Concentration Level: Low
Analytical Method: PFAS per USEPA Method 1633 compliant with DoD QSM 5.4 (or later versions) Table B-24
Laboratory SOP: ENV-SOP-WCOL-0158

DQIs	QC Sample of Measurement Performance Activity	MPC
Precision	Field Duplicates	RPD ≤ 50%
Accuracy/Bias (contamination)	Reagent or Equipment Blanks as appropriate	No target analyte concentrations ≥½ LOQ or > 1/10 the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.
Analytical Accuracy/Bias (laboratory)	LCS	Percent recovery (%R) must be within the limits included in EPA Method 1633 for solid matrices.
Analytical Accuracy/Bias (matrix interference)	MS and MSD	%R same as LCS
Analytical Precision (laboratory)	LCSD and MSD	RPD ≤ 30%
Analytical Accuracy/Bias (laboratory)	EIS	%R must be within the limits included in EPA Method 1633 for soil matrices.
Sensitivity Check	LOQ Verification Sample (spiked at concentration of lowest calibration standard)	Recovery within ± 30% of true value

Note: The table above complies with the requirements of USEPA Method 1633 and DoD QSM 5.4 Table B-24.

QAPP Worksheet #12c: Measurement Performance Criteria (Grain Size Analysis in Soil)

Matrix: Soil
Concentration Level: Low
Analytical Method: American Society for Testing and Materials (ASTM) D6913 and/or D7928 Modified
Laboratory SOP: Schnabel Engineering SOP

DQIs	QC Sample of Measurement Performance Activity	MPC
Precision	Lab Duplicates	Laboratory statistical RPD
Precision	Field Duplicates	RPD as set by project
Completeness	Reported Sample Data	As determined by the project
Bias/Holding Time	Reported Sample Data	NA

QAPP Worksheet #12d: Measurement Performance Criteria (TOC in Soil)

(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix: Soil
Concentration Level: Low
Analytical Method: TOC by Walkley-Black
Laboratory SOP: ENV-SOP-MTJL-0196

DQIs	QC Sample of Measurement Performance Activity	MPC
Overall Precision	Field Duplicates	RPD </+ 20%
Analytical Precision (Laboratory)	Continuing Calibration Check	+/- 10%
Analytical Accuracy/Bias (Laboratory)	Laboratory Control Samples	32-143%
Overall Accuracy/Bias (Contamination)	Equipment Blank	No target analyte concentrations > 1/2 LOQ
Sensitivity	LOQ variation sample (spiked at LOQ)	Recovery within +/- 10% LOQ
Completeness	100%	100%

QAPP Worksheet #13: Secondary Data Uses and Limitations

(UFP-QAPP Manual Section 2.7)
(USEPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Previous Investigation Sampling Results	Final Base-Wide Preliminary Assessment for Evaluation of Perfluoroalkyl Substances, Former Fort Devens Army Installation BRAC Legacy Sites, Devens, Massachusetts.	KGS 2017 Prepared for USACE	Background information on nature and distribution of potential historical releases of PFAS in Area 3.	The historical information is considered valid, and there are no known limitations regarding its use.
Previous Site Investigation Sampling Results	Final Site Inspection Report for Per- and Polyfluoroalkyl Substances (PFAS) at Former Fort Devens Army Installation, Devens, MA.	BERS-Weston 2018 Prepared for USACE	Use site investigation data on the presence or absence of PFAS in groundwater and soil to address data gaps.	The historical analytical data are considered valid. VAP data may be used for screening only. There are no known limitations regarding the use of soil data.
Previous Site Investigation Sampling Results	Area 3 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation. Former Fort Devens Army Installation, Devens, MA.	KGS 2021 Prepared for USACE	Use site investigation data for groundwater, soil, surface water, and sediment to address data gaps.	VAP data may be used for screening only. There are no known limitations regarding the use of soil, sediment, surface water, and groundwater data from existing wells.

QAPP Worksheets #14 & 16: Project Tasks and Schedule

(UFP-QAPP Manual Section 2.8.2)
(USEPA 2106-G-05 Section 2.2.4)

The project schedule, including the specific task/activity and the person or group responsible for execution is provided in the following table. Note that the schedule is subject to updates and revisions based on field conditions.

Activity	Responsible Party	Deliverable(s)	Deliverable Due Date
DFW 1: Pre-Mobilization Activities			
Final QAPP including Final APP	Andy Vitolins *S-A JV PM*	Final QAPP	One week after resolution of Draft Final QAPP comments.
DFW 2: Environmental Data Collection			
RI Field Activities	Ian Martz *S-A JV Field Operations Lead*	Field notes, DQCR	Weekly submittals due Friday of the week following performance of the activity.
		Data package, including data validation summary	Twelve weeks after completion of field activities.
DFW 3: Final Report			
Draft Stage 1 Area 3 Phase II RI Field Investigation Report	Theresa Cansler *S-A JV RI Field Investigation Report Lead*	Draft Field Investigation Report	Approx. one year after completion of field activities.
Draft Final/Final Stage 1 Area 3 Phase II RI Field Investigation Report	Theresa Cansler *S-A JV RI Field Investigation Report Lead*	Draft Final/Final Field Investigation Report	45 days after receipt of Draft/Draft Final comment resolution.

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

(UFP-QAPP Manual Section 2.6.2.3)
(USEPA 2106-G-05 Section 2.2.6)

The following **Worksheet #15** tables identify the PALs and provide a comparison of the PALs to analytical laboratory reference limits (i.e., limits of detection [LODs] and limit of quantitation [LOQs]) for groundwater, soil, and surface water per analytical method. The objective is for the laboratory to achieve LODs and LOQs low enough to accurately measure analytes at concentrations less than the PALs to obtain a dataset of known quality and sufficient sensitivity to meet project DQOs. The PALs represent the relevant human health screening levels that may be used during future risk assessment and later stages of the CERCLA process.

In addition to the PALs, analytical data will be compared to applicable MCP PFAS standards for groundwater, soil, and surface water for informational purposes. There is no applicable MCP standard for PFAS6 in sediment.

- Groundwater standards (GW-1; groundwater used for drinking water) for individual or sum of the concentrations of PFAS6 (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA).
- Soil standards for soil in an area where groundwater is used for drinking water (S-1/GW-1) for individual concentrations of PFAS6 (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA).
- Surface water standard (GW-3) for individual concentrations of the PFAS6 (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA).

Ecological screening values (ESVs) for the media and receptors presented in the Derivation of PFAS Ecological Screening Values Report (Argonne National Laboratory 2024) have been incorporated into Worksheet #15-2 (PFAS in Soil) and Worksheet #15-4 (PFAS in Surface Water). The soil screening values were developed to be protective of terrestrial plants, invertebrates, and mammalian and avian wildlife, and the surface water values were developed to be protective of aquatic life and aquatic dependent wildlife. The Phase II Area 3 investigation is anticipated to be completed in two stages, both to complete delineation of the nature and extent of PFAS, and to collect remaining samples needed to evaluate human health or ecological risks. A SLERA will be conducted after completion of Stage 1 and Stage 2 investigations.

The ESVs presented here are for informational purposes only, as it is anticipated they will be updated prior to completing the SLERA. The future SLERA will be performed using ESVs from the most recent update, as appropriate.

Ecological risk-based screening levels remain under development at the time of finalization of this QAPP and are not used in the decision rules with regard to further investigative action, because of the uncertainty associated with decision making based upon so few ecological screening criteria. The soil, sediment, and surface water data will be screened against PFAS Ecological Screening Values (ESVs), which currently include benchmarks from the October 2024, Derivation of PFAS Ecological Screening Values, Update prepared by Argonne National Laboratory (ANL) on behalf of DoD, for use at DoD installations where PFAS have been detected in soils and surface waters (ANL 2024). The future SLERA will also consider relevant and appropriate Army-approved or accepted PFAS ESVs from other sources current at the time the SLERA is prepared.

The human health PALs for Fort Devens PFAS sites include:

- Groundwater: USEPA Regional Screening Levels (RSLs) for PFAS in drinking water for that have DoD-approved toxicity values including PFOS, PFOA, PFBS, PFNA, PFHxA, PFHxS, HFPO-DA, PFDA, PFBA, PFPrA and TFSI (DoD 2025).
- Soil: USEPA RSLs for PFAS that have DoD-approved toxicity values including PFOS, PFOA, PFBS, PFNA, PFHxA, PFHxS, HFPO-DA, PFBA, PFDA, PFPrA, and TFSI (DoD 2025).
- Surface Water: Site-specific screening levels (SSSLs) for surface water for recreational adult or child for PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, PFBA, PFDA, HFPO-DA, PFPrA, and TFSI (USEPA Region 1 2023, updated with the USEPA RSL calculator using toxicity values for the PFAS included on the Office of the Assistant Secretary of Defense (ASD) website (DoD 2025).

Although an RSL for hexafluoropropylene oxide dimer acid (HFPO-DA), also known as Gen X, was issued by USEPA, HFPO-DA was manufactured and used after 1995, when Fort Devens was identified for closure. Therefore, HFPO-DA data will not be screened against the SSSL. However, if detected, HFPO-DA data will be compared to corresponding RSL for informational purposes.

The laboratory reference limits were provided by the selected laboratory, Pace.

The PALs are not intended to be used as cleanup levels. Concentrations above the PALs would not automatically trigger a response action but would suggest that further site-specific consideration is appropriate.

The analytical laboratory reference limits presented in **Worksheet #15** tables are as follows:

- LOD – The smallest concentration of a substance that must be present in a sample in order to be detected at the detection limit (DL) with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.
- LOQ – The lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias.
- DL – The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type I error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.

The worksheets that follow include:

- Worksheet #15-1: PFAS in Groundwater
- Worksheet #15-2: PFAS in Soil
- Worksheet #15-3: Total Organic Carbon and Grain Size in Soil
- Worksheet #15-4: PFAS in Surface Water

Worksheet #15-1: Reference Limits and Evaluation Table

Pace (PFAS in Groundwater)

(UFP-QAPP Manual Section 2.6.2.3) / (USEPA 2106-G-05 Section 2.2.6)

Analyte	CAS #	MCP PFAS Standards	Project Action Limits (PALs)	Laboratory Achievable Detection Limits (ng/L)		
		GW-1[a] (ng/L)	DoD Screening Level (ng/L)	LOQ	LOD	DL
Analytical Group: PFAS per USEPA Method 1633 Compliant with DoD QSM 5.4 (or later versions) Table B-24						
Pentafluorpropanoic acid (PFPrA)	422-64-0	NA	980	6.4	6.1	3.0
Perfluorobutanoic acid (PFBA)	375-22-4	NA	1,800	4	1.6	0.51
Perfluoropentanoic acid (PFPeA)	2706-90-3	NA	NA	2	0.40	0.18
Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	NA	NA	1	0.75	0.26
Perfluorohexanoic acid (PFHxA)	307-24-4	NA	990	1	0.40	0.14
Perfluoroheptanoic acid (PFHpA)	375-85-9	20	NA	1	0.80	0.21
Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	NA	NA	1	0.38	0.19
Perfluorooctanic acid (PFOA)	335-67-1	20	4.0	1	0.80	0.21
Perfluorononanoic acid (PFNA)	375-95-1	20	5.9	1	0.40	0.10
Perfluorononanesulfonic acid (PFNS)	68259-12-1	NA	NA	1	0.38	0.15
Perfluorodecanoic acid (PFDA)	335-76-2	20	0.52	1[b]	0.40	0.14
Perfluorodecanesulfonic acid (PFDS)	335-77-3	NA	NA	1	0.39	0.16
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NA	NA	1	0.80	0.25
Perfluorododecanoic acid (PFDoA)	307-55-1	NA	NA	1	0.40	0.11
Perfluorododecanesulfonic acid (PFDoS)	79780-39-5	NA	NA	1	0.39	0.15
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	NA	NA	1	0.40	0.19
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	NA	NA	1	0.80	0.27

Analyte	CAS #	MCP PFAS Standards	Project Action Limits (PALs)	Laboratory Achievable Detection Limits (ng/L)		
		GW-1[a] (ng/L)	DoD Screening Level (ng/L)	LOQ	LOD	DL
Analytical Group: PFAS per USEPA Method 1633 Compliant with DoD QSM 5.4 (or later versions) Table B-24						
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	600	1	0.35	0.094
Perfluorohexane sulfonic Acid (PFHxS)	355-46-4	20	10	1	0.73	0.18
Perfluoroctane sulfonic acid (PFOS)	1763-23-1	20	4.0	1	0.74	0.25
Perfluorooctanesulfonamide (PFOSA)	754-91-6	NA	NA	1	0.40	0.20
Hexafluoropropylene oxide dimer acid (HFPO-DA; GenX)	13252-13-6	NA	1.5	4[b]	2.4[b]	0.99
N-ethylperfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NA	NA	1	0.80	0.29
N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NA	NA	1	0.80	0.29
N-Methyl perfluorooctanesulfonamide (NMeFOSA)	31506-32-8	NA	NA	1	0.80	0.22
N-Ethyl perfluorooctanesulfonamide (NEtFOSA)	4151-50-2	NA	NA	1	0.40	0.13
N-Methyl perfluorooctanesulfonamidoethanol (NMeFOSE)	24448-09-7	NA	NA	10	2.0	0.63
N-Ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)	1691-99-2	NA	NA	10	2.0	0.61
4:2 flourotelomersulfonic acid (4:2 FTS)	757124-72-4	NA	NA	4	1.5	0.40
6:2 flourotelomersulfonic acid (6:2 FTS)	27619-97-2	NA	NA	5	4.6	2.0
8:2 flourotelomersulfonic acid (8:2 FTS)	39108-34-4	NA	NA	4	1.5	0.61
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	NA	NA	4	2.3	0.66
Perfluoro-3-methoxypropanoic acid (PFMPA)	377-73-1	NA	NA	2	0.60	0.18
Perfluoro-4-methoxybutanoic acid (PFMBA)	863090-89-5	NA	NA	2	1.3	0.39
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	151772-58-6	NA	NA	2	1.3	0.58
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	NA	NA	4	2.2	0.67
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	NA	NA	4	2.3	0.87

Analyte	CAS #	MCP PFAS Standards	Project Action Limits (PALs)	Laboratory Achievable Detection Limits (ng/L)		
		GW-1[a] (ng/L)	DoD Screening Level (ng/L)	LOQ	LOD	DL
Analytical Group: PFAS per USEPA Method 1633 Compliant with DoD QSM 5.4 (or later versions) Table B-24						
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	113507-82-7	NA	NA	2	1.1	0.36
3-Perfluoropropyl propanoic acid (3:3FTCA)	356-02-5	NA	NA	5	2.0	0.60
2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)	914637-49-3	NA	NA	25	10	4.3
3-Perfluoroheptyl propanoic acid (7:3FTCA)	812-70-4	NA	NA	25	10	4.2
Bis(trifluoromethane)sulfonimide (TFSI)	82113-65-3	NA	590	3.2	3.0	1.1

Notes:

a. MCP PFAS groundwater standard for category GW-1 (groundwater used for drinking water) for individual or sum of the concentrations of six specific PFAS (PFAS6) (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA).

b. The LOQ and LOD for HFPO-DA and the LOQ for PFDA in groundwater are greater than the January 2025 ASD screening levels. The associated uncertainty will be considered when risk is calculated during risk assessment.

CAS = Chemical Abstract Service
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
NA = not applicable
ng/L = nanogram per liter
RSL = Regional Screening Level

Worksheet #15-2: Reference Limits and Evaluation Table

Pace (PFAS in Soil)

(UFP-QAPP Manual Section 2.6.2.3) / (USEPA 2106-G-05 Section 2.2.6)

Analyte	CAS #	MCP PFAS Standard[a]	Project Action Limit (PAL)	Ecological Soil Screening Levels (µg /kg)[b]				Laboratory Achievable Detection Limits[c] (µg/kg)		
		S-1/GW-1 (µg/kg)[a]	DoD Screening Level (µg/kg)	Terrestrial Plants	Soil Invertebrates	Terrestrial Mammals	Terrestrial Birds	LOQ	LOD	DL
Analytical Group: PFAS per USEPA Method 1633 compliant with DoD QSM 5.4 (or later versions) Table B-24										
Pentafluoropropanoic acid (PFPrA)	422-64-0	NA	3,900	NA	NA	NA	NA	0.8	0.60	0.30
Perfluorobutanoic acid (PFBA)	375-22-4	NA	7,800	NA	NA	2980	NA	0.8	0.32	0.10
Perfluoropentanoic acid (PFPeA)	2706-90-3	NA	NA	NA	NA	NA	NA	0.4	0.16	0.041
Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	NA	NA	NA	NA	NA	NA	0.2	0.075	0.022
Perfluorohexanoic acid (PFHxA)	307-24-4	NA	3,200	NA	NA	6200	NA	0.2	0.080	0.025
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.5	NA	NA	NA	NA	NA	0.2	0.080	0.025
Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	NA	NA	NA	NA	NA	NA	0.2	0.076	0.033
Perfluorooctanic acid (PFOA)	335-67-1	0.72	0.07	101,000	77,800	3,840	NA	0.2[d]	0.080[d]	0.029
Perfluorononanoic acid (PFNA)	375-95-1	0.32	19	NA	10,000	0.0242	NA	0.2	0.080	0.026
Perfluorononanesulfonic acid (PFNS)	68259-12-1	NA	NA	NA	NA	NA	NA	0.2	0.077	0.025
Perfluorodecanoic acid (PFDA)	335-76-2	0.3	0.06	NA	NA	67.7	NA	0.2[d]	0.080[d]	0.029
Perfluorodecanesulfonic acid (PFDS)	335-77-3	NA	NA	NA	NA	NA	NA	0.2	0.077	0.030
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NA	NA	NA	NA	NA	NA	0.2	0.080	0.028
Perfluorododecanoic acid (PFDoA)	307-55-1	NA	NA	NA	NA	NA	NA	0.2	0.080	0.032
Perfluorododecanesulfonic acid (PFDoS)	79780-39-5	NA	NA	NA	NA	NA	NA	0.2	0.078	0.024
Perfluorotridecanoic acid (PFTriA)	72629-94-8	NA	NA	NA	NA	NA	NA	0.2	0.080	0.040
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	NA	NA	NA	NA	NA	NA	0.2	0.080	0.029
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	1,900	NA	100,000	817	15.8	0.2	0.071	0.021
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.3	130	NA	10,000	145	NA	0.2	0.073	0.020
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	2	0.63	17,300	57,600	4	38.6	0.2	0.074	0.020
Perfluorooctanesulfonamide (PFOSA)	754-91-6	NA	NA	NA	NA	NA	NA	0.2	0.040	0.014
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	NA	23	NA	NA	NA	NA	1	0.80	0.32
N-ethylperfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NA	NA	NA	NA	NA	NA	0.2	0.16	0.044
N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NA	NA	NA	NA	NA	NA	0.2	0.080	0.040
N-Methyl perfluorooctanesulfonamide (NMeFOSA)	31506-32-8	NA	NA	NA	NA	NA	NA	0.2	0.0400	0.015
N-Ethyl perfluorooctanesulfonamide (NEtFOSA)	4151-50-2	NA	NA	NA	NA	NA	NA	0.2	0.08	0.034
N-Methyl perfluorooctanesulfonamidoethanol (NMeFOSE)	24448-09-7	NA	NA	NA	NA	NA	NA	2	0.80	0.209
N-Ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)	1691-99-2	NA	NA	NA	NA	NA	NA	2	0.80	0.291
4:2 flourotelomersulfonic acid (4:2 FTS)	757124-72-4	NA	NA	NA	NA	NA	NA	0.8	0.30	0.098

Analyte	CAS #	MCP PFAS Standard[a]	Project Action Limit (PAL)	Ecological Soil Screening Levels (µg /kg)[b]				Laboratory Achievable Detection Limits[c] (µg/kg)		
		S-1/GW-1 (µg/kg)[a]	DoD Screening Level (µg/kg)	Terrestrial Plants	Soil Invertebrates	Terrestrial Mammals	Terrestrial Birds	LOQ	LOD	DL
1H, 1H, 2H, 2H-perfluorooctane sulfonate (6:2 FTS)	27619-97-2	NA	NA	NA	NA	NA	NA	0.8	0.61	0.17
1H, 1H, 2H, 2H-perfluoroecane sulfonate (8:2 FTS)	39108-34-4	NA	NA	NA	NA	NA	NA	0.8	0.31	0.082
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	NA	NA	NA	NA	NA	NA	0.8	0.76	0.25
Perfluoro-3-methoxypropanoic acid (PFMPA)	377-73-1	NA	NA	NA	NA	NA	NA	0.4	0.32	0.12
Perfluoro-4-methoxybutanoic acid (PFMBA)	863090-89-5	NA	NA	NA	NA	NA	NA	0.4	0.32	0.11
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	151772-58-6	NA	NA	NA	NA	NA	NA	1	0.80	0.35
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	NA	NA	NA	NA	NA	NA	1	0.75	0.33
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	NA	NA	NA	NA	NA	NA	0.8	0.76	0.23
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	113507-82-7	NA	NA	NA	NA	NA	NA	0.4	0.29	0.12
3-Perfluoropropyl propanoic acid (3:3FTCA)	356-02-5	NA	NA	NA	NA	NA	NA	1	0.80	0.21
2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)	914637-49-3	NA	NA	NA	NA	NA	NA	5	4	1.4
3-Perfluoroheptyl propanoic acid (7:3FTCA)	812-70-4	NA	NA	NA	NA	NA	NA	5	4	1.7
Bis(trifluoromethane)sulfonimide (TFSI)	82113-65-3	NA	2,300	NA	NA	NA	NA	0.4	0.30	0.11

Notes:

a. MCP PFAS soil standard for category S-1/GW-1 (in an area where groundwater is used for drinking water) for individual concentrations of six specific PFAS (PFAS6) (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA).
b. A second stage of the Phase II investigation is anticipated to be required following this first stage investigation in Area 3, both to complete delineation of the nature and extent of PFAS, and to collect remaining samples needed to evaluate human health or ecological risks. These screening levels will be considered in the future Screening Level Ecological Assessment (SLERA) completed after Stage 2; however, additional screening levels may also be considered as new data become available.
c. Sample results will be reported on a dry weight basis. The detection limits listed are based on wet weight. Actual reporting limits will vary based on sample weight and moisture content.
d. The LOQs and LODs for PFOA and PFDA in soil, are greater than the January 2025 ASD screening levels. The associated uncertainty will be considered when risk is calculated during risk assessment.

µg/kg = microgram per kilogram
CAS = Chemical Abstract Service
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
mg/kg = milligram per kilogram
NA = not applicable
RSL = Regional Screening Level

Worksheet #15-3: Reference Limits and Evaluation Table

Pace (Total Organic Carbon and Grain Size in Soil)

(UFP-QAPP Manual Section 2.6.2.3 an Figure 15) / (USEPA 2106-G-05 Section 2.2.6)

Method and Analyte Description	CAS #	Project Action Limit (PAL)	LOQ	DL	LOD	Units	LCS-Low	LCS-High	LCS-RPD%	MS-Low	MS-High	MS-RPD%
Walkley-Black Total Organic Carbon (TOC)	7440-44-0	NA	100	25.5	50	mg/kg	46	130	20	46	130	20
Grain Size	NA	NA	--	0.5	1.0	% passing	NA	NA	NA	NA	NA	NA

Notes:

CAS = Chemical Abstract Service
DL = detection limit
LCS = laboratory control sample
LOD = limit of detection
LOQ = limit of quantitation
MDL = method detection limit
mg/kg = milligram per kilogram
MS = matrix spike
NA = not applicable
RPD = relative percent difference

Worksheet #15-4: Reference Limits and Evaluation Table

Pace (PFAS in Surface Water)

(UFP-QAPP Manual Section 2.6.2.3) / (USEPA 2106-G-05 Section 2.2.6)

Analyte	CAS #	MCP PFAS Standards	Project Action Limits (PALs)	Ecological Freshwater Screening Levels (ng/L)[c,d]			Laboratory Achievable Detection Limits (ng/L)		
		GW-3[a] (ng/L)	USEPA Region 1 Site-Specific SL[b] (ng/L)	Aquatic Life	Aquatic-Dependent Mammals	Aquatic-Dependent Birds	LOQ	LOD	DL
Analytical Group: PFAS per USEPA Method 1633 compliant with DoD QSM 5.4 (or later versions) Table B-24									
Pentafluorpropanoic acid (PFPrA)	422-64-0	NA	47,000	NA	NA	NA	6.4	6.1	3.0
Perfluorobutanoic acid (PFBA)	375-22-4	NA	82,000	75,700	119,000	NA	4	1.6	0.51
Perfluoropentanoic acid (PFPeA)	2706-90-3	NA	NA	NA	NA	NA	2	0.40	0.18
Perfluoropentanesulfonic acid (PFPeS)	2706-91-4	NA	NA	NA	NA	NA	1	0.75	0.26
Perfluorohexanoic acid (PFHxA)	307-24-4	NA	49,000	33,800	544,000	NA	1	0.40	0.14
Perfluoroheptanoic acid (PFHpA)	375-85-9	40,000,000	NA	NA	NA	NA	1	0.80	0.21
Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	NA	NA	NA	NA	NA	1	0.38	0.19
Perfluorooctanic acid (PFOA)	335-67-1	40,000,000	0.26	109,000	47,600	NA	1	0.80	0.21
Perfluorononanoic acid (PFNA)	375-95-1	40,000,000	290	16,900	116	NA	1	0.40	0.10
Perfluorononanesulfonic acid (PFNS)	68259-12-1	NA	NA	NA	NA	NA	1	0.38	0.15
Perfluorodecanoic acid (PFDA)	335-76-2	40,000,000	0.52	3,440	93.7	NA	1	0.40	0.14
Perfluorodecanesulfonic acid (PFDS)	335-77-3	NA	NA	NA	NA	NA	1	0.39	0.16
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NA	NA	NA	NA	NA	1	0.80	0.25
Perfluorododecanoic acid (PFDoA)	307-55-1	NA	NA	NA	NA	NA	1	0.40	0.11
Perfluorododecanesulfonic acid (PFDoS)	79780-39-5	NA	NA	NA	NA	NA	1	0.39	0.15
Perfluorotridecanoic acid (PFTriA)	72629-94-8	NA	NA	NA	NA	NA	1	0.40	0.19
Perfluorotetradecanoic acid (PFTA)	376-06-7	NA	NA	NA	NA	NA	1	0.80	0.27
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	30,000	446,000	209,000	2,783,000	1	0.35	0.094
Perfluorohexane Sulfonic acid (PFHxS)	355-46-4	500,000	1,900	94,200	14,100	NA	1	0.73	0.18
Perfluoroctane Sulfonic acid (PFOS)	1763-23-1	500,000	10	4,850	16.7	487	1	0.74	0.25
Perfluorooctanesulfonamide (PFOSA)	754-91-6	NA	NA	NA	NA	NA	1	0.40	0.20
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	NA	32	NA	NA	NA	4	2.4	0.99
N-ethylperfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NA	NA	NA	NA	NA	1	0.80	0.29
N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NA	NA	NA	NA	NA	1	0.80	0.29
N-Methyl perfluorooctanesulfonamide (NMeFOSA)	31506-32-8	NA	NA	NA	NA	NA	1	0.80	0.22
N-Ethyl perfluorooctanesulfonamide (NEtFOSA)	4151-50-2	NA	NA	NA	NA	NA	1	0.40	0.13
N-Methyl perfluorooctanesulfonamidoethanol (NMeFOSE)	24448-09-7	NA	NA	NA	NA	NA	10	2.0	0.63
N-Ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)	1691-99-2	NA	NA	NA	NA	NA	10	2.0	0.61
4:2 flourotelomersulfonic acid (4:2 FTS)	757124-72-4	NA	NA	NA	NA	NA	4	1.5	0.40

Analyte	CAS #	MCP PFAS Standards	Project Action Limits (PALs)	Ecological Freshwater Screening Levels (ng/L)[c,d]			Laboratory Achievable Detection Limits (ng/L)		
		GW-3[a] (ng/L)	USEPA Region 1 Site-Specific SL[b] (ng/L)	Aquatic Life	Aquatic-Dependent Mammals	Aquatic-Dependent Birds	LOQ	LOD	DL
6:2 flourotelomersulfonic acid (6:2 FTS)	27619-97-2	NA	NA	NA	NA	NA	5	4.6	2.0
8:2 flourotelomersulfonic acid (8:2 FTS)	39108-34-4	NA	NA	NA	NA	NA	4	1.5	0.61
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	NA	NA	NA	NA	NA	4	2.3	0.66
Perfluoro-3-methoxypropanoic acid (PFMPA)	377-73-1	NA	NA	NA	NA	NA	2	0.60	0.18
Perfluoro-4-methoxybutanoic acid (PFMBA)	863090-89-5	NA	NA	NA	NA	NA	2	1.3	0.39
Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	151772-58-6	NA	NA	NA	NA	NA	2	1.3	0.58
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	NA	NA	NA	NA	NA	4	2.2	0.67
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	NA	NA	NA	NA	NA	4	2.3	0.87
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	113507-82-7	NA	NA	NA	NA	NA	2	1.1	0.36
3-Perfluoropropyl propanoic acid (3:3FTCA)	356-02-5	NA	NA	NA	NA	NA	5	2.0	0.60
2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)	914637-49-3	NA	NA	NA	NA	NA	25	10	4.3
3-Perfluoroheptyl propanoic acid (7:3FTCA)	812-70-4	NA	NA	NA	NA	NA	25	10	4.2
Bis(trifluoromethane)sulfonimide (TFSI)	82113-65-3	NA	28,300	NA	NA	NA	3.2	3.0	1.1

Notes:

a. MCP PFAS groundwater standard for category GW-3 (groundwater to surface water) for individual concentrations of six specific PFAS (PFAS6) (PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA).
b. Site-specific surface water SLs for recreational child scenario for PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, PFBA, PFDA, HFPO-DA, PFPrA, and TFSI (USEPA Region 1 2023).
c. A second stage of the Phase II investigation is anticipated to be required following this first stage investigation in Area 3, both to complete delineation of the nature and extent of PFAS, and to collect remaining samples needed to evaluate human health or ecological risks. These screening levels will be considered in the future Screening Level Ecological Assessment (SLERA) completed after Stage 2; however, additional screening levels may also be considered as new data become available.
d. These wildlife-based values do not reflect site-specific receptors or conditions. If an exceedance of these values is noted in the SLERA, additional screening will consider receptors and assumptions appropriate to the exposure area.

CAS = Chemical Abstract Service
DL = detection limit
LOD = limit of detection
LOQ = limit of quantitation
NA = not applicable
ng/L = nanogram per liter

QAPP Worksheet #17: Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)
(USEPA 2106-G-05 Section 2.3.1)

The RI field activities at Area 3 of the former Fort Devens are intended to evaluate fate and transport pathways of PFAS from identified source areas to areas of potential exposure. The data collected will also be used to identify potential human health or ecological risks and will be utilized in future CERCLA-compliant risk assessments, if needed, and development of potential remedial alternatives, if needed. A second stage of the Phase II investigation is anticipated to be required following this first stage, both to complete delineation of the nature and extent of PFAS, and to collect remaining samples needed to evaluate human health or ecological risks.

The **Area 3 Phase II PFAS RI WP** summarizes the number of groundwater, soil, surface water, and sediment samples collected during the SI, Phase I RI, and supplemental sampling, the results of those samples compared to SSSLs, proposed Phase II RI groundwater, soil, and surface water samples, and the purpose of Stage 1 of the Phase II RI sampling.

17.1 Overall Investigation Approach Rationale

This worksheet describes the design for data collection and documents Step 7 of the DQO process. For each field task, this section summarizes the data need, the rationale for data collection, and the approach for obtaining the data. The general process for the Stage 1 and future Stage 2 investigations will consist of identifying and delineating potentially PFAS-impacted areas in and around AOCs 20, 21, 30, 31, and 50 of Area 3 at Devens using data from soil, groundwater, and surface water sampling.

17.1.1 PFAS-Specific Field Guidance

In accordance with various available protocols, the S-A JV has developed technical guidance instructions (TGIs) specific for field sampling on PFAS projects. Special considerations will be made throughout each of the field activities described below regarding PFAS-containing materials and cross-contamination potential. All field staff will be provided with a summary of materials (clothing, notebook, pens/markers, etc. that are prohibited for use when collecting PFAS samples) and field equipment approved for field investigation efforts, and recommendations will be provided on any materials that are prohibited for the collection of PFAS samples (i.e., Teflon or low-density polyethylene supplies). The S-A JV will confirm with the laboratory analyzing samples (Pace) that sampling containers are high-density polyethylene with unlined polypropylene caps. Wet ice will be used to pack sample containers for shipment, and PFAS samples will be stored in coolers separate from other types of samples (if necessary).

Non-dedicated sampling equipment and drilling rods will be rinsed with Alconox or Liquinox cleaning solution, followed by a distilled or deionized water rinse. If necessary, a decontamination pad will be set up in a central area of the site in order to clean/rinse drilling augers.

17.1.2 Standard Operating Procedures

Sampling will be conducted in accordance with the following standard operating procedures (SOPs) (see also **Worksheet #21**):

- **RI-SOP-01:** TGI – *Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide* (Rev #10, 26 January 2022)
- **RI-SOP-02:** TGI – *Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells* (Rev #3, 5 April 2023)
- **RI-SOP-03:** USEPA – *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (Rev #4, 19 September 2017)
- **RI-SOP-04:** TGI – *Equipment and Reagent Blank Sample Collection for PFAS Analysis* (Rev #2, 21 February 2022)
- **RI-SOP-05:** TGI – *Ground Penetrating Radar* (Rev #6, 8 February 2023)
- **RI-SOP-06:** TGI – *Manual Water-Level and NAPL Monitoring* (Rev #4, 1 March 2023)
- **RI-SOP-07:** TGI – *In-Situ and Ex-Situ Water Quality Parameters – Surface Water and Groundwater* (Rev #1, 15 April 2022)
- **RI-SOP-08:** TGI – *Sample Chain of Custody* (Rev #3, 28 March 2022)
- **RI-SOP-09:** TGI – *Investigation-Derived Waste Handling and Storage* (Rev #1, 15 May 2020)
- **RI-SOP-10:** TGI – *Groundwater and Soil Sampling Equipment Decontamination* (Rev #3, 30 August 2023)
- **RI-SOP-11:** TGI – *Monitoring Well Development* (Rev #2, 5 April 2023)
- **RI-SOP-12:** TGI – *Monitoring Well Installation* (Rev #2, 30 August 2023)
- **RI-SOP-13:** TGI – *Soil Description* (Rev #4, 5 June 2023)
- **RI-SOP-14:** TGI – *Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis* (Rev #3, 22 June 2022)
- **RI-SOP-15:** TGI – *Vertical Aquifer Profile (VAP) Sampling* (Rev #2, 15 June 2022)
- **RI-SOP-16:** TGI – *Solid Slug Testing* (Rev #7, 1 March 2023)
- **RI-SOP-17:** TGI – *Soil Drilling and Sample Collection* (Rev #3, 5 April 2023)

The sampling methods described in the SOPs establish equipment requirements, procedures for handling equipment and containers before sampling, sampling procedures under various conditions, collecting equipment blank samples, field duplicate requirements, and storing samples to ensure that sample contamination does not occur during collection, transport, and analysis.

These SOPs meet, or are more stringent than, sampling recommendations provided by the USEPA in Technical Brief EPA/600/F-17/022h, updated January 2020, *Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Methods and guidance for sampling and analyzing water and other environmental media* (USEPA 2020).

The SOPs provide procedural guidance in general accordance with industry standards/guidelines and regulatory requirements. General and PFAS-specific field guidance documents (i.e., SOPs) are provided in **Attachment A**.

17.2 Site Preparation and Utility Survey

Site preparation will be conducted before any intrusive activities are conducted. The property owner/leasee will be notified of the planned field activities a minimum of 30 days before the start of intrusive activities. Some locations are anticipated to be located in public rights-of-way or on private property not owned by the U.S. Army or MassDevelopment. For these locations, access agreements will be pursued, and no work will be conducted until a signed access agreement is executed by the property owner(s), S-A JV, and USACE For any locations on or adjacent to public rights-of-way, the S-A JV will complete a traffic safety assessment and use a police detail if needed.

S-A JV field personnel will complete the site-specific munitions and explosives of concern awareness training with the Devens Fire Department before the start of field activities. Field personnel will also have current health and safety training as required by state/federal regulations, such as 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Additional requirements are outlined in the Area 3 PFAS RI Site-specific Safety and Health Plan. Personnel responsible for overseeing drilling operations will have at least 5 years of prior relevant drilling experience.

Preparation activities for intrusive work will include (but are not limited to) vegetation clearing for drilling rig access as necessary and utility location. The utility survey will be performed in accordance with **RI-SOP-05** to identify buried and overhead infrastructure that may be encountered during ground-intrusive activities, and to prevent damage to infrastructure assets and physical harm to field personnel and on-site workers. The utility survey will include:

- Notification of Massachusetts Dig Safe System, Inc./811;
- Completion of the Utility Location checklist provided in the field forms (**Attachment B**); and
- Identification of a minimum of three reliable lines of evidence including:
    - Private utility location, such as ground-penetrating radar, electromagnetic geophysical techniques, and/or other appropriate methods of detection;
    - Soft dig methods (i.e., air-knife) for clearing locations during drilling to a depth of 5 feet bgs;
    - Review of public records, utility maps, and existing as-built-drawings; and
    - Site inspection of overhead utility infrastructure or ground infrastructure that indicates a buried utility.

17.3 Soil Investigation

Nature and extent of PFAS in soil will be addressed through collection of soil data from soil borings. A total of 8 soil borings will be installed (using direct-push technology [DPT] drilling techniques) to determine PFAS presence or absence in groundwater and/or bound SSSL exceedances during historical sampling activities. Soil descriptions will be recorded in accordance with the Unified Soil Classification System. The following will be recorded from each soil core at a minimum: depth interval, recovery, particle size (Udden-Wentworth), sorting, angularity/plasticity/dilatancy, principal and minor components, moisture,

consistency/density, and color. Each recovered soil core will be photographed. Soil will be analyzed by USEPA Method 1633.

Surficial and subsurface soil samples will be collected from 8 locations in and around Area 3 (shown on **Area 3 Phase II PFAS RI WP Figure 4-8 [AOC 21] and Figure 4-9 [AOC 50])** and analyzed for PFAS. The soil sampling proposed in this QAPP is discrete sampling for the purposes of site investigation.

The field tasks associated with the soil investigation are outlined in the table below.

Table 17.3: Soil Investigation Tasks

Soil Investigation Task	Supporting Document
Utility Survey	**RI-SOP-05:** TGI - *Ground Penetrating Radar* (Rev #6, 8 February 2023)
Surface and Subsurface Soil Sampling	**RI-SOP-01:** TGI – *Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide* (Rev #10, 26 January 2022) **RI-SOP-04:** TGI – *Equipment and Reagent Blank Sample Collection for PFAS Analysis* (Rev #2, 21 February 2022) **RI-SOP-08:** TGI – *Sample Chain of Custody* (Rev #3, 28 March 2022) **RI-SOP-09:** TGI - *Investigation-Derived Waste Handling and Storage* (Rev #1, 15 May 2020) **RI-SOP-10:** TGI – *Groundwater and Soil Sampling Equipment Decontamination* (Rev #3, 30 August 2023) **RI-SOP-13:** TGI – *Soil Description* (Rev #4, 5 June 2023) **RI-SOP-17:** TGI – *Soil Drilling and Sample Collection* (Rev #3, 5 April 2023)

Soil samples will be collected to provide characterization of PFAS source strength and delineation of PFAS concentrations in soils. An S-A JV field geologist will oversee the work and record soil lithology and recovery; soil will be screened with a photoionization detector (PID) every 1 foot at the continuous logging locations. Soil descriptions will be recorded in accordance with the S-A JV TGI, which incorporates elements from various standard systems such as ASTM D2488-06, Unified Soil Classification System, Burmister, and Wentworth. The following will be recorded from each soil core at a minimum: depth interval, recovery, particle size (Udden-Wentworth), sorting, angularity/plasticity/dilatancy, principal and minor components, moisture, consistency/density, and color. When possible, the recovered soil cores will be photographed.

Soil samples from the proposed soil locations will be collected from the following discrete depth intervals and homogenized for sample collection: 0 to 0.5 foot, 0.5 to 3 foot, 3 to 7 feet, and 7 to 15 feet. If the water table is encountered at a depth shallower than the bottom depth of these intervals, the deepest sample will end at the water table depth. It is anticipated that sampling intervals will be selected based on the soil lithology observed with the objective of collecting samples from different lithological layers (if observed).

Soil samples will be analyzed for PFAS by Pace. Select soil samples will also be collected from the VAP borings and analyzed for total organic carbon (TOC), pH, and grain size (clay content) to further support analysis of PFAS transport in the unsaturated zone. These samples will be collected from the depth interval with the most permeable lithology based on visual observation. The results will be used along with data

collected from other monitoring locations within the groundwater sampling interval to estimate hydraulic conductivity.

17.4 Groundwater Investigation

Nature and extent of PFAS in groundwater will be addressed through collection of groundwater data from permanent monitoring wells. A total of 8 VAP locations will be installed to obtain screening data to determine PFAS presence or absence in groundwater and assist in placement of permanent monitoring wells. Based on the VAP analytical data, 10 overburden and 4 bedrock monitoring wells will be installed to collect reproducible groundwater data to allow preparation of a future human health risk assessment (HHRA; shown on **Area 3 Phase II PFAS RI WP Figure 4-1)**. Data from the permanent monitoring wells will be used to establish nature and extent of PFAS in groundwater. The maximum detected concentrations will be used as EPCs for preparation of future risk assessments. Once developed, the new monitoring wells and 45 existing monitoring wells identified for sampling (**Worksheet #18**) will be sampled and water levels collected twice, once in fall and once in spring. Data from the new and existing monitoring wells will be sufficient for future risk assessment purposes. Groundwater samples collected from VAP location and permanent monitoring wells will be analyzed by USEPA Method 1633.

Overburden monitoring wells will be installed using sonic drilling techniques. Screen intervals will be determined following the installation of vertical profile locations. Bedrock monitoring well installation will generally occur after the installation of overburden monitoring wells. The bedrock wells will be completed as single-screened monitoring wells targeting the first water-bearing fracture zone encountered in competent bedrock. Wells are planned to be no greater than 100 feet bgs, but boreholes may also be extended deeper if needed for vertical delineation. Final determination of screened intervals will be based on geophysical logging and packer test results.

The field tasks associated with the groundwater investigation are outlined in the table below. SOPs listed in the table are included in **Attachment A**.

Table 17.4: Groundwater Investigation Tasks

Groundwater Investigation Task	Supporting Document
Utility Survey	**RI-SOP-05:** TGI – *Ground Penetrating Radar* (Rev #6, 8 February 2023)
Monitoring Well Installation	**RI-SOP-12**: TGI – *Monitoring Well Installation* (Rev #2, 30 August 2023)
Monitoring Well Development and Water-Level Monitoring	**RI-SOP-06**: TGI – *Manual Water-Level and NAPL Monitoring* (Rev #4, 1 March 2023) **RI-SOP-11**: TGI – *Monitoring Well Development* (Rev #2, 5 April 2023)
Aquifer Testing	**RI-SOP-16**: TGI – *Solid Slug Testing* (Rev #7, 1 March 2023)
Groundwater Sampling	**RI-SOP-01**: TGI – *Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide* (Rev #10, 26 January 2022) **RI-SOP-02:** TGI – *Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells* (Rev #3, 5 April 2023) **RI-SOP-03:** USEPA SOP – *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (Rev #4, 19 September 2017)

Groundwater Investigation Task	Supporting Document
	RI-SOP-04: TGI – *Equipment and Reagent Blank Sample Collection for PFAS Analysis* (Rev #2, 21 February 2022) **RI-SOP-07**: TGI – *In-Situ and Ex-Situ Water Quality Parameters – Surface Water and Groundwater* (Rev #1, 15 April 2022) **RI-SOP-08**: TGI – *Sample Chain of Custody* (Rev #3, 28 March 2022) **RI-SOP-09**: TGI – *Investigation-Derived Waste Handling and Storage* (Rev #1, 15 May 2020) **RI-SOP-10**: TGI – *Groundwater and Soil Sampling Equipment Decontamination* (Rev #3, 30 August 2023)**)** **RI-SOP-15**: TGI – *Vertical Aquifer Profile (VAP) Sampling* (Rev #2, 15 June 2022**)**

17.5 Vertical Profiling

A total of 8 VAP borings will be installed in and around Area 3. It is anticipated that VAP locations will be installed using DPT methods.

Groundwater samples will be collected via a retractable well screen, which is advanced with 1-inch steel drilling rods (SP-22 or similar). Groundwater samples will be collected using the "top-down" approach (i.e., samples collected as the borehole is drilled to minimize any potential for cross-contamination). Each VAP location will be abandoned using tremie-grout techniques following the completion of sampling unless permanent monitoring wells are installed. All drilling will be completed by a licensed Massachusetts driller under the oversight of a S-A JV geologist and will be conducted in accordance with all promulgated state and federal laws.

17.6 Monitoring Well Installation

Up to a total of 10 new overburden monitoring wells and 4 new bedrock monitoring wells will be installed in and around Area 3, as shown on **Area 3 Phase II PFAS RI WP Figure 4-1**, two of which will be installed as overburden/bedrock couplets.

Overburden and bedrock wells will be installed as discussed below. Filter packs, seals, and surface completions will be completed consistent with Massachusetts guidance. Well construction details (included the materials used) will be recorded by a S-A JV field geologist. The measuring points and well labels will be marked with an indelible ink pen on both the inner and outer well casings or inside the roadbox lid. All drilling and well construction will be completed by a licensed Massachusetts driller under the oversight of a S-A JV geologist and will be conducted in accordance with all promulgated state and federal laws. All well locations will be surveyed by a licensed Massachusetts surveyor for northing, easting, and ground/top of casing elevations.

17.6.1 Overburden Monitoring Well Installation

Overburden monitoring wells will be installed using sonic drilling techniques. Sonic drilling requires the addition of drilling water to the borehole; inert dye (fluorescein or similar) will be introduced into the drilling water to allow the S-A JV to confirm that all drilling water has been removed from the screened interval, and that future groundwater samples are representative. Overburden soil will be logged at select

drilling locations by a S-A JV field geologist. The wells will be completed flush with the surface grade encased by a 2-foot by 2-foot concrete pad and secured using an 8-inch protective roadbox or 4-inch-diameter steel standpipe.

Piezometers and permanent monitoring wells will be constructed of 1- or 2-inch-diameter schedule 40 polyvinyl chloride (PVC) with 10-foot long screen (10-slot size [0.010-inch]). Deeper wells may require schedule 80 PVC and/or 4-inch diameter well materials.

Screen intervals will be determined following the installation of VAP locations. Screen depths will be selected based the following:

- Overburden wells: Installed to target highest PFAS concentrations (if PFAS is detected) and/or specific hydrostratigraphic units.
- Weathered rock wells: Installed to target shallow weathered rock hydrostratigraphic unit.

17.6.2 Bedrock Monitoring Well Installation

Shallow bedrock well locations will be installed using air hammer drilling techniques in the bedrock portion of the well down to the first water-bearing zone. Potential source/plume locations will be completed as single-screened monitoring wells targeting the first water-bearing fracture zone encountered in competent bedrock. Wells are planned to be no greater than 100 feet below the bedrock surface, but may be extended to 200 feet if needed for vertical delineation. Wells may be terminated at a shallower depth if drilling observations indicate that a significant fracture has been encountered. Final determination of screened intervals will be based on geophysical logging. Packer tests will only be completed if multiple fracture zones are observed, and the tests will help select most appropriate interval.

17.6.2.1 Bedrock Drilling Methodology

All bedrock wells will be double-cased. Drilling through overburden will be completed using either sonic or hollow-stemmed augers to the bedrock surface. Air rotary or air-hammer drilling will be used to drill approximately 5 feet into rock to create a socket for the surface casing. Surface casing will be constructed of 4-inch diameter steel. Casing will be grouted in place and allowed to cure for a minimum of 24 hours before drilling resumes.

Bedrock boreholes will be drilled to 4-inch diameter by air hammer methods. Drillers will use un-dyed potable water as a drilling fluid (if needed, for dust suppression purposes). While drilling, the S-A JV field geologist will log changed drilling conditions include water-production, drilling rate, increased “chatter”, or changes in drilling return water color or turbidity. The driller will maintain an estimate of drilling water lost to the formation, if any. Rock cuttings will not be logged for lithology.

Borehole yield tests will be conducted at key decision points to determine if the drilled section of the borehole has encountered water bearing fractures of sufficient yield to test or build monitoring wells. Tests will be completed as drilling-water falling head tests. With the tools removed from the borehole, water will be added to the top of casing. The water level in the borehole will be manually measured for 10 minutes. The rate of recovery (gallons per minute [gpm]) and specific capacity (gallons per minute per

foot [gpm/foot]) will be estimated based on the casing diameter and volume. The recovery rates will be evaluated as follows:

- A total borehole recovery rate of less than 0.25 gpm will be considered insufficient yield for testing or well construction. If a location is at a decision point for drilling deeper, drilling will continue. If a location is at its maximum planned depth, the location will be abandoned.
- A total borehole recovery rate of greater than 0.25 gpm will be considered sufficient yield for testing. Geophysics and packer testing would then be performed. The final decision on whether to construct a well would then be based on the results of that testing, as described in the sections below.

After each borehole is drilled, the driller will flush the borehole until clear of cuttings. The borehole will be left open temporarily to allow geophysical logging and packer testing, as described below.

17.6.2.2 Borehole Geophysics

Geophysics work will be completed by a S-A JV geophysics subcontractor at each new bedrock borehole. Borehole geophysical logging will be completed a minimum of 24 hours after drilling is completed to allow the water-column to equilibrate and any turbidity to settle.

The logging suite is anticipated to include tools to evaluate the nature of the bedrock, the depths and orientation of fractures, and relative groundwater yield of the fractures encountered. The logging suite will include natural gamma, induction conductivity, fluid temperature/resistivity, three-arm caliper, acoustic and optical televiewers, and heat-pulse flowmeter. Flow meter logging will be completed first under ambient (unstressed) conditions, and then under dynamic (pumping) conditions. For dynamic flow logging, a submersible pump will be deployed at the top of the water column and pumped at a rate sufficient to created steady drawdown and induce upward flow within the water-column. Pumping and drawdown data will also be used to estimate the specific capacity of the full borehole.

If significant ambient vertical flow is observed (i.e., exceeding 0.25 gpm) and the well is expected to remain open for greater than 2 weeks, temporary packers will be deployed to separate the fracture zones contributing to vertical flow.

17.6.2.3 Packer Testing

Packer testing will be completed at boreholes where multiple hydraulically active fracture zones were observed in the geophysical logging and where the data leave uncertainty about well construction. If geophysical logging has identified only one zone (for first water locations) or two zones (for deep borehole locations), then packer testing may not be needed to decide well construction, and water-quality data from the target zones will be evaluated after the well is constructed and developed. In those cases, packer testing would only be completed if geophysical logging data leaves uncertainty about whether the zones have sufficient yield to support a monitoring well.

Packer testing intervals will be selected based on review of the geophysical logs and will target zones with evidence of groundwater yield. The number of zones tested will be based on number of hydraulically active zones observed but is estimated to be no greater than two intervals per 100 feet of open borehole. Packer testing will be conducted in the following manner:

- A water level measurement will be measured in the open borehole before testing starts to establish equilibrium conditions.
- A 10- or 15-foot double-packer assembly will be lowered to straddle the target interval and then inflated to isolate the interval. Packer testing will begin from the shallowest interval, moving sequentially deeper.
- Once the packers have been inflated, baseline water levels will be manually recorded outside and inside of the packer assembly for a minimum of 10 minutes to confirm that the packers are maintaining a proper seal. Transducers will be used to record water levels, supplemented by manual measurements.
- Once the water levels have stabilized, a submersible pump will be installed and started with a rate of 1 gpm. Flow and drawdown will be monitored during the purging process to establish the specific capacity of the interval. The minimum acceptable yield to complete a test will be 0.25 gpm with 25 feet of drawdown (i.e., specific capacity of 0.01 gpm/foot). Pumping flow rate adjustments will be made quickly at the start of the test to limit drawdown beyond 25 feet. If the yield of an interval is below the threshold described above, the test will be stopped and no groundwater sample will be collected.
- If the yield of an interval is sufficient for the collection of groundwater samples, the packer test will continue until three volumes of water have been removed from the borehole. The volume of water for one volume will include the water contained within the standpipe and the packer interval.
- Once the pre-determined volume has been removed, a groundwater sample will be collected and field parameters (including pH, conductivity, oxidation-reduction potential [ORP], and dissolved oxygen [DO]) will be recorded.
- Groundwater samples will be sent to for PFAS analysis under appropriate chain-of-custody procedures.

17.6.2.4 Bedrock Monitoring Well Construction

Selection of bedrock monitoring well screened intervals will be made based on borehole geophysics and packer testing results. Wells will only be completed in zones with a minimum estimated yield of at least 0.25 gpm with 25 feet of drawdown (i.e., specific capacity of 0.01 gpm/foot). Where multiple zones meet the flow criteria, selection priority will be given to zones of highest yield and highest PFAS concentrations. For deep boreholes where multiple intervals may be selected, priority will be given to vertical separation (e.g., placing a shallow well in the upper 100 feet and deeper well in the bottom 100 feet).

Where screened intervals are above the base of the borehole, the borehole will be grouted back to within 20 feet of the screened interval. After the grout has set, bentonite chips will be used to backfill any remaining depth to within approximately 2 feet of the base of the screen, where the filter pack will start.

Monitoring wells will be constructed of 2-inch-diameter schedule 40 PVC with 10-foot long screens (10-slot size [0.010-inch]). Deeper wells may require schedule 80 PVC well materials. Filter packs, seals, and surface completions will be completed consistent with Massachusetts guidance. The wells will be completed flush with the surface grade encased by a 2-foot by 2-foot concrete pad and secured using an 8-inch protective roadbox or 4-inch-diameter steel standpipe. Well construction details (included the materials used) will be recorded by a S-A JV field geologist. The measuring points and well labels will be

marked with an indelible ink pen on both the inner and outer well casings or inside the roadbox lid. Well construction will be completed by a licensed Massachusetts driller under the oversight of a S-A JV geologist and will be conducted in accordance with all promulgated state and federal laws. All well locations will be surveyed by a licensed Massachusetts surveyor for northing, easting, and ground/top of casing elevations.

17.7 Groundwater Well Development and Water-Level Monitoring

Wells will be developed before sampling using the methodology outlined in **RI-SOP-11.** The water will be containerized per the waste management protocol identified in **Section 17.10**.

Each overburden monitoring well will be developed using a submersible pump and surge block to remove fines and improve the hydraulic connection of the well with the native formation. Where sonic drilling methods are used (and drilling water is introduced into the formation), well development will also recover any drilling fluids.

Each open bedrock borehole will be initially developed with the drill rig using air-lift methods to remove any remaining sediment and rock flour generated during the drilling process. This development will ensure hydraulic communication of any fractures encountered with the borehole. After permanent PVC wells are installed within the open boreholes, the same well development procedures described above for overburden well development will be used.

Monitoring well measuring point elevations will be recorded by a Massachusetts -licensed professional surveyor to the nearest 0.010-inch North American Vertical Datum of 1988 (NAVD 88). Synoptic water levels in all wells will be measured from the established measurement point before each groundwater sampling event using a combination electronic water level and oil-water interface probe. Water levels will then be converted to water table elevations referenced to the measuring point elevations surveyed by a Massachusetts -licensed surveyor. A new groundwater contour map will be developed using survey and synoptic water-level data.

17.8 Slug Testing

Slug testing will be conducted at each new overburden monitoring well location to estimate the hydraulic conductivities. A solid slug of calibrated/known volume will be used to conduct rising and falling head tests in locations with adequate water column length (i.e., the water column is of sufficient length to allow for placement of a transducer at least 1 foot below the anticipated submersion depth of the slug). A small-diameter pressure transducer will be installed in each well at least 15 minutes prior to conducting the slug tests, to allow for equilibration with groundwater. A falling head test will first be completed by lowering the solid slug into the well. The target for initial groundwater displacement will be between 1 and 3 feet and/or generally less than 25% of the effective screen length. Water levels will be recorded to within 80 to 95% recovery. After the falling head test is completed, a rising head test will be conducted by quickly removing the slug (with the same displacement and recovery targets). Each test will be completed a second time to improve the accuracy of the hydraulic conductivity measurements.

17.9 Groundwater Sampling and Gauging

Groundwater samples will be collected during the installation of VAP borings in 10-foot intervals (starting at the water table) with a peristaltic or bladder pump setup with dedicated tubing. Samples will be collected after a minimum of three casing volumes have been purged from within the drilling rods. Groundwater samples will be collected via a retractable well screen setup (SP-22 or similar), which is advanced with 1-inch steel drilling rods. Groundwater samples will be collected using the "top-down" approach (i.e., samples collected as the borehole is drilled to minimize any potential for cross-contamination).

Two sets of groundwater samples will be collected from each of the newly installed monitoring wells and from the existing monitoring wells, once during the spring (April/May; higher water table) and again in the fall (October/November; lower water table); samples will be collected in accordance with low-flow guidance. All sampled monitoring wells will also be gauged, and water level measurements recorded to evaluate groundwater flow direction and horizontal/vertical hydraulic gradients, where appropriate.

Wells will be purged with a low-flow peristaltic pump, with purging to be conducted by low-stress (flow) protocols. Field parameters (temperature, pH, conductivity, dissolved oxygen [DO], turbidity, and oxidation-reduction potential [ORP]) will be measured during groundwater sampling to ensure that a stable sample is collected. Purging will be considered complete after water quality parameters specified under the low-flow protocols can be demonstrated to be stabilized; stabilization is not a requirement for VAP sampling. Sampling conditions will be noted in the sampling logs. Groundwater samples will be collected using the same flow rate at which the well was purged.

Groundwater samples will be shipped to Pace for PFAS analysis by USEPA Method 1633. VAP groundwater samples will be centrifuged prior to analysis.

17.10 Surface Water Sampling

Surface water samples will be collected from 18 previously sampled locations near Area 3 and analyzed for PFAS, as shown on **Area 3 Phase II PFAS RI WP Figure 4-7.** The field tasks associated with the surface water investigation are outlined in the table below.

Table 17.10: Surface Water Investigation Tasks

Surface Water Investigation Task	Supporting Document
Surface Water Sampling	**RI-SOP-14:** TGI – *Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis* (Rev #3, 22 June 2022)
Measurement of Water Quality Parameters	**RI-SOP-07**: TGI – *In-Situ and Ex-Situ Water Quality Parameters – Surface Water and Groundwater* (Rev #1, 15 April 2022)

Surface water samples will be collected from immediately below the water surface and from mid-depth using the procedures appropriate given site conditions and may include direct collection in the sample jar and/or use of a peristaltic pump. Due to the competing nature of the hydrophilic head and hydrophobic tail groups that comprise PFAS molecules, PFAS have a tendency to accumulate at the air/water interface; therefore, concentrations of PFAS in the surface water may be higher at or near the surface. Collecting samples near the surface is considered a worst-case scenario (Interstate Technology Regulatory Council

[ITRC] 2022). Surface water samples are anticipated to be collected from locations accessible by foot, and a boat/vessel will not be required.

Water quality parameters will be collected from each sampling location including DO, ORP, specific conductance, temperature, turbidity, and pH.

Surface water samples will be analyzed for PFAS by Pace.

17.11 Equipment Decontamination

Sampling equipment is decontaminated before sample collection to ensure that the sampling equipment that contacts a sample or monitoring equipment that is brought into contact with environmental media to be sampled is free from analytes of interest and/or constituents that could interfere with laboratory analysis for analytes of interest. Sampling equipment must be appropriately cleaned before using for sampling or contacting environmental media to be sampled and following completion of the sampling event before shipment or storage. The effectiveness of the decontamination procedure will be verified by collecting and analyzing equipment blank samples.

The drilling contractor will design and construct a decontamination pad which is watertight and allows for the collection of water used for decontamination. Sampling equipment that may require decontamination includes groundwater sampling tools, drilling equipment, water-quality meters, oil-water meters, and other activity-specific sampling equipment.

All non-disposable sampling equipment and downhole equipment that contacts environmental media will be decontaminated before use and in between wells and/or sample locations in accordance with the Groundwater and Soil Sampling Equipment Decontamination TGI (**RI-SOP-10)** included in **Attachment A**.

17.12 Waste Management

Waste will be managed in accordance with state and federal regulations to ensure completeness, accuracy, and consistency of waste documentation and to protect employees and contractors from environmental and regulatory risk.

Investigative-derived waste (IDW), including drill cuttings, monitoring well development water, monitoring well purge water, decontamination rinsate, as well as general site refuse, will be managed in accordance with the Investigation-Derived Waste Handling and Storage TGI (**RI-SOP-09**) included in **Attachment A** and PFAS-specific IDW management guidelines provided by the USACE. Drill cuttings monitoring well development water, monitoring well purge water, and decontamination rinsate will be containerized and transported to a central staging area for subsequent characterization. General site refuse will be collected in trash bags and disposed as general refuse in a dumpster.

Drill cuttings, development/purge water, and decontamination fluids will be collected and stored in onsite fractionation tanks, which will be stored in manner not-to-exceed the time requirements of the Resource Conservation and Recovery Act (RCRA) and applicable laws until sampled, tested, and treated/disposed. Decontamination waste generated on PFAS-impacted sites will not be commingled with any other waste.

Any additional waste containers (i.e., drums or tanks) will be U.S. Department of Transportation (DOT) approved, compatible with the waste stream, and appropriately labeled. Drums will be staged on a pallet

and covered with poly-sheeting to protect the drums from precipitation. Waste characterization analytical parameters will be collected per the disposal facility requirements. A profile will be submitted to the disposal facility for approval. A manifest will be generated for transportation of the drums. All loading and transportation will be performed in accordance with DOT regulations. After transport and disposal of IDW, the USACE PM will be provided with all original l manifests, destruction/disposal documents, and any analytical results within 30 days of disposal. Copies of the manifests, destruction/disposal documents, and any analytical results will be maintained at the office of the Devens USACE PM and included as an appendix to the RI.

17.13 Surveying

All investigation locations (and relevant site features if needed) will be surveyed by a Massachusetts - licensed surveyor to the nearest vertical 0.01 foot and horizontal 0.1 foot. The survey will be referenced to the Massachusetts State Plane Coordinate System North American Datum of 1983 (NAD 83) for the horizontal datum and NAVD88 for the vertical datum. The elevations of the ground surface, measuring point (i.e., top of PVC riser), and top of protective casing at each monitoring well will be surveyed. A metes-and-bounds survey for the parcel will also be conducted.

17.14 Reporting

After completion of the first stage of Area 3 Phase II PFAS RI field activities, a Stage 1 Field Investigation Report and Stage 2 Work Plan Addendum will be prepared. The Stage 1 Field Investigation Report will present and evaluate the efficacy of the data for meeting the stated Stage 1 Area 3 Phase II PFAS RI objectives. The Stage 2 Work Plan Addendum will include scope that builds off of the findings of the first stage, completes delineation, and provides data required to complete an HHRA and a SLERA. The RI Report will be prepared upon the conclusion of the Stage 2 investigation in accordance with the USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA 1988).

QAPP Worksheet #18: Sampling Locations and Methods/Standard Operating Procedure Requirements

(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(USEPA 2106-G-05 Section 2.3.1 and 2.3.2)

Sampling Location	Matrix	Sample Depth /Screening Interval (feet below ground surface)	Sample Location Identification (ID)[a]	Analyte[b]	Anticipated Number of Soil Samples	Anticipated Number of Groundwater Samples	Anticipated Number of Surface Water Samples	Sample Type	Sampling SOP Reference	Rationale for Sampling Location
AOC 20/21	Groundwater	Various – (11) existing and (2) proposed MWs to be sampled. Two sampling events in spring/fall.	See Table 5-1, Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP	PFAS		26		Discrete	See Worksheet 17.4, 17.6, and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
AOC 30	Groundwater	VAP samples will be collected approximately every 10 feet below the water table until refusal. Up to eight discrete groundwater samples will be collected from each VAP location.	30VP-24-01	PFAS		8		Discrete	See Worksheet 17.4, 17.5, and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
	Groundwater	Various – (1) proposed MW to be sampled. Two sampling events in spring/fall.	30MW-24-01	PFAS		2		Discrete	See Worksheet 17.4 and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
AOC 31	Groundwater	Various – (1) existing and (1) proposed MW to be sampled. Two sampling events in spring/fall.	See Table 5-1, and Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP	PFAS		4		Discrete	See Worksheet 17.4, 17.6, and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
AOC 50	Soil	0-0.5, 0.5-3, 3-7, 7-15[c]	50SB-24-01 to 50SB-24-08	PFAS	32			Discrete	See Worksheet 17.3 and 17.10	See Exhibit 4-1 of the Phase II RI WP
				TOC, Grain Size, pH	8			Discrete	See Worksheet 17.3 and 17.10	See Exhibit 4-1 of the Phase II RI WP
	Groundwater	VAP samples will be collected approximately every 10 feet below the water table until refusal. Up to eight discrete groundwater samples will be collected from the VAP location.	50VP-24-01	PFAS		8		Discrete	See Worksheet 17.4, 17.5, and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
	Groundwater	Various – (33) existing and (2) proposed MWs to be sampled. Two sampling events in spring/fall.	See Table 5-1, Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP	PFAS		70		Discrete	See Worksheet 17.4, 17.6, and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
Off-Base	Groundwater	VAP samples will be collected approximately every 10 feet below the water table until refusal. Up to eight discrete groundwater samples will be collected from the VAP location.	A3VP-24-01 to A3VP-24-06	PFAS		48		Discrete	See Worksheet 17.4, 17.5, and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
	Groundwater	Various – (7) proposed MWs to be sampled. Two sampling events in spring/fall.	A3MW-24-01 to A3MW-24-06; A3MW-24-01BR	PFAS		14		Discrete	See Worksheet 17.4, 17.5, and 17.9	See Exhibit 4-2 and Exhibit 4-3 of the Phase II RI WP
Various	Surface Water	Samples will be collected from immediately below the water surface.	See Exhibit 5-7 of the Phase II RI WP	PFAS			18	Discrete	See Worksheet 17.11	See Exhibit 5-7 of the Phase II RI WP

Sampling Location	Matrix	Sample Depth /Screening Interval (feet below ground surface)	Sample Location Identification (ID)[a]	Analyte[b]	Anticipated Number of Soil Samples	Anticipated Number of Groundwater Samples	Anticipated Number of Surface Water Samples	Sample Type	Sampling SOP Reference	Rationale for Sampling Location
				TOTAL:	**32 (PFAS)** **8 (pH, TOC, grain size)**	**180**	**18**			

Notes:

a. Locations for installation of permanent monitoring wells will be determined after analysis of VAP groundwater data. Two rounds of groundwater sampling will be conducted after installation and development of the wells.

b. TOC, grain size, and pH will be collected at each of the soil borings from the depth interval with the most permeable lithology based on visual observation.

c. If the water table is encountered at a depth shallower than the bottom depth of these intervals, the deepest sample will end at the water table depth.

SOP – standard operating procedure

TBD – to be determined

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

(UFP-QAPP Manual Section 3.1.2.2)
(USEPA 2106-G-05 Section 2.3.2)

Analytical SOP requirements for the analyses applicable to this PFAS QAPP are provided in the following table.

Laboratory (Name, sample receipt address, point of contact, email, and phone numbers):

Pace Analytical Services, LLC (Pace)
106 Vantage Point Drive,
West Columbia, South Carolina 29172
Contact: Kathy Smith
Phone: (803) 683-9550 (Office)
Email: kathy.smith@pacelabs.com

DoD ELAP for Pace (Expiration Date: November 18, 2025) is included in **Attachment C**. A current ELAP certification will be provided prior to start of the field investigations if necessary.

- Level IV data packages to be delivered within 21 calendar days
- Sample Delivery Method: Federal Express

Parameter	Analytical and Preparation Method / SOP Reference	Container(s) (Quantity, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time
Groundwater/Surface Water					
PFAS	Draft Method 1633[1] / Pace SOP ENV-SOP-WCOL-0158	2 x 500 mL HDPE container with polypropylene liner-less cap 1 x 125 mL HDPE container with polypropylene liner-less cap	None, Cool, 0-6°C[2] Freeze, ≤ -20 °C	28 days 90 days	90 days

Parameter	Analytical and Preparation Method / SOP Reference	Container(s) (Quantity, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time
Soil					
PFAS	Draft Method 1633[1] / Pace SOP ENV-SOP-WCOL-0158 v05	1 x 90 mL HDPE container with polypropylene liner-less cap	None, Cool, 0-6°C[2]	90 days	90 days
TOC	TOC in accordance with Walkley-Black / Pace SOP ENV-SOP-MTJL-0196 v05	1 x 4-ounce glass jar/ Teflon lined lid	None, Cool, 0-6°C[2]	NA	28 days
pH	pH in accordance with SW-846 9045 C/D / Pace SOP ENV-SOP-MTJL-0163 v13	1 x 4-ounce glass jar	None, Cool, 0-6°C[2]	NA	15 minutes
Grain Size	Grain size in accordance with ASTM D6913 / ASTM D7928 Modified / Schnabel Engineering SOP	16-ounce glass jar (150-350 grams is used for analysis; larger amounts from 500-5,000 grams with appreciable gravel component), this must be a dedicated bottle for grain size only	None	NA	NA

Notes:

1 Draft Method 1633, and future updates to Final Method 1633.
2 Maintain all samples protected from light at 0-6 ºC from the time of collection until shipped to the laboratory. Samples must be shipped as soon as practical with sufficient ice to maintain the sample temperature below 6 ºC during transport and be received by the laboratory within 48 hours of collection. The laboratory must confirm that the sample temperature is 0-6 ºC upon receipt.

°C = degree Celsius
HDPE = high-density polyethylene
mL = milliliter

QAPP Worksheet #20: Field QC Sample Quantities and Control Frequencies

(UFP-QAPP Section 3.1.1 and 3.1.2)
(USEPA 2106-G-05 Section 2.3.5)

Matrix/ Analysis	Estimated Parent Sample Quantity[a]	Field QC Sample						Laboratory QC Sample				Total[d]
		Field Duplicate		Field Blank[b,c]		Equipment Blank[c]		Matrix Spike		Matrix Spike Duplicate		
		Freq.	No.	Freq.	No.	Freq.	No.	Freq	No.	Freq[e]	No.	
Groundwater												
PFAS	180	1/10	18	1/event	3	1/week	9	--	--	--	--	210
Soil												
PFAS	32	1/10	4	1/event	1	1/week	1	--	--	--	--	38
TOC, Grain Size, pH	8	--	--	--	--	--	--	--	--	--	--	8
Surface Water												
PFAS	18	1/10	2	1/event	1	1/week	1	--	--	--	--	22

Notes:

a. Sample quantities are approximate.
b. Field blanks and equipment blanks will be submitted concurrent with groundwater samples. A total of four events are included: soil sampling, VAP sampling, and two rounds of groundwater sampling (spring/fall).
c. Equipment blanks will be collected at a rate of one per week. Field durations are estimated as follows: soil sampling, 1 week; VAP sampling, 5 weeks; permanent well sampling (two events), 4 weeks.
d. Sample quantities from permanent monitoring wells is estimated from anticipated 10 new overburden wells, 4 bedrock wells, and 45 existing wells with two rounds of sampling (59 wells; 118 samples).

-- = not applicable
No. = number
QC = quality control

QAPP Worksheet #21: Field Standard Operating Procedure References

(UFP-QAPP Manual Section 3.1.2) / (USEPA 2106-G-05 Section 2.3.2)

Field SOPs are included in **Attachment A** of this QAPP.

SOP# or Reference	Title, Revision, and Date	Originating Organization	SOP Option of Equipment Type (if SOP provides different options)	Modified for Field Work? (Yes/No)
RI-SOP-01	Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide (Rev #10, 26 January 2022)	S-A JV	NA	No
RI-SOP-02	Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells (Rev #3, 5 April 2023)	S-A JV	Sampling Supplies	No
RI-SOP-03	Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (Rev #4, 19 September 2017)	USEPA	Sampling Supplies and Equipment	No
RI-SOP-04	Equipment and Reagent Blank Sample Collection for PFAS Analysis (Rev #2, 21 February 2022)	S-A JV	NA	No
RI-SOP-05	Ground Penetrating Radar (Rev #6, 8 February 2023)	S-A JV	NA	No
RI-SOP-06	Manual Water-Level and NAPL Monitoring (Rev #4, 1 March 2023)	S-A JV	NA	No
RI-SOP-07	In-Situ and Ex-Situ Water Quality Parameters – Surface Water and Groundwater (Rev #1, 15 April 2022)	S-A JV	NA	No
RI-SOP-08	Sample Chain of Custody (Rev #3, 28 March 2022)	S-A JV	NA	No
RI-SOP-09	Investigation-Derived Waste Handling and Storage (Rev #1, 15 May 2020)	S-A JV	NA	No
RI-SOP-10	Groundwater and Soil Sampling Equipment Decontamination (Rev #2, 14 June 2022)	S-A JV	NA	No
RI-SOP-11	Monitoring Well Development (Rev #2, 5 April 2023)	S-A JV	NA	No
RI-SOP-12	Monitoring Well Installation (Rev #1, 23 June 2022)	S-A JV	NA	No
RI-SOP-13	Soil Description (Rev #4, 5 June 2023)	S-A JV	NA	No
RI-SOP-14	Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis (Rev #3, 22 June 2022)	S-A JV	NA	No
RI-SOP-15	Vertical Aquifer Profile (VAP) Sampling (Rev #2, 15 June 2022)	S-A JV	NA	No
RI-SOP-16	Solid Slug Testing (Rev #7, 1 March 2023)	S-A JV	NA	No
RI-SOP-17	Soil Drilling and Sample Collection (Rev #3, 5 April 2023)	S-A JV	NA	No

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

(UFP-QAPP Manual Section 3.1.2.4)
(USEPA 2106-G-05 Section 2.3.6)

Field equipment will be maintained, inspected, and tested as presented in the table below.

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure
Global positioning system (GPS)	VAP locations	Calibration within the manufacturer's specified range	Daily when instrument is being used	Redo until calibration results are within range.
Electric water level indicator	Groundwater samples	Calibration within the manufacturer's specified range	Daily when instrument is being used	Redo until calibration results are within range.
Turbidity meter	Groundwater samples	• Calibration within the manufacturer's specified range Acceptance criteria: (± 5% of standard)	Daily when instrument is being used	Redo until calibration results are within range.
Multiparameter water quality meter	Groundwater samples	• Calibration within the manufacturer's specified range • Acceptance criteria: ○ Dissolved Oxygen ▪ ± 0.5 milligrams per liter (mg/L) of sat. value ▪ < 0.5 mg/L for the 0 mg/L solution, but not a negative value ○ Specific Conductance (±5% of standard or ± 10 microSiemens per	• Daily when instrument is being used • End of the day (drift check)	Redo until calibration results are within range.

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure
		centimeter [µS/cm; whichever is greater]) ○ pH (± 0.3 pH unit with pH 7 buffer) ○ ORP (± 10 millivolts [mV]) • Drift check		
Electric submersible pump	Groundwater samples	Working as designed	Daily when instrument is being used	Redo until calibration results are within range and if needed, replace pump.
Bladder pump	Groundwater samples	Working as designed	Daily when instrument is being used	Redo until calibration results are within range and if needed, replace pump.
Peristaltic pump	Groundwater samples	Working as designed	Daily when instrument is being used	Redo until calibration results are within range and if needed, replace pump.
Photoionization detector and/or other air monitoring equipment	Drilling, well installation, groundwater sampling	• Calibration using isobutylene within the manufacturer's specified range using a 10.6 election-volts (eV) lamp. • Acceptance criteria: zero fresh air recheck following calibration [100 to 2,000 parts per million] • Drift check	• Daily when instrument is being used • End of the day (drift check)	Redo until calibration results are within range.

QAPP Worksheet #23: Analytical Standard Operating Procedure References

(UFP-QAPP Manual Section 3.2.1)
(USEPA 2106-G-05 Section 2.3.4)

All laboratory analytical SOPs pertinent to environmental investigations are included for reference in **Attachment C**. Laboratory SOPs included in **Attachment C** will be updated, as needed, for the final lab chosen for PFAS analyses.

SOP #	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Yes/No)
ENV-SOP-WCOL-0158	PFAS by Method 1633 v05; Date: 14 August 2024	Definitive	Aqueous/Solids	Sciex-5500 Triple Quad-LC/MS/MS	Pace	No
ENV-SOP-MTJL-0196	TOC by Walkley-Black v05; Date: 15 August 2024	Definitive	Solids	HACH Spectrophotometer, DR6000	Pace	No
ENV-SOP-MTJL-0163	pH & Corrosivity by EPA 150.1, SM 4500H+B, SW-846 9040B, C, 9045C, D v13; Date: 20 May 2025	Definitive	Solids	Thermo Scientific™ Orion™ Versa Star pH meter	Pace	No
SOP-Graduation with Hydrometer	Particle Size Distribution of Soils and Solids/Grain Size Classification by ASTM D6913 and/or D7928; Date: SOP is not dated	Definitive	Solids	Sieves, Hydrometer, Drying Oven, Analytical Balance	Schnabel Engineering	No

Note:

LC/MS/MS = liquid chromatography with tandem mass spectrometry

QAPP Worksheet #24: Analytical Instrument Calibration

(UFP-QAPP Manual Section 3.2.2)
(USEPA 2106-G-05 Section 2.3.6)

Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
Instrument: LC/MS/MS for PFAS					
Mass Calibration, Mass Calibration Verification	Instrument must have a valid mass calibration prior to any sample analysis and updated on an as-needed basis (e.g., QC failures, ion masses fall outside of the ± 0.5 amu of the true value, major maintenance or the instrument is moved). Mass calibration is verified after each mass calibration, prior to initial calibration (ICAL).	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Mass calibration range must bracket the ion masses of interest. The most recent mass calibration must be used for every acquisition in an analytical run. Mass Calibration Verification must meet manufacturer's acceptance criteria.	If the mass calibration fails, then recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance. Flagging is not appropriate. Problem must be corrected.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158
Ion Transitions (Precursor → Product)	Every field sample, standard, blank, and QC sample.	In addition to the requirements of EPA Draft Method 1633[2], the following must be met: 1) If a qualitative or quantitative standard containing an isomeric mixture (branched and linear isomers) of an analyte is commercially available for an analyte, the quantification ion used must be the	NA Flagging is not appropriate.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158

Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
		quantification ion identified in Table 2 of EPA Draft Method 1633[1] unless interferences render the product ion unusable as the quantification ion. 2) In cases where interferences render the product ion unusable as the quantification ion, project approval is required before using the alternative product ion.			
ICAL	At instrument set-up, after major maintenance, and after initial calibration certification (ICV) or continuing calibration verification (CCV) failure, prior to sample analysis.	One of the following two approaches must be used to evaluate the linearity of the instrument calibration. Weighting (typically 1/x or 1/x2) is allowed for linear and non-linear regressions. Option 1: Calculate the relative standard deviation (RSD) of the RR or RF values of the six initial calibration standards for each native compound and isotopically labeled compound. The RSD must be ≤ 20% to establish instrument linearity. Option 2: Calculate the relative standard error (RSE) of the six initial calibration standards for each native compound and isotopically labeled compound. The RSE for all method analytes must be ≤ 20% to establish instrument linearity. Commercial PFAS standards available as salts are acceptable providing the measured mass is corrected to the neutral acid concentration. Results shall be reported as the neutral acid with appropriate CAS number.	Correct problem, then repeat ICAL. Flagging is not appropriate. No samples shall be analytes until the ICAL has passed.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158

Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
Instrument Blank (IBLK)	Immediately following the highest standard analyzed, daily prior to sample analysis, and after each bracketing CCV.	Concentration of each analyte must be ≤½ the LOQ. Instrument Blank must contain EIS to enable quantitation of contamination.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If sample concentrations exceed the highest allowed standard and the sample(s) following exceed this acceptance criteria (>½ LOQ), they must be reanalyzed.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158
ICV	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Analyte concentrations must be within ± 30% of their true value.	Correct problem and verify second source standard; rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158
Instrument Sensitivity Check (ISC)	Daily. At the beginning of each analytical sequence, prior to sample analysis.	Analyte concentrations must be at LOQ; concentrations must be within ±30% of their true values.	Correct problem, rerun ISC. If problem persists, repeat ICAL.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158
CCV	Daily prior to sample analysis (ISC); after every 10 field samples; at end of analytical sequence.	All analytes must be within ± 30% of their true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternately, recalibrate if necessary; then reanalyze all samples since the last acceptable CCV.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158

Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
LOD/LOQ Verification	Quarterly	LOD meets method qualitative requirements; LOQ is recovered within LCS criteria.	Perform instrument maintenance and repeat failed LOD or LOQ study passing two consecutive tests or perform new DL study.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158
Ion Ratio	All analytes detected in a sample	Must meet all of the requirements (± 50 % initial calibration mid-point).	Recalibrate if acceptance criteria are not met.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158
Bile Salt Standards	Daily prior to analysis of all matrices	The retention time of the bile salt(s) peak must be resolved from PFOS (both linear and branched isomers) by at least one minute.	Not Applicable.	Analyst, Supervisor, QA Manager	ENV-SOP-WCOL-0158
Instrument: Total Organic Carbon Analyzer					
Initial Calibration (ICAL) Multipoint calibration	As needed to meet method criteria	r2 =/> 0.990	Perform instrument maintenance; recalibrate if necessary.	Analyst, Supervisor	ENV-SOP-MTJL-0196
CCV/ICV	At the beginning of each batch and every 10 samples in the analytical sequence	90-110%	Perform instrument maintenance; recalibrate if necessary; reanalyze all samples analyzed from the last passing CCV.	Analyst, Supervisor	ENV-SOP-MTJL-0196
Instrument: pH Meter					
ICAL	Prior to sample analysis	Slope between pH buffers 4 to 7 and 7 to 10 must not differ greater than 3%. Final pH slope must be within 95-102%.	Perform instrument maintenance; recalibrate if necessary.	Analyst, Supervisor	ENV-SOP-MTJL-0163
CCV/ICV	At the beginning of each batch and every 10 samples in the analytical sequence	pH 7 buffer within ±0.05 pH units of true value (98.6-101%)	Perform instrument maintenance; recalibrate if necessary; reanalyze all samples analyzed from the last passing CCV.	Analyst, Supervisor	ENV-SOP-MTJL-0163

Notes:

1 SOP reference numbers correspond to analytical SOPs in QAPP **Worksheet #23**.
2 Draft Method 1633, and future updates to Final Method 1633.

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

(UFP-QAPP Manual Section 3.2.3)
(USEPA 2106-G-05 Section 2.3.6)

The laboratory analytical instrumentation and equipment will be maintained, tested, and inspected following the procedures and frequency specified by the DoD Environmental Laboratory Accreditation Program-evaluated laboratory Quality Manual, analytical methods used, and in accordance with Section 5.5, Module 2, "Calibration Requirements," of the *DoD QSM 5.4* (DoD 2021a).

Instrument and equipment maintenance logs must be kept documenting analytical instrumentation and equipment maintenance, testing, and inspection activities. Instrument maintenance procedures documented in laboratory QA Manual and SOPs will be followed.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
LC/MS/MS	Clean ESI chamber	NA	NA	Weekly or as needed	NA	NA	Analyst	ENV-SOP-WCOL-0158
LC/MS/MS	Replace delay column	NA	Peak shape and resolution; LC pressure profiles	Biannually or as needed	NA	NA	Analyst	ENV-SOP-WCOL-0158
LC/MS/MS	Replace analytical column	NA	Peak shape and resolution; ICAL or senstivity problems	Biannually or as needed	NA	NA	Analyst	ENV-SOP-WCOL-0158
LC/MS/MS	Replace guard cartridge	NA	Visible blockage and/or dirt on frit	Weekly or as needed	NA	NA	Analyst	ENV-SOP-WCOL-0158
HACH Spectrophotometer	Refer to manufacturer's instruction	QC samples performed with each batch	QC samples performed with each batch	As needed to meet method criteria	Refer to SOP	Perform necessary maintenance; recalibrate instrument	Analyst, Supervisor	ENV-SOP-MTJL-0196

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Grain Size Sieves	Brush clean with soap and water after use	NA	Visual Inspection	Inspect before and after each use	NA	Replace if damaged	Analyst, QA Manager	Schnabel Engineering SOP
Hydrometer for Grain Size Analysis	Visual inspection	Inspection for cracks or breaks	Inspection for cracks or breaks	Each day of use	No cracks or breaks	Replace hydrometer	Analyst, QA Manager	Schnabel Engineering SOP
Analytical Balance	Assure the balance is in a vibration-free area, is level, and the interior housing is clean	Verification with ASTM certified weights	Visual inspection and weight verification	Each day of use	The reading must be ±0.1% or ±0.5 mg, whichever is greater	1) verify cleanliness of weights, 2) remove balance from service and place a call to service firm, 3) management must evaluate data generated since last acceptable reading to determine any potential impacts to data quality	Analyst, QA Manager	Schnabel Engineering SOP

Notes:

1 SOP reference numbers correspond to analytical SOPs in QAPP **Worksheet #23**.

LC/MS/MS = liquid chromatography with tandem mass spectrometry
SOP = standard operating procedure

QAPP Worksheets #26 & 27: Sample Handling, Custody, and Disposal

(UFP-QAPP Manual Section 3.3)
(USEPA 2106-G-05 Section 2.3.3)

Sampling organization: S-A JV
Laboratory: Pace
Method of sample delivery (shipper/carrier): Federal Express
Number of days from reporting until sample disposal: At least 60 days

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	S-A JV	See "Sample Identification System" below.
Chain-of-custody form completion	S-A JV	See RI-SOP-09. Also see "Sample Handling and Custody" below.
Packaging	S-A JV	See "Field Procedures" below.
Shipping coordination	S-A JV	See "Transfer of Custody and Shipment" below.
Sample receipt, inspection, and log-in	Pace	See "Laboratory Custody Procedures" below.
Sample custody and storage	Pace	See "Laboratory Custody Procedures" and "Final Evidence Files" below.
Sample disposal	Pace	See "Sample Holding Times" below and QAPP **Worksheets #19 & 30**.

Sample Identification (ID) System

A sample identification system will be established in accordance with naming conventions used previously by the USACE and previous investigations. A sample numbering system will be used to identify each sample; the sample numbers will be sequentially assigned to ensure that there are no duplicates of sample numbers. This system will provide a tracking procedure to allow retrieval of information about a particular sample and will ensure that each sample is uniquely numbered. The sample identification will consist of the components described below:

VAP Groundwater and Soil

Sample ID for VAP Groundwater and Soil - The sample ID for VAP groundwater and soil samples consists of the following elements:

Property	- Year	- Location Sequence	- Location Type	- Depth or Depth Interval

Property -Alpha and/or numeric characters used to represent the specific Former Fort Devens property:

- AOC 20 = 20
- AOC 21 = 21
- AOC 30 = 30
- AOC 31 = 31
- AOC 50 = 50

Year: A two-digit number corresponding to the year of installation/sample collection (e.g., "24" = installed/collected in 2024).

Location Sequence: A sequential number corresponding with proposed location (e.g., 01 through 100).

Location Type- Two or three uppercase alpha characters designating the type of location:

- SO = soil
- VAP = vertical aquifer profile

Depth or Depth Interval: The depth or depth interval from which the sample is collected.

EXAMPLE: A soil sample collected at AOC 21 at proposed collocated location 21SB-24-01 from 7 feet bgs to 15 feet bgs would be 21SB-24-01-7-15. A VAP groundwater sample from the same location, collected from 8 feet bgs to 12 feet bgs, would be 21VP-24-01-8-12

Groundwater from a Permanent Monitoring Well

Sample ID for Groundwater from a Permanent Monitoring Well – The sample ID groundwater samples collected from newly installed permanent monitoring wells consists of the following elements:

Property	- Year Monitoring Well Installed	- Monitoring Well Sequential Number	- Location Type if Bedrock Well	- Date

Property - Alpha and/or numeric characters used to represent the specific Former Fort Devens property):

- AOC 20 = 20
- AOC 30 = 30
- AOC 31 = 31
- AOC 50 = 50

Year: A two-digit number corresponding to the year of sample collection (e.g., "24" = collected in 2024).

Monitoring Well Sequence: A sequential number appended to "MW" (e.g., MW01 through MW100).

Location Type: Two uppercase alpha characters "BR" designating if well is bedrock. Wells are assumed to be overburden wells unless indicated with "BR":

Date: Six-digits corresponding to the date of sample collection (MMDDYY).

EXAMPLE: A sample collected from bedrock monitoring well location 20MW-24-01BR on June 1, 2024 would have the following sample ID: 20MW-24-01BR-060124. A sample collected from overburden monitoring well location 30MW-24-01 on June 1, 2024 would have the following sample ID: 30MW-24-01-060124.

QC Samples

Sample ID for QC samples - The sample IDs for QC samples consists of the following elements:

Property	**- QC Code**	**- QC Sample Sequence**	**-Media Type (for field duplicates)**	**- Date**

Property - Alpha and/or numeric characters used to represent the specific Former Fort Devens property:

- AOC 20 = 20
- AOC 21 = 21
- AOC 30 = 30
- AOC 31 = 31
- AOC 50 = 50

QC Codes:

- DUP = field duplicate
- EB = equipment blank
- FB = field blank

QC Sample Sequence: A sequential number corresponding with the QC sample type for a property (e.g., 01 through 100).

Media Type (for Field Duplicates):

- SO = soil
- VAP = groundwater from VAP
- GW = groundwater from permanent well
- SW – surface water

Date: A six-digit corresponding to the date of sample collection (MMDDYY).

EXAMPLE: The second equipment blank associated with sample collection at AOC 50 collected on June 1, 2024 would be: 50-EB-02-060124.

Sample Handling and Custody

Sample custody procedures ensure the timely, correct, and complete analysis of each sample for all parameters requested. A sample is considered to be in someone's custody if it:

- Is in his/her possession
- Is in his/her view, after being in his/her possession
- Is in his/her possession and has been placed in a secure location
- Is in a designated secure area

Sample custody documentation provides a written record of sample collection and analysis. The sample custody procedures provide for specific identification of samples associated with an exact location, the recording of pertinent information associated with the sample (including time of sample collection and any preservation techniques), and a chain-of-custody record that serves as physical evidence of sample custody.

The chain-of-custody documentation system provides the means to individually identify, track, and monitor each sample from the time of collection through final data reporting. Chain-of-custody procedures document pertinent sampling data and all transfers of custody until the samples reach the analytical laboratory. All chain-of-custody forms must be filled out and signed in ink. The following information is typically recorded on manual chain-of-custody forms:

- Project name and/or project number
- Signature of S-A JV field sampler collecting the samples
- Date and time of sample collection
- Discrete or incremental sampling sample designation
- Sample matrix
- Analyses required
- Preservation technique
- Signatures and dates for transfer of custody
- Air express/shipper's bill of lading identification number.

The chain-of-custody form serves as an official communication to the laboratory detailing the specific analyses required for each sample. The chain-of-custody record will accompany the samples from the time of sampling through all transfers of custody. It will be kept on file at the laboratory, where samples are analyzed and archived. Three copies of the chain-of-custody form are created: one copy is retained by the S-A JV field sampler on site, one copy is forwarded electronically to the S-A JV PM, and one copy is sent to the laboratory with the samples. The on-site S-A JV staff completes a chain-of-custody record to accompany each shipment from the field to the laboratory. The completed chain-of-custody is placed in a zip-lock bag and taped to the inside cover of the sample shipping container. If there is more than one container in a shipment, copies of the chain-of-custody form will be placed in each container. The container is then sealed with custody seals, and custody is transferred to the laboratory. Commercial carriers are not required to sign off on the chain-of-custody form as long as the forms are sealed inside the sample cooler and the custody seals remain intact.

Samples will be packaged for shipment as outlined below:

- Securely affix the sample label to the outside of container with clear packing tape.
- Check the cap on the sample container to confirm that it is properly sealed.
- Wrap the sample container cap with clear packing tape or place the sample container in a plastic bag to prevent the label from becoming loose or separated from the sample container.
- Complete the chain-of-custody form with the required sampling information and confirm that the recorded information matches the sample labels. Note: If the designated sampler relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the chain-of-custody before this transfer. The appropriate personnel will sign and date the chain-of-custody form to document the sample custody transfer.
- Using duct tape, secure the outside drain plug at the bottom of the cooler.
- Wrap sample containers in bubble wrap or other cushioning material.
- Place 1 to 2 inches of cushioning material at the bottom of the cooler.
- Place the sealed sample containers into the cooler.
- Place ice in plastic bags and seal. Place loosely in the cooler beneath, around, and/or on top of the sample containers.
- Fill the remaining space in the cooler with cushioning material.
- Place chain-of-custody forms in a plastic bag and seal. Tape the plastic bag with the forms to the inside of the cooler lid.
- Close the lid of the cooler, lock if applicable, and secure with duct tape.
- Wrap packing or strapping tape around both ends of the cooler at least twice.
- Mark the cooler on the outside with the shipping address and return address, affix “Fragile” labels and draw (or affix) arrows indicating “This Side Up.” Cover the labels with clear plastic tape to prevent them from becoming loose or separated from the cooler.
- Place a signed custody seal (or two) over the sample cooler lid so tampering would be evident if the cooler is opened prematurely.

Field Procedures

The S-A JV field sampler is personally responsible for the care and custody of samples until they are properly dispatched. As few people as possible should handle the samples.

The S-A JV field sampler is responsible for entering the proper information in the field logbook including all pertinent information such as sample identification number, date and time of sample collection, type of analysis, description of sample location, and relevant observations. The information entered into the field logbook will be used to generate a chain of custody. Field logbooks will provide the means of recording the data collecting activities that are performed. As such, entries will be described in as much detail as possible so that people going to the site can reconstruct a situation without reliance on memory. Entries will be made in ink with no erasures. If an incorrect entry is made, the information will be crossed out with one strike mark and initialed by the person making the entry.

All sample containers will be labeled with the project identification, sample number, matrix, analysis required, preservation used, and the sampler's initials. Sample labels will be completed using waterproof ink. The completed sample labels will be affixed to each sample bottle and covered with clear tape.

The S-A JV field sampler will review all sampling activities to determine whether proper custody procedures were followed during the field work and if additional samples are required.

Transfer of Custody and Shipment

The custody of samples must be maintained from the time of sampling through shipment and relinquishment to the laboratory. Instructions for transferring custody are given below.

A chain-of-custody form must accompany all samples. When transferring custody of samples, the individuals relinquishing and receiving will sign, date, and note the time on the chain-of-custody form. This form documents sample custody transfer from the S-A JV field sampler, through the shipper, to the analytical laboratory. Because a common carrier will usually not accept responsibility for handling chain-of-custody forms, the name of the carrier is entered under "Received by," the bill-of-lading number is recorded in the comments section, and the chain-of-custody form is placed in a zip-lock plastic bag and taped to the inside lid of the shipping cooler. Copies of the chain-of-custody form will be placed in each cooler included in the shipment. Copies of the chain-of-custody for and bill of lading will be retained by the S-A JV field sampler and placed into the project files, as well as sent to the S-A JV PM electronically.

Samples will be packaged for shipment and dispatched to the appropriate laboratory via overnight delivery service. Samples will be shipped within 24 hours of sampling if possible, or soon thereafter. Shipping containers will be sealed for shipment to the laboratory as described above. Custody seals will be applied to each cooler to document that the container was properly sealed, as well as to ensure that the container was not tampered with during shipment. The custody seals will be placed on the coolers in such a manner that the custody seal would be broken if the cooler were opened.

Laboratory Custody Procedures

A designated sample custodian will accept custody of the samples and verify that all information on the sample labels matches that on the chain-of-custody form. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document the condition of the samples upon receipt by the laboratory.

Once the samples have been accepted by the laboratory, checked, and logged in, they must be maintained in accordance with laboratory custody and security requirements.

To assure traceability of samples while in the possession of the laboratory, a unique laboratory identification number will be assigned to each sample.

The laboratory must document the following stages of analysis:

- Sample extraction/preparation
- Sample analysis
- Data reduction
- Data reporting.

Laboratory personnel are responsible for the custody of the samples until they are returned to the sample custodian.

Sample Holding Times

Information on sample holding times and required preservation for PFAS samples by media is provided in QAPP **Worksheets #19 & 30**.

Final Evidence Files

As the final phase of sample custody, the chain-of-custody records are archived in the project file. Laboratory custody forms, the sample preparation and analysis logbook, and data packages will become part of the laboratory final evidence file. Other relevant documentation, including records, reports, correspondence, logs, photographs, and data review reports, will be archived by S-A JV personnel.

QAPP Worksheet #28: Analytical Quality Control and Corrective Action

(UFP-QAPP Manual Section 3.4)
(USEPA 2106-G-05 Section 2.3.5)

This worksheet includes information for each sampling technique, analytical method/SOP, matrix, and analytical group.

QAPP Worksheet #28a: Analytical Quality Control and Corrective Action (PFAS in Soil/Aqueous)

Matrix: Soil/Aqueous
Concentration Level: Low
Analytical Method: PFAS per USEPA Method 1633 compliant with DoD QSM 5.4 (or later versions) Table B-24
Laboratory SOP: ENV-SOP-WCOL-0158

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Flagging Criteria	Measurement Performance Criteria/Comments
Instrument Blank (IB)	At the beginning of the analytical sequence and after the analysis of high concentration samples and standards (e.g., customer samples, highest calibration standard, calibration verification standard).	No analytes detected > ½ LOQ.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If field sample analyte concentrations exceed the highest calibration standard and the same analytes in the following field sample or in consecutive following field samples also exceed the IB acceptance criteria (i.e., > 1/2 LOQ), the affected samples shall be reanalyzed using a fresh aliquot of the sample extract. If the extract cannot be reanalyzed and re-extraction is not possible, apply qualifier to affected results and explain in the case narrative.	Analyst, Supervisor, and/or QC Manager	Flagging is only appropriate in cases where the extract cannot be reanalyzed, and re-extraction is not possible.	NA

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Flagging Criteria	Measurement Performance Criteria/Comments
Extracted Internal Standard (EIS) Compounds	Every field sample, QC sample, and standard.	Isotopically labeled analogs of analytes must be used when they are commercially available. Where Method 1633 does not provide EIS recovery acceptance criteria for the sample matrix under evaluation, a laboratory shall use laboratory-developed recovery acceptance criteria no wider than any acceptance criteria provided by the customer. Preliminary laboratory-developed acceptance criteria of 20-150% shall be used until laboratory acceptance criteria are developed in accordance with Method 1633. Where Method 1633 does not provide EIS recovery acceptance criteria for the sample matrix under evaluation, the lower limit of the laboratory-developed acceptance criteria cannot be < 20%.	Follow the requirements listed in Method 1633, Section 15.3.2 for all samples matrices. If EIS recoveries still fall outside of the acceptance range, the client must be contacted for additional measures to be taken.	Analyst, Supervisor, and/or QC Manager	Apply qualifiers to affected analyte results and explain in the case narrative.	NA

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Flagging Criteria	Measurement Performance Criteria/Comments
Method Blank (MB)	One per preparatory batch.	No analytes detected > ½ LOQ.	Correct the problem. If required, reprepare and analyze MB and all QC samples and affected field samples processed with the contaminated blank if sufficient sample material is available.	Analyst, Supervisor, and/or QC Manager	If the samples cannot be reprepared and analyzed, apply qualifier to affected analyte results of all samples in the associated preparatory batch and explain in the case narrative.	NA
Laboratory Control Sample (LCS) and Low-Level Laboratory Control Standard (LLLCS)[2]	One set per preparatory batch. Shall contain all EIS, NIS, and all analytes to be reported.	Where Method 1633 does not provide LCS and LLLCS recovery acceptance criteria for the sample matrix under evaluation, a laboratory shall use laboratory-developed recovery acceptance criteria no wider than any acceptance criteria provided by the customer. Preliminary acceptance criteria of 40-150% shall be used until acceptance criteria are developed by the laboratory in accordance with Method 1633. Where Method 1633 does not provide LCS and LLLCS recovery acceptance criteria for the sample matrix under evaluation, the laboratory-developed acceptance criteria shall not be < 40%.	Correct problem. If required, reprepare and analyze the LCS and/or LLLCS and all affected QC samples and field samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If the samples cannot be reprepared and analyzed, apply qualifier to affected analyte results of all samples in the associated preparatory batch and explain in the case narrative.	Analyst, Supervisor, and/or QC Manager	If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	EPA Draft Method 1633[1] equivalent to the LCS is the Ongoing Precision and Recovery Standard (OPR). EPA Draft Method 1633[1] equivalent to the LLLCS is Low-Level Ongoing Precision and Recovery Standard (LLOPR).

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Flagging Criteria	Measurement Performance Criteria/Comments
Non-Extracted Internal Standards (NIS)	Every sample, standard, and QC sample	50-200% of average response from initial calibration	Check to be sure there are no errors in calculations, integrations, or internal standards solutions. Correct if errors are found. If instrument performance problem is identified, correct the problem and reanalyze the sample. If no problem is found, prepare and analyze a second aliquot of extract. If reanalysis is not within limits, reanalyze the sample with a dilution. If upon the analysis of the dilution the responses are within limits, then the sample or select analytes may need to be reported from the dilution or qualified.	Analyst, Supervisor, and/or QC Manager	Apply qualifiers to affected analyte results and explain in the case narrative.	NA

Notes:
1 LCS/LCSD used when MS/MSD are not client-supplied.
2 Draft Method 1633, and future updates to Final Method 1633.

QAPP Worksheet #28b: Analytical Quality Control and Corrective Action (PFAS in Soil/Aqueous)

Recovery Limits

Matrix: Soil/Aqueous
Analytical Method: PFAS per USEPA Method 1633 compliant with DoD QSM 5.4 (or later versions) Table B-24

Analyte	Acronym	CAS Number	Soil Accuracy Limits (LCS) (%R)	Aqueous Accuracy Limits (LCS)[a] (%R)
1H,1H,2H,2H-Perfluorohexanesulfonic acid	4:2FTS	757124-72-4	60-150	70-145
1H,1H,2H,2H-Perfluorooctanesulfonic acid	6:2 FTS	27619-97-2	55-200	65-155
1H,1H,2H,2H-Perfluorodecanesulfonic acid	8:2 FTS	39108-34-4	70-150	60-150
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	70-160	65-145
N-Ethyl-perfluorooctane sulfonamidoacetic acid	NEtFOSAA	2991-50-6	65-165	70-145
N-Methyl-perfluorooctane sulfonamidoacetic acid	NMeFOSAA	2355-31-9	65-155	50-140
N-Methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	70-155	60-150
N-Ethyl perfluorooctanesulfonamide	NEtFOSA	4151-50-2	70-140	65-145
N-Methyl perfluorooctanesulfonamidoethanol	NMeFOSE	24448-09-7	70-140	70-145
N-Ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	1691-99-2	70-135	70-135
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	70-145	70-140
Perfluorobutanoic acid	PFBA	375-22-4	70-140	70-140
Perfluorobutanesulfonic acid	PFBS	375-73-5	65-145	60-145
Perfluorodecanoic acid	PFDA	335-76-2	70-155	70-140
Perfluorodecanesulfonic acid	PFDS	335-77-3	40-155	60-145
Perfluorododecanoic acid	PFDoA	307-55-1	70-150	70-140
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	25-160	50-145
Perfluoroheptanoic acid	PFHpA	375-85-9	65-145	70-150
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	65-155	70-150
Perfluorohexanoic acid	PFHxA	307-24-4	65-140	70-145
Perfluorohexanesulfonic acid	PFHxS	355-46-4	60-150	65-145
Perfluorononanoic acid	PFNA	375-95-1	70-155	70-150
Perfluorononanesulfonic acid	PFNS	68259-12-1	55-140	65-145
Perfluorooctanoic acid	PFOA	335-67-1	70-150	70-150
Perfluorooctanesulfonic acid	PFOS	1763-23-1	65-160	55-150

Analyte	Acronym	CAS Number	Soil Accuracy Limits (LCS) (%R)	Aqueous Accuracy Limits (LCS)[a] (%R)
Perfluorooctanesulfonamide	PFOSA	754-91-6	70-140	70-145
Perfluoropentanoic acid	PFPeA	2706-90-3	60-150	65-135
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	55-160	65-140
Perfluorotetradecanoic acid	PFTeDA	376-06-7	65-150	60-140
Perfluorotridecanoic acid	PFTrDA	72629-94-8	65-150	65-140
Perfluoroundecanoic acid	PFUnA	2058-94-8	70-155	70-145
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	30-140	55-140
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	60-150	60-150
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	60-155	50-150
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	70-150	70-155
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	45-160	55-160
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	70-140	70-140
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	45-130	65-130
2H,2H,3H,3H-Perfluorooctanoic acid	5:3FTCA	914637-49-3	60-130	70-135
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	60-150	50-145

Note:

a. Consistent with USEPA Method 1633 compliant with DoD QSM 5.4 Table B-24 for aqueous matrix.

QAPP Worksheet #28c: Analytical Quality Control and Corrective Action (TOC in Soil)

(UFP-QAPP Manual Section 3.4 And Tables 4, 5, and 6)
(EPA 2106-F-05 Section 2.3.5)

Matrix: Soil
Concentration Level: Low
Analytical Method: TOC by Walkley-Black
Laboratory SOP: ENV-SOP-WCOL-0158

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Flagging Criteria	Measurement Performance Criteria/Comments
Initial Calibration (ICAL)	ICAL prior to sample analysis	r2 >/= 0.99	Correct problem, then repeat ICAL	Analyst, Supervisor	Per Method Criteria	Per Method Criteria
Continuing Calibration Verification (CCV)	Before sample analysis, after every 10 samples and at the end of the analytical sequence	All reported analytes within +/- 10% of true value	Immediately analyze two additional CCVs. If both pass, samples may be reported without reanalysis. If either fails or two consecutive CCVs cannot be performed, reanalyze all sample since last acceptable CCV. Perform ICAL if necessary.	Analyst, Supervisor	Per Method Criteria	Per Method Criteria
Laboratory Control Sample (LCS)	One per preparatory batch	%R = 32-143	Correct problem, then reprep and reanalyze the LCS and all samples in the associated analytical batch for failed analytes, if sufficient sample volume remains.	Analyst, Supervisor	Per Method Criteria	Per Method Criteria
Method Blank	One per prep batch	No analytes detected 1/2 LOQ or > 1/10 the amount measured in any sample. Common contaminant must be less than LOQ	Correct problem. If required, reprep and reanalyze MD and all QC samples and field samples processed with the contaminated blank.	Analyst, Supervisor	Per Method Criteria	Per Method Criteria

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Flagging Criteria	Measurement Performance Criteria/Comments
Duplicate	One per every 10 samples	RPD + < 20%	Correct problem, then reprep and reanalyze the LCS and all samples in the associated analytical batch for failed analytes, if sufficient sample volume remains.	Analyst, Supervisor	Per Method Criteria	Per Method Criteria

QAPP Worksheet #29: Project Documents and Records

(UFP-QAPP Manual Section 3.5.1)
(USEPA 2106-G-05 Section 2.2.8)

This worksheet provides the minimum specifications for all data management tasks and deliverables, as well as procedures for controlling project documents, records, and databases. Its purpose is to ensure data completeness, data integrity, and ease of retrieval.

29.1 Data Management Specifications

29.1.1 Data Recording/Data Entry

Analytical results will be provided by the analytical laboratory in both digital and pdf formats. The electronic data deliverable will be directly uploaded into the project database and will be used to directly produce tables, reducing the redundant manual entry of analytical results during report preparation and precludes transcription errors that may occur otherwise. Qualified technical personnel will review these electronic data against copies of final laboratory reports before releasing the data for validation. Any data manually transcribed from sampling logs or field books will be reviewed for accuracy by qualified staff other than staff who transcribed the data. The QA activities will be documented on a QA checklist.

29.1.2 Data Transformations and Data Reduction

Data transformation and reduction (data transformation and reduction [T&R]) will be accomplished using EQuIS, ESRI ArcGIS, and Microsoft Excel. Data T&R will be reviewed for accuracy by qualified staff other than staff who performed the data T&R. The QA activities will be documented on a QA checklist.

29.2 Control of Documents, Records, and Databases.

All project documents and records will be generated, verified, and retained as shown in the worksheet below.

Record	Generation	Frequency	Verification	Storage Location/Archival
Sample Collection and Field Records				
• Field logbook or data collection sheets • Chain-of-custody forms • Air bills • Contractor DQCRs • Deviations • CA reports • Correspondence • Field audit checklists	Field Sampler *S-A JV TBD*	Daily or as needed	Andy Vitolins *S-A JV PM*	Project file
• Data verification checklists	Jennifer Singer *S-A JV Project Chemist*	As needed	Andy Vitolins *S-A JV PM*	Project file

Record	Generation	Frequency	Verification	Storage Location/Archival
Sample Collection and Field Records				
• Non-chemistry data pertaining to sample locations, hydrogeological information, physical parameters, and monitoring well information.	Jennifer Singer *S-A JV Project Chemist or designee*	As needed	Jennifer Singer *S-A JV Project Chemist or designee*	Project file
• Data validation report • Data usability assessment report	Evin McKinney *Synectics Data Validator*	As needed	Jennifer Singer *S-A JV Project Chemist*	Project file
Laboratory Records				
• Chain-of-custody records • Sample receipt records • Electronic data deliverables in Electronic Data Deliverable (EDD) Stage 2B deliverable format • Electronic data deliverables in EQuIS 7 (or most up-to-date version at the time of sample collection) 4-file format • Analytical results and supporting data • Sample data packages	Kathy Smith *Pace PM*	As needed	Erin Boyd *Pace QA Manager*	Project file
• Records of sample preparation • Records of sample analysis • Instrument calibration records • Raw data files	Laboratory Analysts *Pace*	As needed	Erin Boyd *Pace QA Manager*	Project file

QAPP Worksheets #31, 32, & 33: Assessments and Corrective Actions

(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(USEPA 2106-G-05 Section 2.4 and 2.5.5)

This worksheet is used to document responsibilities and procedures for conducting project assessments, documenting assessments, responding to assessment findings, and implementing corrective actions (CAs). Appropriately scheduled assessments allow management to implement CAs in a timely manner; thereby correcting non-conformances and minimizing their impact on DQOs/Project Quality Objectives.

ASSESSMENT

Different types of assessments are used for evaluating project activities including, but not limited to, laboratory assessments, field audits, and field documentation review. The tables below identify the type, frequency, and responsible parties of planned assessments that will be performed for the project.

CORRECTIVE ACTION

Once a process displays a characteristic out of specification with those required for the project or quality objectives, CA must be conducted to identify the cause of the deficiency or non-conformance. When the cause of the problem is identified, appropriate CA can be instituted and then monitored for effectiveness. Assessment response and CAs are specified in the tables below.

ROOT CAUSE ANALYSIS

Determining the root cause of a non-conformance is an integral part of the QC process. The depth and extent of the root cause analysis (RCA) depends on the situation; the root cause may be as simple (minor) as an overlooked step or procedure, or it may be complicated. RCA is the responsibility of the functional manager or a designee. Input can be obtained as necessary from field personnel and technical advisors to identify the factors that led to the problem. The root cause is almost always “upstream” from where the problem is detected.

A two-step strategy will be employed for determining the root cause of a deficiency or non-conformance for this project. First, the problem will be traced back to the source. Second, the cause will be evaluated using basic questions such as who, what, when, where, why, and how. This process will be repeated until the cause is identified.

IMPLEMENTATION OF CORRECTION ACTION

Following the RCA, the project personnel will undertake the most effective remedy to correct the problem. Potential remedies to be considered may include the following:

- Supplemental personnel training
- Changes of equipment or modification of equipment currently in use
- Acquisition of supplemental equipment
- Implementation of new procedures or modification of existing procedures
- Changes in QC procedures.

Successful implementation of CA will be documented on the Deficiency Notice or Non-conformance Report. Through follow-up phase surveillance, the S-A JV field sampler will verify that the CA implemented has rectified the non-conforming condition and is sufficient to prevent recurrence. The results of the CA will be presented in the RI Report.

Field procedure/documentation corrective actions and follow-up will be verbally discussed, then confirmed with an email between the S-A JV field sampler and S-A JV project manager.

Laboratory-related issues identified by the validator and associated corrective action and follow-up will be verbally discussed between the lab, validator, and S-A JV project chemist and project manager and confirmed with an email.

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
Review of QAPP, SOPs, and daily QC report with field staff	S-A JV TBD	Before sampling startup	Before sampling	Contained within daily QC report.	Before sampling
Daily logbook and field forms	S-A JV TBD	Daily	During field activities	Contained within written report	As part of Draft Report
Laboratory assessment for appropriate certifications and capacity; QAPP review with laboratory staff	Jennifer Singer *S-A JV Project Chemist*	Before sampling startup	Before sampling	Receipt of copies of certifications. Email traffic concerning laboratory capacity before sampling startup. QAPP sign-off sheet received from the laboratory.	Before sampling
Daily tailgate safety meeting	S-A JV TBD	Daily	During field activities	Verbal debriefing and daily sign-off log. If a safety violation occurs, an incident report is completed.	Last deliverable received no later than one week after field activities
Field sampling and chain-of-custody form review against QAPP requirements	S-A JV TBD	Daily	During field activities	Communication in the form of an email	Last email received no later than 24 hours after last sampling event
Laboratory report deliverables and analytical results review against QAPP requirements	Jennifer Singer *S-A JV Project Chemist*	Per sample delivery group (i.e., analytical samples received in each shipment)	Immediately following field sampling	Communication if the form of an email	Three weeks after receipt of data
Data verification	Jennifer Singer *S-A JV Project Chemist* and/or Evin McKinney Synectics *Data Validator*	Per sample delivery group (i.e., analytical samples received in each shipment)	Following analytical report	Communication in the form of an email requesting additional laboratory forms, backup data that may be missing, and/or clarification of the analytical report	Three weeks after receipt of data
Data validation	Evin McKinney *Synectics Data Validator*	Per sample delivery group (i.e., analytical samples received in each shipment)	Following analytical report	Communication in the form of an email requesting additional laboratory forms, backup data that may be missing, and/or clarification of the analytical report	Three weeks after receipt of data

Assessment Type	Responsibility for Responding to Assessment Findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsibility for Monitoring Corrective Action Implementation
Review of QAPP, SOPs, and daily QC report with field staff	Andy Vitolins *S-A JV PM*	Daily QC report will be amended with CA	Within 24 hours	*S-A JV TBD*	Andy Vitolins *S-A JV PM*
Daily logbook and field forms	S-A JV TBD	Daily QC report will be amended with CA	Within 24 hours	*S-A JV TBD*	Andy Vitolins *S-A JV PM*
Laboratory assessment for appropriate certifications and capacity; QAPP review with laboratory staff	Erin Boyd *Pace QA Manager*	Response to email	Within 48 hours after notification	Erin Boyd *Pace QA Manager*	Jennifer Singer *S-A JV Project Chemist*
Daily tailgate safety meeting	Andy Vitolins *S-A JV PM*	Included as part of the Incident Report	Within 48 hours after notification	*S-A JV TBD*	Andy Vitolins *S-A JV PM*
Field sampling and chain-of-custody form review against QAPP requirements	Andy Vitolins *S-A JV PM*	Response to email	Within 24 hours after sampling	*S-A JV TBD*	Andy Vitolins *S-A JV PM*
Laboratory report deliverables and analytical results review against QAPP requirements	Erin Boyd *Pace QA Manager*	If required, laboratory reports will be amended and corrections noted in the case narrative	Within 72 hours of notification	Erin Boyd *Pace QA Manager*	Jennifer Singer *S-A JV Project Chemist*
Data verification	Erin Boyd *Pace QA Manager*	If required, laboratory reports will be amended and corrections noted in the case narrative	Up to 7 days	Erin Boyd *Pace QA Manager*	Jennifer Singer *S-A JV Project Chemist*
Data validation	Kathy Smith *Pace PM*	If required, laboratory reports will be amended, corrections noted in the case narrative, and documented in the validation report	Up to 7 days	Kathy Smith *Pace PM*	Jennifer Singer *S-A JV Project Chemist*

QAPP Worksheet #34: Data Verification and Validation Inputs

(UFP-QAPP Manual Section 5.2.1)
(USEPA 2106-G-05 Section 2.5.1)

This worksheet lists the inputs that will be used during data verification and validation. Inputs include all requirements documents (e.g., contracts, SOPs, planning documents), field records (both hard copy and electronic), and interim and final reports. Data verification is a completeness check that all specified activities involved in data collection and processing have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements including those in the contract, methods, SOPs, and the QAPP. Required documents, as well as records subject to verification and validation, are listed below. See **Attachment A** for the field SOPs.

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	**X**	
2	Contract	**X**	
3	Field SOPs	**X**	
4	Laboratory SOPs	**X**	
Field Records			
5	Field logbooks	**X**	**X**
6	Equipment calibration records	**X**	**X**
7	Chain-of-custody forms	**X**	**X**
8	Sampling diagrams/surveys	**X**	**X**
9	Relevant correspondence	**X**	**X**
10	Change orders/deviations	**X**	**X**
11	Field audit reports	**X**	**X**
12	Field CA reports	**X**	**X**
Analytical Data Package			
13	Cover sheet (laboratory identifying information)	**X**	**X**
14	Case narrative	**X**	**X**
15	Internal laboratory chain-of-custody	**X**	**X**
16	Sample receipt records	**X**	**X**
17	Sample chronology (i.e., dates and times of receipt, preparation, and analysis)	**X**	**X**
18	Communication records	**X**	**X**
19	Project-specific proficiency testing sample results		
20	LOD/LOQ establishment and verification	**X**	**X**
21	Standards traceability	**X**	**X**
22	Instrument calibration records	**X**	**X**

Item	Description	Verification (completeness)	Validation (conformance to specifications)
23	Definition of laboratory qualifiers	**X**	**X**
24	Results reporting forms	**X**	**X**
25	QC sample results	**X**	**X**
26	CA reports	**X**	**X**
27	Raw data	**X**	**X**
28	Electronic data deliverable	**X**	**X**

QAPP Worksheet #35: Data Verification Procedures

(UFP-QAPP Manual Section 5.2.2)
(USEPA 2106-G-05 Section 2.5.1)

Follow-up inspections are conducted to ensure that procedures are being correctly performed, no changed conditions exist that may impact the quality of work, and lessons learned are being applied as identified. The responsible individual will inspect the relevant follow-up items from the checklist in the appropriate SOP at least as often as specified in this worksheet. **Worksheets #31, 32, & 33** describe actions to be taken if non-conforming conditions are observed during the QC inspections.

Records Reviewed	Required Documents	Process Description	Responsible Person, Organization
Field logbook (sampling methods and procedures)	• QAPP • Field SOPs	Establish that required sampling methods were used and documented. Establish that any required field monitoring was performed, and results are documented. Verify that the sampling procedures and field measurements met performance criteria and that any deviations were documented in the field logbook.	**Daily:** S-A JV TBD **At conclusion of field activities:** Jennifer Singer *S-A JV Project Chemist*
Field logbook (documentation)	• QAPP • Field SOPs	Verify that the records are present and complete for each day of field activities. Verify that all planned samples, including field QC samples, were collected and the sample collection locations are documented. Verify that meteorological data were provided for each day of field activities. Verify that changes/exceptions are documented and reported in accordance with requirements.	**Daily:** S-A JV TBD **At conclusion of field activities:** Jennifer Singer *S-A JV Project Chemist*
Chain-of-custody forms	• QAPP • Field SOPs • Laboratory SOPs/QA Manual	All samples to be analyzed by the laboratory will be shipped via overnight delivery service under chain-of-custody procedures. Before shipment of the samples to the laboratory, the chain-of-custody form will be checked by the S-A JV field sampler for completeness and correctness. Upon receipt at the laboratory, the sample custodian will check the chain-of-custody forms and shipping documentation for verification against the sample coolers they represent and will sign and date the chain-of-custody forms to acknowledge sample receipt. The laboratory is responsible for verifying the integrity of the custody seals and that the sample containers are received in good condition. The Laboratory	**Daily:** S-A JV TBD **Upon receipt:** *Pace Sample Custodian*

Records Reviewed	Required Documents	Process Description	Responsible Person, Organization
		Information Management System will provide evidence of sample custody from receipt by the laboratory until appropriate disposal.	
Laboratory corrective action and report procedure	• QAPP • Laboratory SOPs/QA Manual	Routine CAs apply to all analytical QC parameters and analytical system specification defined in the laboratory SOPs. Bench analysts have full responsibility and authority for performing routine CAs, which are documented as part of the analytical record. Defective processes, holding time violations, systematic errors, and quality defects that occur are to be reported by the analyst to the laboratory supervisor and a non-conformance record initiated. The Laboratory PM will then notify the S-A JV Project Chemist and PM. All notifications must be made in a timely manner. The non-conformance record should become part of the analytical record.	**Before release:** Erin Boyd *Pace QA Manager* **Upon receipt:** Jennifer Singer *S-A JV Project Chemist*
Analytical data package	• QAPP • Laboratory SOPs/QA Manual	All data produced by the laboratory will be required to undergo several levels of review, which will include two levels of management review at the laboratory. The laboratory will review the data packages internally for completeness and verification that all the required forms and raw data are included for each data package type. The laboratory QA Manager may also review randomly chosen data packages for additional internal audits. Any deviations should be documented in the report narrative.	Erin Boyd *Pace QA Manager*
Analytical data package	• QAPP • Laboratory SOPs • USEPA National Functional Guidelines	The Project Chemist or Data Validator will verify that data have been received for all samples sent to the laboratory. The data will be evaluated to determine whether the laboratory met the QC requirements for the analysis as stated in the analytical method, laboratory SOPs, QAPP, DoD General Data Validation Guidelines, (DoD 2019), and Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24 (DoD 2022). This verification should include (at a minimum): (1) review of dates of sample preparations and analyses to verify that they have been performed within applicable holding times, (2) review of associated blanks for potential contamination, (3) determination that project quantitation limits were achieved, and (4) review of QC sample performance	Jennifer Singer *S-A JV Project Chemist* Evin McKinney *Synectics Data Validator*

Records Reviewed	Required Documents	Process Description	Responsible Person, Organization
		criteria. Any deviations should be documented in the report narrative.	
Laboratory electronic data deliverable	• QAPP	The electronic data deliverable will be reviewed for correctness and completeness.	Jennifer Singer *S-A JV Project Chemist* Evin McKinney *Synectics Data Validator*

QAPP Worksheet #36: Data Validation Procedures

(UFP-QAPP Manual Section 5.2.2)
(USEPA 2106-G-05 Section 2.5.1)

RI actions will be documented and submitted for an overall data package certification. A certification package is prepared by the S-A JV for review by USACE. This package will document the steps taken to ensure the quality of the information relied upon to determine the nature and extent of PFAS impacts at Fort Devens.

Data validator:	Evin McKinney, Synectics
Analytical group/method:	PFAS
Data deliverable requirements:	EDD Stage 2B EQuIS 7 4-file format
Analytical specifications:	PFAS by USEPA Method 1633 compliant with DoD QSM 5.4 (or later versions)
MPC	DoD QSM version 5.4 (2021a) or later (see **Worksheets #12 and #28**)
Percent of data packages to be validated:	90% Stage 2B, 10% Stage 4
Percent of raw data reviewed:	10% of Stage 4 validation
Percent of results to be recalculated:	10% of Stage 4 validation
Validation procedures:	UFP-QAPP, DoD QSM version 5.4 (2021a) or later, DoD General Data Validation Guidelines, (DoD 2019), Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24 (DoD 2022).

QAPP Worksheet #37: Data Usability Assessment

(UFP-QAPP Manual Section 5.2.3)
(USEPA 2106-G-05 Section 2.4)

The Data Usability Assessment will be performed by S-A JV for data associated with the former Fort Devens. Synectics will perform third-party data validation to keep the data validation independent of the S-A JV project team. Documentation generated during the Data Usability Assessment will consist of data validation checklists with a summary of overall data usability and a summary table of qualified results. Data will be validated for the critical samples as defined in the UFP-QAPP, DoD QSM version 5.4 (2021a) or later, DoD General Data Validation Guidelines (DoD 2019), DoD Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24 (DoD 2022) as appropriate.

The Data Usability Assessment process involves data verification and validation. Data verification is the process by which laboratory results are checked to confirm that the proper QC steps were performed and key items have met QC objectives (both analytical and contractual). Key steps of the data verification include:

- Identifying sample collection, handling, and analysis procedures
- Documenting handling and analysis activities (e.g., QC checklist)
- Verifying (internally, at the data generator level) all sampling, handling, on-site analytical laboratory data
- Verifying laboratory data (e.g., laboratory-qualified data)
- Verifying sampling, on-site analytical laboratory data
- Verifying data package deliverable completeness
- Reviewing the case narrative
- Presenting all analytical results
- Summarizing QC sample data.

All required data deliverables must be present in the data package to proceed to the next step of data validation.

Data validation entails a review of the sample collection, handling, and QC data to verify that the laboratory was operating within required limits, and which (if any) environmental samples were related to out-of-control QC samples. The objective of data validation is to identify any questionable or invalid laboratory measurements.

The DQIs used to evaluate conformance with the project DQOs are presented below.

DQIs are generally defined in terms of six parameters:

1. Representativeness
2. Comparability
3. Completeness
4. Precision
5. Accuracy
6. Sensitivity

Each parameter is defined below. Specific objectives for the site actions are presented in other sections of this QAPP as referenced below.

37.1 Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent site conditions and is dependent on sampling and analytical variability and the variability of environmental media at the site. Actions have been designed to assess the presence of chemical constituents at the time of sampling. The QAPP presents the rationale for sample quantities and location. This QAPP presents field sampling and laboratory analytical methodologies. Use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements are intended to ensure that each individual sample accurately and precisely represents site conditions.

37.2 Comparability

Comparability is the degree of confidence with which one dataset can be compared to another. Comparability between phases of the actions (if additional phases are required) will be maintained through consistent use of the sampling and analytical methodologies set forth in this QAPP, established QC procedures, and use of appropriately trained personnel.

37.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount obtained. Completeness of a field or laboratory dataset will be calculated using the equation below by comparing the number of valid sample results generated to the total number of results collected:

$$\text{Completeness} = \frac{\text{Number valid results}}{\text{Total number of results generated}} \times 100$$

As a general guideline, overall project completeness is expected to be at least 90%. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

37.4 Precision

Precision is a measure of the reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the objectives of the action. To maximize precision, sampling and analytical procedures will be followed. All work for the site actions will adhere to established protocols presented in the QAPP laboratory duplicates, and field duplicates. Checks for field measurement precision will include duplicate field measurements.

The precision of data will be measured by calculating the RPD using the following equation:

$$\text{RPD} = \frac{(A-B)}{(A+B)/2} \times 100$$

Where:

A = Analytical result from one of two duplicate measurements.

B = Analytical result from the second measurement.

37.5 Accuracy

Accuracy is a measure of how close a measured result is to the true value. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, reference standards, MSs, blank spikes, and surrogate standards will be used to assess the accuracy of the analytical data.

Accuracy will be calculated in terms of percent recovery as follows:

$$\%\,R = \frac{A-X}{B} \times 100$$

Where:

A = Value measured in spiked sample or standard.

X = Value measured in original sample.

B = True value of amount added to sample or true value of standard.

37.6 Sensitivity

Sensitivity is a quantitative measurement to determine if the analytical laboratory's procedures/methodologies and their associated detection limits can satisfy the project requirements as they relate to the project action limits. The detection limits (as described in DoD QSM 5.4) are DL, LOD, and LOQ. Analytes that are not detected are reported as less than the LOD. Detects less than the LOQ but greater than the DL are reported as estimated and J-flagged by the laboratory. The LOD and LOQ are verified by the laboratory quarterly. The current DoD DLs for the analytical laboratory are presented in **Worksheet #15**.

37.7 Data Validation and Usability

Synectics will validate data generated using the UFP-QAPP, DoD QSM version 5.4 (2021a) or later, DoD General Data Validation Guidelines (DoD 2019), and Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24 (DoD 2022). These procedures and criteria may be modified, as necessary, to address project-specific and method-specific criteria, control limits, and procedures. Data validation will consist of data screening, checking, reviewing, editing, and interpretation to document analytical data quality and to determine whether the quality is sufficient to meet the DQOs.

The data validator will verify that laboratory reporting of analytical parameters is in accordance with the procedures specified for each analytical method and/or as specified in this QAPP. Deviations from the analytical methods/QAPP requirements will be detailed by the laboratory in the report case narrative. Changes to the reporting requirements specified in the QAPP will be communicated to the S-A JV project chemist and laboratory PM and also noted on the chain-of-custody form as appropriate.

Upon receipt of laboratory data, the data validator will execute the following procedures:

- Evaluate completeness of data package.
- Verify that field chain-of-custody forms were completed and samples were handled properly.
- Verify that holding times were met for each parameter. Holding time exceedances, should they occur, will be documented. Data for all samples exceeding holding time requirements will be

flagged as either estimated or rejected. The decision as to which qualifier is more appropriate will be made on a case-by-case basis.

- Verify that parameters were analyzed according to the methods specified.
- Review QC data (i.e., confirm that duplicates, blanks, and spikes were analyzed on the required number of samples, as specified in the method, and verify that duplicate and MS recoveries are acceptable).
- Investigate anomalies identified during review. When anomalies are identified, they will be discussed with the PM and/or Laboratory Manager as appropriate.
- If data appear suspect, investigate the specific data of concern.

Deficiencies discovered because of the data review, as well as the CAs implemented in response, will be documented and submitted in the form of a written report addressing the following topics, as applicable to each method:

- Assessment of the data package
- Description of any protocol deviations
- Failures to reconcile reported data
- Assessment of any compromised data
- Overall appraisal of the analytical data
- Table of site name, sample quantities, matrix, and fractions analyzed.

It should be noted that qualified results do not necessarily invalidate data. The goal to produce the best possible data does not necessarily mean that data must be produced without QC qualifiers. Qualified data can provide useful information.

During the review process, laboratory qualified and unqualified data are verified against the supporting documentation. Based on this evaluation, qualifier codes may be added, deleted, or modified by the data reviewer. Results will be qualified with the following codes in accordance with DoD General Data Validation Guidelines, November 2019:

U The analyte was not detected and was reported as less than the LOD or as defined by the customer. The LOD has been adjusted for any dilution or concentration of the sample.

J The reported result was an estimated value with an unknown bias.

J+ The result was an estimated quantity, but the result may be biased high.

J- The result was an estimated quantity, but the result may be biased low.

N The analysis indicates the presence of an analyte for which there was presumptive evidence to make a "tentative identification."

NJ The analyte has been “tentatively identified” or “presumptively” as present, and the associated numerical value was the estimated concentration in the sample.

UJ The analyte was not detected and was reported as less than the LOD or as defined by the customer. However, the associated numerical value is approximate.

X The sample results (including non-detects) were affected by serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria. The presence or absence of the analyte cannot be substantiated by the data provided. Acceptance or rejection of the

data should be decided by the project team (which should include a project chemist), but exclusion of the data is recommended.

It should be noted that no compound concentration, even if it has passed all QC tests, is guaranteed to be accurate. Strict QC serves to increase confidence in data, but any value potentially contains error.

Resolution of any issues regarding laboratory performance or deliverables will be handled between the laboratory and the data validator. Suggestions for re-analysis may be made by the S-A JV QC Manager at this point.

37.8 Validation Reports

The data validation reports will identify all deficiencies and the potential impact on the results. The S-A JV QC Manager (or his designee) will amend qualifiers generated during the validation process. The validation checklists and the database will be the primary locations of all applicable data qualifiers. Qualifiers will not be applied to the hard copy analytical reports.

37.9 Field Data Review

Field data are generated from in-field measurement, which may include a geophysical survey, well development, and groundwater sampling. The quality objective for the in-field measurement activities is to obtain accurate measurements of sample characteristics, including aqueous pH, conductivity, temperature, turbidity, and DO, using appropriate equipment. Data are recorded in field logbooks or on field sampling sheets and calibration logs. Calibration logs will be reviewed by the S-A JV field sampler with other field documentation to identify any potential impacts to data quality and usability. Field logbooks are reviewed as part of the QC inspections.

37.10 Reconciliation with Data Usability Requirements

Data results will be examined to determine the performance that was achieved for each data usability criterion. The performance will then be compared with the project objectives and DQOs. Deviations from objectives will be noted. Data that have been rejected will not be used. Data that have been qualified but not rejected will be considered useable (i.e., qualified as estimated) and definitive data. If further limitations must be placed on qualified data, the associated data are non-definitive data and should be used for screening purposes only.

Additional action may be warranted when performance does not meet performance objectives for critical data. Options for CA relating to incomplete information, questionable results, or inconsistent data may include any or all the following:

- Retrieval of missing information
- Request for additional explanation or clarification
- Re-analysis of sample from extract (when appropriate)
- Recalculation or reinterpretation of results by the laboratory.

These actions may improve the data quality, reduce uncertainty, and eliminate the need to qualify or reject data. If these actions do not improve the data quality to an acceptable level, the following additional actions may be taken:

- Extrapolation of missing data from existing data points
- Use of historical data
- Evaluation of the critical/non-critical nature of the sample.

If the data gap cannot be resolved by these actions, the data bias and potential for false negatives and positives can be evaluated. If the resultant uncertainty level is unacceptable, the following action must be taken: additional sample collection and analysis.

References

Argonne National Laboratory. 2021. Derivation of PFAS Ecological Screening Values Report. Prepared for DoD. September.

ASTM. 2009. D6913-04 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.

ASTM. 2021. D7928-21 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.

BERS-Weston. 2018. Final Site Inspection Report for Per-and Polyfluoroalkyl Substances (PFAS) at Former Fort Devens Army Installation, Devens, MA. May.

DoD. 2019. DoD General Data Validation Guidelines. 4 November.

DoD. 2021. Quality Systems Manual for Environmental Laboratories. Version 5.4. October.

DoD. 2022. Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24. October.

ITRC. 2022. PFAS Technical and Regulatory Guidance Document. Available online at: https://pfas-1.itrcweb.org/. September.

KGS. 2017. Final Base-Wide Preliminary Assessment for Evaluation of Perfluoroalkyl Substances, Former Fort Devens Army Installation BRAC Legacy Sites, Devens, Massachusetts. August.

KGS. 2021. Area 3 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation, Former Fort Devens Army Installation, Devens, MA. February.

USACE. 2014. EM 385-1-1, Safety and Health Requirements Manual. 30 November 2014.

USEPA. 2000. Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4 HW EPA/600/R-00/007. January.

USEPA. 2001. Requirements for Quality Assurance Project Plans. USEPA QA/R-5. March 2001.

USEPA. 2005a. Intergovernmental Data Quality Task Force, Uniform Federal Policy for Implementing Environmental Quality Systems. EPA 505-F-03-001. Final Version 2, March 2005.

USEPA. 2005b. Intergovernmental Data Quality Task Force, Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual. EPA-505-B-04-900A, Final Version 1. March 2005.

USEPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process, QA/G-4. February 2006.

USEPA. 2012. Guidance for Quality Assurance Project Plans. CIO 2106-G-05 QAPP. January 2012.

USEPA. 2016. Lifetime Health Advisories and Health Effects Support Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate. EPA-HQ-OW-2014-0138; FRL-9946-91-OW. Federal Register/ Vol. 81. No. 101. May 25.

USEPA. 2020. Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) Methods and guidance for sampling and analyzing water and other environmental media. EPA/600/F-17/022h. January.

USEPA. 2023. Regional Screening Level (RSL). May. Available online at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables.

USEPA Region 1. 2023. Site-specific Screening Levels for PFOA, PFOS, PFBS, PFNA, PFHxS, HFPO-DA, PFHxA, and PFBA for the Fort Devens NPL Site. June. Included with USEPA comments on the Draft Final Devens Phase II PFAS Remedial Investigation Work Plan – Area 1.

Attachment A

Field Standard Operating Procedures

TGI – Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide

Rev: 10

Rev Date: January 26, 2022

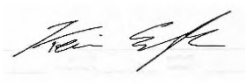
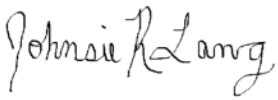
Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	April 27, 2017	All	Initial Release	Erica Kalve Erika Houtz Sue Tauro
	1	June 19, 2018	1 through 4 and 17	Updated Information on Sampling Materials	Erica Kalve Erika Houtz
	2	October 15, 2018	6 to 16	Minor updates on laboratory elements, updates to decontamination procedures, and clarification on equipment and reagent blank collection	Erika Houtz Erica Kalve
	3	December 17, 2018	4, 6, 17	Removed Sharpies from acceptable field writing implements; Changed language in Section 3.2 and Section 10.5 to provide stricter guidance for DoD projects.	Erika Houtz, Erica Kalve
	4	March 26, 2019	4,5	Removed Citranox from acceptable Decon solutions in Table 1a, added all fluoropolymer containing materials to prohibited items in Table 1b. Made a correction that Liquinox contains trace levels of 1,4 Dioxane, not Alconox.	Erika Houtz
	5	October 16, 2020	14	Added Air Force preference to sample surface water at surface for Air Force investigations.	Erika Houtz

	6	March 23, 2021	4, 5, 7, 12, 13, 14, 15, 16, 17	Made clarifications that fine/ultra-fine point Sharpies are allowed. Referenced 2018 MDEQ sampling guidance. Made updates to 'After Sample Collection' in Section 7.	Kevin Engle
	7	April 18, 2021	All	Changed title from Poly- and Perfluoroalkyl Substances to **"Per- and Polyfluoroalkyl Substances"** and changed PFASs to PFAS.	Rosario Varrella, Erika Houtz
	8	May 4, 2021	12, 13, 15, 16	Clarified that sample containers should have an HDPE lined screw cap and that LDPE plastic sheeting should be used.	Kevin Engle, Erika Houtz
	9	October 20, 2021	Note that numbers have shifted one page forward relative to prior versions. 5, 7, 9-12, 15, 16, 18-25.	Specific acceptable sunscreen and insect repellent brands were added to Table 1. Clarified language regarding footwear and H&S trainings. Laboratories section and Section 10.5 was updated to reflect new laboratory names and an updated version of the QSM. Sections 5 and 6 were updated to provide clearer language on health and safety protocols for sunscreen, insect repellent, and rain events. Added language to specify decontamination of reusable equipment prior to initial use in Section 7.1. Section 8 on Waste Management was updated to state that	Kevin Engle, Erika Houtz

				waste storage and disposal should be determined in the site specific workplan. Section 9 was updated to include Rite in the Rain® notebooks as approved for PFAS sampling. Changed the term "sample port" to "sample location" when describing where to place plastic sheeting. Section 10.1 was updated to indicate an equipment blank can be collected for unvetted hazard controls that contact a sample. References were updated to include the newer version of the DoD QSM, MDEQ Sampling Guidance, and California State Water Board PFAS Sampling Guidance.
	10	January 26, 2022	Various, Section 7	TGI formatted to comply with new QMS TGI template and Arcadis brand compliance. Indicated to avoid use of anti-fog spray on safety glasses due to possible presence of PFAS.

Approval Signatures

Prepared by:		1/26/2022
	Kevin Engle, PG Geologist (Preparer)	Date
Reviewed by:		1/26/2022
	Johnsie Lang, PhD (Subject Matter Expert)	Date

1 Introduction

This document is intended to provide guidance to field staff sampling for Per- and Polyfluoroalkyl Substances (PFAS). The content in this document describes the intended use, scope and application, personnel qualifications, equipment, cautions, health and safety considerations, procedures, waste management, data recording and management, and quality assurance of PFAS sampling.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

The purpose of this Technical Guidance Instructions (TGI) is to provide guidance on field sampling to be used for **Per- and Polyfluoroalkyl Substances** (PFAS). This protocol was adapted from various sources including Arcadis Australia, Transport Canada, and the U.S Army Corp of Engineers (USACE) Omaha. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. **Table 1a** provides a summary of materials that have been approved for site investigation; this list is expected to grow longer as industry experience increases. **Table 1b** provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding

PFAS cross-contamination potential, and it is recommended that these materials be prohibited for sample collection; for materials that are suspected of containing PFAS and/or to retain PFAS, these recommendations are considered preliminary and subject to change. Further discussion of approved and prohibited materials is found throughout this document.

Table 1a: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Investigations

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to investigation	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Fine/Ultra-Fine point Sharpies®	Larger point Sharpies® should be avoided.	MDEQ 2018
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to investigation	DER 2016

Sampling Materials	Additional Considerations	References
Alconox® or Liquinox® followed by deionized water or PFAS-free water rinse	Liquinox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016
Sun and Biological Protection		
OFF Deep Woods, Sawyer Permethrin	Apply >10 m away from sampling area	MDEQ 2018
Banana Boat, Coppertone, Neutrogena, Meijer, and L'Oreal Sunscreens	Apply >10 m away from sampling area	MDEQ 2018

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

Table 1b: Summary of Sampling Equipment and Materials Not Recommended for PFAS Site Investigations.

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFAS	References
Water Sampling Materials				
Teflon®, PTFE-containing or other fluoropolymer coated or containing field equipment (e.g., tubing, bailers, liners, tape, plumbing paste, pump parts)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFAS	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFAS	References
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Markers		x		NHDES 2016
Decontamination				
[Some] detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

Note: For materials that are suspected of containing PFAS, or have the potential to retain PFAS, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFAS, field personnel are advised to err on the side of caution by strictly following these protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for false detections of PFAS. A summary of other specific items related to field sampling for PFAS are discussed in the sections below.

This TGI applies to all Arcadis and subcontractor personnel involved in field sampling for PFAS.

4 Personnel Qualifications

4.1 Sampling Personnel

Field personnel must have current health and safety training, including 40-hour HAZWOPER training, up to date 8-hour refresher, site supervisor training, and site-specific training, as needed. In addition, field personnel will be versed in the other relevant SOPs (e.g., low flow sampling) and will possess the skills and experience necessary

to successfully complete the desired field work. The site Health and Safety Plan (HASP) and other documents will identify any other training requirements such as site-specific safety training or access control requirements.

4.2 Laboratories

These laboratories are example laboratories that could be used to analyze environmental media for PFAS, pending project approval:

- United States: Pace, SGS, Vista, ALS, and Eurofins
- Canada: AXYS-SGS and Bureau Veritas

Other laboratories may be used if they are appropriately accredited for PFAS analysis according to any project requirements. It is recommended that a laboratory is Environmental Laboratory Accreditation Program (ELAP)-accredited for PFAS analysis in accordance with the Department of Defense (DoD) Quality Systems Manual (QSM) 5.3 Table B-15 or any subsequent updates. **For all data collection efforts at DoD sites, PFAS data must be obtained using a method that is DoD ELAP-accredited under QSM 5.3 or later.**

5 Equipment List

The following equipment and materials must be available for sampling:

- Site plan of sampling locations, relevant work plan (or equivalent), and this TGI;
- Appropriate health and safety equipment, as specified in the site HASP;
- Dedicated plastic sheeting (preferably high-density polyethylene [HDPE]) or other clean surface to prevent sample contact with the ground;
- Conductivity/temperature/pH meter;
- Dissolved oxygen meter, oxidation reduction potential meter, and turbidity meter;
- Depth to water meter;
- If using low-flow groundwater sampling techniques, peristaltic pump (groundwater sampling)/bladder pump (with PFAS free bladder/ HDPE bladder), flow through cell, and accompanying HDPE and silicone tubing;
- Hydrasleeves™, if using Hydrasleeves™ for groundwater sampling;
- Metal trowel for soil samples; specialized soil/sediment sampling equipment as required;
- Brushes for scrubbing sampling equipment;
- Pens, pencils, and/or fine/ultra-fine point Sharpies® for writing;
- Clipboards, field binders, and field note pages that are not waterproof;
- Labeled sample bottles:
    - Water: HDPE bottles fitted with polypropylene screw cap only; some types of PFAS samples (primarily drinking water) may require preservative, which will be indicated by the laboratory conducting the analysis. The laboratory will specify the sample bottle volume.

  - Soil and sediment: HDPE bottles fitted with polypropylene screw cap only; no preservatives. The laboratory will specify the sample bottle volume.
- If high concentrations of PFAS related to class B firefighting foams are expected, bring additional small vials to conduct field-based shaker tests for foaming;
- Ziploc® bags to hold ice and samples;
- Bottles containing “PFAS-free” water used for reagent blanks;
- Labeled, thoroughly decontaminated coolers for samples with ice; Blue ice is not permitted;
- Deionized or distilled water for initial decontamination rinsing;
- “PFAS-free” water provided by the laboratory for final decontamination rinsing;
- Methanol, isopropanol, or acetone if able to be brought safely to field site; especially important for decontamination during soil sampling;
- Alconox or Liquinox®;
- Packing and shipping materials;
- Groundwater and/or Sampling Log; and
- Chain-of-Custody (COC) Forms.

6 Cautions

6.1 Food Packaging

Some food packaging may be treated with PFAS-containing chemicals to prevent permeation of oil and water in the food outside of the packaging. To avoid potential food packaging-related PFAS contact:

- Do not bring any food outside of the field vehicles onsite and eat snacks and meals offsite.
- Wash hands after eating.
- Remove any field garments or outer layers prior to eating. Do not put them back on until done eating and hands are washed.

6.2 Field Gear

6.2.1 Clothing

Many types of clothing are treated with PFAS for stain and water resistance, in particular outdoor performance wear under brand names such as Gore-Tex®. To avoid potential clothing-related PFAS contact:

- Do not wear any outdoor performance wear that is water or stain resistant, or appears to be. Err on the side of caution.

- Wear pre-laundered (multiple washings, i.e., 6+) clothing that is not stain resistant or waterproof (unless made from the materials listed in Section 5.3.1).
- Natural fabrics such as cotton are preferred. Synthetic fabrics may also be acceptable if there is no indication on the label that the fabric is water and stain resistant.
- Most importantly, avoid contacting your clothing with sampling equipment, bottles, and samples.

6.2.2 Personal Protective Equipment

Safety Footwear

Some safety footwear has been treated to provide a degree of waterproofing and increased durability and may represent a source of trace PFAS. If at all possible, Gore-Tex footwear should not be worn and safety footwear without waterproofing should be worn; footwear that provides adequate safety from physical hazards is required and takes precedence over potential PFAS concerns. To avoid any PFAS cross contamination to samples from footwear:

- Do not contact your footwear with equipment, bottles, or samples in any way.
- Do not allow gloves used for sampling to come in contact with safety footwear.

Nitrile Gloves

Wear disposable nitrile gloves at all times. Don a new pair of nitrile gloves **before** the following activities at each sample location:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or “PFAS-free” water bottles;
- Insertion of anything into the sample ports (e.g., HDPE tubing); and
- Handling of any quality assurance/quality control (QA/QC) samples including field blanks and equipment blanks.

Don a new pair of nitrile gloves **after** the following activities:

- Handling of any non-dedicated sampling equipment;
- Contact with contaminated surfaces; or
- When judged necessary by field personnel.

6.3 Personal Hygiene

- Shower at night.
- Do not use personal care products after showering such as lotions, makeup, and perfumes, UNLESS medically necessary.
- Use sunscreen and insect repellent as necessary for health and safety, i.e., if sampling is to occur outdoors in direct sunlight and/or if insect hazards may be present. Specific products that are acceptable for PFAS

sampling are listed in Table 1 and in Section 6.1. Apply sunscreen and insect repellant prior to initiating field sampling. If sunscreen and/or repellant need to be reapplied, ensure a safe distance away from the sampling locations and equipment (i.e., more than 10 meters (m) away). Wash hands after application and don new gloves following hand washing.

6.4 Visitors

Visitors to the site are asked to remain at least 10 m from sampling areas.

7 Health and Safety Considerations

7.1 Biological and Environmental Hazard Controls

7.1.1 Sunscreens and Insect Repellents

When site conditions warrant, insect repellent and sunscreen should be applied. Some insect repellents and sunscreen have been approved for PFAS sampling by individual states. According to Michigan Department of Environmental Quality (MDEQ; now known as Michigan Department of Environment, Great Lakes, and Energy [EGLE]), the products below are allowable (MDEQ 2018). Note that California State Water Quality Control Board's PFAS sampling guidance refers to MDEQ/EGLE's allowable list of sunscreens and insect repellents (California State Water Quality Control Board 2020).

Insect Repellents

- OFF Deep Woods
- Sawyer Permethrin

Sunscreen

- Banana Boat Sport Performance Sunscreen Lotion Broad Spectrum SPF 30
- Meijer Sunscreen Lotion Broad Spectrum SPF 30
- Neutrogena Ultra-Sheer Dry-Touch Sunscreen Broad Spectrum SPF 30
- Banana Boat for Men Triple Defense Continuous Spray Sunscreen SPF 30
- Banana Boat Sport Performance Coolzone Broad Spectrum SPF 30
- Banana Boat Sport Performance Sunscreen Lotion Broad Spectrum SPF 30
- Banana Boat Sport Performance Sunscreen Stick SPF 50
- Coppertone Sunscreen Lotion Ultra Guard Broad Spectrum SPF 50
- Coppertone Sport High-Performance AccuSpray Sunscreen SPF 30
- Coppertone Sunscreen Stick Kids SPF 55
- L'Oréal Silky Sheer Face Lotion 50+
- Meijer Clear Zinc Sunscreen Lotion Broad Spectrum SPF 15, 30 and 50
- Meijer Wet Skin Kids Sunscreen Continuous Spray Broad Spectrum SPF 70
- Neutrogena Beach Defense Water + Sun Barrier Lotion SPF 70
- Neutrogena Beach Defense Water + Sun Barrier Spray Broad Spectrum SPF 30
- Neutrogena Pure & Free Baby Sunscreen Broad Spectrum SPF 60+

Please plan for sampling events and purchase these products ahead of time. For any sunscreens and bug sprays, including those listed above, always follow these instructions for application:

- Insect repellents and sunscreen should be applied away from the work area prior to initiating sampling.
- When re-applying, stay at least 10 m away from the sampling locations and equipment.
- Wash hands after application and don new nitrile gloves.

7.1.2 Rain Event

Special care should be taken when rain is falling at the project site:

- Field sampling during extreme rainfall should be avoided if possible. If sampling needs to take place during a rain event (or other extreme weather condition), ensure the rain gear or other safety clothing is appropriate. For example, rain gear made from the following materials is allowable: polyurethane, PVC, wax coated fabrics, rubber/neoprene, uncoated Tyvek® (MDEQ 2018).
- If project timelines are tight, consider the use of a gazebo tent that can be erected over the top of the monitoring well to provide shelter from the rain. The canopy material is possibly a PFAS-treated surface and should be managed as such; therefore, wear gloves when moving the tent, change them immediately after moving the tent, and avoid further contact with the tent until all sampling activities have been finished and the team is ready to move on to the next site.

7.1.3 Other H&S Considerations

- ***If an unapproved or potentially suspect hazard control is needed for health and safety, apply or keep that control away from the samples, document its use in field notes, and, if it does contact a sample, take an equipment blank with that material.***
- The ability to safely access the surface water sampling locations must be verified before sampling.
- Field activities must be performed in accordance with the site HASP, a copy of which will be present onsite during such activities.
- Safety hazards associated with sampling surface water include fast-moving water, deep water, and steep slopes close to sampling sites. Use extreme caution when approaching sampling sites.
- If thunder or lighting is present, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lighting.
- Use caution when removing well caps as well may be under pressure, cap can dislodge forcefully and cause injury.
- Avoid the use of anti-fog sprays on glasses, which may contain PFAS. It's recommended to instead purchase pre-treated anti-fog safety glasses.

8 Procedure

8.1 Field Equipment Cleaning

Reusable field sampling equipment will require cleaning before initial use and between uses. For groundwater sampling, between uses, decontaminate the flow-through cell and any non-dedicated equipment (i.e., interface probe of depth to water meter) that comes into contact with well water. Trowels and other materials used to sample soil samples will also require decontamination, although dedicated, single use equipment such as liners should be used where possible.

After donning a new pair of nitrile gloves:

- Rinse sampling equipment with Alconox or Liquinox® cleaning solution; Scrub equipment with a plastic brush if needed;
- Rinse two times with distilled water or deionized water;
- Rinse one time with “PFAS-free” water or once with methanol/isopropanol/acetone, if it is available, and once with “PFAS-free” water; organic solvents are especially useful for decontaminating soil sampling equipment. If organic cleaning solvents cannot be brought to site, scrub equipment a second time after a single distilled or deionized water rinse, then rinse two times with distilled or deionized water and once with “PFAS-free” water (i.e., two scrubbings and four water rinsings total).
- Collect all rinsate in a sealed pail for disposal. Do not reuse decontamination solutions between sampling locations.

8.2 Borehole/Monitoring Well Development

If a drill rig is being used to drill for soil cores or to install monitoring wells, wear clean nitrile gloves before collecting each continuous soil sample. Additional requirements include the following:

- Verify in writing with the manufacturer that single-use liners used to collect each sample are made of a material that does not contain PFAS;
- Collect soil samples in laboratory-supplied HDPE bottles.
- Store the sample bottles in coolers and keep at a temperature of 0 to 6ºC until transported to the laboratory.

8.2.1 Well Condition Survey/ Water Level Monitoring

Using equipment that has been thoroughly decontaminated according to the procedures in Section 7.1, conduct the well condition surveys and water level monitoring:

- Conduct monitoring well inspections and record water levels.
- Use an interface probe to evaluate presence/absence of non-aqueous phase liquid (NAPL).
- Measure the depth to water from the top of the polyvinyl chloride (PVC) riser and the total depth of the well.
- Record information in the field notes.

8.2.2 Monitoring Well Development and Purging

Follow these requirements for monitoring well development and purging:

- Do not use Teflon™ tubing for purging or sample collection. HDPE tubing is acceptable.
- Do not re-use materials between wells. Upon completion of use, remove all disposable materials (such as HDPE and/or silicone tubing) and place in heavy duty garbage bags for disposal.
- During development of the well, create sufficient energy to agitate the water column and create flow reversals in the well screen, filter pack and formation to loosen fine-grained materials and draw them into the well. The pumping or bailing action should then draw all drilling fluids and fine-grained material out of the borehole and adjacent formation and then out of the well. Review the Arcadis Monitoring Well Development guidance (Arcadis 2010) for more detailed information.
- Follow the low-flow purge and sampling techniques per the U.S. Protection Agency's (EPA's) guidance document titled *Low Stress (Low Flow) purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells* (2010) and ASTM's standard titled *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations* (2002). Also available for review is the Arcadis Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells (Arcadis 2011).
- To purge the well, if using HDPE tubing and a peristaltic pump, insert the end of the tubing to the approximate depth of the midpoint of the screened section of the monitoring wells. Measure the length of HDPE tubing to be inserted into each monitoring well and pre-cut it to approximate lengths (such as the previously measured arm span of a field technician) to avoid contact with any materials other than the monitoring well and peristaltic pump. Flow rates should be as low as can be reasonably achieved. Collect and appropriately dispose of purge water.
- Silicone tubing should direct the purge water through a flow-through cell for field parameter measurements of pH, conductivity, temperature, dissolved oxygen, and turbidity. Calibrate the instrument in the field prior to use. Decontaminate the instrument and flow-through cell at each monitoring well location before purging.
- Record field parameters in intervals (generally of 3-minute duration) to ensure purge water has cycled through the flow-through cell. Sample the wells after field parameter measurements indicate stabilization, which allows collection of representative formation water (generally acceptable standards are three consecutive pH readings to within ±0.1 units, and three consecutive conductivity, temperature and dissolved oxygen measurements to within 3%). Turbidity must be monitored, but does not need to be used as a stabilization indicator of purge completion. Record field parameter measurements at each well. Drawdown should be monitored throughout the purge.
- If wells are suspected to be dewatering throughout the purge (i.e., reduced flow rate/difficulty pumping water or bubbles begin to come through the flow through cell), turn off the pump and allow the water level to recover for ½ hour, followed by sample collection. Document these activities in the field notes.

8.3 Sample Collection

Different laboratories may supply sample collection bottles of varying sizes depending on the type of media to be sampled.

8.3.1 Sample Containers

- Collect samples in HDPE bottles fitted with a HDPE lined (no Teflon™) screw cap.
- Complete bottle labels after the caps have been placed back on each bottle.
- Do not use glass bottles due to potential loss of analyte through adsorption. This is particularly important for aqueous samples.
- Review with analytical lab the sample size, sample container, etc. depending upon the type of PFAS analysis that is being requested.

8.3.2 Soil Sampling

Before Sample Collection

- Place LDPE plastic sheeting adjacent to the sample location for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Trowels or drilling equipment that will come into contact with a sample should be decontaminated prior to sample collection, preferably with methanol/isopropanol/acetone;
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Collect soil samples using a clean stainless-steel trowel or with single-use PFAS-free liners;
- Place soil samples in labeled HDPE bottles supplied by the laboratory.
- Note the time on the sample label.
- Collect any necessary duplicates/co-located samples and matrix spikes – verify with laboratory whether they need to be collected in separate sample bottles.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFAS, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place each sample bottle in two sealed Ziploc® bags. Another brand of LDPE bag is acceptable.
- Record the label information and time of sampling in the field notes.
- Place soil sample bottles in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice.

8.3.3 Groundwater Sampling

Before Sample Collection

- Place LDPE plastic sheeting adjacent to the sample location for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the labeled HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.
- Measure depth to water and field parameters. Turbidity and the physical appearance of the purged water should be noted on the Groundwater Sampling Log.

During Sample Collection

- Start groundwater sample collection upon stabilization of field parameters.
- If low-flow groundwater sampling techniques are being used, disconnect the silicone tubing from the flow-through cell, enabling collection of groundwater samples without passing through the cell.
- Hydrasleeves are also considered acceptable for sampling of PFAS in groundwater – consult the project manager to determine which technique should be used. In general, low flow sampling is preferable.
- Collect groundwater samples (to the neck of the bottle, some headspace is acceptable) from the dedicated sampling ports at the center of the well screen. While collecting the sample, make sure the bottle cap remains in the other hand of the sampler, until replaced on the bottle.
- To mitigate cross contamination, collect groundwater samples in a pre-determined order from least impacted to greater impacted based on previous analytical data or knowledge about past activities at the site. If no analytical data are available, samples are to be collected in the following order:
    1. First sample the upgradient well(s).
    2. Next, sample the well located furthest downgradient of the interpreted or known source.
    3. The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.
- NOTE: If high concentrations of PFAS related to class B firefighting foams are expected in a groundwater sample, conduct a Shaker test by collecting and shaking a small portion of the sample (~10 to 25 mL) on site in a small disposable vial. If foaming is noted within the sample, document the foaming when samples are

submitted for analysis; the 'shaker test' vial can then be disposed. This shaker test provides information about how each of the samples should be handled analytically.

- After collecting the sample, tightly screw on the polypropylene cap (snug, but not too tight). This will minimize leaking or cross contamination of the sample. Most PFAS, including all analytes measured by USEPA Method 537, are not volatile at environmental pH.
- Note the time on the sample label.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFAS, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.
- Do not rinse PFAS sample bottles during sampling. Do not filter samples.

After Sample Collection

- Place each sample bottle in two sealed Ziploc® bags. Another brand of LDPE bag is acceptable.
- Record the label information and time of sampling in the field notes and COC. Note ‘shake test’ results if appropriate.
- Place groundwater samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

  Treat all disposable sampling materials as single use and dispose of them appropriately after sampling at each monitoring well.

8.3.4 Sediment Sampling

Before Sample Collection

- Place LDPE plastic sheeting adjacent to the sample location for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.

- Collect sediment samples either manually using a stainless-steel trowel or using a petite ponar grab sampler, depending on field conditions at each sampling location during sampling program.
- Collect sediment samples from the upper 10 cm of sediment.
- For a sample to be acceptable overlying, low turbidity water must be present.
- Decant the overlying water and use a stainless-steel trowel to collect only the upper 5 centimeters (cm) of sediment.
- Collect sediment samples directly into laboratory-supplied bottles that are suitable in both material and size.
- Do not overfill the sample bottle.
- Make sure that the sample does not contain vegetation, that the sediment is undisturbed, and that the sampler shows no signs of winnowing or leaking.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Note the time on the sample label.
- Collect any necessary duplicates and matrix spikes.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFAS, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place each sample bottle in two sealed Ziploc® bags. Another brand of LDPE bag is acceptable.
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Measure surface water pH, conductivity, temperature, and total dissolved solids (TDS) at each location **after** both surface water and sediment sampling is completed.

8.3.5 Surface Water Sampling

Before Sample Collection

- Place LDPE plastic sheeting adjacent to the sample location for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.

- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Avoid sampling the surface, in general.
- However, for Air Force investigations, collect samples from the water surface.
- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.
- Collect surface water samples directly into laboratory-supplied bottles; wide-mouth bottles may be preferable to narrow mouth bottles for ease of surface water collection.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Note the time on the sample bottle.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFAS, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place each sample bottle in two sealed Ziploc® bags. Another brand of LDPE bag is acceptable.
- Record the label information and time of sampling in the field notes.
- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Measure surface water pH, conductivity, temperature, and TDS at each location **after** both surface water and sediment sampling.

8.4 Shipping

- If samples cannot be shipped the same day as collected, arrange an appropriate means of keeping the samples cool overnight and maintain the temperature between 0 and 10°C for the first 48 hours after collection, and then between 0 and 6°C thereafter.
- Store samples in appropriate transport bottles (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

- Complete the appropriate procedures for COC, handling, packing, and shipping.
- Fill out and check COC Forms against the labels on the sample bottles progressively after each sample is collected.
- Place all disposable sampling materials (such as plastic sheeting, and health and safety equipment) in appropriate containers.
- Ship samples via courier service with priority overnight delivery. Tracking numbers for all shipments should be provided and recorded after they have been sent out to ensure their timely delivery.
- Do not ship samples via Fed Ex for Saturday delivery.

9 Waste Management

All rinsate should be collected in a sealed pail for disposal. Drill cuttings and purge water will be managed as specified in the Field Sampling Plan (FSP) or Work Plan, and according to state and/or federal requirements. PPE and decontaminated fluids will be contained separately and staged at the sampling location. Containers must be labeled at the time of collection. Labels will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, groundwater, PPE). General guidelines for investigation derived waste (IDW) handling and storage are set forth in a separate IDW guidance document (Arcadis 2009).

Typical waste characterization procedures include collection of a composite sample of the drill cutting material and a composite sample of the purge water for laboratory analysis. Samples are typically analyzed for disposal toxicity characteristic leaching procedure (TCLP) analysis for metals and VOCs. For PFAS, a simple leach test with neutral pH water may be more indicative of actual risk. Additionally, generators of waste are required to include analysis of other constituents that are reasonably believed to be present including (in this case) PFAS.

Waste storage and final waste disposition should be determined in the site specific workplan.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

If digital data collection isn't possible, waterproof field books should be avoided for field notes. Instead, field notes on loose paper on Masonite, plastic, or aluminum clip boards is preferred. Please note that newer Rite in the Rain® notebooks are approved for PFAS sampling. Other requirements for field notes include:

- Pens, pencils, and fine/ultra-fine point Sharpies® may be used.
- Keep field notes and writing implements away from samples and sampling materials.
- One person should conduct sampling while another records field notes.

- Do not write on sampling bottles unless they are closed.

10.1 Other Project Documentation

- Complete groundwater and/or soil sampling logs.
- Make sure COC Forms are properly completed. Verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537 list, etc.) are required for analysis and note on the COC.

11 Quality Assurance

Refer to quality control requirements for the project to ensure that appropriate quality assurance and quality control (QA/QC) samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and
- Samples must be stored in appropriate transport bottles (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

11.1 Equipment Blanks (if relevant)

QA/QC sampling typically includes daily collection of equipment blanks using the laboratory-supplied “PFAS-free” water. For peristaltic pump tubing, laboratory supplied “PFAS-free” water should be poured into a clean HDPE sample bottle and then pumped through new HDPE tubing using the peristaltic pump (with new silicone tubing). The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFAS, after the sampling equipment has been appropriately decontaminated. Note that an equipment blank can also be collected if an unapproved or potentially suspect hazard control is needed for health and safety and it contacts a sample, i.e., that material would be exposed to PFAS free water then the water would be collected in a separate sample container.

11.2 Field Duplicates

QA/QC sampling typically includes the collection of one field duplicate for every 10 or 20 samples collected. Each duplicate sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-provided sample bottle. Do not indicate to the laboratory which sample the duplicate replicates, i.e., it should be given a blind reference on the COC and sample name such as “duplicate”.

11.3 Field Reagent Blanks

QA/QC sampling for PFAS typically includes the submission of one laboratory supplied field reagent blank per day. The field reagent blank sample is brought to the site in a laboratory-supplied sample bottle. Field staff

transfer the laboratory-supplied reagent blank to an empty sample bottle. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel and should be placed in the same cooler as the other PFAS samples.

11.4 Matrix Spikes (optional in some cases)

QA/QC sampling includes submitting a sample to be used as a matrix spike if the project requires it. If a separate sample bottle is required, an additional sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-supplied sample bottle.

11.5 Laboratory Analytical QA/QC

- Arcadis recommends that any request for PFAS analysis in groundwater or soil should be conducted by an ELAP-accredited method compliant with QSM 5.3 Table B-15. Requirements laid out in Table B-15 strictly govern acceptable laboratory data quality for PFAS analysis in environmental samples. **For all data collection efforts at DoD sites, PFAS data must be obtained using a method that is DoD ELAP-accredited under QSM 5.3 or later.**
- Laboratory QA/QC should consist of one laboratory blank and one laboratory control sample (or blank spike) per batch of samples, and additional QA/QCs as indicated by the laboratory QA/QC procedures.
- Isotope dilution should be used for quantification with isotope-labeled surrogate standards, as available, according to the guidelines of QSM 5.3 Table B-15. The USEPA has two drinking water methods (USEPA Method 537.1 and USEPA Method 533). Method 537.1 does not allow for isotope dilution but USEPA Method 533 requires isotope dilution.
- For drinking water, groundwater, and surface water samples, laboratories must extract the entire sample and include a solvent rinse of the bottle for analysis. Aqueous samples should generally not be sub-sampled prior to analysis, unless they are high concentration and require serial dilution (US DoD 2017).
- Soil samples should be analyzed in their entirety or thoroughly homogenized before extraction and analysis.
- As part of the internal QA/QC of laboratory results, relative percent difference (RPD) should be calculated between samples and corresponding field or laboratory duplicates. The laboratory quality assurance portion of the laboratory certificates should be reviewed to verify that all calculations/recoveries were within acceptable limits as established by the laboratory method and guidelines in Table B-15 of QSM 5.3 or later (USDoD 2019).

12 References

Arcadis Australia. 2017. Soil and Concrete Sampling for PFAS. April.

Arcadis. 2010. Monitoring Well Development, Rev. #2.2. March 22.

Arcadis. 2009. Investigation-Derived Waste Handling and Storage, Rev. #2. March 6.

Arcadis. 2011. Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells, Rev. #4. February 2.

ASTM. 2002. ASTM D6771-02 - Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (Withdrawn 2011). Available at: https://www.astm.org/Standards/D6771.htm.

California State Water Quality Control Board. 2020. Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidelines for Non-Drinking Water. September. https://www.waterboards.ca.gov/pfas/docs/sept_2020_pfas_sampling_guidelines.pdf

Department of Environment Regulation (DER). Government of Western Australia. 2016. Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). Contaminated Sites Guidelines. February.

Michigan Department of Environmental Quality (MDEQ). 2018. General PFAS Sampling Guidance. October. https://www.michigan.gov/documents/pfasresponse/General_PFAS_Sampling_Guidance_634597_7.pdf

Massachusetts Department of Environmental Protection (MassDEP). 2017. DRAFT Fact Sheet, Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. January.

New Hampshire Department of Environmental Services (NHDES). 2016. Perfluorinated Compound (PFC) Sample Collection Guidance. November.

United Nations Environment Programme (UNEP). 2015. PFAS analysis in water for the Global Monitoring Plan of the Stockholm Convention, Set-up and guidelines for monitoring. Jana Weiss, Jacob de Boer, Urs Berger, Derek Muir, Ting Ruan, Alejandra Torre, Foppe Smedes, Branislav Vrana, Fabrice Clavient, and Heidelore Fiedler. Division of Technology, Industry and Economics. Geneva. April.

United States Army Corps of Engineers (USACE). 2016. DRAFT – Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling. Revision: 1. March.

U.S. Army Corps of Engineers – Omaha District. 2016. Chemistry Requirements – PFAS.

U.S. Department of Defense (DoD). 2019. Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.3. In conjunction with the U.S. Department of Energy. May.

U.S. Environmental Protection Agency. 2009. USEPA Method 537: Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), version 1.1, September. National Exposure Research Laboratory, Office of Research and Development.

U.S. Environmental Protection Agency. 2010. Low Stress (Low Flow) purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells. Available at: https://www.epa.gov/quality/low-stress-low-flow-purging-and-sampling-procedure-collection-groundwater-samples-monitoring.

Transport Canada. February 2016, Per-and Polyfluorinated Alkyl Substances (PFAS) Field Sampling Guidance.

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TGI – Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells

Rev: 3

Rev Date: April 5, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 12, 2018	All	Updated and re-written as TGI with new branding and content	Marc Killingstad
	1	May 8, 2020	Pages 5, 10-11	Added clarification/details for equipment requirements and procedure steps based on USEPA guidance	Marc Killingstad
	2	April 5, 2022	All	Updated to new branding template and minor edits	Marc Killingstad
	3	April 5, 2023	All	Annual review completed by SME. Document version number and document date updated.	Marc Killingstad

Approval Signatures

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	Xuan Xu (Preparer)	Date
Reviewed by:		4/5/2023
	Marc Killingstad (Subject Matter Expert)	Date

1 Introduction

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures to purge monitoring wells and collect groundwater samples using the low flow purging/sampling methodology. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples will be obtained using a 0.45-micron disposable filter. Project teams will evaluate the last time the monitoring wells were developed and determine if additional development might be necessary. Water samples will not be taken immediately following well development. Sufficient time will be allowed for the groundwater flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well

construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations,such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar withrelevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

Specific to this activity, the following materials (or equivalent) will be used:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP) that includes site map, well construction records, sampling plan (sample analyses, sample volume required, and sample holding time), and prior groundwater sampling records (if available)
- Field notebook and/or smart device (phone or tablet)
- Low-flow sampling field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.)as specified in the HASP
- Well keys and other tools to remove manhole covers (manual torque wrench with 9/16” socket and flat head screwdriver typical)
- Photoionization detector (PID) or Flame ionization detector (FID) (as appropriate, depending onsite-specific constituents of concern)
- Electronic water-level indicator (e.g., Solinist Model 101) or oil/water interface probe with 0.01- foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen orlight non-aqueous phase liquid [LNAPL] is present)
- Down-hole multi-parameter water-quality sonde (temperature/pH/specific conductivity/oxidationreduction [ORP]/turbidity/dissolved oxygen) meter coupled with flow-through-cell for measurements, for example:

  - YSI 6-Series Multi-Parameter Instrument
  - Horiba U-22 Multi-Parameter Instrument.
  - Hydrolab Series 3 or Series 4a Multiprobe and Display.

  NOTE: *Transparent, small volume flow-through-cells (e.g., 250 milliliters or less) are preferred as they allow for easy detection of air bubbles and sediment buildup in the cell, which can interfere with the monitoring instrument probes. A small volume cell also allows for quick turnover of water in the cell between measurements of the indicator field parameters. It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.*

- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment
  - Non-phosphate laboratory soap (Alconox or equivalent), brushes, and clean buckets, and/or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the present items are clean
  - Distilled or de-ionized water for equipment decontamination
- Indelible ink pen
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Sampling pump, which may consist of one or more of the following:
  - Submersible pump (e.g., Grundfos Redi-Flo 2)
  - Peristaltic pump (e.g., ISCO Model 150)
  - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:
  - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery
  - Submersible pumps such as Grundfos require a pump controller to run the pump
  - Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N_2 or CO_2 gas cylinders)
- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used
  - For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) will be used through the pump apparatus
  - Teflon® will not be used when sampling for per- and polyfluoroalkyl substances (PFAS)
- Graduated cylinder and stopwatch or other device to measure time to determine pumping rate
- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- Sample labels and Chain-of-Custody forms (COC)
- 0.45-micron disposable filters (if field filtering is required)

- A supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020) may be required for specific projects and will be specified in the project FIP/ work plan and the kick-off notes.
    - If used, in-line 'T' and valve allows for collection of water for turbidity measurements before the pump discharge enters the flow-through cell

NOTE: *The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.*

6 Cautions

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. Itis the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

Weather

- If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rainwater could compromise groundwater samples.
- Avoid extreme weather situations. Be aware that thermal currents and vertical mixing of cold and warm water inside the well casing could create a convection cell within the well and compromise data collection (e.g., biological mechanisms).
    - Direct sunlight and hot ambient temperatures may cause the groundwater in the tubing orflow-through-cell to heat up and de-gas. This may result in the loss of volatile organic compounds (VOCs) and dissolved gases. Shade the equipment from direct sunlight, keep the tubing as short as possible and avoid the hottest times of the day.
    - Sampling during freezing conditions may adversely impact the data quality objectives. USEPA recommends low-flow sampling be conducted at air temperatures above 32°F (0°C) or taking special precautions to prevent groundwater from freezing in the equipment.

Cross-Contamination

- To mitigate potential cross-contamination, groundwater samples are to be collected in a pre- determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of up-gradient, then furthest down-gradient tosource area locations.
- Note that permanent markers could introduce volatile constituents into the samples*; therefore, indelible ink is recommended* to be used for labels on sample containers or sample coolers.
- When using a gasoline generator, this power source will be set-up at least 30 feet downwind from the well to avoid exhaust fumes to contaminate samples.

Pumps

- Preferred methods of extracting groundwater are adjustable rate, submersible pumps - such as centrifugal pumps or bladder pumps – constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e., Teflon®). However, *PTFE will not be used when sampling for per- and polyfluoroalkyl substances (PFAS). PTFE could contain PFAS*.

- When using a bladder pump for collecting VOCs and dissolved gases, “best practice” is to set-up the pump to deliver sufficient water to fill a 40 mL VOC vial.
- The use of peristaltic pumps will be based on the type of data to be collected. *Because the use a peristaltic pump can result in de-gassing of VOC and / or dissolved gases from groundwater, a different type of pump will be considered if these compounds are of concern.*
- *Manual or motor driven inertial pumping devices are not recommended because they cause greater disturbance during purging and pumping than regular pumps and are less easily controlled. This could cause a higher degree of data variability.*

Tubing

- When sampling for VOCs, SVOCs, pesticides, PCBs and inorganics, use of PTFE (Teflon®) or PTFE-lined tubing is preferred. However, PTFE tubing will not be used when sampling for PFAS.
- PVC, polypropylene or polyethelene tubing may be used when sampling for metals or other inorganics.
- Tubing with inside diameters of 1/4 or 3/8 inch is recommended because this will help ensure tubing remains water filled when operating at very low pumping rates.

General Precautions

- Store and/or stage empty and full sample containers and coolers out of direct sunlight.
- It may be necessary to field filter the groundwater for some parameters (e.g., metals) during collection, depending on preservation, analytical method, and project quality objectives. The task-kick-off notes and the FIP/work plan will list the samples that require field filtering.
- Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Over-tightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be always worn in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

Generators and cord and plug equipment will employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source will be equipped with other overcurrent protection means.

Overtightening of lids with Teflon® liners can cause the glass to shatter and create a risk for hand injuries.

8 Procedure

Field personnel will set up and perform low-flow sampling in accordance with the following procedures.

1. Review FIP and groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for each well to perform sampling as efficiently as possible (i.e., reach a stabilized pumping condition).
2. Calibrate field instruments according to manufacturer procedures for calibration and record calibration procedure and results in field log.
3. All equipment will either be new or decontaminated in accordance with appropriate guidance document *(TGI – Groundwater and Soil Sampling Equipment Decontamination)* prior to use.
4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
   a. Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
   b. Record well construction and conditions on the Low-Flow Sampling Field Form **(Attachment A)**.
5. Place clean plastic sheeting on the ground near the well to keep monitoring and sampling equipment off the surface unless the equipment is elevated above the ground (e.g., on a table).
6. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. If appropriate or required for site-specific conditions, insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
7. Measure and record the initial depth to groundwater prior to placing the pumps.
8. Prepare and install the pump in the well.

   NOTE: *Groundwater will be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet below ground surface), a submersible or bladder pump will be used, provided that the well is constructed with a casing diameter of at least two (2) inches (the minimum well diameter capable of accommodating such pumps). For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) will be used to purge and sample the groundwater. Bladder pumps are preferred over peristaltic and submersible pumps to prevent volatilization if sampling of VOCs and/or dissolved gasses is required. Purge water will be collected and containerized according to the direction of the project team.*

   a. For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air-line, sample discharge line, and safety cable prior to placement in the well. Attach the air-line tubing to the air-port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture. Attach and secure a safety cable to the eyebolt on the top of pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting

and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to unintended contamination.

b. If using a bladder pump, connect the air-line to the pump controller output port. The pump controller will be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power (if an on/off switch is present) and verify that all batteries are charged and fully functioning before starting the pump.

c. If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least two (2) feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

d. If using an in-line 'T' and valve, install between pump discharge water line and the bottom inlet port of the flow-through cell. Attach a short piece of tubing to the outlet. This set-up will be used to collect samples for turbidity readings.

9. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the multi-parameter water-quality sonde and make sure to record equipment/instrument identification (manufacturer and model number).

10. Before starting the pump, ensure that the water level inside the well has stabilized (i.e., measure the water level multiple times after deploying the pump in the well).

11. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified) and adjust the pumping rate to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement): the water level should stabilize, however, this is not always possible.

12. If the well diameter is of sufficient size, measure the water level every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping.

13. Maintain a steady flow rate to the extent practicable and do not break pump suction or cause entrainment of air in the sample.

14. Record pumping rate adjustments and depths to water.

    If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters; if the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position.

    For wells screened across the water table, the well may be pumped dry, and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

    For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 feet) is maintained and monitoring for stabilization of field indicator parameters can commence; if a lower stabilization level cannot be

maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen.

15. After water levels have stabilized and a sufficient volume has been purged (see note below), continue pumping and begin monitoring field indicator parameters using a multi-parameter water-quality sonde coupled with a flow-through-cell.

    NOTE: *The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.*

16. Use the flow to measure all indicator field parameters, except for turbidity, every 3 to 5 minutes (or after each volume of the flow-through cell has been purged or other appropriate interval); turbidity samples will be collected before the flow-through-cell using the T-valve and a clean container such as a glass beaker.

17. Record field indicator parameters on the groundwater sampling log.

18. The well is considered stabilized and ready for sample collection when three consecutive readings are within the following limits:

    - **Turbidity** within ± 10% for values greater than 5 nephelometric turbidity units [NTUs] or if three turbidity values are less than 5 NTUs, consider the values stabilized
    - **Dissolved Oxygen (DO)** within ± 10% for values greater than 0.5 mg/L or if three DO values are less than 0.5 mg/L, consider the values stabilized
    - **Specific Conductance** within ± 3%
    - **Temperature** within ± 3%
    - **pH** within ± 0.1 unit
    - **Oxidation/Reduction Potential (ORP)** within ±10 millivolts (mV)

    NOTE: *Alternate stabilization goals may exist in different geographic regions, consult the site- specific FIP/work plan for stabilization criteria).*

    NOTE: *While achieving turbidity levels less than 5 NTU and a stable drawdown of less than 0.3 feet is desirable, sample collection may still take place provided the indicator field parameter criteria in this procedure are met.*

19. If the parameters have stabilized but turbidity remains relatively high (e.g., greater than 50 NTUs), the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. If groundwater turbidity has been minimized (i.e., consecutive readings within ± 10%) and the values for all other parameters have stabilized, the well may be sampled; however, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

20. If after one (1) hour of purging indicator field parameters have not stabilized, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

    In general, three potential options are available if stabilization criteria are not met:

    a. Continue purging until stabilization is achieved.

    b. Discontinue purging, do not collect any samples, and record in field logbook/on the sampling form that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

c. Discontinue purging, collect samples, and provide full explanation of attempts to achieve stabilization. There is a risk that the analytical data obtained under these conditions, particularly metals and hydrophobic organic analytes, may reflect a sampling bias and, as a result, the data may not meet the data quality objectives of the sampling event.

NOTE: *DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); therefore, great care will be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater, again check for and remove air bubbles on the probe before re-measuring. The table below may be used as a general guide for DO values under various temperatures; however, understand that the table corresponds to freshwater solubility and groundwater contaminants may affect oxygen solubility. If DO value is 0.00 or less, then the meter will be serviced and re-calibrated. If DO values are above possible results, then the meter will be serviced and re-calibrated.*

NOTE: *During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field logbook/on the sampling form.*

NOTE: *If other field conditions are suspected of preventing stabilization of certain parameters, detailed observations will be documented in the field logbook/on the sampling form.*

Oxygen Solubility in Fresh Water

Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., Introduction to Environmental Engineering, PWS Publishing Company, Boston, 468 pages (1996)

21. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.
22. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container.
    a. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell will be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection.
    b. Under no circumstances will analytical samples be collected from the discharge of the flow- through cell.
    c. If an in-line ‘T’ and valve are used, the valve needs to be removed as well.

d. Samples will be collected in the following order: VOCs, total organic carbon (TOC), semi- volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific FIP/work plan).
e. When the container is full, tightly screw on the cap.

23. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample will be collected.
    a. Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected.
    b. Continue to run the pump until an initial volume of "flush" water has been run through the filter in accordance with the manufacturer's directions (generally 100 to 300 mL).
    c. Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container.
    d. When the container is full, tightly screw on the cap.
24. Secure with packing material and store the samples on ice in an insulated transport container provided by the laboratory and include a temperature blank in each container to be shipped.
25. Record on the Low-Flow Sampling Field Form (and bound field logbook) the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging **(see Attachment A)**.
26. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup.
27. Slowly remove the pump, tubing, lines, and safety cable from the well.
    a. If using dedicated tubing, do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.
    b. If using dedicated tubing, it will be folded - without pinching it - to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events.
    c. Use a length of rope or string to tie the tubing to the well cap.
    d. Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, coil the tubing neatly and placed in a clean plastic bag that is clearly labeled with the well ID ensuring the bag is tightly sealed before placing it in storage.
28. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.
29. Complete the procedures for packaging, shipping, and handling with the associated Chain-of- Custody.
30. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate *(TGI – Groundwater and Soil Sampling Equipment Decontamination).*
31. At the end of each day of the sampling event, perform calibration check of field instruments and record procedure and results in field log.

9 Waste Management

Materials generated during groundwater sampling activities, including disposable equipment and excess purge water, will be stored on site in appropriately labeled containers and disposed of properly. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage*, the procedures identified in the

FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field logbook.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Management of the original documents from the field will be completed in accordance with the site- specific QAPP.

In general, forms (e.g., Low-Flow Sampling Field Forms), logs/notes (including daily field and calibration logs), digital records, and Chain-of-Custody records will be maintained by the field team lead.

Field logs and Chain-of-Custody records will be transmitted to the Arcadis Project Manager and/or Task Manager, as appropriate, at the end of each day unless otherwise directed. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

11 Quality Assurance

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

Unless described otherwise in the project-specific FIP/work plan, QAPP, or Sampling and Analysis Plan, quality assurance/quality control samples will be collected as follows:

- One duplicate for every 10 samples
- One laboratory matrix/matrix spike sample for every 20 samples
- In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures will be observed in the field:
- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available
- Equipment blanks will include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well)
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled

- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures—calibrate instruments at the beginning of each day, verify the calibration at the end of each day, and record all calibration activities in the field notebook
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for equipment decontamination

12 References

USEPA. 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (September 1986).

USEPA. 1991. *Handbook Groundwater, Volume II Methodology*, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July 1991).

USEPA Region I. 2017. *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells (*EQASOP-GW4; September 19, 2017).

U.S. Geological Survey (USGS). 1977. *National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination*. Reston, Virginia.

13 Attachments

Attachment A – Low Flow Sampling Field Form

Attachment A

Low-Flow Sampling Field Form

GROUNDWATER SAMPLING FORM

Project No. _____ Well ID _____ Date _____

Project Name/Location _____ Weather _____

Measuring Pt. Description _____ Screen Setting (ft-bmp) _____ Casing Diameter (in.) _____ Well Material ____ PVC ____ SS

Static Water Level (ft-bmp) _____ Total Depth (ft-bmp) _____ Water Column (ft) _____ Gallons in Well _____

MP Elevation _____ Pump Intake (ft-bmp) _____ Purge Method: _____ Sample Method _____

Pump On/Off _____ Centrifugal _____ Submersible _____ Other _____

Sample Time: _____ Volume Purged _____

Purge Start _____ Gallons Purged _____ Sample ID _____ Sampled by _____

Purge End _____ Replicate/Code No. _____

Time	Minutes Elapsed	Rate (gpm)/(mL/min) 200mL/min +	Depth to Water (ft) -0.3	Gallons Purged	pH ± 0.1	Cond. (µMhos)/(mS/cm) ± 3%	Turbidity (NTU) ± 10%	DO (mg/L) ± 10%	Temp. (°C)/(°F) ± 3%	Redox (mV) ± 10mV	Appearance	
											Color	Odor
Stabilization Calculations (±)												
Stabilization Criteria					**± 0.1 s.u.**	**±3%**	**± 10% or within 1 NTU (1)**	**± 10%**	**±3%**	**±10 mV**		

(1) **Turbidity** < 50 NTU and ±10% or within 1 NTU of a previous reading when <10 NTU

Constituents Sampled	Container	Number	Preservative

Comments _____

Well Casing Volumes

Gallons/Foot					
	1" = 0.04	*1.5" = 0.09*	*2.5" = 0.26*	*3.5" = 0.50*	*6" = 1.47*
	1.25" = 0.06	*2" = 0.16*	*3" = 0.37*	*4" = 0.65*	

Well Information

Well Location: _____ Well Locked at Arrival: Yes / No

Condition of Well: _____ Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Stick Up Key Number To Well: _____

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U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
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Revision Page

Date	Rev #	Summary of changes	Sections
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1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase

liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection

may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in

the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume

cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the

minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be

changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and

continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods

(e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 μm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to

the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

Turbidity (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

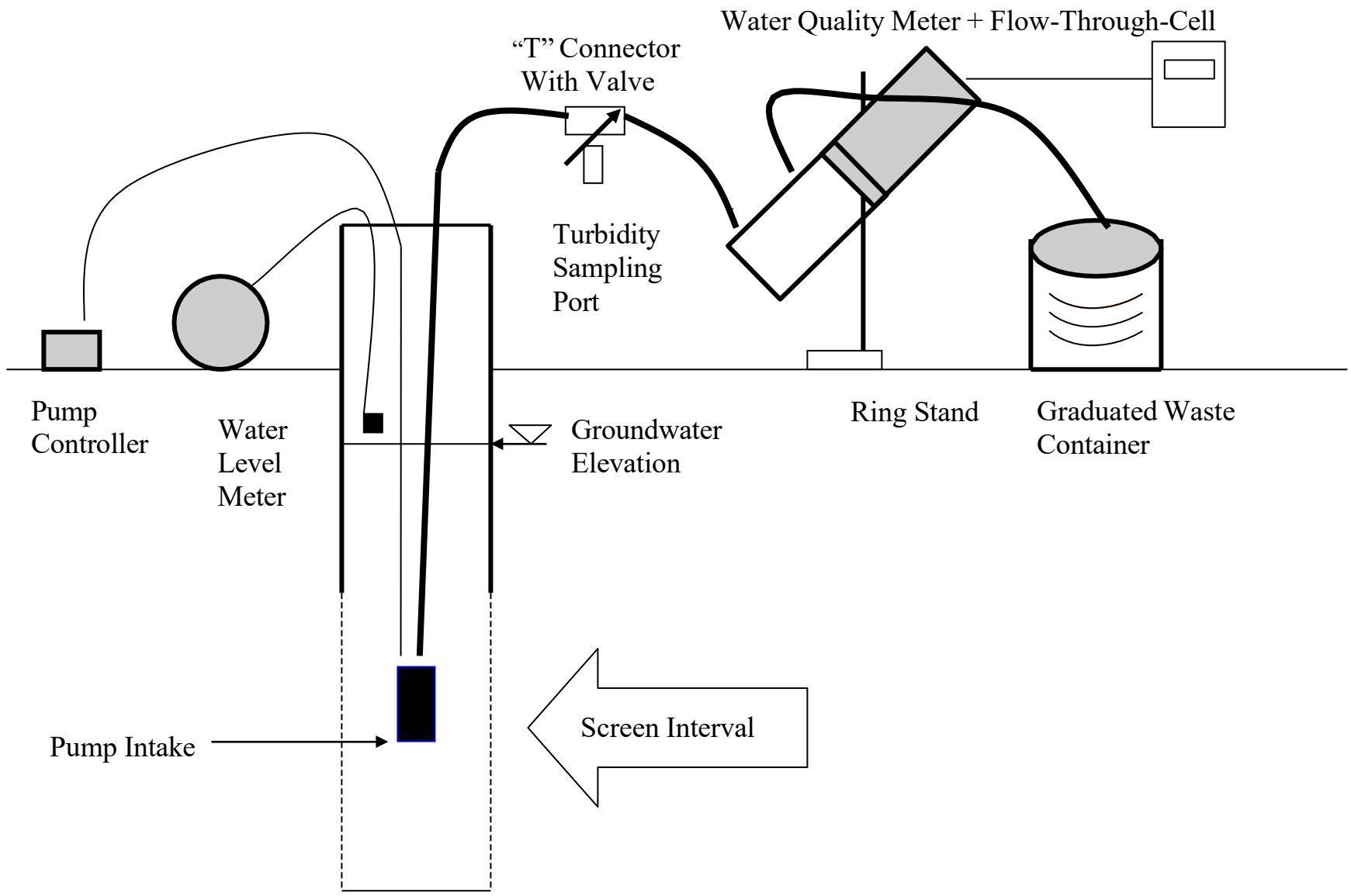
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)_____ Depth to _____/_____ of screen
Well Number_____ Date_____ (below MP) top bottom
Field Personnel_____ Pump Intake at (ft. below MP)_____
Sampling Organization_____ Purging Device; (pump type)_____
Identify MP_____ Total Volume Purged _____

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	±10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

TGI - Equipment and Reagent Blank Sample Collection for PFAS Analysis

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Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
--	0	October 2, 2018	All	TGI – Equipment and Reagent Blank Sample Collection for PFAS Analysis	Erika Houtz
Outdated template	1	December 10, 2021	All	Updated to current TGI format. Also updated sections to match the most recent TGI for PFAS Field Sampling Guidance (Arcadis 2021)	Kevin Engle
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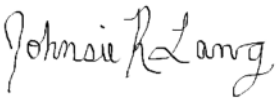
Approval Signatures

Prepared by:		2/21/2022
	Kevin Engle, PG (WY)	Date
Reviewed by:		2/21/2022
	Johnsie Lang, PhD (Subject Matter Expert)	Date

1. Introduction

This document is intended to provide guidance to field staff collected equipment blanks for Per- and Polyfluoroalkyl Substances (PFAS). The content in this document describes the intended use, scope and application, personnel qualifications, equipment, cautions, health and safety considerations, procedures, waste management, data recording and management, and quality assurance of PFAS sampling.

2. Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3. Scope and Application

Equipment and reagent blanks will be collected in the field during sampling activities and submitted for laboratory analysis. These samples are primarily intended to verify that sampling and decontamination practices are effectively preventing cross-contamination caused by reusable sample equipment or other per- and polyfluoroalkyl substances (PFAS)-containing materials.

The intent of this Technical Guidance Instruction (TGI) is to provide instructions for collection of equipment and reagent blanks. More detailed instructions related to general PFAS sampling considerations is provided in the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2021).

4. Personnel Qualifications

Equipment and reagent samples will be collected by persons who have been trained in proper sampling procedures under the guidance of an experienced field geologist, engineer, or technician. Blank sampling should be completed with a two-person sampling team.

5. Equipment List

The following equipment and materials must be available for equipment and reagent blank sampling:

- Site plan which specifies frequency/quantity of blank sampling;
- Relevant work plan (e.g., PQAPP);
- Site Safety and Health Plan (SSHP);
- Appropriate health and safety equipment, as specified in the SSHP;
- Laboratory-provided "PFAS-free" water;
- Nitrile gloves;
- Dedicated plastic sheeting (preferably low-density polyethylene) or other clean surface to prevent sample contact with the ground;
- Pail or bucket with closable lid for excess rinse water;
- Garbage bags;
- Appropriate sample containers and labels;
    - Labeled high density polypropylene (HDPE) sample bottles: see the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2021) for PFAS-specific considerations;
    - Ziploc®-style bags to hold ice and samples;
    - Packing and shipping materials;
    - Chain-of-Custody (COC) Forms; see the Sample Chain of Custody Standard Operating Procedure (SOP) for reference (Arcadis 2017a);
    - Appropriate transport containers (coolers) with ice and appropriate labeling; no blue ice is to be used.
- Decontamination:
    - Equipment cleaning materials: see the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2021) or the Groundwater and Soil Sampling Equipment Decontamination TGI (Arcadis 2017b) as applicable;
    - An organic solvent such as isopropanol, methanol, or acetone should be used to decontaminate reusable equipment if it can be brought to the site safely. While strongly recommended, the use of solvents may be excluded for project-specific health and safety concerns. Refer to Section 7.1.1 for more details.
    - Drum labels as required for investigation-derived waste handling: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c);

- Field Notes:
  - Pens, pencils, and/or fine point Sharpies® for writing;
  - Appropriate field forms;
  - Clipboards, field binders, field notebook, and field note pages that are not waterproof.

6. Cautions

In general, sampling techniques used for PFAS sample collection are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. The most important consideration during PFAS-related sampling is to prevent contact between sample media and suspect PFAS sources. During collection of equipment and reagent blanks, the sampled media (i.e., PFAS-free water) should not contact anything but the sample container. New nitrile gloves should be donned after handling of any non-dedicated sampling equipment; contact with contaminated surfaces; and whenever judged necessary by field personnel. When in doubt change your gloves. More detailed instructions related to general PFAS sampling considerations is provided in the TGI - Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2021).

7. Health and Safety Considerations

Field activities associated with equipment and reagent blank sampling will be performed in accordance with the SSHP, a copy of which will be present on site during such activities. Additional health and safety considerations can be found in TGI for PFAS Field Sampling Guidance (Arcadis 2021).

8. Procedure

The specific procedure for equipment and reagent blank sampling was developed after careful review and consideration of project data quality objectives. Procedures for equipment blank sampling and reagent blank sampling are further described in this section. Note: the laboratory has to analyze the entire sample bottle for aqueous solutions of PFASs. When collecting each blank, fill two sample bottles and instruct the lab to hold one of them in reserve. If an unacceptable detection occurs in a blank, the second bottle of sample may be analyzed.

For additional sampling considerations, reference the TGI for PFAS Field Sampling Guidance (Arcadis 2021).

8.1 Blank Sampling

8.1.1 Decontamination

Prior to collecting blank samples, the applicable piece of equipment should be properly decontaminated following these steps:

- Hand Tools and Sampling Devices (including hand augers and bladder pumps)
  1. Don new pair of nitrile gloves prior to decontamination
  2. Remove o-rings and bladder (applies only to bladder pump)

3. Scrub using a plastic brush and a non-phosphate soap free of volatile organic compounds (VOCs) (e.g., Liquinox, Alconox);
4. Double-rinse in deionized or distilled water;
5. Rinse once with the site-approved organic rinsing solvent (e.g., isopropanol, methanol, acetone);
6. Rinse once with PFAS-free water;
7. Collect all rinsate in a sealed pail for disposal;
8. Allowed time to air dry prior to re-use.
9. Insert new o-rings and bladder (applies only to bladder pump)

While strongly recommended, the use of solvents may be excluded for project-specific health and safety concerns. If solvents are prohibited, then additional procedures should be evaluated by the project team. Contingencies could include the use of dedicated sampling equipment at each sampling location or amending laboratory procedures to mitigate the increased risk of cross-contamination.

The following decontamination procedure could be utilized when organic solvent use is not possible:

1. Don new pair of nitrile gloves prior to decontamination
2. Remove o-rings and bladder (applies only to bladder pump)
3. Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox);
4. Single-rinse in deionized or distilled water;
5. Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox);
6. Rinse twice with deionized water and once with PFAS-free water;
7. Collect all rinsate in a sealed pail for disposal;
8. Allowed time to air dry prior to re-use.
9. Insert new o-rings and bladder (applies only to bladder pump)

- Drilling Rods
  - Drive casings and other drilling equipment will be steam cleaned or replaced with new equipment between boreholes.
  - The drilling equipment will be cleaned in an area designated by the supervising engineer or geologist that is located outside of the work zone.

After verifying the piece of equipment is properly decontaminated, and after determining an equipment blank is warranted per the sampling quality assurance / quality control (QA/QC) plan, follow the specific procedures for the relevant type of equipment found in the following sections.

8.1.2 Drilling Equipment (Hand Auger or Cutting Shoe/Drill Rod)

Two field personnel should participate in the collection of the equipment blank. One person (“Field Personnel #1”) should hold the sampling bottle and collect the sample, and the second person (“Field Personnel #2”) should pour the rinse water.

The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place the sealable bucket or pail on top of plastic sheeting.

4. Don a new pair of nitrile gloves prior to blank collection (Field Personnel #1 and #2). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
5. Open the sample container and position the piece of clean, decontaminated sample equipment (i.e., hand auger or drilling rod/cutting shoe) above the container (Field Personnel #1). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
    a. The bucket of the hand auger can be removed from the rods/handle and held manually.
    b. The drillers should assist the field staff with removing the cutting shoe from the drill string and positioning it for sampling.
6. Slowly pour laboratory-provided "PFAS-free" water over any surface of the decontaminated sampling device that previously contacted sampled material (Field Personnel #2).
    a. Pour water through the inside of the hand auger bucket while manually rotating the bucket so that "PFAS-free" water contacts all sides of the sampling device. Collect runoff in the sample container (Field Personnel #1), making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail.
    b. Pour water through the inside of cutting shoe while drilling contractor holds and manually rotates the shoe so that "PFAS-free" water contacts all sides of the shoe (Field Personnel #2). Collect runoff in the sample container, making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail.
7. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
8. Collect the second bottle with the same procedure (Steps 5 to 7), if collecting a backup.
9. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
10. Add sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
11. Place sealed Ziploc® bag into the sample cooler. Store PFAS samples in separate cooler from any other types of samples.
12. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

8.1.3 Reusable Sediment Sampling Equipment (Stainless-Steel Hand Tools, Petite Ponar Grab Sampler)

Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the rinse water.

The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place sealable bucket or pail on top of plastic sheeting.
4. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.

5. Open sample container and position the clean, decontaminated piece of sample equipment (i.e., hand tool, grab sampler) above the container (Field Personnel #1). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
6. Slowly pour the laboratory-provided "PFAS-free" water over any surface of the sampling device that contacted sampled material (Field Personnel #2).
    a. Pour water over front and back of all decontaminated hand tools such as spoons, spatulas, and trowels so that "PFAS-free" water touches all sides of the sampling device. Collect runoff in the sample container, making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail (Field Personnel #1).
    b. Pour water through inside of the decontaminated Petite Ponar Grab Sampler while rotating the sampler (or the "PFAS-free" water container) so that "PFAS-free" water contacts all interior sides of the sampler (Field Personnel #2). Collect runoff in the sample container, making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail.
7. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
8. Collect the second bottle with the same procedure (Steps 5 to 7), if collecting a backup.
9. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
10. Add the sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
11. Place sealed Ziploc® bag into the sample cooler. Store PFAS samples in separate cooler from any other types of samples.
12. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

8.1.4 Disposable Sediment Sampling Equipment (Lexan TM Liner Sleeve)

Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the rinse water.

The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep the bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place sealable bucket or pail on top of plastic sheeting.
4. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
5. Open sample container and position a clean, new, and unused section of LexanTM liner above the container (Field Personnel #1). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
6. Slowly pour laboratory-provided "PFAS-free" water over any surface of the sampling device that contacted sampled material (Field Personnel #2).

   a. Pour water through inside of Lexan TM liner while rotating the liner so that “PFAS-free” water contacts all interior sides of the liner. Collect runoff in the sample container, making sure that any excess “PFAS-free” water is contained in the sealable bucket or pail.
7. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
8. Collect the second bottle with the same procedure (Steps 5 to 7), if collecting a backup.
9. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
10. Add sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
11. Place sealed Ziploc® bag into the sample cooler. Store PFAS samples in separate cooler from any other types of samples.
12. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

8.1.5 Reusable Water Sampling Equipment (Peristaltic Pump, Bladder Pump, Stainless-Steel Bailer)

8.1.5.1 Peristaltic Pump

Two field personnel should participate in the collection of the equipment blank. One person (“Field Personnel #1”) should hold the sampling bottle and collect the sample, and the second person (“Field Personnel #2”) should set up the pump and pour/ transfer the blank water.

The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting other clean surface to prevent sample contact with the ground.
3. Don new pair of nitrile gloved prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
4. Pour laboratory-supplied “PFAS-free” water into a clean HDPE sample bottle (Field Personnel #2).
5. Insert new HDPE tubing into the HDPE bottle containing “PFAS-free” water and connect tubing to peristaltic pump (with new silicone tubing) (Field Personnel #2).
6. Open sample container, keeping the sample cap in the hand of the sampler until it is replaced on the bottle (Field Personnel #1).
7. Turn the peristaltic pump on and slowly pump the “PFAS-free” water into the labeled sample container (Field Personnel #2).
8. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
9. Collect the second bottle with the same procedure (Steps 6 to 8), if collecting a backup.
10. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.

11. Add the sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
12. Place sealed Ziploc® bag into the sample cooler. Store PFAS samples in separate cooler from any other types of samples.
13. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

8.1.5.1 Bladder Pump

1. Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should set up the pump and pour/ transfer the blank water.
2. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
3. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep the bottle lid on until immediately prior to sample collection.
4. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
5. Don new pair of nitrile gloved prior to blank collection (both field personnel). Do not use gloved hands to handle papers, pens, clothes, equipment, etc., before collecting samples.
6. Pour laboratory-supplied "PFAS-free" water into an approved container (to avoid PFAS cross-contamination) large enough to submerge the bladder pump.
7. After properly decontaminating the bladder pump and replacing the bladder, attach a new section of HDPE tubing to the bladder pump, long enough to hold and direct flow into the labeled sample container. Submerge the bladder pump into the approved container of "PFAS-free" water (Field Personnel #2).
8. Open sample container, keeping the sample cap in the hand of the sampler until it is replaced on the bottle (Field Personnel #1).
9. Turn the bladder pump on and slowly pump the "PFAS-free" water into the labeled sample container (Field Personnel #2).
10. After collecting the necessary sample volume, place cap back on the sample bottle. The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
11. Collect the second bottle with the same procedure (Steps 6 to 8), if collecting a backup.
12. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
13. Add sample to laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
14. Place sealed Ziploc® bag into the sample cooler. Store PFAS samples in separate cooler from any other types of samples.
15. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

8.1.5.2 Stainless-Steel Bailer

Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the rinse water.

The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place sealable bucket or pail on top of plastic sheeting.
4. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
5. Open sample container (Field Personnel #1) and position the bailer above the container (Field Personnel #2). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
6. Fill the stainless-steel bailer with enough laboratory-provided “PFAS-free” water to collect the necessary sample volume (Field Personnel #2).
7. Slowly pour laboratory-provided “PFAS-free” water from the stainless-steel bailer into the sample container (Field Personnel #2).
8. After collecting the necessary sample volume, place cap back on the sample bottle. The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
9. Collect the second bottle with the same procedure (Steps 5 to 8), if collecting a backup.
10. Place filled sample bottles in sealed Ziploc® bags, record any label information that was not pre-filled out, if necessary (e.g., sample time). Record the label information and time of sampling in the field notes and sampling forms.
11. Fill out the laboratory COC and check against the labels on the Equipment Blank sample bottle(s) progressively after each Equipment Blank is collected. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
12. Place sealed Ziploc® bag into the sample cooler. Store PFAS samples in a separate cooler from any other types of samples.
13. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

8.1.6 Field Reagent Blank Sampling

Two field personnel should participate in the collection of the reagent blank. One person (“Field Personnel #1”) should hold the sampling bottle and collect the sample, and the second person (“Field Personnel #2”) should pour the blank water.

This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep the bottle lid on until immediately prior to sample collection.
2. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
3. Open sample container, keeping the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle (Field Personnel #1).
4. Slowly pour laboratory-provided “PFAS-free” water from the laboratory-provided container into the sample container (“Field Personnel #2”).
5. After collecting the necessary sample volume, place cap back on the sample bottle. The bottle should be filled approximately full, but some headspace in the bottle is acceptable.

6. Collect the second bottle with the same procedure (Steps 3 to 5) if collecting a backup.
7. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
8. Add sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
9. Place sealed Ziploc® bag into the sample cooler. Store PFAS samples in separate cooler from any other types of samples.
10. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

9. Waste Management

Excess water generated during equipment and reagent blank collection procedures will be collected and contained on site in appropriate containers, (see the Investigation-Derived Waste Handling and Storage TGI for details [Arcadis 2017c]). All investigation-derived waste (IDW) generated will be placed in Department of Transportation approved containers, sealed, and labeled. Containerized IDW will be stored on site until it is profiled and subsequently transported to an approved facility for disposal or recycling. Waste manifests for all IDW suspected to have come into contact with PFAS should clearly note the presence of PFAS. Additional IDW sampling and management details will be provided in the site-specific Work Plan (QAPP addendum) and will be consistent with applicable client policies and requirements. Disposable personal protective equipment (e.g., gloves, disposable clothing, disposable equipment) will be placed in plastic bags. These bags will be transferred into appropriately labeled containers for appropriate disposal.

10. Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

If digital data collection isn't possible, waterproof field books should be avoided for field notes. Instead, field notes on loose paper on Masonite, plastic, or aluminum clip boards is preferred. Please note that newer Rite in the Rain® notebooks are approved for PFAS sampling. Other requirements for field notes include:

- Pens, pencils, and fine point Sharpies® may be used.
- Keep field notes and writing implements away from samples and sampling materials.
- Do not write on sampling bottle labels unless the sample bottle covers are tightly closed.
- Complete sampling logs in their entirety.

- Make sure COC forms are properly completed. Verify that the analysis method requested is US EPA Method 537.1 for potable water and includes the appropriate analytes desired for analysis.

11. Quality Assurance

Refer to quality control requirements for the project to ensure that appropriate QA/QC samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically:

- **Duplicate samples of each equipment blank and reagent blank should be collected and submitted to the laboratory with instructions to hold for analysis. The purpose of this sample is to provide analytical back-up in case there are any issues with the original blank sample.**
- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and,

Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc®-type bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

12. References

Arcadis. 2021. TGI – Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance. Rev. 9. October 22.

Arcadis. 2017a. SOP – Sample Chain of Custody, Rev. #1. May 23.

Arcadis. 2017b. TGI – Groundwater and Soil Sampling Equipment Decontamination, Rev. #0. February 23.

Arcadis. 2017c. TGI – Investigation-Derived Waste Handling and Storage, Rev. #0. February 23.

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TGI – Ground Penetrating Radar

Rev: 6

Rev Date: February 8, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
Initial Draft	1	March 2017	N/A	N/A	Grant Sprick
Review	2	March 22, 2017	N/A	See tracked changes	Brent Barker
Final Draft/Signatures	3	October 12, 2018	All	Modification to TGI format	Gregory Byer Brent Barker
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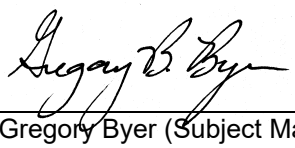
Revision/ Signatures	5	January 3, 2022	All	Update of Technical Guidance	Gregory Byer
Annual Update	6	February 8, 2023	All	Annual Update. Update Document Revision Number and Date.	Gregory Byer

Approval Signatures

Prepared by: 1/8/2023

Brent Barker (Preparer) Date

Reviewed by: 1/8/2023



Gregory Byer (Subject Matter Expert) Date

1 Introduction

This Technical Guidance Instruction (TGI) is intended to provide general guidance on the use of ground penetrating radar systems for environmental, engineering, and other applications requiring detailed imaging of the subsurface. U.S. Army Corps of Engineers (1995) provides technical background regarding the applicability of ground penetrating radar. This guidance is intended to be used to provide Arcadis CPMs and technical staff with a uniform set of procedures either in cases where Arcadis is subcontracting the data collection and processing or in circumstances where the CPM and affiliated technical staff are participating in a ground penetrating radar survey led by designated Arcadis geophysical specialists. Whether the data collection and processing are being subcontracted or performed in-house, directed by geophysical specialists, in all cases the non-geophysical CPM and/or technical staff should consult with Arcadis geophysical specialists for survey design and scoping, data management and processing, and proper data interpretation procedures. It should be noted that it is commonplace to perform ground penetrating radar surveys as a part of a larger scope of work that may include other geophysical techniques such as seismic, electrical resistivity, magnetics, electromagnetics as well as direct observation (ground truthing) with drilling and borehole geophysics.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

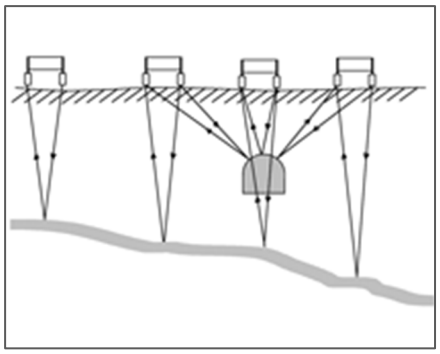
It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

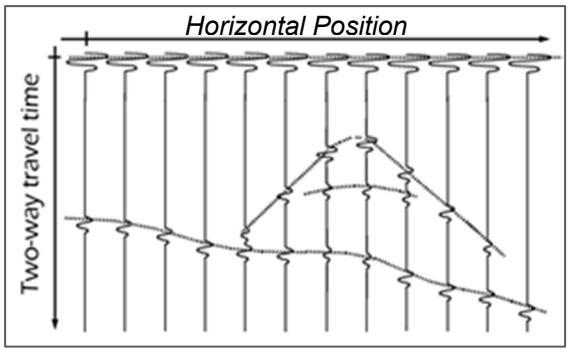
In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This Technical Guidance Instruction (TGI) document outlines the applications, limitations, and methodology for acquiring and interpreting subsurface data using ground penetrating radar (GPR). GPR is a non-invasive and non-destructive tool that transmits pulsed high frequency (generally between 100 and 1000 Megahertz [MHz]) electromagnetic waves into the ground and detects and records the energy returned to the surface with a frequency-matched receiver (see Table 1 for frequencies and applications). The transmitted pulse is reflected from boundaries that possess contrasting dielectric constants[1].



Field Data Collection with a pair of transmitter and receiver antennas moved laterally across the site



Resulting radargram with horizontal distance along the top and the two-wave travel time of the reflected radar pulses on the vertical axis

Reflections typically occur at lithologic contacts where there may be changes in water content and/or mineral composition. Table 2 contains examples of some geologic materials and their typical ranges of electromagnetic properties. Where subsurface materials have extremely high electrical conductivity and magnetic susceptibility including metal objects such as underground storage tanks (USTs), steel drums, and metallic utility pipes anomalously high amplitude reflections, as compared to geologic materials, are generally observed. Non-metallic pipes and utilities often produce weaker GPR reflections due to a lower contrast in dielectric constant between non-metallics and soil.

The two most common performance objectives GPR investigations are matching the survey design with the required depth of penetration and vertical and lateral resolution. For a given set of geologic conditions, both depth of penetration and vertical resolution are inversely related to the transmitter center frequency. The depth of penetration decreases with increasing frequency due to signal attenuation at higher frequencies. Vertical resolution is determined by the wavelength of the pulse. Since higher frequency will potentially yield better resolution, but a loss of total depth of penetration, a compromise in frequency selection may be the result. Conversely, a lower frequency will yield less vertical resolution while offering deeper penetration since attenuation will be lower. At some sites attenuation of the GPR signal may be the overriding limitation. As a rule, environments that are electrically conductive such where there is a high clay content or where the groundwater is groundwater high in total dissolved solids tend to offer the greatest signal attention and may be so severe as to limit the success of the GPR survey, regardless of frequency chosen. Environments with little or no clay minerals

[1] Strength of reflection is determined by a contrast in GPR velocity (see Table 2). At an electrical conductivity of zero, the reflection coefficient is $(V_2 – V_1)/(V_2 + V_1)$, where V_1 and V_2 are the GPR velocities of Layer 1 and Layer 2

or soil moisture, frozen ground, or massive non-conductive rock offer the greatest success to GPR surveys. Table 2 provides the electrical conductivity of some common geologic materials.

Table 1. GPR Antenna Frequencies and Applications	
Antenna Center Frequency (MHz)	**Typical Applications**
1000 or greater	Concrete studies (delaminations, condition of rebar, rebar dimensions, etc.), shallow void surveys (beneath pavement), bridge decking analysis, Subfloor utility investigations (floor drains, conduits, etc.)
500 to 1000	Ice and snow thickness mapping, forensics, search and rescue applications, shallow utility mapping
250 to 500	Search for underground storage tanks or other buried metals such as drums, utility mapping surveys, characterization of fill materials, search for excavations such as graves, roadway mapping, boring clearance work
100 to 250	Shallow geologic investigations, fracture mapping in rock quarries, stratigraphic analysis, fill and waste mapping
100 or less	Deep geologic investigations, permafrost investigations, glacial studies, mining applications

GPR units come in a number of configurations as shown below.

The most common type is a wheeled cart with both antennas in a closed housing (A-C). Low frequency antennas used for deep geologic work are generally large and are kept separate (D). Some units are designed to be towed with a skid plate (E). Units are also manufactured which contain multiple antenna pairs to increase data production (F). Positional control is usually managed using measuring tapes and ground markings, although it is also possible to gather the GPR data using a GPS unit (A). For most surveys where computer analysis is planned after the field activities, the data collection should be done in a methodical manner either in a series of parallel lines in a single direction or a grid of lines crossing at right angles to allow subsequent computer processing and analysis.

Table 2. Electromagnetic Properties of Earth Materials

Material	ε (dimensionless)	σ (mS/m)	Velocity (m/ns)	Attenuation (db/m)
Air	1	0	.3	0
Distilled Water	80	.01	.033	.002
Fresh Water	80	.5	.033	.1
Sea Water	80	3,000	.01	1,000
Dry Sand	3-5	.01	.15	.01
Wet Sand	20-30	.1-1	.06	.03-.3
Limestone	4-8	.5-2	.12	.4-1
Shales	5-15	1-100	.09	1-100
Silts	5-30	1-100	.07	1-100
Clays	5-40	2-1,000	.06	1-300
Granite	4-6	.01-1	.13	.01-1
Dry Salt	5-6	.01-1	.13	.01-1
Ice	3-4	.01	.16	.01
Metals	*	∞		∞

Table 1 Notes:
1. Intrinsic properties of earth materials at GPR frequencies are:
   ε = relative permittivity, also known as dielectric constant (dimensionless)
   σ = electrical conductivity in mS/m
2. Simplified equations for attenuation (a) and velocity (V) (at low loss) are:
   $V = (3x10^8)/\varepsilon^{½}$
   $a = 1.69\sigma/\varepsilon^{½}$
3. mS/m = milliSiemens per meter | m/ns = meters per nanosecond | db/m = decibels per meter
4. Information Source: U.S. Army Corps of Engineers (1995)

4 Personnel Qualifications

GPR investigations should be conducted by qualified and experienced operators, such as an experienced field technician and/or geophysicist. The GPR operator should be experienced in evaluating data quality in the field and be able to adjust data acquisition procedures in response to variable site conditions in order to identify anomalies and resolve target features. Inexperienced Arcadis personnel directing or supervising GPR data acquisition or interpreting processed GPR data should seek appropriate guidance and technical peer review from qualified and experienced personnel available from the relevant members of the Subsurface Investigation Community of Practice.

5 Equipment List

The following equipment will be available, as required, during GPR surveys.

- Personal protective equipment (PPE), as required in the site Health and Safety Plan (HASP).
- Appropriate data collection forms (paper or electronic), field instructions, site plans, field notebook or tablet, spray paint or other means for ground marking of control grid, engineering tape measure, traffic cones or other visible markers for visual control of alignment.
- Specific GPR systems matched to project objectives and site conditions. There are a number of options; however, if Arcadis is self-performing the data collection, a geophysical specialist must be consulted prior to renting equipment (unless company owned) to assure that proper equipment and adequate familiarity with use of that equipment exists. Each manufacturer has their range of products, many of which are designed with specific applications in mind. In general, Arcadis will require that GPR data be stored and downloaded in digital format for later processing. Not all manufacturers offer data storage, and use of those GPR systems is discouraged. The most common acceptable GPR system manufactures include (not comprehensive and subject to change):
    - GSSI – https://www.geophysical.com
    - Sensors & Software – https://www.sensoft.ca
    - Mala - https://www.guidelinegeo.com/products/category/mala-ground-penetrating-radar-gpr/
- A primary and secondary antenna, of appropriate signal frequencies to match anticipated dimension and depth of objective(s). For example, it is good practice to have a 400-500 MHz antenna available at the project site if using a 200-250 MHz antenna in the event that conditions allow use of the higher frequency antenna as needed. Another example is if the lower frequency antenna is used as the primary reconnaissance antenna for mapping the entire site, and the higher frequency antenna is used for follow-up detailed mapping of select anomalous areas found with the lower frequency antenna. This second example is particularly relevant in the situation where the rate of travel of the GPR unit is limited by the memory buffer capacity of the unit (typically the demands on data streaming and store increase with antenna frequency).
- Optionally, a GPS unit which can be mounted to the GPR system for integration of GPS position into GPR data files (if option is available).
- Data processing software for use in the field and office. Generally, each GPR manufacturer has developed proprietary software to process their particular GPR system. Arcadis currently has licenses for Radan (GSSI), Ekko_Project (Sensors & Software), and Reflex (a general seismic and GPR processing program capable of converting most manufacturer-specific formats to industry standard formats). Other software for other GPR systems may be available for short term rental for specific projects. Note that GPR data processing is a highly specialized task and requires an experienced geophysical specialist to perform this task. The scope of GPR processing is beyond the scope of this TGI.

6 Cautions

The effectiveness of GPR is highly site-specific due to a number of possible types of interference and may be subject to the skill level of the operator in certain environments. Reliability and efficiency are enhanced when used in conjunction with other geophysical methods and/or direct observations. Soils with elevated electrical conductivity rapidly attenuate the radar energy, reducing the penetration depth and resolution. Clayey soils and

saturated soils, particularly when high in dissolved solids, can significantly limit or even negate the applicability of GPR. Other potential interference sources include subsurface debris, rebar reinforced concrete, above ground, particularly overhead, reflective metal objects (cars, surface water, transmission lines, canopies, ceilings, etc.), and sources of electromagnetic signal (electrical generators, radio transmitters, etc.).

Both metallic and non-metallic utilities may be imaged by GPR under proper conditions. However, it should be noted that due to differences in the electromagnetic properties of materials (dielectric constant, see above), locating a non-metallic utility (e.g., plastic, vitrified clay tile, etc.) may be more difficult than a metallic pipe because of a low contrast in dielectric constant between non-metallics and soil. A general guideline for effective locating depth for utilities is 1-inch (2.5 cm) diameter of utility can be discerned for each foot (0.3 m) down to the maximum depth of penetration (highly site specific). For instance, one may expect to resolve a utility 10 inches (25 cm) in diameter at a depth of 10 feet (3 m) *if the maximum depth of penetration allows*. This is a general rule of thumb that can be applied to both metallic and non-metallic utilities but should be used cautiously as the type of material can affect the resolution. It is critical to perform initial testing to determine the total depth of penetration prior to beginning the methodical data collection process.

Also, the presence of reinforcing bar (rebar) in concrete can limit or negate the ability to resolve utilities present below the concrete. The resolution of smaller diameter pipes found within or just below the concrete may be completed masked by the strong reflections generated by the rebar.

Working inside of buildings can be especially challenging due the multiple surfaces (walls and ceilings) and fixtures above ground. The operator must know how to account for unwanted data artifacts. Generally, the GPR velocity in air is about 3 to 4 times faster than in the subsurface. For example, a metallic ceiling located 12 feet above the floor will appear in the GPR data at a position in the two-way travel time as a subsurface “depth” of about 3 to 4 feet. Remember, GPR records two-way travel time of the GPR pulse, which is converted to depth based on a measured or assumed GPR wave velocity.

Standing water is problematic. Typically, if a GPR unit is passed through a puddle of standing water a strong ringing response will be recorded, often obscuring subsurface information entirely.

7 Health and Safety Considerations

Minimize physical hazard exposure through use of proper PPE as prescribed in the HASP. Maintain awareness of other potential hazards associated with the physical location where the GPR investigation is being conducted and any ingress or egress conditions.

8 Procedure

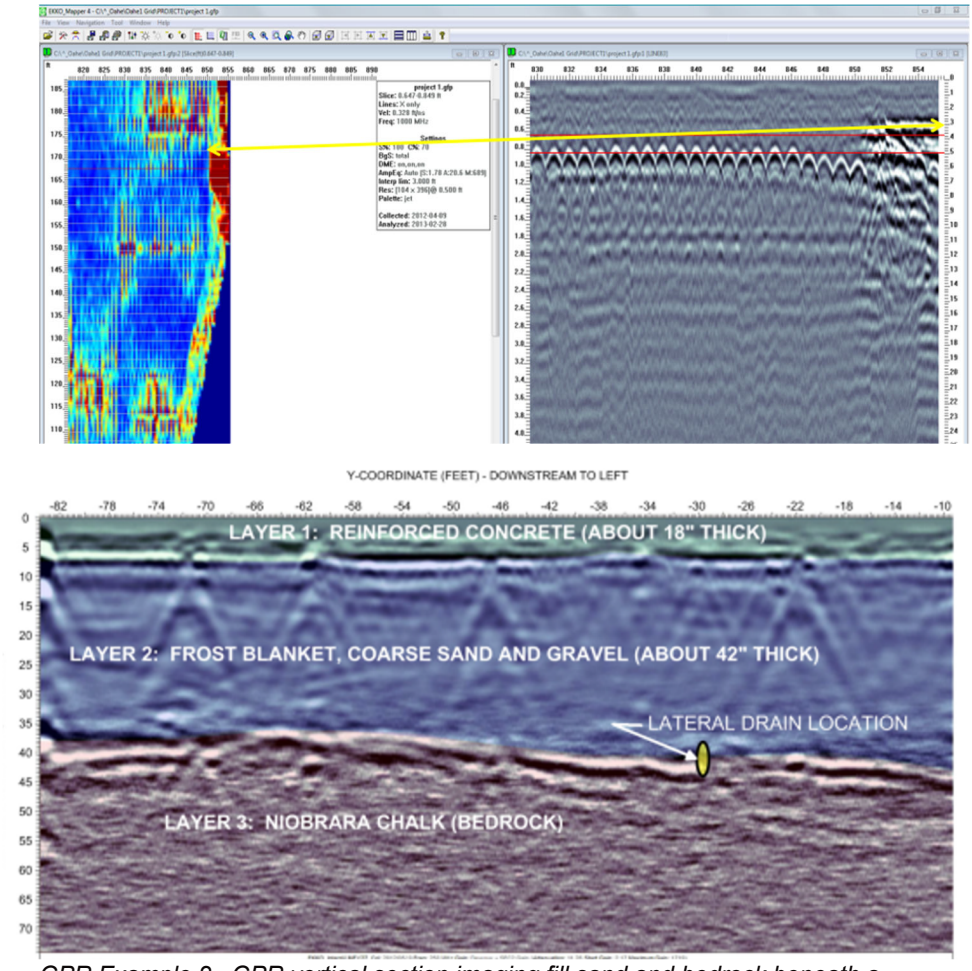
1. Become familiar with the details of the applicability and limitations of GPR.
2. Evaluate site-specific soil information to determine suitability of soils (clay content, saturation, TDS of groundwater) for GPR. In general, soils with greater than 35% clay content are considered restrictive, and soils with less than 10% clay content are considered favorable for reasonably deep penetration with GPR.
3. Evaluate meteorological information regarding recent or forecasted precipitation that could impact soil moisture content and GPR effectiveness. Standing water in paved areas is a condition that may limit or delay the GPR survey. Schedule GPR surveys appropriately.

4. Perform site reconnaissance in advance to identify potential sources of surface interference such as reinforced concrete, large metal objects, electrical equipment, overhead utilities, canopies, etc.
5. Consider complimentary technologies to supplement GPR and provide multiple lines of evidence. Geophysical technologies may include radio frequency tracing, magnetics, electromagnetic surveys, or electrical resistivity surveys. Direct observation (under proper health and safety guidance) is also an appropriate means of ground-truthing.
6. Employ only qualified and experienced GPR operators. For utility locating and mapping applications, the GPR operator should be specifically experienced in evaluating data quality and identifying anomalies in the field requiring variations in data acquisition procedures to positively interpret and locate targets of concern. If uncertain of a subcontractor's capabilities, consult with an Arcadis geophysical specialist.
7. Consider the depth and size of subsurface target features being sought with GPR. Attempt to match the signal frequency to the expected depth and size of the subsurface features. Change antenna as necessary for variable depths and sizes of target objects. Consider the selection of a primary and secondary choice of antennas and use multiple antennas as necessary. Test GPR at well-known, confirmed utility locations as means to verify depth of penetration. GPR wave velocity can also be confirmed by passing over a known utility, assuming it can be imaged.
8. Establish a reference grid over the area to be investigated and identify traverse locations in the field notebook or on a site plan map. It is preferable to perform a bidirectional grid. That is, lines collected both along the X and Y axes. The line separation should be a constant value based on the project objectives and the frequency of the GPR antenna. It is preferable to create a grid that has parallel base lines to minimize distance measurement errors.
9. Most GPR systems are equipped with an odometer to keep track of the distance moved. It is important to confirm the accuracy of the odometer calibration and adjust if necessary. This is done by laying out a measuring tape along a level, smooth surface and traversing a known distance. Recalibrate as needed.
10. Select and input a dielectric constant or average velocity into the GPR unit based on knowledge of the type of subsurface materials. Bear in mind that the dielectric constant or velocity is an approximation based on assumed subsurface materials and may vary based on the variability of the subsurface materials. The dielectric constant or velocity is necessary to estimate the depth of a target but should be considered an approximation not an absolute. Multiple passes over a known utility may be necessary using different dielectric constants before an accurate depth to a target can be estimated. Some manufacturers include the ability to perform hyperbola fitting to estimate dielectric constant or velocity from data collected in the field, and if this option is available, it should be used during initial testing.
11. Depending on the system and antenna frequency, the pace at which the GPR unit is moved along a traverse may affect the target resolution. It is recommended that an initial starting pace should be approximately 1.5 feet (0.5m) per second and modified if necessary, during field operations. Appropriate pacing can be determined in advance if the size of the smallest target is known.
12. Record GPR data while slowly pushing or pulling the antenna along each survey traverse. It is good practice to annotate periodic grid crossings using the system's ability to create fiducial markers. This is especially important for long traverses or locations where the ground surface is rough.
13. The data collection approach is generally one of two types.
    a. One approach, often used by utility location specialists, is to walk in a systematic pattern and mark out targets as they are found using paint or some other means. Once the area of interest is marked out, complete the survey by going back and storing key transects in the system memory for final reporting.

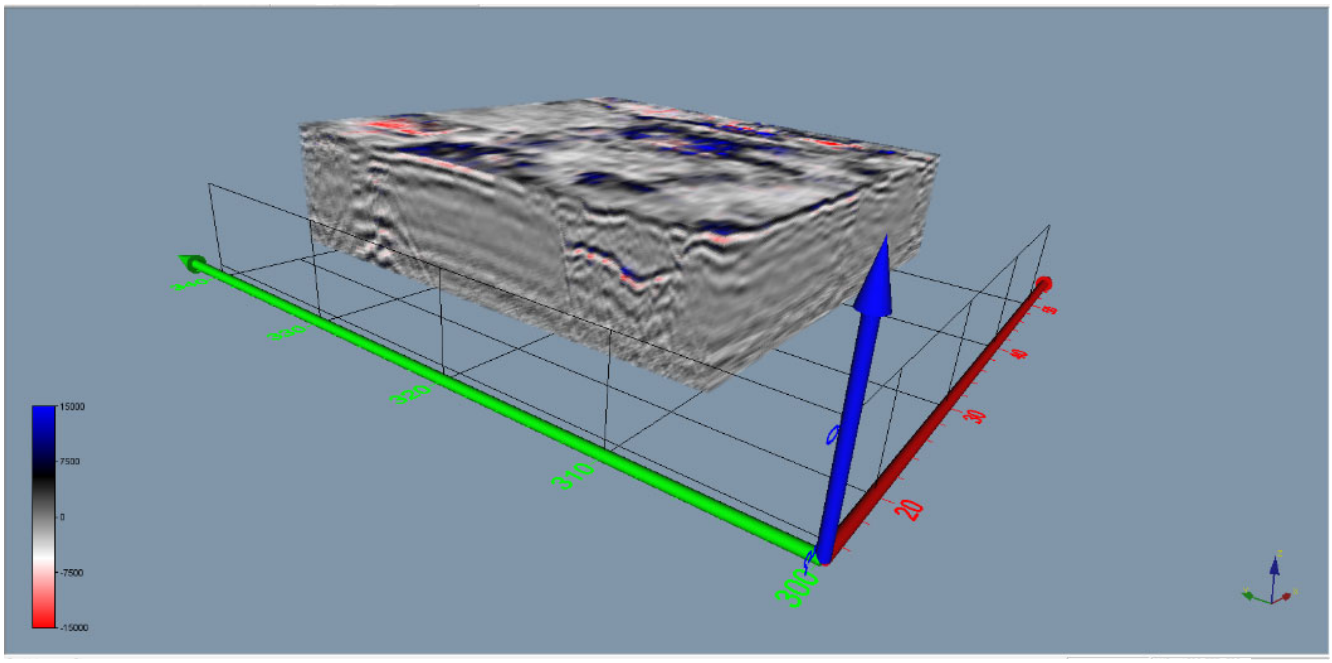
The locations of the final stored traverses should be properly surveyed either by high resolution GPS and/or triangulated using engineer tapes tied to known locations. This first approach is most appropriate for marking out USTs relatively simple utility patterns.

b. The second approach is applicable to mapping large areas, complex utility layouts, fill mapping, or other geologic objectives such as mapping a bedrock surface. In such circumstances the best practice is to layout a control grid and optionally using GPR mounted to the GPR system. The grid can either be a series of parallel lines at right angles to a known fabric, or if conditions are unknown, a bidirectional grid of lines at orthogonal orientations. It is important to start and end the GPR unit at marked out grid points and to keep good notes about the data collection process. Long lines should also be supplemented with fiducial marks at intermediate grid crossings. It is anticipated in this approach that data will be stored in memory and processed using appropriate GPR processing software as mentioned above.

14. For projects where a complete grid of data is stored (13b above), the results may be interpreted either as a series of horizontal slice maps or 3-dimensional data sets. Most contemporary software has the capability of digitizing discrete objects or horizons on a line-by-line basis, after which the interpretations can be exported to a vector drawing format such as DXF or SHP files in the form of 3D points and polylines. Below are examples of GPR outputs.



GPR Example 2. GPR vertical section imaging fill sand and bedrock beneath a concrete slab (250 MHz antenna).



GPR Example 3. 3D GPR image showing two vertical sections and horizontal slice at a crossing of a waste burial pit (250 MHz antenna).

9 Waste Management

GPR is a non-invasive procedure and should not result in the generation of derived wastes. Any trash or rubbish generated during the course of field activities should be disposed of in a proper trash receptacle.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

During GPR data collection, the GPR data files are stored in a memory within the manufacture's data logging computer. Generally, each traverse of the GPR unit is stored as a separate, uniquely named file. Often the file naming scheme either encodes the geometric information related to the data grid or a sequential naming scheme. Accurate note taking should be performed to assure that file names are properly associated with the grid notations. At periodic points during the GPR survey, it is best practice to download and backup the GPR data

files to a company laptop and at least daily to copy the GPR data files and field notes to a secure SharePoint drive on the Arcadis system.

11 Quality Assurance

The following quality control procedures should be observed:

- Seek appropriate input prior to conducting a GPR survey to identify site-specific features (soil conditions/sources of interference) that may impact data acquisition.
- Operate all equipment in accordance with manufacturer's instructions and recommended procedures. Record all system components (Unit, antennae frequency, etc.) information in the field book or a pre-made field form.
- Regardless of which data collection approach is taken, data quality should always be checked in the field to identify factors that may require adjustment to the data acquisition procedures. Make appropriate adjustments to data acquisition methods to achieve survey objectives, as feasible.
- It is recommended that the operation and performance of the GPR equipment is field checked (if possible) by locating existing underground utilities or structures of known depth, size, and construction. These characteristics should be similar to that of unidentified target objects.
- Data interpretation should undergo peer review by appropriate qualified and experienced personnel.

12 References

U.S. Army Corps of Engineers (1995). Geophysical Exploration for Engineering and Environmental Investigations, Engineering Manual (EM) 1110-1-1802.

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TGI - Manual Water-Level and NAPL Monitoring

Rev: 4

Rev Date: March 1, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
0	0	October 11, 2018	All	Updated and re-written as TGI	Marc Killingstad Everett H. Fortner III
1	1	May 8, 2020	All	Updated and added NAPL gauging	Marc Killingstad Everett H. Fortner III Andy Pennington
2	2	April 5, 2022	All	Formatting and Revisions	Martha Wulftange
3	3	December 22, 2022	11	Data Management	Martha Wulftange
4	4	March 1, 2023	All	Annual review completed by SME. Updated document revision number and date on all pages.	Everett H. Fortner III

Approval Signatures

Prepared by:

3/1/2023

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Date

Reviewed by:

3/1/2023

Marc Killingstad, PE (Subject Matter Expert)

Date

1 Introduction

This TGI describes the equipment, field procedures, materials, and documentation procedures to measure and record water-levels using an electronic water-level probe or an oil-water level indicator. This TGI also describes procedures for measuring in-well thicknesses of non-aqueous phase liquid (NAPL), both light and/or dense (LNAPLs and DNAPLs, respectively).

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

The objective of this Technical Guidance Instruction (TGI) is to describe procedures to measure and record water-levels (groundwater and surface-water) using manual water-level meters. Water levels may be measured using an electronic water-level probe or an oil-water level indicator from established reference points (e.g., top of casing). Reference points must be surveyed to evaluate fluid level elevations relative to a vertical datum (e.g., North America Vertical Datum of 1988 [NAVD88] relative to sea level). This TGI also describes procedures for measuring in well thickness of NAPL and DNAPLs.

Surface water-levels can be measured from stilling wells or fixed points (bridges, walls, etc.) and measuring from an established point of reference using a water-level meter. In some cases, surface water water-levels may be determined from a graduated stream gauge, attached to a pole located in open water with known elevation, without the use of a water-level meter.

The use of pressure transducers or other automated devices for the collection of groundwater elevation data will be subject of *TGI – Water-Level Monitoring using Pressure Transducers and TGI – Water-Level Measurements using Sonic Meters.*

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The HASP and other documents will identify other training requirements or access control requirements.

5 Equipment List

The following field equipment is suggested for water-level measurements:

- Site-specific Health and Safety Plan (HASP).
- Appropriate personal protective equipment (PPE) as specified in the HASP.
- Electronic water-level indicator graduated in 0.01 ft. increments.
- Electronic oil-water (interface) level indicator graduated in 0.01 ft. increments, if necessary.
- Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean buckets or clean wash tubs.
- Distilled or de-ionized (required for some sites) water for equipment decontamination.
- Photoionization detector (PID) and/or organic vapor analyzer (optional).
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement) – if required for total depth measurements of deeper wells.
- Solvent (methanol/acetone/isopropyl alcohol) rinse – optional.
- Spray bottle for solvent - optional
- Plastic drop cloth (e.g. Weatherall Visqueen) to place beneath the buckets or tubs to reduce potential for contamination of the tape or probe.
- Tools and/or keys required for opening wells.
- Well construction summary table and/or well construction logs.
- Summary table of previous water-level measurements.
- Field notebook and/or smart device (phone or tablet) or appropriate field forms (see Attachment 1).
- Indelible ink pen

6 Cautions

Electronic water-level indicators and oil-water interface probes may sometimes produce false-positive readings. For example, if the inside casing surface of the well or stilling tube has condensation above the water level, then an electronic water-level probe may produce a signal by contacting the sidewall of the well, rather than the true water-level surface. For accuracy, the electronic water-level probe and/or interface probe should be raised and lowered several times at the approximate depth where the instrument produces a tone indicating a fluid interface to verify consistent, repeatable results (three or more times). Additionally, some wells may be constructed with a sump. If local/regional groundwater levels have declined such that the water-level is below the base of the well screen, a sump may still contain water and provide an erroneous measurement. Therefore, possessing and comparing measurements with a well construction summary table or well construction log is recommended for proper reporting.

If the presence of a NAPL is known or suspected within specific wells, do not use an electronic water- level indicator. Use an oil-water interface probe instead. If NAPL presents ignition or explosion hazards, an intrinsically safe oil-water interface probe is required to be used with grounding and following the manufacturer's instructions.

If the NAPL is known to be very viscous or problematic to gauge, the data quality will require additional consideration prior to measuring. Staff will consider the data quality objectives for the gauging activity – e.g., if quantifying NAPL thickness is necessary, or if assessing the presence/absence is sufficient.

Alternate NAPL measurement methods (such as using drop pipes or temporary coatings for down-well equipment) may be considered.

When measuring total well depths with an electronic water-level indicator, the measurement must have a correction factor applied for post processing or completed at the time of measurement that is equal to the length of the probe beneath the circuit closing electrodes (if applicable to the instrument). This is necessary because the tape distance markings are referenced to the electrode, rather than the end of the probe. Some newer instruments do not have an offset electrode and this correction factor is needed. In addition, total depth measurements are difficult with wells that have large water columns due to buoyancy issues. In addition, the total depth measurement will include notes that indicate a soft or hard bottom if recognized during the measurement.

Ensure that the type of electronic water-level indicator is compatible with the depth and diameter of the wells to be measured. Some smaller piezometers or larger diameter well stilling tubes will accommodate only smaller diameter probes.

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel. Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or oil. Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife). Appropriate personal protective equipment (PPE) will be worn during these activities. Only use non-toxic peppermint oil spray for stinging insect nests. Open well caps slowly and keep face and body away to allow to vent any built-up pressure. Field personnel will thoroughly review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives.

Obtaining measurements from active pumping wells requires knowledge of the construction and design, as the indicator probe and tape can become intertwined within down-well equipment (such as pump impellers) causing a serious health and safety hazard and equipment damage. Ensure that stilling wells have a perforated end and capped bottom to inhibit tape from extending into the downhole pump depth. If a stilling tube is not present or the still tube construction is not known, determine a conservative “not to exceed” measurement depth based on the top of pump depth with an added safety factor. If all information is not known, a water-level will not be taken from the pumping well until clarification on depths are available.

8 Procedure

Calibration procedures and groundwater level measurement procedures for electronic water-level indicators and oil-water indicators are described in the sections below. Calibration documentation can berequested from the rental or manufacturer.

Calibration Procedures

If the indicator requires length and markings verification is required by project data quality plan or other reasons, then the following steps may be used:

- Measure the lengths between each increment marker on the indicator with a measuring tape. The appropriate length of indicator measuring tape, suitable to cover the depth range for the wells of interest, will be checked for accuracy.
- If the indicator measuring tape is inaccurate, the probe will require to be sent back to the manufacturer or rental company. If a replacement can’t immediately be available, then an offset can be measured to correct the measurements.
- If multiple water-level indicators and/or oil-water interface probes are being used for an event, calibration of the multiple devices will be required by measuring a water-level at a single well contemporaneously with all indicators to be used and calculated correction factors provided for data processing (typical corrections are small and range from 0.01 to 0.03 foot).
- Equipment calibration will be recorded in the field logbook and/or smart device.

Water-Level Measurement Procedures

The general procedures to be followed for the collection of fluid level measurements and well depths from the monitoring wells are as follows:

- Check that the water-level/oil-water level indicator battery is functional, before mobilization and prior to each work day (e.g., turn power on and check that meter sounds when probe is lowered into a bucket of water – note that water-level meters will not work with low-electrical-conductivity liquids such as distilled water).
- Record instrument make, model, serial number, and (if present) Arcadis ID number in the field form or electronic field form.
- Don disposable nitrile gloves. Decontaminate the water-level/oil-water indicator, any attached tape and the spool with laboratory-grade soap and distilled water (see Initial Decontamination Procedures below). The spool requires caution with cleaning as it is not water-proof and can be damaged during cleaning.

- The top of the monitoring well will be cleaned with a clean rag to prevent loose particulate matter from falling into the well.
- Perform a well inspection (note that a well inspection form may be required to be filled out along with a photo to document the conditions).
- Place clean plastic sheeting on the ground next to the well.
- Unlock and/or open the monitoring well cover while standing upwind from the well (note that some wells may be under pressure and precaution should be taken with opening well caps – see Section 6).
- Measure the volatile organics present in the monitoring well head space with a PID and record the PID reading (if applicable and requirement for the site).
- Allow the water-level in the well to equilibrate with atmospheric pressure for a few minutes (check previous field forms or field books for equilibration time, if noted).
- Locate the measuring reference point that correlates to the survey point on the well casing. If one is not found, make a reference point by notching the highest and/or north point on the inner casing (or outer if an inner casing is not present) or mark with a permanent mark. All downhole measurements will be taken from the reference point. Document any changes or new reference point addition.
- Measure to the nearest 0.01 foot and record the height of the inner well casing and outer protective casing to ground level (note that some well pads are raised and are not at true ground surface).
- Lower the indicator probe into the center of the well until contact with the water surface is indicated by either an audible alarm or light. The sensitivity of the probe may need adjustment if the alarm or light is not strong signal. Use and install a tape guide (available from some manufacturers) to help with accuracy and provide protection with damaging the measurement tape. If a tape guide is not available, make sure that the tape does rub on the inner or outer casing which could fray and damage the tape.
- If an oil-water interface probe is being used to measure depth and thickness of NAPL, lower the interface probe into the center of the well until a contact with the NAPL surface is indicated by either audible alarm or light. The sensitivity of the probe may need adjustment if the alarm or light is not strong signal. To gauge the water level in a well which contains LNAPL (LNAPL-water interface), advance the interface probe past the LNAPL-water interface until the probe produces a solid audible alarm indicating water. While slowly retrieving the probe upward, the equipment will produce a different tone when the LNAPL-water interface is reached (typically this is a multiple alarm sound or flashing light). This level should represent the depth to water. The depth indicating the bottom of the water column and top of DNAPL layer, if any, is indicated by the multiple alarm signal or flashing light emitted by the interface probe.
- Hold the tape at the measuring point and repeat the measurement two more times.
- Read and record measurement to the nearest 0.01 foot. Check the measurement with previous measurements, if available, and note any anomalies/discrepancies; if significant, contact the project staff.

- Measure and record total depth of well (see Total Depth Measurement Procedures below); note that measurement of total depth is not always performed at wells containing LNAPL or DNAPL, in order to reduce decontamination of the instrument and reduce potential exposure to NAPL.
- Record all measurements (with date and time collected to the nearest minute) and note any inconsistencies/anomalies and relevant observations in the field notebook and/or smart device or appropriate field forms.
- Follow decontamination procedure outlined below before measuring subsequent wells (see
- Decontamina*tion after Water Level and Total Depth Measurements* below).
- Replace cap and lock the well when all activities are completed.

Total Depth Measurement Procedures

- Weighted tape or electronic water-level indicator can be used to measure the total well depth.
- Follow initial procedures noted above in Water-Level Measurements above.
- Lower indicator probe (or tape) until weighted end is resting on the bottom of the well. Raise indicator slowly until there is no slack in the tape. Gently estimate the bottom of the well by slowly raising and lowering the indicator: great care should be taken to avoid damaging the sensor on the probe. The operator may find it easier to allow the weight to touch bottom and then detect the 'tug' on the tape while lifting the weight off the well bottom.
- Because of tape buoyancy and weight effects encountered in deep wells with long water columns, it may be difficult to determine when the probe is in contact the bottom of the well and sediment in the bottom of the well can also make it difficult to determine total depth. Care must be taken in these situations to ensure accurate measurements.
- If total depth measurements are to be collected during low-flow sampling events, the measurement will be made only after low-flow sampling has been completed or at least 12 hours prior to initiating sample collection from the well, in order to minimize: 1) mixing of the stagnant water at the top of the well column with potential formation water underneath; and/or 2) agitation and subsequent entrainment of possible sediment collected at the well bottom).
- Read and record measurement to the nearest 0.1 foot. Please refer to the note regarding total depth measurements described in Section 5 Cautions above.
- Follow decontamination procedure outlined below before gauging the next well (see Decontaminationafter *Water Level, NAPL Level, and Total Depth Measurements* below).

Initial Decontamination

- Note that there may be project specific decontamination procedure documents that will be followed in lieu of the below procedures.
- Set up a decontamination station consisting of three clean buckets (e.g., 5-gallon buckets). The buckets should not be used to containerize purge water; they will be used for decontamination purposes only.
- Fill the first bucket with one gallon of distilled water (use deionized water if metals are a contaminant at the site) and add non-phosphate laboratory-grade soap. Fill the second bucket

with distilled water (use deionized water if metals are a contaminant at the site) and leave the third bucket empty. Place the drop cloth underneath.

- Unwind the entire tape from the spool into a bucket with non-phosphate laboratory-grade soap and distilled water; Brush the tape carefully to remove dirt and possible contamination, using a brush dedicated to the wash bucket.
- Carefully brush all dirt of the spool and wipe down with a soapy cloth or paper towel.
- Transfer the tape into the second bucket containing rinse water. Carefully brush the tape using a second brush, dedicated to the rinse bucket. Lift the tape out of the bucket and allow rinse water to drip off the tape.
- Transfer the tape to the third bucket. Wind the tape onto the spool while wiping excess water off the tape using a paper towel.

Decontamination after Water Level, NAPL Level, and Total Depth Measurements

- Set up a decontamination station consisting of three clean buckets, fill according to the initial decon procedure.
- Unwind the only the length of tape used for gauging from the spool into a bucket with laboratory-grade soap and distilled water. Brush the tape carefully to remove dirt and possible contamination, using a brush dedicated to the wash bucket.
- Continue as described above.
- Extra care should be taken to clean the probe after a total depth measurement. All sediment or dirt needs to be removed during decontamination.
- If an oil-water interface probe is used to gauge NAPL, a solvent may be necessary to remove all NAPL residue. After decontaminations steps above, use a spray bottle filled with chosen solvent (ex. isopropyl alcohol) and spray across all surfaces of the tape. Use paper towels to wipe off solvent and/or residue. This step may be repeated if necessary.

Notes:

- Collect equipment blanks if required by the work plan (minimum 1 per 20 samples or 1 per sampling event).
- Prepare new wash solution and rinse water when necessary (e.g., every 10 to 20 wells). The spent wash and rinse solution should be discharged according to site practices.
- The decontamination station may be expanded by adding extra rinse and/or detergent stations (i.e., solvent wash station) to the set up. The addition of more stations depends on the requirements of the work plan or the site-specific Field Sampling and Quality Assurance Plan and outlined in the project field plan or kick-off meeting.
- Small crates or washtubs are a possible substitute for the buckets. In any case, it is recommended to use containers with a lid.

9 Waste Management

Decontamination fluids, PPE, and other disposable equipment will be properly stored on site in labeledcontainers and disposed of properly. Be certain that waste containers are properly labeled and documented in the field log book. Review *TGI – Investigation Derived Waste Handling and Storage*, foradditional information and state- or client-specific requirements.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Field personnel will complete all applicable field forms for each test (see attached forms and FieldNow® available forms). Forms will include recommended data file naming protocol per the field implementation plan. Data that has been collected must be transmitted at the end of the day (notes/forms/data file). The files must be transmitted to the appropriate project directory (via direct transfer or email to data manager). Work completed that day and any relevant observations noted during the daily activities as well as copies of the data mentioned above should be summarized and provided in an email. The appropriate team member will review the data for accuracy and provide feedback. Field equipment calibration, decontamination activities, and waste management activities will be recorded in the field notebook, appropriate field form, or daily log.

Refer to the Quality Procedure Data Management, QP 4.09, for additional information on data management.

11 Quality Assurance

Suggested quality control measures are below; project teams may implement some or all of these at their discretion and based on project data quality needs.

- As described in the detailed procedure, the electronic water-level meter and/or oil-water interfaceprobe can be calibrated prior to use versus an engineer's rule to ensure accurate length demarcations on the tape or cable. The results will be recorded.
- Measurements will be completed three times, with the final measurement recorded.
- Fluid interface measurements will be verified by gently raising and lowering the instrument through each interface to confirm repeatable results.
- Field notes will be reviewed by the project team once the field data has been delivered.

12 References

Cunningham, W.L., and Schalk, C.W., comps., 2011. *Groundwater technical procedures of the U.S.Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 pp*.

U.S. Environmental Protection Agency, 2013. *SESD Operating Procedure, Groundwater level and WellDepth Measurement.* January 29.

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TGI - In-Situ and Ex-Situ Water Quality Parameters – Surface Water and Groundwater

Rev: 1

Rev Date: April 15, 2022

Version Control

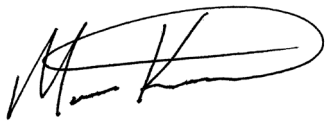
Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 16, 2018	All	Updated and re-written as TGI (in-situ and ex-situ adaptation)	Marc Killingstad
	1	April 15, 2022	All	Review and update to include surface water turbidity sensors	Shannon Dunn / Marc Killingstad

Approval Signatures

Prepared by: 4/15/2022

Chris Shepherd, PG — Date

Reviewed by: 4/15/2022



Marc Killingstad (Subject Matter Expert) — Date

1 Introduction

This Technical Guidance Instruction (TGI) describes methods used to measure water quality parameters in surface water as well as groundwater both in-situ and ex-situ.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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3 Scope and Application

Water quality parameters (e.g., turbidity, specific conductivity, pH, and temperature) of natural waters are usually measured in the field. The temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation reduction potential (ORP) and turbidity of water will be measured in-situ or ex-situ with amultiparameter water quality meter (i.e., multimeter).

Conductivity is the ability of a solution to pass an electric current. This current is carried by inorganic dissolved solids. The measurement is useful to quantify the chemical purity of the water relative to the amount of dissolved solids in a solution. Generally, temperature-compensated conductivity, termed specific conductivity, is measured by a water quality meter. Specific conductivity can also be used to estimate total dissolved solids (TDS) in solution

(grams per liter or g/L) by multiplying the specific conductivity (measured in milli-siemens per centimeter or mS/cm) by 0.65 or a matrix specific factor, which assumes that sodiumchloride is a reasonable surrogate for the dissolved solids in solution.

Measuring the concentration of DO in water is an important component in evaluating the quality of naturalas well as contaminated waters. The effects of wastes on rivers/streams, the suitability of water for fish and other organisms, as well as the effects of remediation efforts, can often be ascertained from the DO content. Dissolved oxygen levels generally range from 5 to 9 milligrams per liter (mg/L) when measured inwater that is in equilibrium with air, depending on the temperature and barometric pressure; however, levels may be lower in a 'reducing' environment where anoxic conditions exist in water (e.g., gasoline plume undergoing bioremediation). DO is measure in both mg/L and percent.

The measurement from an ORP sensor represents the net status of all the oxidation and reduction reactions in the sample being measured. Positive results indicate an oxidizing environment while negativeresults indicate a reducing environment. ORP is determined by measuring the potential of a chemically- inert electrode which is immersed in the solution. The sensing electrode potential is read relative to the reference electrode of the pH probe and the value is presented in millivolts (mV).

ORP meter results can indicate possible contamination and can be particularly useful if it is known that one component of the sample is primarily responsible for the observed value. For example, excess chlorine in a sample will result in a large positive ORP value while the presence of hydrogen sulfide willresult in a large negative ORP value. Together with pH, temperature, and knowledge of the dominant species in a sample, ORP results help predict the oxidation state of ions in solution and whether certainreactions may take place.

Temperature readings will be taken at each water sampling location to assist understanding the water quality as well as compensating measurements. A thermometer is typically part of the multimeter. If not,a temperature probe or thermometer will be used.

Turbidity is a measure of the relative clarity of water. It is an optical measurement of the amount of light scattered in the water. Turbidity is often used as a proxy for the amount of suspended particles in the water. Turbidity is typically reported in nephelometric turbidity units (NTUs) or Formazin Nephelometric Units (FNUs).

Refer to the appropriate TGI(s) for surface water sampling and/or groundwater sampling, if applicable. In addition, the water quality instruments should be cleaned in accordance the manufacturers specifications and the *TGI for Groundwater and Soil Sampling Equipment Decontamination* and all investigative derived wastes (IDW) should be managed in accordance with project plans.

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP), Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the field sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

The following materials, as required, will be available during field measurement of water qualityparameters:

- Site-specific HASP and health and safety documents identified in the HASP (e.g., job safetyassessments [JSAs])
- Field Implementation Plan (FIP) that includes site map with sampling locations, well constructionrecords (table or logs), sampling plan, and prior sampling records (if available)
- Field notebook, pen(s) (indelible ink) and/or smart device (smart phone or tablet, see Section 10)
- Field laptop / smart device / data manager, as appropriate
- Water Quality Measurement Log (**Attachment 1**) or smart device with a digital form; alternatively, the surface water sampling or groundwater sampling form may be used, if appropriate.
- Water Quality Meter Calibration Log (**Attachment 2**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) asspecified in the HASP
- Traffic cones, delineators, and caution tape as appropriate for securing the work area as specified inthe Traffic Safety Plan (TSP)
- Well key(s), as needed
- Photoionization detector (PID), flame ionization detector (FID) or other air monitoring equipment, asneeded, in accordance with the HASP
- Plastic sheeting (e.g., Weatherall Visqueen) or other clean surface to prevent sampling equipment from coming in contact with potentially contaminated surfaces, as needed
- Multiparameter (temperature/pH/specific conductivity/ORP/turbidity/DO) water quality meter or sondewith flow-through cell (as appropriate) plus reader and protective housing, for example:
    - YSI Professional Plus Multiparameter Instrument
    - YSI EX01 or EX02 Multiparameter Sonde
    - Horiba W-22 XD Multiparameter Instrument
    - Hydrolab DS5 Multiprobe and Display

- Turbidity meter (e.g., Lamotte 1974) and sample vessels, as required by FIP or QAPP.
    - Some multiparameter meters have a turbidity sensor; however, the team must verify the sensor will meet the data quality objectives in the FIP or QAPP.
- Operation manual(s) for meter(s)
- Water quality meter extension cable (as needed for in-situ readings of wells)
- Standard solutions for calibration, check expiration dates
- Multimeter maintenance kit and extra DO membranes if using amperometric DO probe
- Extra batteries for the various instruments and/or charging cables
- Electronic water-level indicator (e.g., Solinist Model 101) or oil/water interface probe with 0.01-foot accuracy), as needed
- Tape measure, as needed
- Cleaning equipment (buckets, distilled or deionized water, cleansers appropriate for removingexpected chemicals of concern, paper towels), as needed.

6 Cautions

NOTE: *Proper operation and maintenance are very important for a functioning meter and accuratereadings. Carefully follow manufacturer's instructions for operation (including down-hole use), maintenance, and calibration as each manufacturer's instructions will vary. Some meters require periodic manufacturer calibration.*

Verify the meters meet the project data quality objectives in the FIP and QAPP. In some cases, it may be necessary to use a separate turbidity meter (nephelometer) or higher accuracy and precision meter(s) if the measurements are intended to be used for compliance purposes.

Verify the meter is intended for in-situ measurements (i.e., can be fully submerged in water) and that all necessary parts are available prior tofield mobilization. Check and record the expiration dates of calibration fluids. Verify that calibration readings are reasonableand correspond to previous calibration readings when available. Expired or contaminated calibration fluids may result in erroneous results. If accurate measurements of TDS are required, site-specific calibration will be necessary in accordance with the manufacturer's specifications.

When taking measurements in the field, verify that readings make sense and compare to historicalreadings when possible. See Section 3.

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal PPE will be worn at all times in line with the task and the site-specific HASP. Also, at a minimum, wear latex gloves and safety glasses when working with calibration solutions.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells and some surface water bodies may expose field personnel to hazardous materials such as contaminated groundwater ornon-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around wellhead), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

If working near surface water bodies, it may be necessary to use personal flotation devices and/or use additional safety measures. Consult with the HASP and JSA for site- and task-specific health and procedures.

If working at a site with hazardous levels of volatile organic compounds, headspace and/or breathingzone readings will be measured prior to working at/in the well, in accordance with the HASP.

8 Procedures

This Procedures Section is divided into:

- General Procedures – calibration, operation, and maintenance procedures that apply to all methods and meters
- Calibration – general calibration procedures for:
    - Multimeter
    - Separate turbidity meter, if required
- Operation – general measurement operations for:
    - Ex-situ measurements
        - Multimeter
        - Separate turbidity meter, if required
    - In-situ measurements (downhole/well or submerged applications)
- Maintenance
    - Multimeter
    - Turbidity meter

8.1 General Procedures

The following, general procedures apply to most instruments regardless of whether measuring in-situ or ex-situ. For groundwater, most measurement are conducted ex-situ (i.e., not within the groundwater well/aquifer). It is also possible to use in-situ measurements for some parameters and ex-situ measurements for other parameters. If in-situ measurements are carried out, a special probe and/or cables are required.

- Read through all relevant procedures before field implementation and familiarize yourself with the equipment
- Verify all equipment is present and the instrument is fully functioning prior to field mobilization, if possible
    - Check batteries/power levels
- The meter(s) should be cleaned prior to each use in accordance with cleaning and decontamination procedures as specified in the FIP or QAPP and in accordance with the instruction manual.
    - Most meters can only handle light washing with a mild soap and warm water.
    - After cleaning the sensors should be soaked in distilled/deionized water and then rinsed in distilled/deionized water. The recommended soaking periods vary depending on the sensor (see Section 8.2)
    - It is recommended that you temporarily store the probes in distilled/deionized water uses between measurements as some probes like conductivity require long soaking periods (see Section 8.2).
- The meter will be calibrated following the manufacturer's instructions as calibration steps vary bymanufacturer
    - Probes should be rinsed with a small amount of the calibration solution and then discard that used solution prior to calibration, if applicable. This will reduce cross-contamination of the calibration solution during calibration
    - Two or three-point calibrations are preferred over single point calibrations, where applicable. See Section 8.2 and should be selected based on expected water quality
    - Verify calibration solutions, if applicable, are not expired
    - Caution: calibration solutions should not be reused as it can cross-contaminate the solution unless authorized by the QA/QC manager
    - Ensure the sensor is completely submerged in the calibration solution, if applicable
    - Calibration information will be recorded in the calibration log (Attachment 2) and the field notebook
    - More frequent calibration may be necessary in harsh conditions or per project plans
    - Barometric verification or calibration may be required for some instruments
- The meter will be operated following the manufacturer's instructions
- Multimeters can be operated in-situ (down-hole, in water, etc.) or ex-situ (water is transferred to container for measurement)
    - Ex situ operation is described in Section 8.3.1
    - In situ operation is described in Section 8.3.2
- The meter will be maintained according to the manufacturer's instructions
    - Maintenance information will be recorded in the field notebook or instrument log
    - Manufacturer recalibration or replacement probes may be required on a routine basis
    - Additional details for pH, conductivity, temperature, dissolved oxygen, and turbidity maintenance

are presented in section 8.4 Maintenance below

- More frequent maintenance (probe replacement, sensor reconditioning, etc.) may be necessary in harsh conditions or per project plans

- A replacement meter and probes will be available onsite or ready for overnight shipment, as necessary
- Store the meters in accordance with manufacturer's specifications
    - Most multi-meter sensors should be stored with a small amount of water in the cap to keep it moist but not saturated/submerged.

The complete procedures are described in Section 8.2 through 8.4.

8.2 Calibration

8.2.1 Multimeter Calibration

1) Connect cables from meter to reader
2) Check probes and ensure they are clean
3) Switch on instrument and allow to warm-up, warm up may take from 5 to 15 minutes depending on the instrument and sensors used
4) Check battery life and replace, if needed
5) Adjust date/time, if needed
6) Soak all probes in distilled or de-ionized water for at least 5 minutes (some probes may requirelonger soak times, see below and manufacturer instructions) and then shake off excess liquid
    i. NOTE: *If the probes are recently reconditioned or have slight build-up, allow for longer soaking period*
7) Navigate to calibration display/mode; enable auto stabilization feature, if appropriate
8) **pH Calibration** – when in use, the pH meter will be calibrated daily, at a minimum.
    a. Connect electrode (if applicable) or remove protective cap from electrode
    b. Rinse end of electrode in distilled/deionized water and shake off excess water
    c. Measure and record temperature of buffer solutions
    d. Immerse pH electrode in pH buffer 7.00, set the temperature to that of the buffer 7.00, andallow sufficient time for the electrode to stabilize
    e. Adjust the calibration for the correct readout and temperature
    f. Confirm/press the calibration button
    g. Remove electrode from buffer and rinse with distilled/deionized water
    h. Immerse pH electrode in buffer 4.00, set the temperature control to that of the buffer 4.00,and allow sufficient time for the electrode to stabilize

i. Adjust the calibration for the correct readout and temperature

j. Confirm/press the calibration button

k. Rinse electrode with distilled/deionized water

l. A pH 10 calibration will also be performed if high pH (>9) is anticipated, following manufacturers procedures

m. The pH meter is calibrated

9) **Conductivity Calibration** – when in use, the conductivity meter will be calibrated daily, at aminimum.

a. Conductivity is generally measured in specific conductivity (temperature compensated),verify with the FIP/work plan

b. Soak the probe in distilled/deionized water for at least 30 minutes

c. Remove the probe from the water and fling out drops clinging inside

d. Immerse the probe to or beyond the vent holes in a beaker containing 1.413 mS/cmstandard solution for freshwater measurements or a standard with a higher concentration for marine water, and gently agitate vertically to remove entrapped air

e. Repeat Steps 3 and 4 at least once more

f. Press calibration button

10) **Temperature calibration** – temperature will be verified according to FIP/work plan, if applicable.

11) **Dissolved Oxygen (DO) calibration** – when in use, the DO meter will be calibrated daily usingthe air calibration method or less frequently if using an optical sensor (see below).

a. Preparation

i. Polarographic sensor – periodically recondition sensor, replace fluids, and Teflon®membrane, per manufacturer, and air bubbles should not be present

ii. Galvanic sensor – Periodically recondition sensor, replace fluids, and membrane,per manufacturer, and air bubbles should not be present

iii. Optical sensor – Per manufacturer, most will only require field checks and maintenance, however, weekly checks are recommended to verify the accuracy, ata minimum

b. Obtain a barometric pressure reading from a daily weather report or from the instrument,as required by instrument

c. Keep instrument upright and vent cap/cover while retaining a small amount of clean water(do not cover probes) for non-optical sensors only

d. Allow 5 to 15 minutes for optimum probe stabilization and polarization, for non-optical sensors (reading will range between 5 to 9 mg/L depending on temperature and barometricpressure)

e. Press calibration button if reading is more than 2% from the standard

12) **Oxidation reduction potential (ORP) calibration** – when in use, the ORP meter will becalibrated daily, if required.
    a. Rinse the probe in distilled/deionized water
    b. Remove the probe from the water and fling out drops clinging inside
    c. Immerse the probe in the ORP solution. Gently agitate vertically to remove entrapped air.
    d. Adjust calibration target based on temperature in accordance with manufacturer and calibration solution guide
    e. Allow the sensor to equilibrate to solution
    f. Press calibration button if reading is more than 2% from the standard
13) **Turbidity, if used** – when in use, turbidity sensor will be checked daily and calibrated weekly, at aminimum
    a. Verify with the FIP/work plan if the turbidity sensor will be used and the proper units (NTU, FNU, etc.)
    b. Gently clean the sensor to remove and sediments or buildup and then rinse the sensor with distilled/deionized water one to two times
    c. Remove the probe from the water and fling out drops clinging inside
    d. Next do a final rinse with the calibration solution starting with lower calibration solution and dispose of the used solution.
    e. Immerse the probe in the calibration cup with the guard. It is important to calibrate with the guard on or verify the cup is designed to match the guard as turbidity measurements are affected by the dimensions and reflectivity of the guard. Verify the there are no air bubbles.
    f. Repeat Steps c, d, and e at least once more with higher turbidity calibration solutions
    g. Press calibration button
14) Adjust the instrument to READ or LOGGING mode, per instruction manual and project plans; theinstrument is now ready for use
15) Record the calibration on the field form or smart device.

8.2.2 Turbidity Meter Calibration (if required)

When in use, the turbidity meter will be checked daily and calibrated weekly. The turbidity meter will be calibrated per steps below:

1) Switch on instrument and allow time to warm-up
2) Check battery life and replace, if needed
3) Turbidity sample tubes will always be washed prior to use, but not the calibration standard tubes,using a mild detergent to remove any dirt or fingerprints that could bias the results
4) Dry the outside of the sample turbidity tubes with a clean, lint-free cloth or disposable wipe (non-scratch)

andallow the turbidity tubes to air-dry in an inverted position to prevent dust from entering the tube,as allowable (but, not the calibration standard tubes)—dirt or fingerprints can lead to inaccurateresults.

5) Wipe the 1 NTU standard and place in the chamber after aligning the arrows (manufacturer dependent)

6) Place the light shield over the turbidity standard and allow the meter to stabilize

7) Press the read and/or CAL button, per instructions

8) Repeat steps 3 thru 5 above

9) Adjust to READ mode and the instrument is now ready for use

10) Record the calibration and/or verification in the calibration log.

8.3 Operation

Water quality parameters can be measured ex-situ or in-situ in accordance with the FIP/work plan. The operating procedures for each method are described below. It is also possible to collect a depth-specific water sample from a well or water body for ex-situ measurement.

8.3.1 Ex-situ Operation

For ex-situ operation one or two representative water samples will be collected from the well or surface water body for measurement using the required meters. If two representative samples are collected, both values for each parameter should be reported, however, the average of the two results should be used as the final value.

8.3.1.1 Multimeter

1) Fill two 100-mL plastic clean, disposable containers or cleaned beakers with water from the sample

2) Insert the probe into the first beaker immersing all sensors and allow to stabilize (2 minutes atminimum)

3) Record readings

   a. Temperature – in degrees Celsius or Fahrenheit

   b. pH – in standard units between 0 and 14, in 0.01 increments

   c. Specific conductivity – in mS/cm or micro siemens per centimeter (uS/cm)

   d. DO – in mg/L and percent (will typically read between 0 and 15 mg/L)

   e. ORP – in millivolts (mV; will typically read between -1,400 mV and + 1,400 mV), if required

   f. Turbidity, if used – in NTU or NFU

4) Rinse probe off with distilled/deionized water

5) Repeat Steps 2 thru 4 for the other beaker, if applicable

6) Record results on the water quality measurement log and/or in field notebook - the average will bethe actual result, after stabilization if two samples are used

7) Rinse probe off with distilled/deionized water

NOTE: *If a flow through cell is used during sampling, a single reading can be obtained from the multimeter during each step of the wells purging in accordance with TGI - Low FlowGroundwater Purging and Sampling.*

8.3.1.2 Turbidity Meter, if needed

1) Fill the two cleaned, manufacturer provided sample tubes with water from the sample
    a. If using a flow through cell, it is recommended to collect the turbidity samples before the flow through cell
2) Wipe off and dry the outside of the sample turbidity tubes with a clean, lint-free cloth ordisposable wipe
3) Insert the first sample tube and close the cover
4) Push the READ button
5) Record turbidity reading in NTUs (0 to 1,100 NTUs)
    a. If readings are over the instrument limit, a single 2X dilution can be run by mixing thesample with equal parts distilled or de-ionized water and gently mixing
    b. The resulting value will need to be doubled (for example, if the diluted reading is 750 NTUs, the estimated turbidity would be 750 x 2 = 1,500 NTUs. Diluted samples will bequalified as estimated)
6) Repeat steps 2 thru 5 with the second sample tube
7) Log the results on the water quality measurement log and/or in field notebook - the average willbe the actual result
8) Rinse sample tubes with distilled/deionized water.

NOTE: *If a flow through cell is used during low flow groundwater sampling, a single reading can be obtained from the multimeter during each step of the wells purging in accordance with TGI - Low FlowGroundwater Purging and Sampling. The turbidity sample is recommended to be collected prior to passing through the flow through cell.*

8.3.2 In-situ Operation

1) Connect extension cable and protective housing to meter
2) Measure water level from reference point
3) Lay out plastic sheeting as needed to keep the multimeter clean
4) Clean multimeter and cable per decontamination procedures and instruction manual and rinse with distilled/deionized water using caution, as most meters can only handle light washing with amild soap and warm water
5) Organize work area to prevent dirt or objects from falling in the well
6) Measure and mark extension cable at planned measurement intervals in accordance with the FIP
7) Slowly lower the probe into the well or water body to the desired measurement interval usingcaution to prevent rubbing of cable on the well and minimize water and sediment disturbance

8) Allow readings to stabilize (typically 1 to 3 minutes)
    a. For many instruments, the instrument may need to be slowly oscillated up and down a fewinches to circulate water around the probes
9) Record readings
    a. Temperature – in degrees Celsius or Fahrenheit
    b. pH – in standard units between 0 and 14, in 0.01 increments
    c. Specific conductivity – in mS/cm or uS/cm
    d. DO – in mg/L and percent (will typically read between 0 and 15 mg/L)
    e. ORP – in mV (will typically read between -1,400 mV and +1,400 mV), if required
    f. Turbidity, if used – in NTU or NFU
10) Repeat steps 4 through 9 to complete targeted in-situ measurements
11) Record results on the water quality measurement log or smart device
12) Slowly retrieve the multimeter
13) Clean multimeter and cable per decontamination procedures and instruction manual and rinse with distilled/deionized water using caution, as most meters can only handle light washing with amild soap and warm water

8.4 Maintenance

8.4.1 Multimeter

1) After use, the meter will be inspected and maintained according to the manufacturer's specifications and the inspection/maintenance activities will be recorded in the field notebook
2) Keep records of usage, maintenance, calibration, problems, and repairs
3) Recharge/replace batteries on a regular basis
4) Store meters or electrodes in protective casing when not in use
5) DO membranes will be stored moist, unless specified otherwise by manufacturer
6) Focused probe cleaning may be necessary in accordance with the operation manual and may be needed more frequently in harsh conditions
7) A replacement meter will be available onsite or ready for rapid delivery/shipment
8) Periodic manufacturer calibration may be necessary per operation manual and/or field plans.

8.4.2 Turbidity Meter, if used

1) Recharge battery on a regular basis

2) Store in protective casing when not in use

3) Keep records of usage, maintenance, calibration, problems, and repairs

4) After use, the meter will be inspected with results recorded in the field notebook

5) Keep sample tubes clean inside and out replacing them when they become scratched or etchedand avoid handling the tubes in the region where the light beam enters them.

6) Clean lens periodically per instruction manual

7) Turbidity meter will be sent back to the manufacturer for service when needed

9 Waste Management

IDW, including decontamination liquids, and disposable materials (well material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan (or equivalent), FSP, and/or IDW management guidance document.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The FieldNow® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Management of the original documents from the field will be completed in accordance with the site- specific QAPP. Records generated as a result of this TGI will be controlled and maintained in the projectrecord files in accordance with project requirements.

In general, documentation of the following information is required:

- Calibration – calibration information will be recorded on a calibration form, field log, or electronicdevice per project plans
    - Meter manufacturer and model
    - Serial number
    - Calibration personnel
    - Calibration date/time
    - Standard value, initial and final reading
    - Observations, if applicable

- Readings - data will be recorded on a field log, sampling form, or electronic device per projectplans
    - Instrument model
    - Measurement date/time
    - Field personnel
    - Weather
    - Measurement location and depth, if applicable
    - Source of water (surface water, groundwater, etc.)
    - In-situ vs ex-situ measurement method
    - Value of readings and average reading, if applicable
    - Units of readings
    - Key observations

All records will be provided to the project manager and retained in the project files. Any maintenanceneeds will be communicated to the project manager promptly.

11 Quality Assurance

Quality assurance procedures will be conducted in accordance with the Arcadis Quality ManagementSystem or the site-specific QAPP. Refer to the QAPP or FIP/sampling plan/work plan for the frequency of calibrations.

12 References

Not applicable.

13 Attachments

Attachment A - Water Quality Measurement Log

Attachment B - Water Quality Meter Calibration Log

Attachment A

Water Quality Measurement Log

WATER QUALITY MEASUREMENT LOG

GENERAL INFORMATION

Date _____ Weather _____

Project No _____ Sample Personnel _____

Site Name _____ Sample ID _____

Site Location _____ Start reading time _____

Site/Well No. _____ End reading time _____

MEASUREMENT DATA

Measuring Point (MP) description _____ ☐ Surface Water or ☐ Groundwater

Depth to Water (ft)/Time _____ Instrument model/serial no. _____

Well Screen Interval (ft) _____ Instrument model /serial no. 2 _____

Casing Diameter (in) _____ ☐ In-situ ☐ Ex-situ reading

Meters calibrated (Y/N) _____ (see calibration log, if applicable)

Water Quality Parameters

Time	Depth (ft)	pH (S.U.)	Spec. Cond. (mS/cm or uS/cm)	Temp (°C or °F)	DO (mg/L)	DO (%)	ORP (mV)	Turbidity (NTU)	Observations (Odor, clarity, etc., if applicable)

REMARKS

_____

_____

_____

_____

Attachment B

Water Quality Meter Calibration Log

WATER QUALITY METER CALIBRATION LOG

PROJECT NAME	
PROJECT NO.	
MODEL(s)	
SERIAL #(s)	
SAMPLER	
DATE	

TURBIDITY CALIBRATION

CAL. READING		CAL. READING		CAL. RANGE	TIME
(LOT #)		(LOT #)			
(EXP. DATE)		(EXP. DATE)			
PRE-CAL. / POST-CAL		PRE-CAL. / POST-CAL			
/		/		☐ WITHIN RANGE	
/		/		☐ WITHIN RANGE	
/		/		☐ WITHIN RANGE	
/		/		☐ WITHIN RANGE	

MULTIMETER CALIBRATION

AUTOCAL SOLUTION (Y / N)			CAL. READING	CAL. RANGE	TIME	CALIBRATION RANGES [1]	
(LOT #)							
(EXP. DATE)							
PARAMETER		LOT / EXP. DATE	PRE-CAL. / POST-CAL				
☐	pH		/	☐ WITHIN RANGE		pH	± 0.2 S.U.
☐	CONDUCTIVITY		/	☐ WITHIN RANGE		COND	± 1% OF CAL. STANDARD
☐	ORP		/	☐ WITHIN RANGE		ORP	± 25 mV
☐	DO		/	☐ WITHIN RANGE		DO	Atmospheric
☐	TURBIDITY		/	☐ WITHIN RANGE		TURB	± 5% OF CAL. STANDARD
☐			/	☐ WITHIN RANGE			
☐			/	☐ WITHIN RANGE			

(1) CALIBRATION RANGES ARE SPECIFIC TO THE MODEL OF THE WATER QUALITY METER

NOTES:

SIGNED DATE

CHECKED BY DATE

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TGI – Sample Chain of Custody

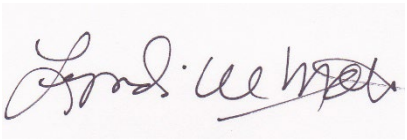
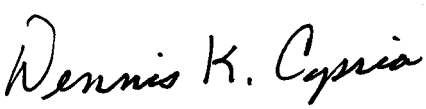
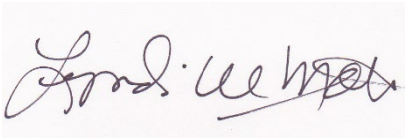
Rev: 3

Rev Date: March 28, 2022

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	April 19, 2017	All	Re-write to COC only	Richard Murphy
	1	May 23, 2017	4,7,9	Add: Guidance on use of previous version of TGI. Add: Info on COCs for multiple shipping containers Modify: Move letter i. to letter m. and change to “when appropriate”	Peter Frederick
	2	April 29, 2020	4, 11	Remove obsolete link	Lyndi Mott
	3	December 28, 2022	All	Updated Arcadis format Added to 6c. Collection time between COC and container must match. Added to 6o. Add name of overnight courier when relinquishing samples. Updated reference documents and added internet links.	Lyndi Mott

Approval Signatures

Prepared by:		3/28/2022
	Lyndi Mott (Preparer)	Date
Reviewed by:		3/28/2022
	Dennis Capria (Chain of Custody Reviewer)	Date
Reviewed by:		12/22/2021
	Lyndi Mott (Subject Matter Expert)	Date

1 Introduction

This Technical Guidance Instruction (TGI) provides the procedure for Arcadis field personnel for required documentation during the collection of environmental field samples and transfer of custody to a laboratory. It provides direction for completion of the Chain of Custody form that must accompany collected field samples for analysis by a laboratory.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This TGI describes the general Chain of Custody (COC) procedures and guidance instructions for samples collected from project sites that are relinquished from Arcadis' possession.

COC is defined as the maintenance of an unbroken record of possession of an item from the time of its collection through some analytical or testing procedure. COC is typically documented by a written record of the collection, possession, and handling of samples collected from a project location. Each sample will be tracked by a documented record that efficiently documents the individuals who were responsible for the sample during each successive transfer of that sample to various recipients beyond Arcadis' possession. This information can be used to legally establish the integrity of the samples and therefore the analytical results derived from the samples. This

information can be used in addition to other records and documentation regarding the samples, such as field forms, field logs, and photographs.

A sample is considered under custody if:

- It is in your possession; or
- It is in your view, after being in your possession; or
- It was in your possession and then you then locked it up to prevent tampering; or
- It is in a designated secure area.

Continued use of previous version of TGI:

Although not recommended, Arcadis program-, project-, and client-teams may be able to use the previous version of this TGI provided that it meets all of the quality expectations of Arcadis and client and meets applicable regulatory requirements. It is up to the program, project, and/or client-team leader to determine whether it is appropriate to adopt the current TGI or to continue using the previous version.

However, all new work not associated with the previous version of this TGI must be performed with the current version of the TGI.

When adopting this new TGI, users of the previous versions must be aware that specific handling, packing, and shipping procedures and guidance has been removed and that those should be addressed within program or project plans (e.g., Quality Assurance Project Plans (QAPP), Work Plans, Sampling and Analysis Plans (SAPs), etc.) or in a more detailed TGI specific to that sampling activity, whether related to media, constituent/analyte, client, state, etc.

In addition, adopting this new TGI will require users to refer to the Arcadis Department of Transportation (DOT) Safety Program for procedures and guidance on the determination and handling, packing, and shipping of samples that are or may be considered hazardous materials.

4 Personnel Qualifications

Arcadis personnel performing work under the purview of this TGI will have received appropriate training and have field experience regarding the collection of samples from project locations. Arcadis personnel will have all other applicable and appropriate training relevant to the sampling work and project site.

5 Equipment List

The following list provides materials that may be required for each COC. Project reporting and documentation requirements must be reviewed with the CPM prior to execution of work. Additional materials, tools, equipment, etc. may be required, and project staff are required to verify with the CPM and/or Technical Expert what specific equipment is required to complete the COC.

- Indelible ink pen (preferably either black or blue ink);
- COC form **(Appendix A)** from either Arcadis, laboratory receiving and analyzing the samples, or other applicable and appropriate entity for the work performed;
- When appropriate, such as for litigation or expert testimony work, custody seals or tape.

6 Cautions

One way in which the law tries to ensure the integrity of evidence is by requiring proof of the chain of custody by the party who is seeking to introduce a particular piece of evidence.

A proper chain of custody requires three types of affirmations: (1) affirmation that a sample is what it purports to be (for example, soil collected from a specified location and depth); (2) affirmation of continuous possession by each individual who has had possession of the sample from the time it is collected until the time it is analyzed or held by a laboratory; and (3) affirmation by each person who has had possession that sample remained in substantially the same condition and not contaminated or affected by outside influences from the moment one person took possession until the moment that person released the evidence into the custody of another (for example, affirmation that the sample was stored in a secure location where no one but the person in custody had access to it).

Proving chain of custody is necessary to "lay a foundation" for the samples in question, by showing the absence of alteration, substitution, or change of condition.

Ensure that appropriate sample containers with applicable preservatives, coolers, and packing material are planned for and provided at the site at the time of sample collection.

Understand the offsite transfer requirements of the samples for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation.

An Arcadis employee appropriately trained at the correct level of internal hazardous materials/DOT)shipping must complete an Arcadis shipping determination to address applicable DOT and International Air Transport Association (IATA) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging, and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.

The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

7 Health and Safety Considerations

Follow the health and safety procedures outlined in the project/site Health and Safety Plan (HASP) as well as other applicable H&S requirements, such as:

- Arcadis Hazardous Material/DOT handling, packaging, and shipping training
- Project site-specific H&S training
- Client-specific H&S training
- Constituent-specific H&S training
- Media-specific H&S training

8 Procedure

Collected samples must be uniquely identified, and properly documented, containerized, labeled with unique identifier, possessed in a secure manner during remainder of sampling event, packaged, and shipped to recipient laboratory.

Sample Identification

The method of sample identification depends on the type of measurement or analyses performed. In some cases, in-situ measurements of existing conditions and/or sample location must be made during sample collection.

These data will be recorded directly on field forms, logbooks, or other project record data sheets used to permanently retain this information for the project file. Examples of location identification information includes: latitude/longitudinal measurements, compass directions, well number, building number, floor number, room name, or proximity to a site feature unique to the site. Examples of in-situ measurements are pH, temperature, conductivity, flow measurement, or physical condition of the media being sampled. Physical samples collected are identified by a unique identifying number or code on a sample tag or label. These physical samples are removed from the sample location and transported to a laboratory for analyses.

In some cases, before samples are placed into individual containers and labeled as individual samples, samples may be separated into portions depending upon the analytical methods and required duplicate or triplicate analyses to be performed.

When completing a COC for samples, personnel must complete the following:

1. Written COCs must be completed with indelible ink (preferably either black or blue colored ink).
2. Written COCs must be completed using legible printed writing, and not cursive writing.
3. All entry fields on the COC form must be completed. If information is not applicable for a specific entry field, personnel will either put “N/A” or use a strike-out line or dash like “----------“ to indicate no applicable information is needed for that field.
4. Use of quotation marks or lines/down arrows to represent repetitive/duplicative text in similar fields.
5. Regardless of the type or specific COC form, the following pertinent information must be provided on the COC form:
    a. Arcadis project number
    b. Arcadis project name
    c. Project location, including street address, city, state, building number, providing as much detail as appropriate
    d. Recipient laboratory contact and sample receiving shipping location information
    e. Entities’/persons’ contact information for who will be receiving analytical results
    f. Name of sampler, i.e., person collecting sample and relinquishing possession of samples to the next entity in the chain of custody
    g. Date of sample collection
    h. If appropriate for the sample media, contaminant/constituent of concern, or analytical method, document time of sample collection using standard military time
    i. Sample analytical method(s)

j. Turnaround time required for analyses and/or reporting

k. Instructions to laboratory regarding handling, timing, analyses, etc. as applicable and appropriate.

l. Printed name and signature of the individual person who collected the samples and relinquishing possession of the samples

m. If appropriate or when documentation of the specific sample collection method will influence how the laboratory handles, prepares, or analyzes the samples, document the sample collection methodology used for collecting the samples (e.g., ASTM D5755)

6. The following additional specific information will be entered on the COC form, regardless of what type of COC is being used:

a. Unique Sample Identifier – The sample identifier (ID) must be unique to the individual sample it is applied to. The information in which the sample ID conveys is determined by the CPM, Technical Expert, and/or other project team members in advance of sample collection so that sample identification is consistently applied for the project. The sample nomenclature may be dictated by a specific client, program, or project database and require unique identification for each sample collected for the project. Consult with the CPM and/or Technical Expert for additional information regarding sample identification.

The sample ID could convey specific information regarding the sample to aid personnel in recognizing what the sample represents, or they may be arbitrary so as to facilitate the anonymity of the sample location, media, constituent of concern, project site, etc.

Examples of unique identifiers include:

1. Well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30). When the depth interval is included, the complete sample ID would be “SB-30 (0.5-1.0) where the depth interval is in feet. Please note it is very important that the use of hyphens in sample names and depth units (i.e., feet or inches) remain consistent for all samples entered on the chain of custody form. DO NOT use the apostrophe or quotes in the sample ID.

2. Sample names may also use the abbreviations “FB,” “TB,” “FD” and “DUP” as prefixes or suffixes to indicate that the sample is a field blank, trip blank, or field duplicate, respectively.

b. List the date of sample collection. All indicated dates must be formatted using either mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g., 03/07/2009).

c. List the local time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15. The time listed on the COC form must match the sample collection time on the sample container(s).

d. Samples should be indicated to be either “Grab” or “Composite”. Grab samples are collected from only one unique location at one specific point in time.

e. Composite samples are a group of individual samples that are combined for analysis in their totality. Composite samples need to be documented if they are either collected from a number of different locations over a broader area to be representative of the entire area being sampled, or if they are representative of a single location over an extended period of time.

f. If used, preservatives for the individual sample will be noted.

g. The requested analytical method(s) that the samples are being analyzed for must be indicated. As much detail, as necessary, should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering "EPA Method 8082 – PCBs" or "EPA PLM 600-R93-116." In cases where multiple analytical methods and/or analytical parameters are required for an individual sample, each method should be indicated for the sample (e.g., EPA 8082/8260/8270 or EPA PLM/400-point count).

h. If there are project-specific sample analytes to be reported, they should be specifically listed for each individual sample (e.g., 40 CFR 264 Appendix IX).

i. The total number of containers for each analytical method requested should be documented. This information may be included under the parameter or as a total for the sample.

j. When necessary, note which samples should be used for site specific matrix spikes in the Remarks or Comments field.

k. Indicate special project-specific requirements pertinent to the handling, shipping, or analyses. These requirements may be on a per sample basis such as "extract and hold sample until notified," or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG).

l. Indicate turnaround time (TAT) required for samples on COC. If individual samples have differing TATs, the different TATs for each sample or groups of samples must be clearly indicated.

m. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory. The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

n. If available, attach the Laboratory Task Order or Work Authorization forms.

o. The "Relinquished By" field must contain the signature of the Arcadis person who relinquished custody of the samples to the next entity in the chain of custody, which may be another person, the shipping courier, or the analytical laboratory. If a courier, enter the shipping courier in the "Received by" such as FedEx. The date/time relinquished should be when the person signs the COC and seals the cooler or shipping container for pick-up by the shipping courier.

p. Dates and times must be indicated using the following format:

   1) Date: either mm/dd/yy e.g., 01/01/17 OR mm/dd/yyyy e.g., 01/01/2017

   2) Time: use military format, e.g., 9:30 a.m. is 0930 and 9:30 p.m. is 2130

q. The "Received By" section is signed by sample courier or laboratory representative who received the samples from the sampler. The laboratory will sign upon laboratory receipt from the overnight courier service.

7. When more than one page of the COC form is required to complete the total number of samples, use as many sheets as necessary to accurately and clearly, document the samples and information. Some COCs may have a standard first page/cover page, and subsequent pages may not contain all the detailed fields as

the first page/cover page. Ensure that any subsequent pages convey all of the necessary and pertinent information for each individual sample as required in this procedure document.

8. Pages of the COC must retain a page count of the total number of pages; e.g., Page 1 of 3, Page 2 of 3, Page 3 of 3.
9. Upon completing the COC forms, forward the original signed COC with the sample package. Ensure that the original COC form is secured with the sample package so that it remains with the physical samples for the duration of transport and handling to its final destination and ensure that the COC form will not be become damaged or rendered unreadable due to sample breakage/leakage if stored inside the sample shipping container or outside influences if COC is stored in an outside plastic pouch to the container.
10. If you've collected enough samples that would require more than one container to ship them all to the same laboratory or location, then each separate/individual container that contains any number of samples must have a separate COC representing only those samples contained within that specific container. For example, if you have 3 total shipping containers for all of your samples, you must have a total of 3 separate, individual COCs for each of the 3 containers representing only those samples in their representative container. Thus, every container holding samples must have its own, individual COC.
11. If electronic chain of custody (eCOC) forms are utilized, ensure that the requirements of this procedure and guidance instructions are followed to the extent possible. Verify that proper signature and COC procedures are maintained with the CPM and/or Technical Expert when using eCOC.

9 Waste Management

Not Applicable.

10 Data Recording and Management

The original signed COC shall be submitted with the samples. Copies of COC records will be transmitted to the CPM or designee at the end of each day unless otherwise directed by the CPM. The sampling team leader retains copies of the chain of custody forms for filing in the project file. Record retention shall be in accordance with client- and project-specific requirements and Arcadis policies, the most stringent will apply.

The option to use the Electronic Chain of Custody (eCOC) form in conjunction with the appropriate sample application(s) may be available through the FieldNow® program but is currently limited to a select list of approved analytical laboratories. Use of the eCOC application is intended to reduce common transcription errors both by field staff and laboratory staff on a conventional handwritten paper COC. Once the eCOC form is completed and approved on the field tablet by field staff, a PDF version of the form is automatically emailed to each assigned team member. In addition, a dedicated or mobile printer is recommended for printing a hard copy of the completed eCOC to be included in each sample cooler to meet laboratory requirements.

11 Quality Assurance

COC forms will be legibly completed in accordance with this procedure and guidance instruction document, as well as other applicable and appropriate project documents such as SAP, Quality QAPP, Work Plan, or other project guidance documents.

COC records will be reviewed by the CPM or their appropriate designee for completeness and accuracy to the applicable requirements. Non-conformances will be noted and corrected in a timely manner on the copies retained by Arcadis as well as contacting the ultimate receiving entity for correction to the originally signed COC in their possession.

12 References

Arcadis Transportation Safety Program requirements, procedures, and guidance instructions.

EPA Samplers' Guide – Contract Laboratory Program Guidance for Field Samplers, EPA document EPA-540-R014-013 October 2014 https://www.epa.gov/sites/default/files/2015-03/documents/samplers_guide.pdf.

EPA Region III – Sample Submission Procedures for the Office of Analytical Services and Quality Assurance (OASQA) Laboratory Branch revision 14.0 October 18, 2018, https://www.epa.gov/sites/default/files/2018-12/documents/sample-submission-procedures-rev14.pdf.

EPA Region IV Science and Ecosystem Support Division Operating Procedure for Sample and Evidence Management May 25, 2016, https://www.epa.gov/sites/default/files/2015-06/documents/Sample-and-Evidence-Management.pdf.

Attachment A

Chain of Custody and Laboratory Analysis Request Form

ARCADIS

ID#

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ____ of ____

Lab Work Order #

Send Results to:

Contact & Company Name:

Telephone:

Address:

Fax:

City State Zip

E-mail Address:

Project Name/Location (City, State):

Project #:

Sampler's Printed Name:

Sampler's Signature

SAMPLE ID	Collection Date	Collection Time	Type (✓) Comp	Type (✓) Grab	Matrix

Preservative									
Filtered (✓)									
# of Containers									
Container Information									
PARAMETER ANALYSIS & METHOD									
									REMARKS

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: _____
G. Other: _____
H. Other: _____

Containment Information Key
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: _____
10. Other: _____

Matrix Key:
SO - Soil
W - Water
T - Tissue
SE - Sediment
SL - Sludge
A - Air
NL - NAPL/Oil
SW - Sample Wipe
Other: _____

Special Instructions/Comments

☐ Special QA/QC Instructions (✓)

Laboratory Information and Receipt		Relinquished By	Received By	Relinquished By	Laboratory Received By
Last Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name
☐ Cooler packed with ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt	Firm:	Firm:	Firm:	Firm:
Shipping Tracking #:	Condition/Cooler Temp:_____	Date/Time:	Date/Time:	Date/Time:	Date/Time:

SOP – Sample Chain of Custody Rev1_May 23, 2017

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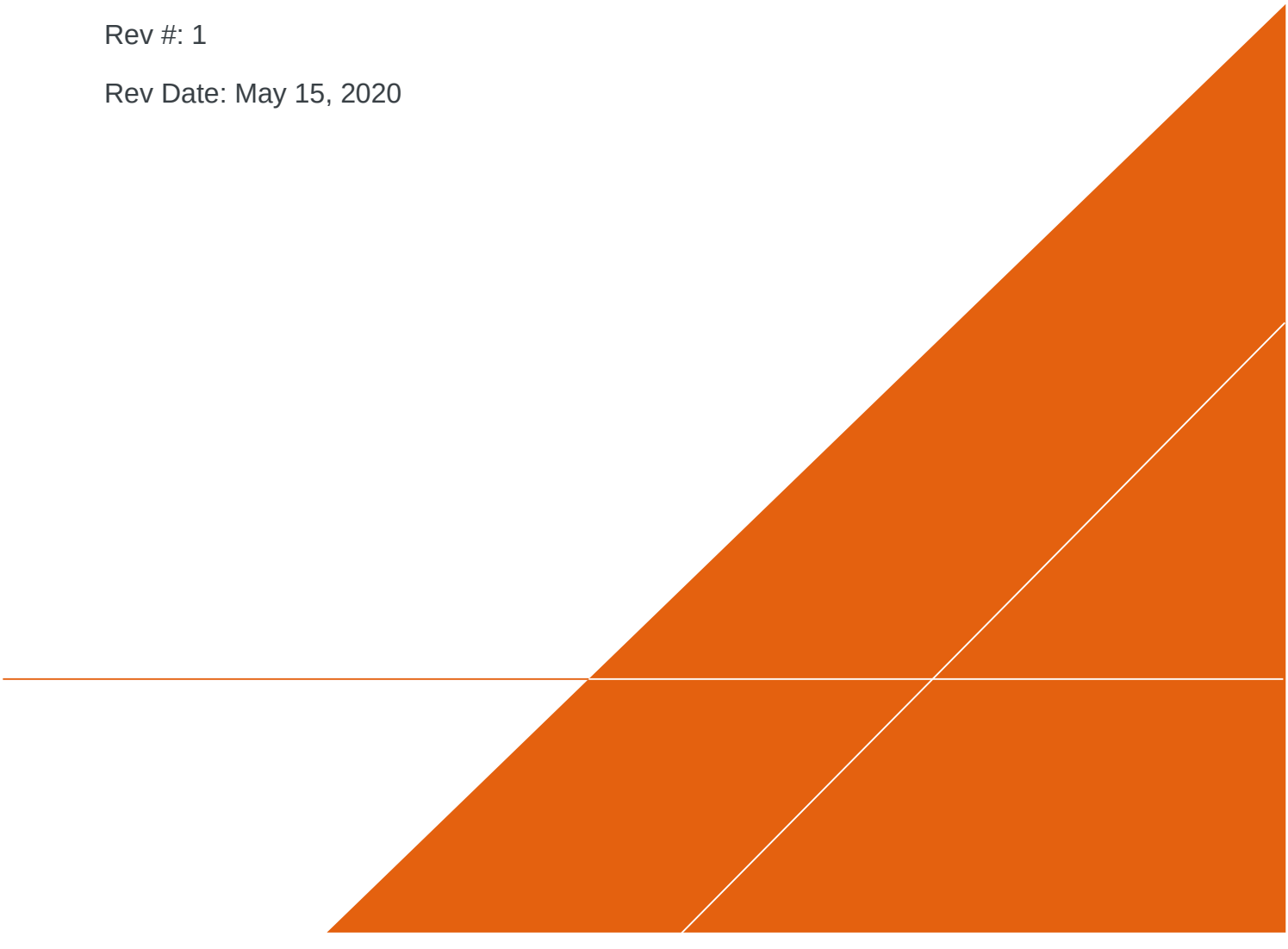
ARCADIS Design & Consultancy for natural and built assets

TGI - INVESTIGATION-DERIVED WASTE HANDLING AND STORAGE

Rev #: 1

Rev Date: May 15, 2020



VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 23, 2017	ALL	Conversion from SOP to TGI	Ryan Mattson / Peter Frederick
1	May 15, 2020	ALL	Updated to reflect regulatory changes	

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APPROVAL SIGNATURES

Prepared by:		02/23/2017
	Derrick Maurer	Date:
Technical Expert Reviewed by:		05/15/2020
	Ryan Mattson (Technical Expert)	Date:

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1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The objective of this Technical Guidance Instruction (TGI) is to describe the procedures to manage investigation-derived wastes (IDW), both hazardous and nonhazardous, generated during site activities, which may include, but are not limited to: drilling, trenching/excavation, construction, demolition, monitoring well sampling, soil sampling, decontamination and remediation. For the purposes of this TGI, IDW is considered to be discarded materials which are defined as solid waste by United States Environmental Protection Agency (EPA) standard 40 CFR § 261.2 (which may include liquids, solids, or sludges). IDW may include soil, groundwater, drilling fluids, decontamination liquids, as well as contaminated personal protective equipment (PPE), sorbent materials, construction and demolition debris, and disposable sampling materials. Hazardous or uncharacterized IDW will be collected and staged at the point of generation. Quantities small enough to be containerized in 55-gallon drums will be taken to a designated temporary onsite storage area (discussed in further detail under Drum Storage) pending characterization and disposal. IDW materials will be characterized using process knowledge and appropriate laboratory analyses to determine the waste classification and evaluate proper safe handling and disposal methods.

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This TGI describes the necessary equipment, field procedures, materials, regulatory references, and documentation procedures necessary for proper handling and storage of IDW up to the time it is properly transported from the project site and disposed. The procedures included in this TGI for handling and temporary storage of IDW are based on the EPA's guidance document *Guide to Management of Investigation Derived Wastes* (USEPA, 1992). IDW is assumed to be contaminated with the site constituents of concern (COCs) until analytical evidence indicates otherwise. IDW will be managed to ensure the protection of human health and the environment and will comply with all applicable or relevant and appropriate requirements (ARAR). Although not comprehensive, the following laws and regulations on Hazardous Waste Management should be considered as potential ARAR. It is the Arcadis Certified Project Manager (CPM) and/or designated Technical Expert to determine which laws and regulations, at all levels of government, are applicable to each project site and activity falling under this TGI.

Federal Laws and Regulations

- Resource Conservation and Recovery Act (RCRA) 42 USC § 6901-6987.
- Federal Hazardous Waste Regulations 40 CFR § 260-265

Department of Transportation (DOT) Hazardous Materials Transportation 49 CFR

Occupational Safety and Health Administration (OSHA) Regulations 29 CFR

State Laws and Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Regional, County, Municipal, and Local Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Initial Storage

Pending characterization, IDW will be temporarily stored appropriately within each area of contamination (AOC). Under RCRA, "storage" is defined as the "holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR § 260.10). The onsite waste staging area will be in a secure and controlled area. Uncharacterized wastes are considered potentially hazardous wastes and must be stored in DOT approved packaging. Liquid wastes must be stored in DOT approved closed head drums or other approved containers (e.g., portable tank containers) that are compatible with the type of material stored therein. Solid materials must be stored in DOT approved open head drums where practicable. Larger quantities of solid IDW can be containerized in bulk containers (such as in a roll-off box). Soil from large excavation projects may be managed in stockpiles with within the AOC and does not need to be containerized until exiting the AOC.

Characterization

Waste characterization can either be based on generator knowledge, such as using historical process knowledge and safety data sheets (SDS), or can be based upon characterization sampling analytical results. IDW typically is not characterized using SDS as it is a mixture of aged chemicals and environmental media. Historical process knowledge should be used to determine if the IDW is a listed hazardous waste (40 CFR § 261.31-33). If the IDW is not a listed hazardous waste, waste

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characterization can be completed by laboratory analysis of representative samples of the IDW. The laboratory used for waste characterization analysis must have the appropriate state and federal accreditations and may be required to be pre-approved by the Client. IDW will be classified as RCRA hazardous or non-regulated under RCRA based on the waste characterization determination.

If IDW is characterized as RCRA hazardous waste, RCRA and DOT requirements must be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR § 262 and 49 CFR § 171-178. Waste material classified as RCRA nonhazardous may be handled and disposed of as nonhazardous waste in accordance with applicable federal, state, and local regulations.

Storage Time Limitations

Containerized hazardous wastes can be temporarily stored for a maximum of 90 calendar days from the accumulation start date for a large quantity generator or a maximum of 180 calendar days from the accumulation start date for a small quantity generator. Wastes classified as nonhazardous may be handled and disposed of as nonhazardous waste and are not subject to storage time limitations.

This is TGI may be modified by the CPM and/or Technical Expert for a specific project or client program, as required, dependent upon client requirements, site conditions, equipment limitations, or limitations imposed by the procedure. The resulting procedure employed to execute the work will be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes will be discussed with the CPM and/or Technical Expert as soon as practicable, and if approved to be performed, be documented.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current regulatory- and Arcadis-required health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Personnel handling and packaging hazardous waste and performing hazardous waste characterizations must have RCRA hazardous waste management training per 40 CFR § 264.16. Additional state-specific hazardous waste management training is required in certain states (i.e., California).

Although not common practice, in certain situations Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator. Arcadis personnel who sign waste profiles and/or waste manifests will have both current RCRA hazardous waste management training per 40 CFR § 264.16 and current DOT hazardous materials transportation training per 49 CFR § 172.704. Arcadis field personnel will also comply with client-specific training. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents will identify other training requirements or access control requirements.

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4 EQUIPMENT LIST

The Following Materials, as required, will be available for IDW handling and Storage:

- Appropriate personal protective equipment as specified in the Site Health and Safety Plan (HASP)
- DOT approved containers
- Hammer
- Leather gloves
- Drum dolly
- Appropriate drum labels (outdoor waterproof self-adhesive)
- Portable tank container
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as determined by the CPM and/or Technical Expert.
- Indelible ink and/or permanent marking pens
- Plastic sheeting
- Appropriate sample containers, labels, and forms
- Stainless-steel bucket auger
- Stainless steel spatula or knife
- Stainless steel hand spade
- Stainless steel scoop
- Digital camera
- Field logbook

5 CAUTIONS

Filled drums can be very heavy, become unbalanced, or spill its contents. Therefore, use appropriate moving techniques and equipment for safe handling. Similar media (e.g. soils with other soils; or liquids with other liquids) will be stored in the same drums to aid in sample analysis and disposal. Drum lids must be secured to prevent rainwater from entering the drums and leakage during movement. Drums containing solid material may not contain any free liquids. Waste containers stored for extended periods of time may be subject to deterioration. Drum Over Packs may be used as secondary containment. All drums must be visually inspected for condition to ensure that they are in good condition without visible evidence of rusting, holes, breakage, etc., to prevent potential leakage and facilitate subsequent disposal. All drum lids must be verified as having a properly functioning secured lid prior to use.

6 HEALTH AND SAFETY CONSIDERATIONS

As determined by the site's known and suspected hazards, appropriate PPE must be worn by all field personnel within the designated work area. Exposure air monitoring may be required during certain field activities as required in the Site Health and Safety Plan. If soil excavation in areas with potentially hazardous contaminants is possible, contingency plans will be developed to address the potential for encountering gross contamination or non-aqueous phase liquids. All excavation activities shall be in compliance with OSHA standard 29 CFR 1926.651 Excavations, and any other applicable regulations.

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Arcadis field personnel and subcontractors will be trained in and perform their work in compliance with all applicable federal, state, and local health and safety regulations as well as Arcadis' HASP and applicable Client health and safety requirements.

7 PROCEDURE

Specific waste temporary storage and handling procedures to be used are dependent upon the type of generated waste, including type of media (e.g. soils or free liquids) and constituents of concern. For this reason, IDW can be stored in a secure location onsite in separate 55-gallon storage drums, where solids can be stockpiled onsite (if nonhazardous) and purge water may be stored in portable tank containers. Waste materials such as broken sample bottles or equipment containers and wrappings will be stored in 55-gallon drums unless they were not in contact with sample media.

Management of IDW

Minimization of IDW should be considered by the project team during all phases of the project. Site managers may want to consider techniques such as replacing solvent based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be properly decontaminated), limitation of traffic between exclusion and support zones, and drilling methods and sampling techniques that minimize the generation of waste. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a core penetrometer or direct push technique instead of coring.

Drum Storage

Drums containing hazardous waste will be stored in accordance with the requirements of 40 CFR 265 Subpart I (for containers) and 265 Subpart DD (for containment buildings). All 55-gallon drums will be stored at a secure, centralized onsite location that is readily accessible for vehicular pick-up. Drums confirmed as, or assumed to contain hazardous waste will be stored over an impervious surface provided with secondary spill containment. The storage location will, for drums containing liquid, have a containment system that can contain at least the larger of 10% of the aggregate volume of staged materials or 100% of the volume of the largest container. Drums will be closed during storage and be in good condition in accordance with the Guide to Management of Investigation-Derived Wastes (USEPA, 1992).

Hazardous Waste Determination

Waste material must be characterized to determine if it meets any of the federal definitions of hazardous waste as required by 40 CFR § 262.11. If the waste does not meet any of the federal definitions, it must then be established if any state-specific or local-specific hazardous waste criteria exist/apply.

Generator Status

Once hazardous waste determination has been made, the generator status will be determined. Large quantity generators (LQG) are generators who generate more than 1,000 kilograms of hazardous waste in a calendar month. Small quantity generators (SQG) of hazardous waste are generators who generate greater than 100 kilograms but less than 1,000 kilograms of hazardous waste in a calendar month. Very small quantity generators (VSQG) are generators who generate less than 100 kilograms of hazardous

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waste per month. Please note that a generator status may change from month to month and that a notice of this change is usually required by the generator's state agency.

Accumulation Time for Hazardous Waste

A LQG may accumulate hazardous waste on site for 90 calendar days or less without a permit and without having interim status, provided that such accumulation is in compliance with requirements in 40 CFR § 262.17. A SQG may accumulate hazardous waste on site for 180 calendar days or less without a permit or without having interim status, subject to the requirements of 40 CFR § 262.16. VSQG requirements are found in 40 CFR § 262.14. NOTE: The federal VSQG and SQG provisions may not be recognized by some states (e.g., California and Rhode Island). State-specific and local-specific regulations must be reviewed and understood prior to the generation of hazardous waste.

Satellite Accumulation of Hazardous Waste Satellite accumulation (SAA) will mean the accumulation of as much as fifty-five (55) gallons of hazardous waste, or the accumulation of as much as one quart of acutely hazardous waste, in containers at or near any point of generation where the waste initially accumulates, which is under the control of the operator of the process generating the waste, without a permit or interim status and without complying with the requirements of 40 CFR § 262.15 and without any storage time limit, provided that the generator complies with 40 CFR § 262.15.

Once more than 55 gallons of hazardous waste accumulates in SAA, the generator has three days to move this waste into storage.

Storage recommendations for hazardous waste include:

- Ignitable or reactive hazardous wastes must be >50 feet from the property line per 40 CFR § 265.176 (LQG generators only).
- Hazardous waste should be stored on a concrete slab (asphalt is acceptable if there are no free liquids in the waste).
- Drainage must be directed away from the accumulation area.
- Area must be properly vented.
- Area must be secure.

Drum/Container Labeling

Drums will be labeled on both the side and lid of the drum using a permanent marking pen. Old drum labels must be removed to the extent possible, descriptions crossed out should any information remain, and new labels affixed on top of the old labels. Other containers used to store various types of waste (e.g., polyethylene tanks, roll-off boxes, end-dump trailers, etc.) will be labeled with an appropriate "Waste Container" or "Testing in Progress" label pending characterization. Drums and containers will be labeled as follows:

- Appropriate waste characterization label (Pending Analysis, Hazardous, or Nonhazardous)
- Waste generator's name (e.g., client name)
- Project Name
- Name and telephone number of Arcadis project manager
- Composition of contents (e.g., used oil, acetone 40%, toluene 60%)
- Media (e.g., solid, liquid)
- Accumulation start date

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- Drum number of total drums as reconciled with the Drum Inventory maintained in the field log book.

IDW containers will remain closed except when adding or removing waste. Immediately upon beginning to place waste into the drum/container, a “Waste Container” or “Pending Analysis” label will be filled out to include the information specified above, and affixed to the container. Once the contents of the container are identified as either non-hazardous or hazardous, the following additional labels will be applied.

- Containers with waste determined to be non-hazardous will be labeled with a green and white "Nonhazardous Waste" label over the "Waste Container" label.
- Containers with waste determined to be hazardous will be stored in an onsite storage area and will be labeled with the "Hazardous Waste" label and affixed over the "Waste Container" label.

The ACCUMULATION DATE for the hazardous waste is the date the waste is first placed in the container and is the same date as the date on the "Waste Container" label. DOT hazardous class labels must be applied to all hazardous waste containers for shipment offsite to an approved disposal or recycling facility. In addition, a DOT proper shipping name will be included on the hazardous waste label. The transporter should be equipped with the appropriate DOT placards. However, placarding or offering placards to the initial transporter is the responsibility of the generator per 40 CFR § 262.33.

Inspections and Documentation

All IDW will be documented as generated on a Drum Inventory Log maintained in the field log book. The Drum Inventory will record the generation date, type, quantity, matrix and origin (e.g., Boring-1, Test Pit 3, etc.) of materials in every drum, as well as a unique identification number for each drum. The drum inventory will be used during drum pickup to assist with labeling of drums. The drum storage area and any other areas of temporarily staged waste, such as soil/debris piles, will be inspected weekly. The weekly inspections will be recorded in the field notebook or on a Weekly Inspection Log. Digital photographs will be taken upon the initial generation and drumming/staging of waste, and final labeling after characterization to document compliance with labeling and storage protocols, and condition of the container. Evidence of damage, tampering or other discrepancy should be documented photographically.

Emergency Response and Notifications

Specific procedures for responding to site emergencies will be detailed in the HASP. If the generator is designated as a LQG, a Contingency Plan will need to be prepared to include emergency response and notification procedures per 40 CFR § 265 Subpart D. In the event of a fire, explosion, or other release which could threaten human health outside of the site or when Client or Arcadis has knowledge of a spill that has reached surface water, Client or Arcadis must immediately notify the National Response Center (800-424-8802) in accordance with 40 CFR § 262.265. Other notifications to state and/or other local regulatory agencies may also be necessary.

Drilling Soil Cuttings and Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities, subsurface soil sampling, or installation of monitoring wells. Depending on the drilling method, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Soil cuttings will be labeled and stored in 55-gallon drums with bolt-sealed lids.

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Excavated Solids

Excavated solids may include, but are not limited to: soil, fill, and construction and demolition debris. Prior to permitted treatment or offsite disposal, potentially hazardous excavated solids may be temporarily stockpiled onsite as long as the stockpile remains in the same AOC from where it was excavated. Potentially hazardous excavated solids removed from the AOC must be immediately containerized in labeled drums or closable top roll-offs lined with 9-mil polyvinyl chloride (PVC) sheeting and are subject to LQG storage time limits. Nonhazardous excavated solids can be stockpiled either inside or outside of the AOC, do not have to be containerized and are not subject to hazardous waste regulations. Potentially hazardous excavated solids must not be mixed with nonhazardous excavated solids. All classes of excavated solid stockpiles should be maintained in a secure area onsite. At a minimum, the floor of the stockpile area will be covered with a 20-mil high density polyethylene liner that is supported by a foundation or at least a 60-mil high density polyethylene liner that is not supported by a foundation. The excavated material will not contain free liquids. The owner/operator will provide controls for windblown dispersion, run-on control, and precipitation runoff. The run-on control system will prevent flow onto the active portion of the pile during peak discharge from at least a 25-year storm and the run-off management system will collect and control at least the water volume resulting from a 24-hour, 25-year storm (USEPA, 1992). Additionally, the stockpile area will be inspected on a weekly basis and after storm events. Individual states may require that the stockpile be inspected/certified by a licensed professional engineer. Stockpiled material will be covered with a 6-mil polyvinyl chloride (PVC) liner or sprayed dust control product. The stockpile cover will be secured in place with appropriate material (concrete blocks, weights, etc.) to prevent the movement of the cover.

Decontamination Solutions

Decontamination solutions are generated during the decontamination of personal protective equipment and sampling equipment. Decontamination solutions may range from detergents, organic solvents and acids used to decontaminate small field sampling equipment to steam cleaning rinsate used to wash heavy field equipment. These solutions are to be labeled and stored in closed head drums compatible with the decontamination solution. Decontamination procedures, including personnel and field sampling equipment, must comply with applicable Arcadis procedural documents.

Disposable Equipment

Disposable equipment includes personal protective equipment (e.g., tyvek coveralls, gloves, booties and APR cartridges) and disposable sampling equipment such as trowels or disposable bailers. If the media sampled exhibits hazardous characteristics per results of waste characterization sampling, contaminated disposable equipment will also be disposed of as a hazardous waste. If compatible with the original IDW waste stream (i.e., the IDW is a solid and the disposal equipment is a solid), the disposable equipment can be combined with the IDW. If these materials are not compatible (i.e., the IDW is a liquid and the disposal equipment is a solid), the disposable equipment will be stored onsite in separate labeled 55-gallon drums. Uncontaminated or decontaminated disposable equipment can be considered nonhazardous waste.

Purge Water

Purge water includes groundwater generated during well development, groundwater sampling, or aquifer testing. The volume of groundwater generated will dictate the appropriate storage procedure. Monitoring

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well development and groundwater sampling may generate three well volumes of groundwater or more. This volume will be stored in labeled 55-gallon drums. Aquifer tests may generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Therefore, large-volume portable polyethylene tanks will be considered for temporary storage pending groundwater-waste characterization.

Purged Water Storage Tank Decontamination and Removal

The following procedures will be used for inspection, cleaning, and offsite removal of storage tanks used for temporary storage of purge water. These procedures are intended to be used for rented portable tanks such as Baker Tanks or Rain for Rent containers. Storage tanks will be made of inert plastic materials. The major steps for preparing a rented tank for return to a vendor include characterizing the purge water, disposing of the purge water, decontaminating the tank, final tank inspection, and mobilization. Decontamination and inspection procedures are described in further detail below.

- Tank Cleaning: Most vendors require that tanks be free of any visible sediment and water before returning, a professional cleaning service may be required. Each specific vendor should be consulted concerning specific requirements for returning tanks.
- Tank Inspection: After emptying the tank, purged water storage tanks should be inspected for debris, chemical staining, and physical damage. The vendors require that tanks be returned in the original condition (i.e., free of sediment, staining and no physical damage).

8 WASTE MANAGEMENT

Soil/Solids Characterization

Waste characterization will be conducted in accordance with waste hauler, waste handling facility, and local/state/federal requirements. In general, RCRA hazardous wastes are those solid wastes determined by a Toxicity Characteristic Leaching Procedure (TCLP) test or to contain levels of certain toxic metals, pesticides, or other organic chemicals above specific applicable regulatory agency thresholds. If the one or more of 40 toxic compounds listed in Table I of 40 CFR § 261.24 are detected in the sample at levels above the maximum unregulated concentrations, the waste must be characterized as a toxic hazardous waste. Wastes can also be considered “listed” hazardous waste depending on site-specific processes.

Composite soil samples will be collected at a frequency of one sample per 250 cubic yard basis for stockpiled soil or one per 55-gallon drum per different waste stream for containerized. A four-point composite sample will be collected per 250 cubic yards of stockpiled material and for each drum waste stream. Sample and composite frequencies may be adjusted in accordance with the waste handling facility’s requirements and may be reduced for large volumes of waste with consistent properties. Waste characterization samples will be considered valid for consistent waste streams for a period of 1 year. Waste characterization samples may be analyzed for the TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls (PCBs), as well as reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- or local-specific regulations may require a different or additional sampling approaches.

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Wastewater Characterization

Waste characterization will be conducted in accordance with the requirements of the waste hauler, waste handling facility, and local/state/federal governments. In general, purge water should be analyzed by methods appropriate for the known contaminants, if any, that have been historically detected in the monitoring wells. Samples will be collected and analyzed in accordance with the requirements of the waste disposal facility. Wastewater characterization samples may be analyzed for TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls, as well as corrosivity (pH), reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- and/or local-specific regulations may require different or additional sampling approaches.

Sample Handling and Shipping

All samples will be appropriately labeled, packed, and shipped, and the chain-of-custody will be filled out in accordance with current Arcadis sample chain of custody, handling, packing, and shipping procedures and guidance instructions.

It should be noted that additional training is required for packaging and shipping of hazardous and/or dangerous materials. Please refer to the current Arcadis training requirements related to handling and shipping of samples, shipping determinations, and hazardous materials.

Preparing Waste Shipment Documentation (Hazardous and Nonhazardous)

Waste profiles will be prepared by the Arcadis CPM and forwarded, along with laboratory analytical data to the Client for approval/signature. The Client will then return the profile to Arcadis who will then forward to the waste removal contractor for preparation of a manifest. The manifest will be reviewed by Arcadis prior to forwarding to the Client for approval. Upon approval of the manifest, the Client will return the original signed manifest directly to the waste contractor or to the Arcadis CPM for forwarding to the waste contractor. Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator.

Final drum labeling and pickup will be supervised by an Arcadis representative who is trained and experienced with applicable waste labeling procedures. The Arcadis representative will have a copy of the drum inventory maintained in the field book and will reconcile the drum inventory with the profile numbers on the labels and on the manifest. Different profile numbers will be generated for different matrices or materials in the drums. For example, the profile number for drill cuttings will be different than the profile number for purge water. When there are multiple profiles it is critical that the proper label, with the profile number appropriate to a specific material be affixed to the proper drums. A copy of the Arcadis drum inventory will be provided to the waste transporter during drum pickup and to the facility receiving the waste.

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9 DATA RECORDING AND MANAGEMENT

Waste characterization sample handling, packing, and shipping procedures will be documented in accordance with relevant Arcadis procedures and guidance instructions as well as applicable client and/or project requirements, such as a Quality Assurance Project Plan or Sampling and Analysis Plan. Copies of the chain-of-custody forms will be maintained in the project file. Arcadis should photograph or maintain a copy of any hazardous waste manifest signed on behalf of Client in the corresponding office DOT record file.

10 QUALITY ASSURANCE

The CPM or APM will review all field documentation once per week for errors or omissions as compared to applicable project requirements including but not limited to: the proposal/scope of work, QAPP, SAP, HASP, etc. Deficiencies will be noted, tracked, and resolved. Upon correction, they will be noted for project documentation.

11 REFERENCES

United States Environmental Protection Agency (USEPA). 1992. Guide to Management of Investigation-Derived Wastes. Office of Remedial and Emergency Response. Hazardous Site Control Division. January 1992.

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ARCADIS Design & Consultancy for natural and built assets

TGI – Groundwater and Soil Sampling Equipment Decontamination

Rev: 3

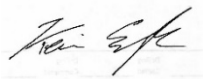
Rev Date: August 30, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	February 23, 2017	All	Conversion from SOP to TGI	Cassandra McCloud / Pete Frederick
	1	May 8, 2020	4, 5	Added note regarding use of Liquinox and 1,4-Dioxane	Marc Killingstad
	2	June 14, 2022	All	Conversion to new TGI format and minor edits.	Kevin Engle / Marc Killingstad
	3	August 30, 2023	All	Annual review completed by SME. Updated Rev 1.	Marc Killingstad

Approval Signatures

Prepared by: 8/30/2023



Name (Preparer) Date

Reviewed by: 8/30/2023

Marc Killingstad (Subject Matter Expert) Date

1 Introduction

This document is intended to provide guidance to staff performing decontamination procedures at project sites. The content in this document describes the intended use, scope and application, personnel qualifications, equipment, cautions, health and safety considerations, procedures, waste management, data recording and management, and quality assurance of decontamination procedures.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

Decontamination is performed on sampling equipment prior to sample collection to ensure that the sampling equipment that contacts a sample, or monitoring equipment that is brought into contact with environmental media to be sampled, is free from analytes of interest and/or constituents that could interfere with laboratory analysis for analytes of interest. Sampling equipment must be appropriately cleaned prior to use for sampling or coming into contact with environmental media to be sampled and following completion of the sampling event prior to shipment or storage. The effectiveness of the decontamination procedure should be verified by collecting and analyzing equipment blank samples.

The sampling equipment cleaning procedures described herein includes pre-field, in the field, and post- field cleaning of sampling equipment which may be conducted at an established equipment decontamination area (EDA) on site, as appropriate and necessary. Sampling equipment that may require decontamination at a given site include soil sampling tools; groundwater, sediment, and surface-water sampling devices; water testing instruments; down-hole instruments; and other activity-specific sampling equipment. Non-disposable equipment will be cleaned before collecting each sample, between each sample collected, and prior to placing sampling equipment in protective cases, or containers for transport. Cleaning procedures for sampling equipment should be monitored by collecting equipment blank samples as required in project work plans, field sampling plans, quality assurance project plans (QAPP), or other pertinent project documents. Dedicated and/or single-use (i.e., not to be re-used) sampling equipment will not require decontamination.

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour hazardous waste operations and emergency response (HAZWOPER) training and/or Occupational Safety and Health Administration (OSHA) HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project HASP and other documents will identify other training requirements or access control requirements.

5 Equipment List

The equipment required for equipment decontamination is presented below. Note that certain contaminants may require specific materials be used that are not captured in this list. Always review project and contaminant specific TGIs or work plans to ensure proper equipment is utilized. Note for per- and polyfluoroalkyl substances (PFAS) see *TGI – Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide*.

- Health and safety equipment, including appropriate personal protective equipment (PPE), as required in the site HASP
- Deionized water that meets the analytical criteria for deionized water with no detectable constituents above the reporting limits for the methods to be used and analytes being analyzed for. Deionized water is used for inorganics, and organic-free water for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, etc.
- Non-phosphate detergent such as Alconox® or, if sampling for phosphorus or phosphorus- containing compounds, Liquinox (or equivalent). NOTE: Liquinox has shown to provide false positives for 1,4-Dioxane and should not be used at sites where that may be a constituent of concern (COC).
- Tap water
- Rinsate collection plastic containers

- Department of Transportation (DOT)-approved waste shipping container(s), as specified in the work plan, field sampling plan, or regulatory requirements if decontamination waste is to be shipped for disposal
- Brushes
- Large heavy-duty garbage bags
- Spray bottles
- (Optional) – Isopropyl alcohol (free of ketones) or methanol. These can be wipes or diluted with water (usually 1part isopropyl/methanol to 10 parts water) if a spray is needed.
- Airtight, sealable plastic baggies, such as Ziploc®-type
- Plastic sheeting

6 Cautions

Rinse equipment thoroughly and allow the equipment to dry before re-use or storage to prevent introducing solvent into sample medium. If manual drying of equipment is required, use clean lint-free material to wipe the equipment dry. Ensure all rinse materials do not adversely affect sample collection efficiency or analytical results.

Store decontaminated equipment in a clean, dry environment. Do not store near combustion engine exhausts. Properly containerize equipment to ensure cross-contamination doesn't happen from other uncontaminated surfaces or equipment.

If equipment is damaged to the extent that decontamination is uncertain due to cracks, gouges, crevices, or dents, the equipment should not be used and should be discarded or submitted for repair prior to use for sample collection.

A proper shipping determination regarding hazardous materials will be performed by a DOT-trained individual for cleaning materials shipped by Arcadis.

Caution should be exercised to avoid contact with the pump casing and water in the container while the pump is running (do not use metal drums or garbage cans) to avoid electric shock.

7 Health and Safety Considerations

Review the safety data sheets (SDS) for the cleaning agents and materials used in decontamination. If solvent is used during decontamination, use appropriate PPE and work in a well-ventilated area and stand upwind while applying solvent to equipment. Apply solvent in a manner that minimizes potential for exposure to workers and bystanders. Follow health and safety procedures outlined in the HASP.

8 Procedure

A designated area will be established to clean sampling equipment in the field prior to and following sample collection. Equipment cleaning areas will be set up within or adjacent to the specific work area, but not at a location that expose equipment to contamination (i.e., exposed to combustion engine exhaust). Detergent solutions will be prepared in clean containers for use in equipment decontamination. Decontaminated equipment

will be handled by workers wearing clean gloves, properly changed to prevent cross-contamination. The procedures detailed in this section provide an overview of common decontamination techniques. Additional steps may be required based on the type of contaminant present or client/site requirements.

Cleaning Sampling Equipment

1. Wash the equipment/pump with potable water.
2. Wash with detergent solution (Alconox®, Liquinox® or equivalent) to remove all visible particulate matter and any residual oils or grease. NOTE: Liquinox® has shown to provide false positives for 1,4-Dioxane and will not be used at sites where that may be a COC.
3. If equipment is very dirty, precleaning gross debris with a brush and tap water may be necessary.
4. If non-aqueous phase liquids are present, the use of isopropyl alcohol (free of ketones) or methanol is recommended. Cloth wipes or diluted solution can be used to remove the non-aqueous phase liquids that are hard to remove with detergent solution in step 2. Consult with project manager if non-aqueous phase liquids are present onsite and design an appropriate decontamination procedure that includes step 4.
5. Rinse with deionized water.

Decontaminating Submersible Pumps

Submersible pumps may be used during well development, groundwater sampling, or other investigative activities. The pumps must be cleaned and flushed before and between uses. This cleaning process will consist of an external detergent solution wash and tap water rinse, a flush of detergent solution through the pump, followed by a flush of potable water through the pump. Flushing will be accomplished by using an appropriate container filled with detergent solution and another container filled with potable water. The pump will be be flushed with deionized water as the last step prior to use. The pump will run long enough to effectively flush the pump housing and hose (unless new, disposable hose is used). Disconnect the pump from the power source before handling. The pump and hose will be placed on or in clean polyethylene sheeting to avoid contact with the ground surface.

9 Waste Management

Equipment decontamination rinsate will be managed in conjunction with all other waste produced during the field sampling effort. Waste management procedures are outlined in the work plan or Waste Management Plan (WMP).

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff

are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Equipment cleaning and decontamination will be noted during project documentation. Information will include the type of equipment cleaned, the decontamination location, specific procedures utilized, solvents and/or cleaning agents used, source of water, and deviations or omissions from this TGI.

Unusual field conditions should be noted if there is potential to impact the efficacy of the decontamination or subsequent sample collection.

An inventory of the solvents brought on site and used and removed from the site will be maintained in the project documentation. Records will be maintained for solvents used in decontamination, including lot number and expiration date.

Containers with decontamination fluids will be labeled.

11 Quality Assurance

Equipment blanks should be collected to verify that the decontamination procedures are effective in minimizing potential for cross contamination. The equipment blank is prepared by pouring deionized water (or organic-free water, for organic analyses) over the clean and dry tools and collecting the water into appropriate sample containers. Equipment blanks should be analyzed for the same set of parameters that are performed on the field samples collected with the equipment that was cleaned as specified in the sampling and analysis plan. Equipment blanks are collected per equipment set, which represents all the tools needed to collect a specific sample.

12 References

USEPA Region 9 - Field Sampling Guidance #1230, Sampling Equipment Decontamination.

USEPA Region 1 - Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

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TGI – Monitoring Well Development

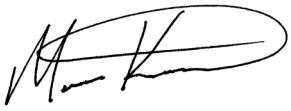
Rev: 2

Rev Date: April 5, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	4/24/2017	All	Re-written as TGI	Marc Killingstad
	1	4/12/2022	All	Updated to new format and some minor content changes	Marc Killingstad
	2	4/5/2023	All	Annual review completed by Marc Killingstad. Updated document revision number and date, version control and signature page.	Marc Killingstad

Approval Signatures

Prepared by:		4/5/2023
	Jay Erickson (Preparer)	Date
Reviewed by:		4/5/2023
	Marc Killingstad (Subject Matter Expert)	Date

1 Introduction

This Technical Guidance Instruction (TGI) covers the development of screened wells used for obtaining representative groundwater information and samples from granular aquifers (i.e., monitoring wells).

Note: This TGI only applies to monitoring well development and not remediation (injection/extraction) well development.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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3 Scope and Application

The objectives of monitoring well development are:

1. Repair damage to the borehole wall from drilling that can include clogging, smearing or compaction of aquifer materials;
2. Remove fine-grained sediment from the formation and filter pack that may result in high turbidity levels in groundwater samples;
3. To re-sort formation and filter pack material adjacent to the well screen;

4. To recover any drilling fluids (if used) that may affect the permeability of the formation and filter pack or alter the water quality around the well; and
5. To optimize the well efficiency and hydraulic communication between the well screen and the formation.

Successful monitoring well development is dependent on the following:

1. Hydrostratigraphy – Permeable formations containing primarily sand and gravel are more easily developed due to lower percentages of silt and clay material. Water in permeable formations can be moved in and out of the screen and/or through the formation easier than in less permeable deposits.
2. Well Diameter – Development tooling including brushes, surge blocks, pumps and jetting tools are more readily available for wells 4 inches in diameter and greater.
3. Well Design – Wells with filter packs and screens designed to match the formation through the analysis of formation sieve samples are easier to develop. An important aspect to well design is to minimize the size of the annular space between the formation and well screen. Adequate room must be allowed for the proper installation of well materials, but not too large as to prevent/reduce communication with the surrounding formation.
4. Drilling Methods – Different drilling methods result in varying amount of borehole damage and, therefore, impact the degree to which development will be successful.

Well development methods for monitoring wells include the following:

1. Bailing – Use of a bailer to remove water and sediment from the well casing. This technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow is in only one direction, toward the well screen. The most effective use of bailing during monitoring well development is in conjunction with other methods (e.g., surging/swabbing) to remove fines accumulated in the monitoring well between cycles of other development methods.
2. Pumping/over pumping – Use of a pump to remove water and sediment from the well casing, over pumping involves pumping the well at a rate that exceeds the design capacity of the well. Similar to bailing, this technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow is in only one direction, toward the well screen. Small diameter monitoring wells have the additional constraint on pump size and flow rates which further limit the effectiveness of this methodology.
3. Backwashing (rawhiding) – Consists of starting and stopping a pump intermittently to produce rapid pressure changes in a well. This method can produce better results than pumping alone since the procedure involves movement of the water in and out of the screen and formation. However, in many cases the surging action is not rigorous enough to fully develop the well and might be considered the final phase of development after a more rigorous method has been used. Again, small diameter monitoring wells have the additional constraint on pump size and flow rates which further limit the effectiveness of this methodology.
4. Surging/swabbing – Use of a mechanical surge block or swabbing tool to operate like a piston with an up and down motion. The downstroke causes a backwash action that breaks up bridged sediment and the upstroke pulls the dislodged sediment into the well. This method works well for both small and large diameter monitoring wells. Care should be taken on the downstroke so as not to force fines back into the formation, frequent pumping/purging during surging help to keep fines out of the well. Double surge blocks are recommended, and this is typically the most effective method for development of monitoring wells.

5. Jetting – Use of a tool fitted with nozzles that direct streams of water horizontally into well screens at high velocity. Due to the size of the tooling, this method is better suited for wells 4 inches in diameter and larger. The method is also more effective with wire-wrapped/continuous slot screens due to the increased open area. Jetting requires specialized equipment and concurrent pumping to prevent reintroducing fines into the filter pack. Additionally, depending on the configuration of the tool, jetting may require subsequent surging/pumping to remove fines dislodged in the filter pack and formation. Typically, jetting is not a preferred option for new well development but may be effective as part of a re-development/rehabilitation effort.

For most situations, surging/swabbing coupled with bailing or pumping to remove dislodged materials is recommended.

Final well development for properly designed and constructed monitoring wells may begin after the annular seal materials have been installed and allowed to cure, since these wells are designed to retain approximately 90% of the filter pack material. This cure time is typically at least 24 to 48 hours after the sealing materials have been installed.

This TGI is meant to provide a general guide for proper development of newly installed monitoring wells.

A site-specific field implementation plan (FIP) for well installation and development detailing the specific methods and tools is strongly recommended to provide site-specific instruction and guidance.

4 Personnel Qualifications

Generally, Arcadis field personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, and/or state/federal regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The HASP and other documents will identify other training requirements and access control requirements.

The designated Field Manager is responsible for periodic observation of field activities and review of field generated documentation associated with this TGI. The Field Manager is also responsible for implementation of corrective action if problems occur (e.g., retraining personnel, additional review of work plans and TGIs, variances to QC sampling requirements, issuing non-conformances, etc.).

Prior to mobilizing to the field, personnel will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan/work plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Field personnel assigned to install and develop monitoring wells are responsible for completing their tasks in accordance with the specifications outlined in this TGI and other appropriate and relevant guidelines.

Monitoring well development activities will be performed by persons who have been trained in proper well development procedures under the guidance of an experienced field geologist, engineer, or technician.

5 Equipment List

Required equipment depends on the selected method and should be detailed in the site-specific FIP; however, the following are typically required.

- Approved site-specific Health and Safety Plan (HASP)
- Approved site-specific FIP which will include site map, well construction information/borehole information, and development plan
- Personal protective equipment (PPE) and health and safety equipment, as required by the HASP
- Field notebook and/or smart device (phone or tablet)
- Cleaning/decontamination equipment
    - Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean buckets or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the presentitems are clean
    - Distilled or de-ionized water for equipment decontamination
- Monitoring well keys
- Water-level meter
- Down-hole multiparameter water quality sonde (e.g., YSI)
- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment fromcontact with potential sources of contamination
- Well development forms/logs
- Well construction logs/diagrams
- Weighted tape (of sufficient length for maximum site depth)
- Turbidity meter
- Camera
- Watch/timing device

6 Cautions

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

Prior to beginning field work, the project technical team will ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members. An internal call with the project technical team to review the FIP/field sampling plan/work plan scope and objectives is strongly recommended prior to mobilization to ensure that the field work will be effectively and efficiently executed.

Where surging is performed to assist in removing fine-grained material from the sand pack, surging must be performed in a gentle manner. Excessive suction could promote fine-grained sediment entry into the outside of the sand pack from the formation.

Avoid using development fluids or materials that could impact groundwater or soil quality or could be incompatible with the subsurface conditions.

In some cases, it may be necessary to add potable water to a well to allow surging and development, especially for new monitoring wells installed in low permeability formations. Before adding potable water to a well, the Certified Project Manager (CPM) and/or Project Hydrogeologist must be notified, and the CPM shall make the decision regarding the appropriateness and applicability of adding potable water to a well during well development procedures. If potable water is to be added to a well as part of development, the potable water source should be sampled and analyzed for constituents of concern, and the results evaluated by the CPM prior to adding the potable water to the well. If potable water is added to a well for development purposes, at the end of development the well will be purged dry to remove the potable water, or if the well no longer goes dry then the well will be purged to remove at least three times the volume of potable water that was added

7 Health and Safety Considerations

Field activities associated with monitoring well development will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

Appropriate PPE will be worn at all times in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to well locations may expose field personnel to hazardous materials such as contaminated groundwater or NAPL (e.g., petroleum hydrocarbons, chlorinated solvents). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biological hazards (e.g., ticks in long grass/weeds around wellhead), and potentially the use of sharp cutting tools (scissors, knife). Open well caps slowly and keep face and body away while allowing to vent any built-up pressure to vent. Only use non-toxic peppermint oil spray for stinging insect nests. Review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives and use appropriate hand protection.

Do not enter confined spaces unless following appropriate confined space entry procedures specified in the HASP.

If thunder or lightning is present, discontinue sampling until 30 minutes have passed after the last occurrence of thunder or lightning.

8 Procedure

As indicated above, for most monitoring wells, gentle surging coupled with bailing or pumping to remove dislodged sediment is recommended.

8.1 Preliminary Well Development

After installation of the primary filter pack around the monitoring well screen, preliminary well development is recommended be performed to ensure that the filter pack settles and does not bridge within the annular space. The preliminary well development steps are as follows:

1. Measure and record depth to water, total depth of well, and depth to top of the sand pack in the annulus.
2. Use steel or weighted bailer to remove any fines that have accumulated in the bottom of the well.
3. Lower an appropriately sized double-surge block into the screened portion of the well on a rigid pipe or high-density tubing and gently cycle up and down to force water in and out of the screen slots and formation. A two-foot throw is recommended (use tape or chalk marks on the pipe or tubing); however, the entire length of well screen must be gently surged.
4. Start above the screen and gently surge over two-foot intervals while working down to the screen bottom.

NOTE: Care must be taken not to surge the well too aggressively at this point as the casing is not well-supported and damage could occur. The objective is to create enough surging action to settle the primary filter pack and provide some preliminary removal of accumulated materials before final development.

NOTE: If possible, ensure that the developer surges the block upward faster than downward to pull the fines out of the filter pack, instead of forcing them back in (and allowing for proper settlement).

5. Monitor the total depth of the well periodically during surging to ensure that we are not pulling excessive amounts of filter pack through the screen and remove any debris accumulated in the well with a weighted bailer or pump.
6. Re-measure the top of the sand in the annulus to see if more sand pack is necessary. Remove any fines that have accumulated out of the well using a submersible pump or weighted bailer.

NOTE: If the monitoring well was drilled using mud rotary drilling methodology or if significant fines were encountered during the well installation, consider adding a commercially available 'mud' dispersant (e.g., AQUA-CLEAR PFD, Nu Well 220, etc.) as part of the preliminary development. This will help to break up the 'skin' along the borehole wall created by either the drilling fluid or smearing during drilling and assist in final development. Follow manufacturer's directions for dosing, and the mixture should be worked through the entire saturated screen interval by gently surging or brushing.

8.2 Final Well Development

After sufficient time has passed to allow for proper curing of the well seal/grout (i.e., 24 to 48 hours), final well development can be performed. Final well development steps are as follows:

1. Don appropriate PPE (as required by the site-specific HASP).
2. Place plastic sheeting around the well.
3. Clean all equipment entering each monitoring well, except for new, disposable materials that have not been previously used.
4. Open the well cover while standing upwind of the well, remove well cap. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in

the field notebook. If the well headspace reading is less than 5 PID units, proceed; if the headspace reading is greater than 5 PID units, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don the appropriate respiratory protection in accordance with the requirements of the HASP. Record all PID readings.

5. Obtain an initial measurement of the depth to water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field logbook. It is recommended to use a weighted tape for the total well depth measurement.
6. The depth to the bottom of the well should be sounded and then compared to the completion form or construction diagram for the well. Any discrepancies should be reported immediately to the CPM and/or Project Hydrogeologist. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the CPM and/or Project Hydrogeologist and obtain approval to continue or cease well development activities.

NOTE: If the monitoring well was drilled using mud rotary drilling methodology or if significant fines were encountered during the well installation, it is recommended that a commercially available 'mud' dispersant (e.g., AQUA-CLEAR PFD, Nu Well 220, etc.) be included as part of the final well development to effectively break up the 'skin' along the borehole wall created by either the drilling fluid or smearing during drilling.

Per manufacturer's instructions, the general procedure for adding dispersant is as follows:

i. Determine volume of water in screen area and double the calculated volume to account for water in gravel pack and formation interface

ii. Once the water volume is determined, calculate the required treatment volume of dispersant need per manufacturer's recommendations

iii. Mix thoroughly before introducing into well

iv. The preferable application method utilizes a tremie line with the product applied into the screened area

v. Mixture should be thoroughly blended in well, then agitated via surging/swabbing/brushing repeatedly (e.g., every two hours) for a period of up to 24 hours

vi. The dispersant should sit for at least 6 to 8 hours or overnight before continuing well development activities

7. After allowing the dispersant to sit for the required time (if dispersant is used), start the mechanical development by lowering an appropriately sized double-surge block (or similar) into the well on a rigid pipe or high-density tubing.
    i. Surging should start above the screen to reduce the possibility of "sand-locking" the surge block. Initial surging should be with a long stroke and at a slow rate (20 to 25 strokes per minute)
    ii. After surging above the screen, the well should be cleaned via bottom-loading bailer, submersible pump, or inertia pump tubing with check valve to the bottom of the well

iii. Begin surging at the lower end of the screen, gradually working upward, surging in 2-ft intervals until the entire screen has been developed.

iv. Surge the well a minimum of 10 throws per 2-ft screen interval.

v. Each interval may require several surge cycles to achieve the best development.

vi. The entire length of well screen must be surged.

vii. Ensure that the developer surges the block upward faster than downward to pull the fines out of the filter pack, instead of forcing them back in (and allowing for proper settlement)

viii. measure total depth of the well periodically during surging to ensure that excessive amounts of sediment are not being pulled through the screen. Remove any debris accumulated in the well via simultaneous airlifting (if a combined tool is available) or with bailing/pumping.

8. After completing a cycle of surging, lower a bottom-loading bailer, submersible pump, or inertia pump tubing with check valve to the bottom of the well and gently bounce on the bottom of the well to collect/remove accumulated sediment, if any. Remove and empty the bailer, if used. Repeat until the bailed/pumped water is free of excessive sediment and contact at the bottom of the well feels solid. Alternatively, measurement of the well depth with a weighted tape can be used to verify that sediment and/or silt has been removed to the extent practicable, based on a comparison with the well installation log or previous measurement of total well depth.
9. After surging the well for a minimum of two cycles and removing excess accumulated sediment from the bottom of the well, re-measure the depth-to-water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book.
10. Remove formation water by pumping/bailing.

    i. Where pumping is used, measure and record the pre-pumping water level.

    ii. Operate the pump at a relatively constant rate

    iii. Measure the pumping rate using a calibrated container and stopwatch, and record the pumping rate in the field log book

    iv. Measure and record the water level in the well at least once every 5 minutes during pumping

    v. Record any relevant observations in terms of color, visual level of turbidity, sheen, odors, etc.

    vi. Pump or bail until termination criteria specified in the site-specific FIP are reached

    vii. Record the total volume of water purged from the well

NOTE: The FIP may also specify a maximum turbidity requirement for completion of development. Unless otherwise specified the maximum turbidity should be 50 NTUs or less

11. While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Well Development Log.
12. While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Log.
13. While developing, water is also periodically collected directly from the well or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. Development is

considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans or within 10% if not otherwise specified), the extracted water is clear and free of fine sediment and most importantly, when acceptable volume of water has been removed and/or a sufficient amount of surging has been performed.

14. In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete when minimal amounts of fine-grained sediments are recovered, and an acceptable volume of water has been removed.
15. If the well goes dry, stop pumping or bailing. Note the time that the well went dry. After allowing the well to recover, note the time and depth to water. Resume pumping or bailing when sufficient water has recharged the well.
16. Contain all development water in appropriate containers.
17. When complete, secure the lid back on the well.
18. Place disposable materials in plastic bags for appropriate disposal and decontaminate reusable, downhole pump components and/or bailer

9 Waste Management

Investigation-Derived Waste (IDW), including purge water and decontamination liquids, will be stored on site in appropriately labeled containers and disposed of properly. Disposable materials will be stored and disposed of separately. Containers must be labeled at the time of collection and will include date, location(s), site name, city, state, and description of matrix contained (e.g., water, PPE). Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage*, the procedures identified in the FIP/field sampling plan/work plan or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field log.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

All well development activities will be documented on appropriate log forms as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site; times of arrival and departure; significant weather conditions; timing of well development activities; development

method(s); observations of purge water color, turbidity, odor, sheen, etc.; purge rate; and water levels before, during, and after pumping.

Management of the original documents from the field will be completed in accordance with the site-specific QAPP. Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

Development activities will be documented on appropriate field logs as well as in a proper field notebook. All field data will be recorded digitally or with indelible ink. Field forms, logs/notes (including daily field and calibration logs), digital records, and chain-of-custody records will be maintained by the field team lead. Any deviations or omissions from this TGI should be documented.

Initial field logs and forms will be transmitted to the Arcadis CPM and/or Technical Lead at the end of each day unless otherwise directed by the CPM. The field team leader retains copies of the field documentation.

11 Quality Assurance

Quality assurance procedures will be conducted in accordance with the Arcadis Quality ManagementSystem or the site-specific QAPP. Refer to the QAPP or FIP/sampling plan/work plan for specific requirements.

12 References

American Society for Testing Materials (ASTM), Designation D5521-05. *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

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TGI – Monitoring Well Installation

Rev: 2

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Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	4/24/2017	All	Re-written as a TGI	Marc Killingstad Peter C. Frederick
	1	6/23/2022	All	Put into new template format, reviewed and made minor revisions	Whitney Plasket Marc Killingstad
	2	8/30/2023	All	Annual review completed by SME. Updated Rev 1.	Marc Killingstad

Approval Signatures

Prepared by:		8/30/2023
	Whitney Plasket	Date
Reviewed by:		8/30/2023
	Marc Killingstad	Date

1 Introduction

This Technical Guidance Instruction (TGI) describes methods used to install groundwater monitoring wells in unconsolidated aquifers. It is assumed that the monitoring well to be installed has been properly designed, including sizing of the filter pack and screen, the length of the screen, total depth of the well, material strength and compatibility and surface completion. Typical monitoring wells are constructed of manufactured screen and engineered filter pack and are generally suitable for formations with granular materials having a grain size distribution with up to 50% passing a #200 sieve and up to 20% clay-sized material. Monitoring wells installed in formations finer than this may not be able to produce turbidity free water.

2 Intended Use and Responsibilities

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3 Scope and Application

The monitoring well installation procedures set forth herein are consistent with the approach and methods presented in the American Society of Testing and Materials (ASTM) *D5092 – Standard Practice for Design and Installation of Groundwater Monitoring Wells* (ASTM D5092). As such, following this TGI in combination with proper well design (see appropriate TGI and/or consult with appropriate subject matter expert), well development (see appropriate TGI), groundwater sampling procedures (see appropriate TGI), and well maintenance and

rehabilitation (see appropriate TGI and/or consult with appropriate subject matter expert), will result in a monitoring well suitable for: (1) collection of groundwater samples representative of the surrounding formation and free of artificial turbidity; (2) measurement of accurate groundwater levels; and (3) hydraulic testing of formation sediments immediately adjacent to the open interval of the well to assess hydraulic properties (e.g., slug testing).

Monitoring well boreholes in unconsolidated (overburden) materials are often drilled using the hollow-stem auger drilling method; however, other drilling methods are also suitable for installing overburden monitoring wells and may be appropriate given site-specific geologic conditions or project objectives. These methods include drive-and-wash, spun casing, rotosonic (sonic), dual-rotary (Barber Rig), and fluid/mud rotary with core barrel or roller bit. Direct-push techniques (e.g., Geoprobe® or cone penetrometer) and driven well points may also be used in some cases within the overburden.

Monitoring wells to be installed within consolidated materials such as fractured bedrock are commonly drilled using air rotary, water-rotary (coring or tri-cone roller bit), or sonic drilling methods. For guidance when installing monitoring wells in consolidated materials, please consult the appropriate subject matter expert and, if available, the applicable guidance document.

The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling/well depths, site or regional geologic knowledge, type of monitoring to be conducted using the installed well, project objectives, and cost. Consultation with the appropriate subject matter expert is also strongly recommended.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). No polyvinyl chloride (PVC) glue/cement will be used in constructing or retrofitting monitoring wells that will be used for water-quality monitoring.

Coated bentonite pellets are generally not recommended because of potential chemical incompatibilities between the coating material and groundwater chemistry.

Specifications of materials to be installed in the borehole will be obtained prior to mobilizing onsite. These materials generally include:

- Well casing (length, material, and diameter);
- Well screen (length, material, diameter, and slot size);
- Grout (typically neat cement grout, which is 5-6 gallons of water per 94 lb. bag of Portland Type I/II cement *with no bentonite* but, as applicable, up to 5% bentonite can be added);
- Filter pack (filter pack type and fine sand seal type, as applicable); and
- Bentonite (type, as applicable/needed, non-coated pellets or tablets are generally preferred over chips).

Well materials will be inspected and, if needed, cleaned, or replaced prior to installation. The field task manager or field team lead will communicate with the drilling company ahead of time to make sure the materials meet the required specification for well construction.

NOTE: If installing monitoring wells for per- and polyfluoroalkyl substances please refer to *TGI for Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide*.

4 Personnel Qualifications

Arcadis field personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or state/federal regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, Arcadis field personnel will review and be thoroughly familiar with relevant site-specific documents including but not limited to the field implementation plan (FIP)/task-specific work plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Personnel responsible for overseeing drilling operations will have at least 16 hours of prior training overseeing drilling activities with an experienced geologist, environmental scientist, or engineer with at least 2 years of prior experience.

Arcadis personnel directing, supervising, or leading well installation activities will have a minimum of 1 year of previous environmental monitoring well installation experience. Field employees with less than six months of experience will be accompanied by a supervisor (as described above) to ensure that proper well installation techniques are employed.

Additionally, the Arcadis field team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization particularly the selected drilling method/rig.

Monitoring well installation activities will be performed by persons who have been trained in proper well installation procedures under the guidance of an experienced field geologist, engineer, or technician. Field sampling is typically performed for soil or bedrock characterization as part of monitoring well installation; therefore, field personnel will have undergone in-field training in soil or bedrock description and sample collection methods, as described in *TGI for Soil Drilling and Sample Collection, TGI for Bedrock Core Collection and Description, and TGI for Soil Description*.

5 Equipment List

The following materials may be required during soil boring and monitoring well installation activities:

- Site Plan with proposed soil boring/well locations;
- Field Implementation Plan (FIP)/Work Plan that includes site map with proposed well locations, well construction details (tabulated and drawings) which will include well casing material and size, well screen material and size, length of screen, target depth and screen interval, filter pack material, development methods, and previous boring logs (as available);
- Field Sampling Plan (FSP), and site-specific Health and Safety Plan (HASP);
- Personal protective equipment (PPE) as required by the HASP;

- Traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area, if such are not provided by drillers;
- Appropriate soil sampling equipment (e.g., stainless steel spatulas, knife);
- Soil and/or bedrock logging equipment as specified in the FIP/work plan or other appropriate project documents;
- Appropriate sample containers and labels;
- Drum labels as required for investigation derived waste handling;
- Insulated coolers with ice, when collecting samples requiring preservation by chilling;
- Photoionization detector (PID) or flame ionization detector (FID);
- Ziplock style bags;
- Water level or oil/water interface meter;
- Locks and keys for securing the well after installation;
- Decontamination equipment (bucket, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels);
- Engineer's tape/measuring wheel;
- Weighted tape;
- Disposable bailers;
- Forms/notes:
    - Tablet with digital forms
    - Field notebook
    - Chain-of-custody forms
    - Digital camera (or smart phone with camera);
    - Appropriate field forms, consider including a photo of the well head and a Google Earth map showing the well location.

Prior to mobilizing to the site, Arcadis personnel will contact the drilling subcontractor or in-house driller (as appropriate) to confirm that appropriate sampling and well installation equipment will be provided. Specifications of the sampling and well installation equipment are expected to vary by project, and so communication with the driller is necessary to ensure that the materials provided will meet the project objectives. Equipment/materials typically provided by the driller could include:

- Drilling equipment required by the ASTM standard guidance document D1586, when performing split-spoon sampling;
- Disposable plastic liners (when drilling with direct-push equipment);
- Drums for investigation derived waste (IDW);
- Equipment to move IDW drums, if required;
- Drilling and sampling equipment decontamination materials;
- Decontamination pad materials, if required;

- Traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area, if required; and
- Well construction materials.

6 Cautions

- Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service. See Arcadis standard for proper utility clearance protocol.
- Prior to beginning field work, contact the project technical team (including Project Hydrogeologist) to ensure that all field procedures, logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.), and objectives are clearly understood by all team members.
- Some regulatory agencies require a minimum annular space between the well or permanent casing and the borehole wall. When specified, the minimum clearance is typically 2 to 3 inches on all sides (e.g., a 2-inch diameter well requires a 6-inch diameter borehole). In addition, some regulatory agencies have specific requirements regarding grout mixtures and well seal materials. Determine whether the oversight agency has any such requirements prior to finalizing the drilling and well installation plan. If installing a monitoring well into consolidated sediments, refer to regulatory agency rules regarding casing.
- The maximum screen length may also be dictated by regulatory agencies. If installing a monitoring well with greater than a 10-ft screen, refer to regulatory agency rules regarding screen length.
- If dense non-aqueous phase liquids (DNAPL) are known or expected to exist at the site, refer to the project specific documents for additional details regarding drilling and well installation to reduce the potential for inadvertent DNAPL remobilization. Similarly, if light non-aqueous phase liquids (LNAPLs) are known or expected to be present as “perched” layers above the water table, refer to the *DNAPL Contingency Plan*. Follow the general provisions and concepts in the DNAPL contingency plan during drilling above the water table at known or expected LNAPL sites.
- Avoid using drilling fluids or materials that could impact groundwater or soil quality or could be incompatible with the subsurface conditions. Water used for drilling and sampling of soil or bedrock, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Consider testing of water supply as necessary.
- Similarly, consider the compatibility between the well materials and the surrounding environment. For example, PVC well materials are not preferred when DNAPL is present. In addition, some groundwater conditions leach metals from stainless steel or are corrosive to metal well materials, and some remedial technologies are incompatible with certain materials of construction. If questions arise, contact the CPM and Project Hydrogeologist/Technical Lead to discuss.
- Specifications of materials used for backfilling the borehole will be obtained, reviewed, and approved to meet project quality objectives. Bentonite is not recommended where DNAPLs are likely to be present or in groundwater with high salinity. In these situations, neat cement grout is preferred.
- As noted above, coated bentonite pellets are not recommended for monitoring well construction, as the coating could impact the water quality in the completed well.

- Heat of hydration during neat cement grout curing must be considered to avoid damage to PVC well materials. The annular space for a typical monitoring well is small enough that heat of hydration should not create excessive temperature increases which may damage PVC well material. However, washouts in the borehole can lead to thick accumulations of grout which can produce enough heat during curing to weaken and potentially damage PVC casing. If heat of hydration is a concern, contact the Project Hydrogeologist/Technical Lead to address the issue.
- Similarly, it is imperative that backfill volumes (filter pack and well seal) be estimated and then closely monitored to ensure that materials are not 'lost' to the formation. If estimated volumes do not reasonably match actual volumes, contact the Project Hydrogeologist/Technical Lead to address the issue.

7 Health and Safety Considerations

Field activities associated with monitoring well installation will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. The HASP may require that the drilling company provide their own HASP and/or Job Safety Analyses (JSAs).

The HASP will be followed, as appropriate, to ensure the safety of field personnel. Review all site-specific and procedural hazards as they are provided in the HASP, and review Job SafetyAnalysis (JSA) documents in the field each day prior to beginning work.

Prior to drilling, utility clearance must be performed (see Section 6). Appropriate personal protective equipment (PPE) must always be worn in accordance with the task and the HASP.

Working outside at sites with suspected contamination may expose field personnel to hazardous materials such as contaminated groundwater or NAPL (e.g., oil). Other potential hazards include biological hazards (e.g., stinging insects, ticks in long grass/weeds, etc.), and potentially the use of sharp cutting tools (scissors, knife). Only use non-toxic peppermint oil spray for stinging insect nests. Review client-specific health and safety requirements, which may preclude the useof fixed/folding-blade knives and use appropriate hand protection.

If thunder or lightning is present, discontinue drilling and sampling until 30 minutes have passed after the last occurrence of thunder or lightning.

8 Procedure

The procedures for installing groundwater monitoring wells are presented below:

Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Sonic, and Dual-Rotary Drilling Methods

1. Prior to monitoring well installation, determine the expected volumes of filter pack and seal materials including grout (neat cement or cement-bentonite) and bentonite (if applicable).
2. Locate boring/well location, establish work zone, and set up sampling equipment decontamination area.
3. During well installation, record construction details, measurements, and tabulate materials used (e.g., screen and riser footages; filter pack volume; bags of cement/sand; volume of grout; etc.) in the field notebook as well as appropriate field forms.

4. Advance boring to desired depth.
    a. Collect soil and/or bedrock samples at appropriate interval(s), document, and store samples for laboratory analysis as specified in the FIP/Work Plan.
    b. Decontaminate equipment between samples in accordance with the *TGI for Groundwater and Soil Sampling Equipment Decontamination* or if installing monitoring wells for per- and polyfluoroalkyl substances please refer to *TGI for Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide* for both sampling and decontamination guidance.
    c. A common sampling method that produces high-quality soil samples with relatively little soil disturbance is described in *ASTM D1586 – Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586). Split-spoon samples are obtained during drilling using hollow-stem auger, drive-and-wash, spun casing, and fluid/mud rotary.
    d. Sonic drilling produces soil cores that, for the most part, are relatively undisturbed, but note that when drilling in consolidated or finer-grained sediment the vibratory action during core barrel advancement may create secondary fractures or breaks.
    e. Dual-rotary removes cuttings by compressed air or water/mud and allow only a general assessment of geology.
5. Describe each soil sample as outlined in *TGI for Soil Description* and document descriptions in the field notebook and/or field tablet or field forms and photo document the samples. It should be noted that electronic logs must be backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data. During boring advancement, document all drilling events in field notebook or field forms, including blow counts (number of blows required to advance split-spoon sampler in 6-inch increments) and work stoppages. Blow counts will not be available if sonic, dual-rotary, or direct-push methods are used.
6. Before installing a screen, it is important to confirm that the borehole has been advanced into the targeted saturated zone. This is particularly important for wells installed to monitor the water table and/or the shallow saturated zone, as the capillary fringe may cause soils above the water table to appear saturated. If one or more previously installed monitoring wells exist nearby, use the depth to water at such well(s) to estimate the water-table depth at the new borehole location.

    NOTE: *To verify that the borehole has been advanced into the saturated zone, it is necessary to measure the water level in the borehole. For boreholes drilled without using water (e.g., hollow-stem auger, cable-tool, air rotary, air hammer), verify the presence of groundwater (and/or LNAPL, if applicable) in the borehole using an electronic water level meter, oil-water interface probe, or a new/decontaminated bailer. For boreholes drilled using water (e.g., drive and wash, spun-casing with roller-bit wash, sonic, or water rotary with core or roller bit), monitor the water level in the borehole as it re-equilibrates to the static level.*

    In low-permeability units like clay, fine-grained glacial tills, shale, and other bedrock formations, it may be necessary to wait overnight to allow the water level to equilibrate. Document depth to water in the borehole on the appropriate field forms and field notebook. If there are questions concerning the depth of the well/screen interval, consult with the project technical lead prior to finalizing well depth/screen interval. To the extent practicable, ensure that the depth of the well below the apparent water table is deep enough so that the installed well can monitor groundwater year-round, accounting for seasonal water-table fluctuations. When in doubt, err on the side of slightly deeper well installation.

7. Upon completing the borehole to the desired depth, if a screened well construction is required, install the monitoring well by lowering the screen and casing assembly through the augers or casing. Monitoring wells typically will be constructed of 2-inch-diameter (although sometimes 4-inch), flush-threaded PVC or stainless steel slotted or wire wrapped well screen and blank riser casing. Smaller diameters may be used if wells are installed using direct-push methodology or if multiple wells are to be installed in a single borehole, according to the well design as outlined in the FIP/Work Plan. The screen length and other construction details will be specified in the FIP/Work Plan based on regulatory requirements and specific monitoring objectives. Monitoring well screens are usually 5 to 10 feet long, but the screen length will depend on the purpose for the well and the objectives of the groundwater investigation and will (in most cases) be determined prior to the field mobilization.

   NOTE: *The slot size and filter pack gradation will be predetermined in the Work Plan (or equivalent) or FSP and based on site-specific grain-size analysis (sieve analysis) or other geologic considerations or monitoring objectives. Consult the Project Hydrogeologist and/or subject matter expert if there are questions/concerns regarding the filter pack and slot size specified. If the screen slot size and filter pack have not been based on site-specific grain-size analysis, consider collecting soil samples during well installation so future wells can be properly designed.*

   NOTE: *A blank sump may be attached below the well screen if the well is being installed for DNAPL recovery /monitoring purposes. If so, the annular space around the sump may be backfilled with filter pack during placement around the well screen.*

8. A blank riser will extend from the top of the screen to the level specified in the FIP/Work Plan (e.g., approximately 2.5 feet above grade if a stick up or just below grade where a flush-mounted monitoring well is specified).

   NOTE: *For wells greater than 50 feet deep, placement of centralizers may be desired to assist in centering the monitoring well in the borehole during installation. Refer to the FIP/Work Plan and/or consult with the Project Hydrogeologist/Technical Lead.*

9. When the monitoring well assembly has been set, using a tremie place the washed silica filter pack in the annular space from the bottom of the boring to a height above the top of the screen as specified in the FIP/Work Plan (typically placed to at least 2 feet above the top of the well screen). The filter pack will be placed, and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth.

   NOTE: *It is very important to verify that the expected volume of filter pack matches with the actual amount placed. There can be differences due to irregularities in the borehole geometry. Washout of the borehole will result in the need for greater than calculated well materials. If a difference of more than 10% is noted, consult with the Project Hydrogeologist/Technical Lead. The filter pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the FIP/Work Plan.*

10. After placement of the filter pack, preliminary well development is recommended be performed to ensure that the filter pack settles and does not bridge within the annular space and to remove any fines accumulated in the well during installation. This typically entails gently surging the entire well screen to prevent filter pack material bridging and to settle the filter pack prior to well seal installation. For recommended procedures, please refer to the *TGI for Monitoring Well Development*. Monitor the placement of the filter pack (e.g., with a weighted tape measure) and, as necessary during preliminary development (i.e., settlement), add filter pack to ensure proper thickness/height above screen is attained.

11. Depending on the project-specific requirements and applicable federal/state/local regulations, a well seal comprised of either fine sand or hydrated bentonite will then be placed in the annular space above the filter pack, typically at a minimum of 2 feet thick—follow the specifications outlined in the FIP/Work Plan). If non-hydrated bentonite is used, allow sufficient time for hydration to occur (typically a minimum of 30 minutes, but follow manufacturer's recommendations and/or specifications outlined in the FIP/Work Plan). Potable water may be added to hydrate the bentonite if the seal is above the water table. Monitor the placement of the fine sand/bentonite seal (e.g., with a weighted tape measure).

    NOTE: *Coated bentonite pellets are generally not recommended for monitoring well construction because of potential chemical incompatibilities between the coating material and groundwater chemistry.*

12. During the extraction of the augers or casing, a neat cement or cement/bentonite grout will be placed in the annular space from the well seal to a depth as specified in the FIP/Work Plan (e.g., approximately 2 ft. below groundwater surface). It is recommended that grout be placed with a tremie pipe. Ensure that seal materials are mixed at the proper ratios with water following manufacturer's recommendations.

    NOTE: *If it is necessary to install a monitor well into a permeable zone below a confining layer (i.e., confined conditions), particularly if the deeper zone is believed to have water quality that differs significantly from the zone above the confining layer, then a telescopic well construction may be considered.*

    In this case, the borehole is advanced approximately 3 to 5 feet into the top of the confining layer (depending upon the thickness of the confining layer), and a permanent casing (typically PVC or stainless steel) is installed into the socket drilled into the top of the confining layer.

    The casing is then grouted in place. The preferred methods of grouting telescoping casings include (1) pressure-injection grouting using an inflatable packer installed temporarily into the base of the casing, such that grout is injected out the bottom of the casing until it is observed at ground surface outside the casing; (2) displacement-method grouting (also known as the Halliburton method), which entails filling the casing with grout and displacing the grout out the bottom of the casing by pushing a drillable plug, typically made of wood to the bottom of the casing, following by tremie grouting the remainder of the annulus outside the casing; or (3) tremie grouting the annulus surrounding the casing using a tremie pipe installed to the base of the borehole.

    In all three cases, the casing is grouted to the ground surface, and the grout is allowed to set prior to drilling deeper through the casing. Refer to the FIP/Work Plan, Project Hydrogeologist, and/or subject matter expert for the completion of non-standard monitoring wells, including telescopic wells.

13. Install the monitoring well surface completion as specified in FIP/Work Plan. Typical completions are a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing and will slope gently away from the casing to promote drainage away from the well.

14. When an above-grade completion is used, the riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the riser will be sealed using an unvented, expandable locking plug.

15. Monitoring wells will be labeled as specified in the FIP/Work Plan. If not specified, use indelible ink or paint with the appropriate designation on both the inner and outer well casings and/or inside of the curb box lid. If called for, mark a consistent measuring point by cutting a V in the PVC casing or marking the measuring point in black.
16. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 9 below.
17. After completing well installation, finalize documentation and follow data management procedures outlined in Section 10 below.
18. For final well development guidance and procedures, please refer to the *TGI for Monitoring Well Development.*

Direct-Push Method

The direct-push drilling method may also be used to complete soil borings and install monitoring wells. Examples of this technique include the Diedrich ESP vibratory probe system, GeoProbe®, or AMS Power Probe® dual-tube system. Environmental probe systems typically use a hydraulically operated percussion hammer. Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow and provides the force needed to penetrate very stiff to medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual-tube liner for sampling soil. The outside diameter (OD) of the outer casing ranges from 1.75 to 2.4 inches and the OD of the inner sampling tube ranges from 1.1 to 1.8 inches.

The outer casing isolates shallow layers and permits the unit to continue to probe at depth. The double-rod system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, the inside diameter (ID) of the steel casing provides clearance for the installation of small-diameter (e.g., 0.75- to 1-inch ID) micro-wells.

If direct-push drilling has been determined to be a viable method for site conditions and project objectives, procedures for installing monitoring wells in soil using the direct-push method are described below.

1. Locate boring/well location, establish work zone, and set up sample equipment decontamination area.
2. Advance soil boring to designated depth, collecting samples at intervals specified in the FIP/Work Plan. Samples will be collected using dedicated, disposable, plastic liners. Collect and describe samples in accordance with the procedures outlined in Steps 4 and 5 above. Collect samples for laboratory analysis as specified in the FIP/Work Plan.
3. Upon advancing the borehole to the desired depth, install the micro-well through the inner drill casing. The micro-well will consist of approximately 1-inch ID PVC or stainless-steel slotted screen and blank riser. The filter pack, well seal, and neat cement/cement-bentonite grout will be installed as described, where applicable, in Steps 9 through 12 above.
4. Install surface completion (protective steel casing or flush-mount), as appropriate and as described in Steps 13 through 15 above.
5. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 9 below.
6. After completing well installation, finalize documentation and follow data management procedures outlined in Section 10 below.

Driven Well Point Installation

If specified in the FIP/Work Plan, well points installed by pushing or driving using a drilling rig or direct-push rig (or hand-driven where possible) will typically consist of a 1- to 2-inch-diameter threaded steel casing with either 0.010- or 0.020-inch slotted stainless-steel screen. The screen length will vary depending on the hydrogeologic conditions of the site. The casings will be joined together with threaded couplings and the terminal end will consist of a steel well point. Because they are driven or pushed to the desired depth, well points do not have annular backfill materials such as sand pack or grout. Refer to the FIP/Work Plan and/or consult with the Project Hydrogeologist/Technical Lead and/or subject matter expert for specific guidance on drive point installation procedures/specifications.

9 Waste Management

IDW, including soil cuttings and excess drilling fluids (if used), decontamination liquids, and disposable materials (well material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan (or equivalent), FSP, and/or IDW management guidance document.

Investigative-Derived Waste (IDW) generated during drilling activities, including soil and excess drilling fluids (if used), and decontamination liquids, will be stored on site in appropriately labeled containers and disposed of properly. Disposable materials will be stored and disposed of separately. Containers must be labeled at the time of collection and will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, PPE).

Waste will be managed in accordance with the *TGI for Investigation-Derived Waste Handling and Storage,* the procedures identified in the FIP/work plan or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field log.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

If not using FieldNow®, all well drilling/installations activities will be documented on appropriate field/log forms as well as in a proper field notebook and/or Personal Digital Assistant (PDA) and/or tablet. All field data will be recorded digitally or with indelible ink. Field forms, logs/notes (including daily field and calibration logs), digital records, and chain-of-custody records will be maintained by the field team lead. Any deviations or omissions from this TGI will be documented.

Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of well installation activities, soil descriptions, well construction specifications (screen and riser material and diameter, sump length, screen length and slot size, riser length, filter pack type and volume, type of well seal (fine sand or bentonite seal) and volume, type and volume of grout (neat cement or cement-bentonite), and other materials used.

Management of the original documents from the field will be completed in accordance with the site-specific QAPP. Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

Initial field logs and forms will be transmitted to the Arcadis CPM and/or Technical Lead at the end of each day unless otherwise directed by the CPM. The field team leader retains copies of the field documentation.

Locations of newly installed wells will be documented photographically and/or on a site sketch. If appropriate, a measuring wheel, engineer's tape, or handheld GPS will be used to determine approximate distances from key site features or estimated coordinates.

The well location, ground surface elevation, and inner and outer casing elevations will be surveyed using the method specified in the FIP/Work Plan. Generally, a local baseline control will be set up. This local baseline control can then be tied into the appropriate vertical and horizontal datum, such as the National Geodetic Vertical Datum (NGVD)of 1929 or North American Vertical Datum (NAVD) of 1988 and the State Plane Coordinate System. At a minimum, the elevation of the top of the inner casing used for water-level measurements should be measured to the nearest 0.01 foot. Elevations will be established in relation to the NGVD of 1929 or the NAVD of 1988. A permanent mark will be placed on top of the inner casing to mark the point for water-level measurements.

11 Quality Assurance

Quality assurance procedures will be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP. Refer to the QAPP or FIP/sampling plan/work plan for specific requirements.

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate TGI. All well construction materials will be inspected and cleaned (as necessary) prior to well installation.

Field-derived quality assurance blanks will be collected as specified in the FIP/work plan and/or site- specific QAPP, depending on the project quality objectives. Typically, field rinse blanks (equipment blanks) will be collected when non-dedicated equipment (e.g., split-spoon sampler, stainless steel spoon) is used during soil sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminants from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities and during transport to the laboratory.

Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook.

12 References

American Society for Testing Materials (ASTM) D5092 - *Standard Practice for Design and Installation of Ground Water Monitoring Wells*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

American Society of Testing and Materials (ASTM) D1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

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TGI – Soil Description

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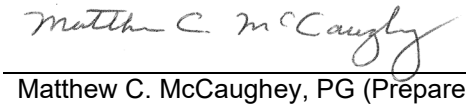
Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	May 20, 2008	17	Original SOP	Joe Quinnan Joel Hunt
	1	September 2016	15	Updated to TGI	Nick Welty Patrick Curry
	2	February 16, 2018	15	Updated descriptions, attachments and references in text	Nick Welty Patrick Curry
	3	April 15, 2022		Minor description edits, intro of grain-size K analysis, revised boring log template	Matt McCaughey Patrick Curry
	4	June 5, 2023		Annual review completed by SME.	Patrick Curry

Approval Signatures

Prepared by:		6/5/2023
		
	Matthew C. McCaughey, PG (Preparer)	Date
Reviewed by:		6/5/2023
	Patrick Curry, PG (Subject Matter Expert)	Date

1 Introduction

This Arcadis Technical Guidance Instruction (TGI) describes proper soil description procedures based on visual inspection and testing of soil cores and samples. This document has been developed to emphasize field observation and documentation of details required to:

- Make hydrostratigraphic interpretations guided by depositional environment/geologic settings
- Provide information needed to understand the distribution of constituents of concern; properly design wells, piezometers, and/or additional field investigations; and develop appropriate remedial strategies.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This TGI should be followed for unconsolidated material unless there is an established client-required specific procedure or regulatory-required specific procedure. In cases where there is a required specific procedure, it should be followed and should be referenced and/or provided as an appendix to reports that include soil classifications and/or boring logs. When following a required non-Arcadis procedure, additional information required by this TGI should be included in field notes with client approval.

This TGI incorporates elements from various standard systems such as ASTM D2488-06, Unified Soil Classification System, Burmister and Udden Wentworth. However, none of these standard systems focus specifically on contaminant hydrogeology and remedial design. Therefore, although each of these systems contain valuable guidance and information related to correct descriptions, strict application of these systems can omit information critical to our clients and the projects that we perform.

This TGI includes the following attachments:

- **Attachment A –** Field Soil Description Guide
- **Attachment B –** Particle Size System Comparison
- **Attachment C –** Description of Logging Terms
- **Attachment D –** Blank Boring Log
- **Attachment E –** Completed Boring Log

This TGI does not address details of health and safety; drilling method selection; boring log preparation; sample collection; or laboratory analysis. Refer to other Arcadis procedure, guidance, and instructional documents, the project work plans including the quality assurance project plan, sampling plan, and health and safety plan (HASP), as appropriate.

4 Personnel Qualifications

Soil descriptions should only be performed by Arcadis personnel or authorized sub-contractors with a degree in geology or a geology-related discipline. Field personnel will complete training on the Arcadis soil description TGI in the office and/or in the field under the guidance of an experienced field geologist with at least 2 years of prior experience applying the Arcadis soil description method.

5 Equipment List

The following equipment should be taken to the field to facilitate soil descriptions:

- Field book, field forms or digital devices to record soil descriptions
- Field book for supplemental notes
- This TGI for Soil Descriptions and any project-specific procedure, guidance, and/or instructional documents (if required)
- Field card showing Wentworth scale
- Munsell® soil color chart
- Tape measure divided into tenths of a foot
- Stainless steel knife or spatula
- Hand lens
- Water squirt bottle
- 4-ounce glass jars with lids (for collecting soil core samples)
- Personal protective equipment (PPE), as required by the HASP
- Digital camera

- Folding table

6 Cautions

Drilling and drilling-related hazards including subsurface utilities are discussed in other procedure documents and site-specific HASPs and are not discussed herein.

Soil samples may contain hazardous substances that can result in exposure to persons describing soils. Routes for exposure may include dermal contact, inhalation and ingestion. Refer to the project specific HASP for guidance in these situations.

7 Health and Safety Considerations

Field activities associated with soil sampling and description will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. Know what hazardous substances may be present in the soil and understand their hazards. Always avoid the temptation to touch soils with bare hands, detect odors by placing soils close to your nose, or tasting soils.

8 Procedure

8.1 General Procedures

- Select the appropriate sampling method to obtain representative samples in accordance with the selected sub-surface exploration method, e.g., split-spoon or Shelby sample for hollow-stem drilling, acetate sleeves for direct push, bagged core for sonic drilling, etc.
- Proceed with field activities in required sequence. Although completion of soil descriptions is often not the first activity after opening sampler, identification of stratigraphic changes is often necessary to select appropriate intervals for field screening and/or selection of laboratory samples.
- Set up boring log field sheet.
    - Determine the proper units of measure. Drillers in both the US and Canada generally work in feet due to equipment specifications. Field geologists typically record drilling depths, core recovery, and sample intervals in feet and grain size in millimeters
    - Use the Arcadis standard boring log form (**Attachment D**). *Note that as of April 2022, several digital logging applications are available through the FieldNow™ program and the Fulcrum app. A future revision of this TGI, likely in early 2023, will emphasize digital logging methods and field boring log forms will no longer be acceptable. FieldNow is discussed further in Section 10.*
    - The boring log template includes a graphic log of the primary soil texture to support quick visual evaluation of grain size. The purpose of the graphic log is to quickly assess relative soil permeability. Note, for poorly sorted soils (e.g., glacial till), the principal component may not correlate to permeability of the sample. In this case, the geologist should use best judgement to graph overall soil type consistent with relative soil permeability. For example, for a dense sand/silt/clay till, the graphic log would reflect the silt/clay, rather than sand.

    - Record depths along the left-hand side at a standard scale to aid in the use of this tool.
- Examine each soil core (this is different than examining each sample selected for laboratory analysis) and record the soil conditions in accordance with guidelines provided in Section 8.2.
- At the end of the boring, record the amount of drilling fluid used (if applicable) and the total depth logged.
- At a minimum, a written or digital boring log should be prepared with the following information:
    - Describe type of surface material (asphalt, grass, topsoil, gravel, etc.)
    - Describe the type of fill or non-native soils and estimated depth to native soils
    - Record sample intervals (soil cores, environmental and/or geotechnical samples)
    - Describe soil conditions in accordance with this TGI
    - Record moisture content and estimated depth to water table or saturated zone
    - Record the total depth and document why drilling was stopped (refusal, target depth achieved, etc.)

8.2 Soil Description Procedures

The standard soil description order is presented below.

- Depth
- PRIMARY TEXTURE
- Principal and Minor Components with Descriptors
    - % Modifiers and grain size fraction
    - Angularity for very coarse sand and larger particles
    - Consistency or Density
    - Plasticity for silt and clay
    - Dilatancy for silt and silt-sand mixtures
- Sorting
- Moisture Content
- Color
- Notes

Depth. To measure and record the depth below ground surface (bgs) of top and bottom of each stratum, the following information should be recorded.

- Measured depth to the top and bottom of sampled interval. Use starting depth of sample based upon measured tool length information and the length of sample interval.
- Length of sample recovered, not including slough (material that has fallen into hole from previous interval), expressed as fraction with length of recovered sample as numerator over length of sampled interval as denominator (e.g., 36/60 for 36 inches recovered from 5-ft [60-inch] sampling interval).
- Thickness of each stratum measured sequentially from the top of recovery to the bottom of recovery.
- Any observations of sample condition or drilling activity that would help identify whether there was loss from the top of the sampling interval, loss from the bottom of the sampling interval, or compression of the sampling interval. Examples: 14/24, gravel in nose of spoon; or 36/60 bottom 12 inches of core empty.

Determination of Components. Obtain a representative sample of soil from a single stratum. If multiple strata are present in a single sample interval, each stratum should be described separately. More specifically, if the sample is from a 2-foot-long split-spoon where strata of coarse sand, fine sand and clay are present, then the resultant description should be of the three individual strata unless a combined description can clearly describe the interbedded nature of the three strata. Example: SAND, fine; with interbedded lenses of Silt and Clay, ranging between 1 and 3 inches thick.

Identify principal component and express volume estimates for minor components on logs using the following standard modifiers.

Modifier	Percent of Total Sample (by volume)
and	36 – 50
some	21 - 35
little	10 - 20
trace	<10

Determination of components is based on using the Udden-Wentworth particle size classification (see below) and measurement of the average grain size diameter. Each size class differs from the next larger class by a constant ratio of ½. Due to visual limitations, the finer classifications of Wentworth's scale cannot be distinguished in the field and the subgroups are not included. Visual determinations in the field should be made carefully by comparing the sample to the Soil Description Field Guide (**Attachment A**) that shows Udden-Wentworth scale or by measuring with a ruler.

The following table summarized the modified Udden-Wentworth Scale for grain size classification. Note that gravel is a size category encompassing the granule, pebble, cobble, and boulder size classes.

Udden-Wentworth Scale (Modified by Arcadis, 2008)				
Size Category	**Size Class**	**Millimeters**	**Inches**	**Standard Sieve #**
Gravel (Cobble)	Boulder	256 – 4096	10.08+	
	Large cobble	128 - 256	5.04 -10.08	
	Small cobble	64 - 128	2.52 – 5.04	
Gravel (Pebble)	Very large pebble	32 – 64	0.16 - 2.52	
	Large pebble	16 – 32	0.63 – 1.26	
	Medium pebble	8 – 16	0.31 – 0.63	
	Small pebble	4 – 8	0.16 – 0.31	No. 5 +
	Granule	2 – 4	0.08 – 0.16	No.5 – No.10

Sand	Very coarse sand	1 -2	0.04 – 0.08	No.10 – No.18
	Coarse sand	½ - 1	0.02 – 0.04	No.18 - No.35
	Medium sand	¼ - ½	0.01 – 0.02	No.35 - No.60
	Fine sand	1/8 -¼	0.005 – 0.1	No.60 - No.120
	Very fine sand	1/16 – 1/8	0.002 – 0.005	No. 120 – No. 230
Fines	Silt (subgroups not included)	1/256 – 1/16	0.0002 – 0.002	Not applicable (analyze by pipette or hydrometer)
	Clay (subgroups not included	1/2048 – 1/256	0.00002 – 0.0002	

Identify components as follows. Remove particles greater than very large pebbles (64-mm diameter) from the soil sample. Record the volume estimate of the greater than very large pebbles. Examine the sample fraction of very large pebbles and smaller particles and estimate the volume percentage of the pebbles, granules, sand, silt and clay. Use the jar method, visual method, and/or wash method (Appendix X4 of ASTM D2488) to estimate the volume percentages of each category.

Sieve and hydrometer grain-size analysis can be used to vet the visual description, as well as used to estimate hydraulic conductivity. Lab or field sieve analysis is advisable to characterize the variability and facies trends within each hydrostratigraphic unit. It is recommended that sieve-hydrometer analysis be performed on representative samples from each soil type to estimate the fraction of each grain size category using ASTM D422 Standard Test Method for Particle-Size Analysis of Soils. If desired sieve sizes can be specified to follow the Udden-Wentworth classification (U.S. Standard sieve sizes 6; 12; 20; 40; 70; 140; and 270) to retain pebbles; granules; very coarse sand; coarse sand; medium sand; fine sand; and very fine sand, respectively.

Several empirical formulas provide a reliable means of estimating hydraulic conductivity (K) from grain-size distribution data, provided that the formation does not contain abundant fines that result in cohesive or plastic behavior or include cobble-sized grains (Payne et al. 2008). Grain-size analysis can help bracket the permeability of hydrostratigraphic units (HSUs) and identify order-of-magnitude spatial variations in K. Arcadis has completed modifications to the Excel-based program HydroGeoSieveXL (Devlin 2015) to process sieve data quickly and estimate K. The tool calculates estimated K values from grain-size data using 15 different empirical formulas. A decision matrix then selects which of the formulas is relevant for the soil type and calculates an average K.

Principal Component. The principal component is the size fraction or range of size fractions containing the majority of the volume. Examples: the principal component in a sample that contained 55% small to medium pebbles would be “PEBBLES, small to medium”; or the principal component in a sample that was 20% fine sand, 30% medium sand and 25% coarse sand would be “SAND, fine to coarse” or for a sample that was 40% silt and 45% clay the principal component would be “CLAY and SILT”.

The boring log form (**Appendix D**) includes a graphic log to visually illustrate a relative estimate of soil permeability. To use the graphic log, place an ‘X’ or shade the appropriate column for the primary soil texture. If the soils have a high percentage of a secondary soil texture (i.e., when the ‘and’ modifier’ is used), it’s acceptable to mark off the appropriate column for the secondary soil texture in this instance. However, care should be used to avoid marking off the columns for other minor soil textures because doing so will make it difficult to determine the relative soil permeability of the poorly sorted soils.

As noted above, for poorly sorted soils such as glacial till, the principal component may not correlate to permeability of the sample. In this case, the geologist should use best judgement to graph overall soil type consistent with relative soil permeability.

Minor Component(s). The minor component(s) are the size fraction(s) containing less than 50% volume. Example: the identified components are estimated to be 60% medium sand to granules, 25% silt and clay; 15% pebbles – there are two identified minor components: silt and clay; and pebbles.

Include a standard modifier to indicate percentage of minor components (see particle size table) and the same descriptors that would be used for a principal component. An example of minor constituents with modifiers include: some silt and clay, low plasticity; little medium to large pebbles, sub-round.

8.2.1 Secondary Descriptors

The following are the descriptors used outside of the principal and minor components. Note that plasticity should be provided as a descriptor for clay and clay mixtures. Dilatancy should be provided for silt and silt mixtures. Angularity should be provided as a descriptor for pebbles and coarse sand.

Angularity. Describe the angularity for very coarse sand and larger particles in accordance with the table below (ASTM D-2488-06). Figures showing examples of angularity are available in ASTM D-2488-06 and the Arcadis Soil Description Field Guide (**Appendix B**).

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Sub-Angular	Particles are like angular description but have rounded edges
Sub-Rounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges.

Plasticity. Describe the plasticity for silt and clay based on observations made during the following test method (ASTM D-2488-06).

- As in the dilatancy test (described below), select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material, adding water, if necessary, until it has a soft, but not sticky, consistency.
- Shape the test specimen into an elongated pat and roll by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation. Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble when the soil is near the plastic limit.

Description	Criteria
Non-plastic	A 1/8-inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Dilatancy. Describe the dilatancy for silt and silt-sand mixtures using the following field test method (ASTM D-2488-06).

- From the specimen, select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material adding water, if necessary, until it has a soft, but not sticky, consistency.
- Smooth the ball in the palm of one hand with a small spatula.
- Shake horizontally, striking the side of the hand vigorously with the other hand several times.
- Note the reaction of water appearing on the surface of the soil.
- Squeeze the sample by closing the hand or pinching the soil between the fingers, and not the reaction as none, slow, or rapid in accordance with the table below. The reaction is the speed with which water appears while shaking and disappears while squeezing.

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

Note that silt and silt-sand mixtures will be non-plastic and display dilatancy. Clay mixtures will have some degree of plasticity but do not typically react to dilatancy testing. Therefore, the tests outlined above can be used to differentiate between silt-dominated and clay-dominated soils.

Sorting. Sorting is the opposite of grading, which is a commonly used term in the USCS or ASTM methods to describe the uniformity of the particle size distribution in a sample. Well-sorted samples are poorly graded and poorly sorted samples are well graded. Arcadis prefers the use of sorting for particle size distributions and grading to describe particle size distribution trends in the vertical profile of a sample or hydrostratigraphic unit because of

the relationship between sorting and the energy of the depositional process. For soils with sand-sized or larger particles, sorting should be determined as follows:

Description	Criteria
Well Sorted	the range of particle sizes is limited (e.g., the sample is comprised of predominantly one or two grain sizes)
Poorly Sorted	A wide range of particle sizes are present

You can also use sieve analysis to estimate sorting from a sedimentological perspective; sorting is the statistical equivalent of standard deviation. Smaller standard deviations correspond to higher degree of sorting (see Remediation Hydraulics, 2008).

Consistency or Density. This can be determined by standard penetration test (SPT) blow counts (ASTM D-1586) obtained when using hollow-stem auger drilling methods and a split spoon sampling device. Otherwise, some field tests are available as outlined below. When drilling with hollow-stem augers and split-spoon sampling, the SPT blow counts and N-value is used to estimate density. The N-value is the blows per foot for the 6" to 18" interval. For example, for a 24-inch split spoon soil core, the recorded blows per 6-inch interval are: 4/6/9/22. Since the second interval is 6" to 12", the third interval is 12" to 18", the N value is 6+9, or 15. Fifty blow counts for less than 6 inches is considered refusal. In recent years, more common drilling methods include rotary-sonic or direct push. When blow counts are not available, density is determined using a thumb test. Note however, the thumb test only applies to fine-grained soils.

Fine-grained soil – Consistency

Description	Criteria	Blow Counts (6-12 to 12-18-inch split spoon interval)
Very soft	Easily penetrated several inches by thumb	N-value < 2
Soft	Easily penetrated one inch by thumb	N-value 2-4
Medium Stiff	Indented about ½ inch with much effort	N-value 5-8
Stiff	Indented with ¼ inch with great effort	N-value 9-15
Very Stiff	Readily indented by thumbnail	N-value 16-30
Hard	Indented by thumbnail with difficulty	N-value > than 30

Coarse-grained soil – Density

Description	Criteria	Blow Counts (6-12 to 12-18-inch split spoon interval)
Very loose	Density classification of coarse-grained soils is only required when blow counts from standard penetration tests are performed during hollow-stem auger drilling	N-value 1- 4
Loose		N-value 5-10
Medium dense		N-value 11-30
Dense		N-value 31- 50
Very dense		N-value >50

Moisture Content. Moisture content should be described for each soil sample in accordance with the table below (percentages should not be used unless determined in the laboratory). *Note that some drilling methods (e.g., sonic) can compress and dry out the sample during drilling. Therefore, it can be difficult to determine if a sample is saturated, or merely moist. In this case, care should be taken to try and determine a static water level within the borehole by measuring depth to water through the drill casing, if possible.*

Description	Criteria
Dry	Absence of moisture, dry to touch, dusty
Moist	Damp but no visible water
Wet	Visibly free water

Color. Color should be described using simple basic terminology and modifiers based on the Munsell system. Munsell alpha-numeric codes are required for all samples. If the sample contains layers or patches of varying colors this should be noted, and all representative colors should be described. The colors should be described for moist samples. If the sample is dry, it should be wetted prior to comparing the sample to the Munsell chart.

Notes. Additional comments should be made where observed and should be presented as notes with reference to a specific depth interval(s) to which they apply. Some of the significant information that may be observed includes the following.

- Odor - You should not make an effort to smell samples by placing near your nose since this can result in unnecessary exposure to hazardous materials. However, odors should be noted if they are detected during the normal sampling procedures. Odors should be based upon descriptors such as those used in NIOSH “Pocket Guide to Chemical Hazards”, e.g., “pungent” or “sweet” and should not indicate specific chemicals such as “phenol-like” odor or “BTEX” odor.
- Structure
- Bedding planes (laminated, banded, geologic contacts).
- Presence of roots, root holes, organic material, man-made materials, minerals, etc.
- Mineralogy

- Cementation
- NAPL presence/characteristics, including sheen (based on client-specific guidance).
- Reaction with HCl - typically only used for special soil conditions, such as caliche environments.
- Origin, if known (Lacustrine; Fill; etc.).

8.3 Example of Soil Descriptions

The standard generic description order is presented below.

- Depth
- PRIMARY TEXTURE
- Principal and Minor Components with Descriptors
    - % Modifiers and grain size fraction
    - Angularity for very coarse sand and larger particles
    - Consistency or Density
    - Plasticity for silt and clay
    - Dilatancy for silt and silt-sand mixtures
- Sorting
- Moisture Content
- Color
- Notes

10-15 feet CLAY, trace silt, trace small to very large pebbles, subround to subangular up to 2" diameter; medium to high plasticity, stiff, moist, dark grayish brown (10YR 4/2). NOTE: Lacustrine; laminated 0.1 to 0.2" thick, laminations brownish yellow (10YR 4/3).

10 -15 feet SAND, medium to very coarse, little granules to medium pebbles, subround to subangular, trace silt; poorly sorted, wet, grayish brown (10YR5/2).

Unlike the first example where a density of cohesive soils could be estimated, this rotary-sonic sand and pebble sample was disturbed during drilling (due to vibrations in a loose sand and pebble matrix) so no density description could be provided. Neither sample had noticeable odor so odor comments were not included.

9 Waste Management

Project-specific requirements should be identified and followed. The following procedures, or similar waste management procedures are generally required.

Water generated during cleaning procedures will be collected and contained onsite in appropriate containers for future analysis and appropriate disposal. PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

Soil materials will be placed in sealed 55-gallon steel drums or covered roll-off boxes and stored in a secured area. Once full, the material will be analyzed to determine the appropriate disposal method.

10 Data Recording and Management

10.1 Digital Data Collection Process Overview

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

10.2 Digital Data Collection Tools for Soil Descriptions

Arcadis is transitioning from the use of paper forms to a digital soil description logging process using web-based FieldNow applications accessible on field tablets and smart phones. Company-wide roll out of a FieldNow application for soil descriptions is targeted by the end of 2022.

Paper forms are included in Revision 3 (April 2022) of this Soil Description TGI. Specifically, a blank boring log and completed boring log are provided in **Attachment D** and **Attachment E**. Additional guidance and examples of the digital data collection tools for soil descriptions will be provided in the next revision to this TGI.

10.3 Additional Guidance

The general logging scheme for soil descriptions is described in this document. Depending on project data quality objectives, specific soil description parameters that are not applicable to project goals may be omitted at the project manager's discretion. In any case, use of consistent procedures is required.

Completed logs and/or logbook will be maintained in the task/project field records file. Digital photographs of typical soil types observed at the site and any unusual features should be obtained whenever possible. Photographs should include a ruler or common object for scale. Photo location, depth and orientation must be recorded in the daily log or logbook and a label showing this information in the photo is useful.

For projects involving soil logging and soil sampling, the soil sample should be recorded on the Arcadis boring log form and the field logbook based on Data Quality Objectives for the task/project.

11 Quality Assurance

Soil descriptions should be completed only by appropriately trained personnel. Descriptions should be reviewed by an experienced field geologist for content, format and consistency. Edited boring logs should be reviewed by the original author to assure that content has not changed.

12 References

ASTM D-1586, Test Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM D-2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

ASTM D422, 63rd Edition, 1972 - Standard Test Method for Particle-Size Analysis of Soils.

Devlin, J.F. 2015. HydroGeoSieve XL: an Excel-based tool to estimate hydraulic conductivity from grain-size analysis. Hydrogeology Journal, DOI 10.1007/s10040-015-1255-0.

Folk, Robert L. 1980. Petrology of Sedimentary Rocks, p. 1-48.

Payne, F. C., Quinnan, J. A., & Potter, S. T. 2008. Remediation Hydraulics. Boca Raton: FL: CRC Press.

United States Bureau of Reclamation. Engineering Geology Field Manual. United States Department of Interior, Bureau of Reclamation. http://www.usbr.gov/pmts/geology/fieldmap.htm.

Munsell® Color Chart – available from Forestry Suppliers, Inc.- Item 77341 “Munsell® Color Soil Color Charts.

Field Gauge Card that Shows Udden-Wentworth scale – available from Forestry Suppliers, Inc. – Item 77332 “Sand Grain Sizing Folder.”

NIOSH Pocket Guide to Chemical Hazards.

Attachment A

Soil Field Reference Guide

The purpose of this attachment is to present a field reference guide for use during soil logging. Field staff are encouraged to bring a laminated copy of this reference guide into the job site.

ON THE ORIGINAL DRAWING.
USE TO VERIFY FIGURE
REPRODUCTION SCALE

SOIL DESCRIPTION FIELD GUIDE (APRIL, 2022; REV. 3.0)

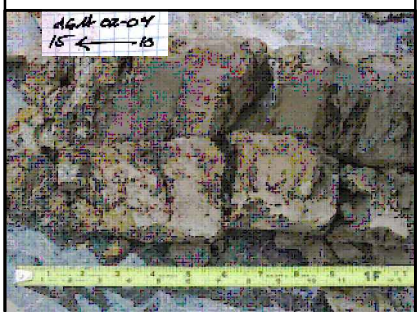
ARCADIS Design & Consultancy for natural and built assets

FINE-GRAINED SOILS

Description	Criteria
	Descriptor - Plasticity
Nonplastic	A 1/8-inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.
	Descriptor - Dilatancy
No Dilatancy	No visible change when shaken or squeezed.
Slow	Water appears slowly on the surface of soil during shaking and does not disappear or disappears slowly when squeezed.
Rapid	Water appears quickly on surface of soil during shaking and disappears quickly when squeezed.
Minor Components with Descriptors	
	Moisture
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet	Visible free water; soil is usually below the water table. (Saturated)
	Consistency
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated 1 inch by thumb.
Medium stiff	N-value 5-8 or indented about 1/2 inch by thumb with great effort.
Stiff	N-value 9-15 or indented about 1/4 inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty.
Color using Munsell	
Geologic Origin (if known)	
Other	

EXAMPLE OF SOIL DESCRIPTION AND PHOTO

10-15 feet CLAY, trace silt, trace small to very large pebbles, subround to subangular up to 2" diameter; medium to high plasticity, stiff, moist, dark grayish brown (10YR 4/2). NOTE: Lacustrine; laminated 0.1 to 0.2" thick, laminations brownish yellow (10YR 4/3).



DESCRIPTION ORDER

Depth Interval
PRIMARY TEXTURE (e.g., SAND)
Principal and Minor Components with Descriptors:
- % Modifiers and grain size fraction
- Angularity coarse sand and larger
- Consistency or Density
- Plasticity for silt and clay
- Dilatancy for silt and silt-sand

Sorting for granular sediments
Moisture Content
Color
Other NOTES

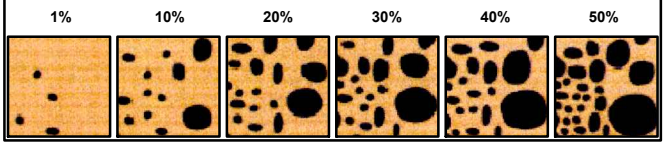
MINOR COMPONENTS % MODIFIERS

Modifier	Percent of Total Sample (by volume)
and	36 - 50
some	21 - 35
little	10 - 20
trace	<10

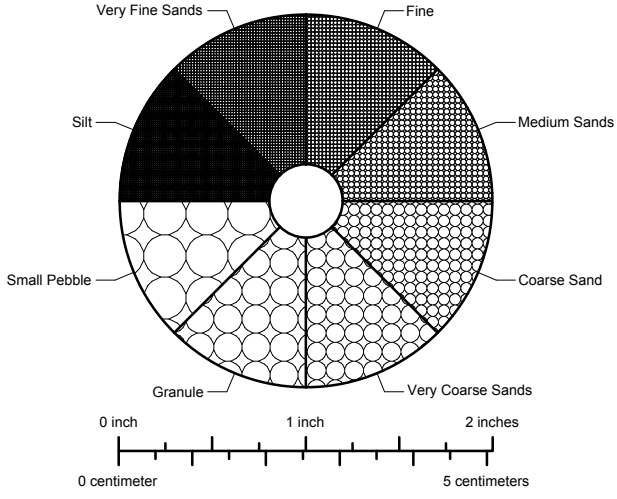
UDDEN-WENTWORTH SCALE

Fraction	Sieve Size	Grain Size	Approximate Scale
Boulder		256 - 4096 mm	Larger than volleyball
Large Cobble		128 - 256 mm	Softball to volleyball
Small Cobble		64 - 128 mm	Pool ball to softball
Very Large Pebble		32 - 64 mm	Pinball to pool ball
Large Pebble		16 - 32 mm	Dime size to pinball
Medium Pebble		8 - 16 mm	Pencil eraser to dime size
Small Pebble	No. 5+	4 - 8 mm	Pea size to pencil eraser
Granule	No. 10 - 5	2 - 4 mm	Rock salt to pea size
Very Coarse Sand	No. 18 - 10	1 - 2 mm	See field gauge card
Coarse Sand	No. 35 -18	0.5 - 1 mm	See field gauge card
Medium Sand	No. 60 - 35	0.25 - 0.5 mm	See field gauge card
Fine Sand	No. 120 - 60	0.125 - 0.25 mm	See field gauge card
Very Fine Sand	No. 230 - 120	0.0625 - 0.125 mm	See field gauge card
Silt and Clay. See SOP for description of fines	Not Applicable	<0.0625 mm	Analyze by pipette or hydrometer

PARTICLE PERCENT COMPOSITION ESTIMATION



GRAPH FOR DETERMINING SIZE OF PARTICLES



FOR COARSE-GRAINED SOILS

Description	Criteria
	Descriptor - Angularity
Angular	Particles have sharp edges and relatively planar sides withunpolished surfaces.
Subangular	Particles are similar to angular but have rounded edges.
Subround	Particles have nearly planar sides but have well-roundedcorners and edges.
Round	Particles have smoothly curved sides and no edges.
Minor Components with Descriptors	
	Sorting Cu= d60/d10
Well Sorted	Near uniform grain-size distribution Cu= 1 to 3.
Poorly Sorted	Wide range of grain size Cu= 4 to 6.
	Moisture
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet	Visible free water; soil is usually below the water table. (Saturated)
	Density
Very loose	N-value 1 - 4
Loose	N-value 5 - 10
Medium Dense	N-value 11 - 30
Dense	N-value 31 - 50
Very dense	N-value >50
Color using Munsell	
Geologic Origin (if known)	
Other	
	Cementation
Weak Cementation	Crumbles or breaks with handling or little finger pressure.
Moderate Cementation	Crumbles or breaks with considerable finger pressure.
Strong Cementation	Will not crumble with finger pressure.
	Reaction with Dilute HCl Solution (10%)
No Reaction	No visible reaction.
Weak Reaction	Some reaction, with bubbles forming slowly.
Strong Reaction	Violent reaction, with bubbles forming immediately.

EXAMPLE OF SOIL DESCRIPTION AND PHOTO

10 -15 feet SAND, medium to very coarse, little granules to medium pebbles, subround to subangular, trace silt; poorly sorted, wet, grayish brown (10YR 5/2).

SOIL DESCRIPTION FIELD GUIDE (APRIL, 2022; REV. 3.0)

ARCADIS Design & Consultancy for natural and built assets

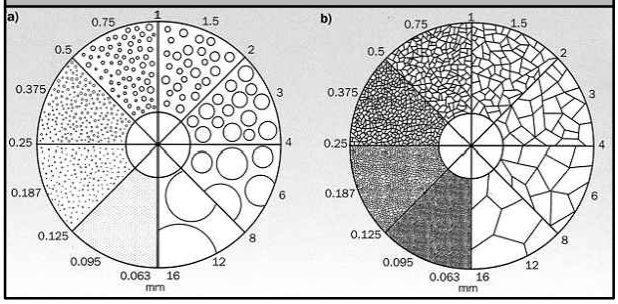
VARIATIONS IN SOIL STRATIGRAPHY

Term	Thickness of Configuration
Parting	0 - to 1/16-inch thickness.
Seam	1/16 - to 1/2-inch thickness.
Layer	1/2 - to 12-inch thickness.
Stratum	> 12-inch thickness.
Pocket	Small erratic deposit, usually less than 1 foot in size.
Varved Clay	Alternating seams or layers of sand, silt, and clay (laminated).
Occasional	≤ 1 foot thick.
Frequent	> 1 foot thick.

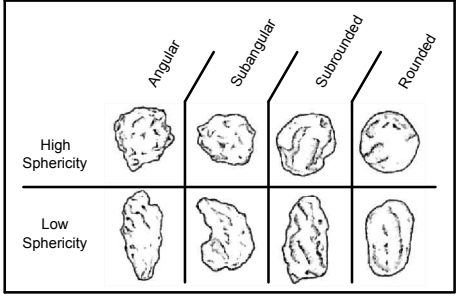
SOIL STRUCTURE DESCRIPTIONS

Term	Description
Homogeneous	Same color and appearance throughout.
Laminated	Alternating layers < 1/4 inch thick.
Stratified	Alternating layers ≥ 1/4 inch thick.
Lensed	Inclusions of small pockets of different materials, such as lenses of sand scattered through a mass of clay; note thickness.
Blocky	Cohesive soil can be broken down into small angular lumps, which resist further breakdown.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear to be polished or glossy, sometimes striated.

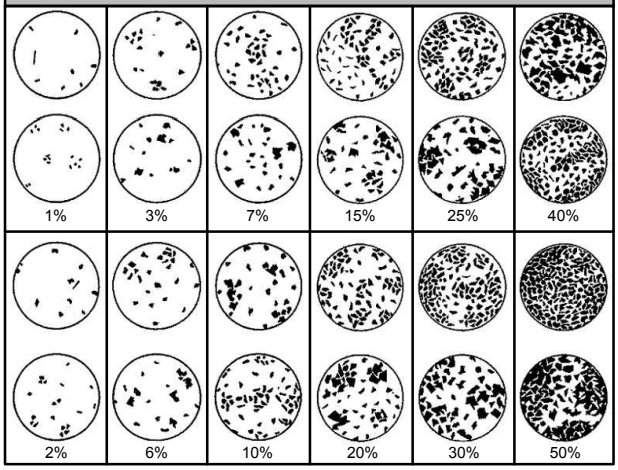
GRAPH FOR DETERMINING SIZE OF PARTICLES



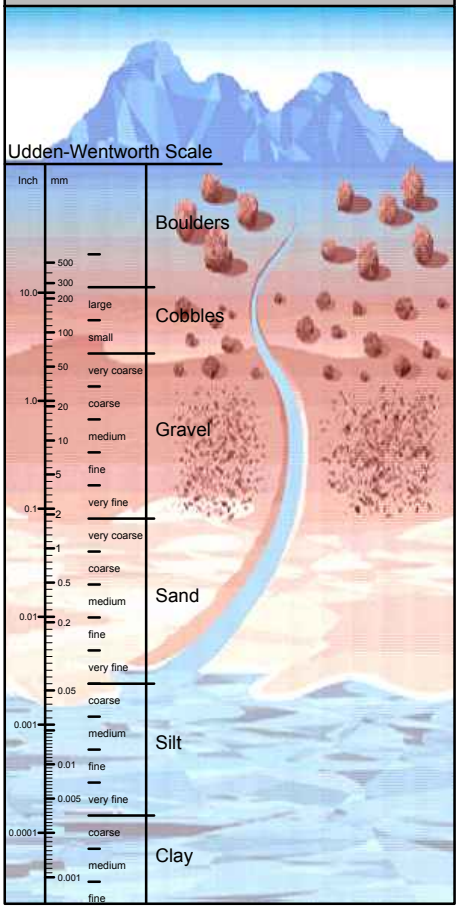
ANGULARITY CHART



PARTICLE PERCENT COMPOSITION ESTIMATION



SORTING



SETTLING TABLE (SILT/CLAY)

Diameter of Particle (mm)	<0.625	<0.031	<0.016	<0.008	<0.004	<0.002	<0.0005
Depth of Withdrawal (cm)	10	10	10	10	5	5	3
Time of Withdrawal	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec
Temperature (Celsius)							
20	00:00:29	00:01:55	00:07:40	00:30:40	00:61:19	04:05:00	37:21:00
21	00:00:28	00:01:52	00:07:29	00:29:58	00:59:50	04:00:00	
22	00:00:27	00:01:50	00:07:18	00:29:13	00:58:22	03:54:00	
23	00:00:27	00:01:47	00:07:08	00:28:34	00:57:05	03:48:00	
24	00:00:26	00:01:45	00:06:58	00:27:52	00:55:41	03:43:00	33:56:00
25	00:00:25	00:01:42	00:06:48	00:27:14	00:54:25	03:38:00	
26	00:00:25	00:01:40	00:06:39	00:26:38	00:53:12	03:33:00	
27	00:00:24	00:01:38	00:06:31	00:26:02	00:52:02	03:28:00	
28	00:00:24	00:01:35	00:06:22	00:25:28	00:50:52	03:24:00	31:00:00
29	00:00:23	00:01:33	00:06:13	00:24:53	00:49:42	03:10:00	
30	00:00:23	00:01:31	00:06:06	00:24:22	00:48:42	03:05:00	

10 inches
9 inches
8 inches
7 inches
6 inches
5 inches
4 inches
3 inches
2 inches
1 inch
1/10in
0 mm
10 mm
20 mm
30 mm
40 mm
50 mm
60 mm
70 mm
80 mm
90 mm
100 mm
110 mm
120 mm
130 mm
140 mm
150 mm
160 mm
170 mm
180 mm
190 mm
200 mm
210 mm
220 mm
230 mm
240 mm
250 mm

Attachment B

Particle Size System Comparison

The purpose of this attachment is to illustrate how the Udden-Wentworth particle sizes and descriptive terms compares to other particle size systems.

When in the field, it is a customary practice to compare current soil descriptions to historical soil boring logs for reference purposes. When reviewing boring logs prepared by others, field staff should first note the particle size system used and recognize these particle size systems may differ. This will avoid confusion when cross referencing between historical and new boring logs and when reviewing existing geologic cross-sections.

For example, a well-sorted sand with grain sizes ranging from 1 to 2 mm should be classified as a very coarse sand by the Udden-Wentworth system. As shown in this attachment, the same particle size would be classified as a medium sand by the United Soil Classification System. The later system has fewer particle size grades and in general, is less descriptive than the Udden-Wentworth system.

PARTICLE SIZE SYSTEM COMPARISON

Grain size distribution in millimeters (mm)

Udden-Wentworth — Remediation Geologists and Engineers

		V. Fine	Fine	Medium	Coarse	V. Coarse	Granule	Pebbles				Cobbles		
								Small	Medium	Large	V. Large	Small	Large	
CLAY	SILT	SAND					GRAVEL							
0.039	0.065	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256	
	1/16	1/8	1/4	1/2										

United Soil Classification System — Geotechnical Engineers

		Fine	Medium	Coarse	Fine	Coarse	
CLAY	SILT	SAND			GRAVEL		COBBLE
	0.074	0.42		2	4.75	19	75	300

U.S. Dept. of Agriculture — Soil Scientists

		V. Fine	Fine	Medium	Coarse	V. Coarse	
CLAY	SILT	SAND					GRAVEL
0.002	0.05	0.10	0.25	0.5	1	2	75

Remediation Hydraulics 2008, page 195): The Udden-Wentworth scale is preferred "...because the geometric progression of grain-size diameter also reflects relationships that are important when considering the erosion and deposition of sediments during the depositional process. The correlation between increasing grain size and degree of sorting and permeability is the most important, as permeability structure is responsible for the mobile and immobile porosity within aquifer systems. "

Attachment C

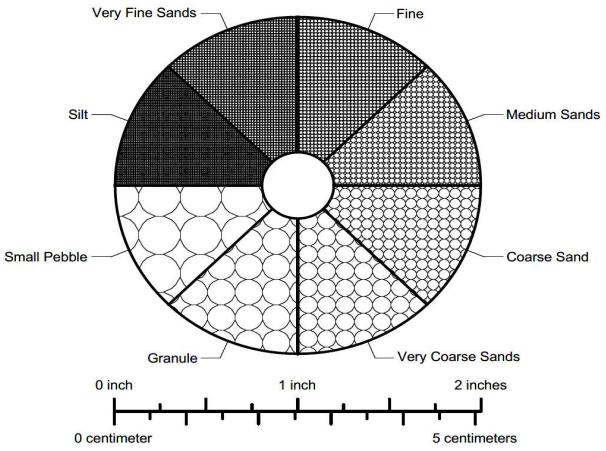
Description of Soil Logging Terms

The purpose of this attachment is to concisely define the soil logging terms used when filling out boring logs. During report preparation, project staff could use this sheet as an index placed in front of the completed boring logs. Also, it can serve as a supplemental reference sheet during field activities.

Description of Logging Terms

Note: Soil descriptions based on Arcadis Technical Guidance and Instructions (TGI) procedures. Key terms defined below.

GRAPH FOR DETERMINING SIZE OF PARTICLES



Udden Wentworth Soil Sizes

Boulder	> 256 mm
Large Cobble	128 to 256 mm
Small Cobble	64 to 128 mm
Very Large Pebble	32 to 64 mm
Large Pebble	16 to 32 mm
Medium Pebble	8 to 16 mm
Small Pebble	4 to 8 mm
Granule	2 to 4 mm
Very Coarse Sand	1 to 2 mm
Coarse Sand	0.5 to 1 mm
Medium Sand	0.25 to 0.5 mm
Fine Sand	0.125 to 0.25 mm
Very Fine Sand	0.062 to 0.12 mm
Silt/Clay	<0.065 mm

Primary Texture *(e.g. CLAY, SILT, SAND, GRANULE, PEAT, MUCK, FILL, etc.)*
List particle size with the highest percentage per sample interval (e.g. SAND)
Always CAPITALIZE the primary texture
Follow primary texture with a comma followed by grain-size descriptors, etc.

Minor Texture

And	(36 to 50%)
Some	(21 to 35%)
Little	(10 to 20%)
Trace	(>10%)

Angularity

Angular	Sharp edges
Sub-Angular	Rounded edges
Sub-Rounded	Well-rounded
Rounded	Smooth curved edges

Sand Density (Blow Counts/ft)

Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	<50

Silt/Clay Consistency (Blow Counts/ft)

Very Soft	0-2,	thumb easily penetrates several inches
Soft	3-4,	thumb easily penetrates one inch
Medium Stiff	5-8,	thumb indents 0.5 in. with much effort
Stiff	9-15,	thumb indents 0.25 in. with great effort
Very Stiff	16-30,	thumbnail is readily intended

Sorting

Well Sorted	1 to 3 Particle Sizes
Poorly Sorted	4+ Particle Sizes

Moisture Content

Dry	Dry to touch
Moist	No visible water
Wet	Visible free water

Plasticity (for silts and clays)

Non-Plastic	3 mm thread can not be rolled
Low Plasticity	3 mm thread can barely be rolled
Medium Plasticity	3 mm thread can easily and quickly rolled, but not rerolled
High Plasticity	3 mm thread can be rolled slowly, but can be rerolled

Dilatancy (for silts and silt-sand mixtures)

None	No visible change in the specimen
Slow	Water appears slowly during shaking / disappears slowly or not at all upon squeezing
Rapid	Water appears quickly during shaking / disappears quickly upon squeezing

Example Description

10 -15 feet SAND, medium to very coarse, little granules to medium pebbles, subround to subangular, trace silt; poorly sorted, wet, grayish brown (10YR5/2).

Attachment D

Blank Boring Log

The purpose of this attachment is to present a blank field form for use during soil logging. A digital version (Microsoft Excel) of this field form is available from the authors (upon request). If project specific modifications to this boring log template are warranted, please contact the Site Investigation Community of Practice leader for further assistance.

BORING LOG

ARCADIS

Boring ID:		**Project Name:**		**Page:**	/
Permit ID:		**Date Started:**		**Ground Elevation:**	
Site Address:		**Date Completed:**		**Vertical Datum:**	
City, State:		**Total Depth:**		**Northing:**	
Drilling Co:		**Depth to Water:**		**Easting:**	
Driller:		**Hole Diameter:**		**Horizontal Datum:**	
Drilling Method:		**Core Device:**		**Prepared by:**	
Boring Status:		**Drilling Fluid:**		**Reviewed by:**	

Drilling Information				Graphical Log for Primary Texture									Soil Description (Udden-Wentworth System)	Field Notes
				Fines		Sand					Gravel			
Drilling Depth (ft bgs)	Core Interval (ft)	Core Recovery (inches)	Vapor Reading (ppm)	clay	silt	very fine	fine	medium	coarse	very coarse	granule	pebble	cobble	boulder	Depth Interval (ft), PRIMARY TEXTURE, Principal and Minor Components with Descriptors (% modifiers and grain size fraction, angularity for coarse sand and larger, consistency/density, plasticity for silt and clay, dilatancy for silt/silt-sand); Sorting, Moisture Content, Color. NOTES: *Texture Modifiers: Trace (<10%), Little (10 to 20%), Some (21 to 35%), And (36 to 50%)*	Driller's Observations, Geologic Formation, Field Screening Results, Sample Interval etc.

BORING LOG

Boring ID: _____ **Project Name:** _____ **Page:** _____ / _____

Drilling Information				Graphical Log for Primary Texture										Soil Description (Udden-Wentworth System)	Field Notes
				Fines		Sand					Gravel				
Drilling Depth (ft bgs)	Core Interval (ft)	Core Recovery (inches)	Vapor Reading (ppm)	clay	silt	very fine	fine	medium	coarse	very coarse	granule	pebble	cobble	boulder	Depth Interval (ft), PRIMARY TEXTURE, Principal and Minor Components with Descriptors (% modifiers and grain size fraction, angularity for coarse sand and larger, consistency/density, plasticity for silt and clay, dilatancy for silt/silt-sand); Sorting, Moisture Content, Color. NOTES: *Texture Modifiers: Trace (<10%), Little (10 to 20%), Some (21 to 35%), And (36 to 50%)*	Driller's Observations, Geologic Formation, Field Screening Results, Sample Interval etc.

Attachment E

Completed Boring Log

The purpose of this attachment is to provide an example of a completed boring log for reference purposes to field staff. The example provided is for a soil boring completed outside the waste mass of a closed municipal landfill near Baltimore, Maryland. The objective of the drilling program was to determine the depth to groundwater to determine the appropriate depth interval to install a soil gas monitoring well and groundwater monitoring well across the first water-bearing zone. The site geology consists of unconsolidated sediments of the Mid-Atlantic Coastal Plain, specifically the Upper Patapsco formation. These sediments were deposited in a moderate gradient fluvial environment during the Cretaceous period. The landfill was constructed into a regional clay confining unit.

BORING LOG

ARCADIS

Boring ID:	MW-08	**Project Name:**	Acme Landfill	**Page:**	1 / 1
Permit ID:	MD-PG-100	**Date Started:**	7/18/2018	**Ground Elevation:**	50.5 ft
Site Address:	100 Landfill Road	**Date Completed:**	7/18/2018	**Vertical Datum:**	NAVD 88, feet
City, State:	Baltimore, Maryland	**Total Depth:**	35 ft below ground	**Northing:**	123456.79
Drilling Co:	Earth Matters	**Depth to Water:**	19 ft below ground	**Easting:**	123456.79
Driller:	Rod E. Piper	**Hole Diameter:**	2-inch	**Horizontal Datum:**	NAD 83 feet, MD State
Drilling Method:	Direct-push/hollow-stem	**Core Device:**	5-foot macrocore sampler	**Prepared by:**	Sandy Pebbles
Boring Status:	completed as well	**Drilling Fluid:**	none	**Reviewed by:**	Clay Brown

Drilling Information				Graphical Log for Primary Texture										Soil Description (Udden-Wentworth System)	Field Notes
				Fines		Sand					Gravel				
Drilling Depth (ft bgs)	Core Interval (ft)	Core Recovery (inches)	VOC Vapor Reading (ppm)	clay	silt	very fine	fine	medium	coarse	very coarse	granule	pebble	cobble	boulder	Depth Interval (ft), PRIMARY TEXTURE, Principal and Minor Components with Descriptors (% modifiers and grain size fraction, angularity for coarse sand and larger, consistency/density, plasticity for silt and clay, dilatancy for silt/silt-sand); Sorting, Moisture Content, Color. NOTES: *Texture Modifiers: Trace (<10%), Little (10 to 20%), Some (21 to 35%), And (36 to 50%)*	Driller's Observations, Geologic Formation, Field Screening Results, Sample Interval etc.
0 to 1			< 1												0-0.5 ft, topsoil with organics	Grass covered area
1 to 2			< 1				X								0.5-5 ft, SAND, fine, trace silt, trace pebble, round; poorly sorted, moist, yellowish brown (7.5 YR 5/8). NOTE: some cementation, does not react with HCl	continuous macro-core logging
2 to 3	0-5	43.2/60	< 1				X									
3 to 4			< 1				X									cemented sand @3.6-4 ft
4 to 5			< 1				X									
5 to 6			< 1				X	X	X						5-10 ft, SAND, fine to coarse, round to subround; well sorted, moist, light to strong brown (7.5 YR 6/4 to 7.5 YR 5/6).	
6 to 7			< 1				X	X	X							
7 to 8	5-10	40.8/60	< 1				X	X	X							
8 to 9			< 1				X	X	X							
9 to 10			< 1				X	X	X							
10 to 11			< 1				X	X	X						10-12.5 ft, same as above with trace silt	
11 to 12			< 1				X	X	X							
12 to 13	10-15	36/60	< 1				X	X	X							
13 to 14			< 1				X	X	X						12.5 to 15 ft, same as above, color change to pink (7.5 YR 7/3) and reddish yellow (7.5YR 6/8)	
14 to 15			< 1				X	X	X							
15 to 16			< 1						X	X					15-18.9 ft, SAND, coarse to very coarse, round to subround; well sorted, moist, strong brown (7.5YR 5/6) to reddish yellow (7.5YR 6/6)	
16 to 17			< 1						X	X						
17 to 18	15-20	55.2/60	< 1						X	X						
18 to 19			< 1		X	X	X								18.9-22.7 ft, SAND, very fine to fine, and SILT, coarse to very coarse, poorly sorted, wet, light gray (7.5YR 7/1)	water table encountered @ 18.9 ft
19 to 20			< 1		X	X	X									
20 to 21			< 1		X	X	X									
21 to 22			< 1		X	X	X									
21 to 23	20-25	36/60	< 1		X	X	X									
23 to 24			< 1	X	X										22.7-25 ft, CLAY and SILT, high plasticity, soft to stiff at 25 ft, dry to moist, light gray (2/5YR 7/1) w/ red mottling (2.5YR 4/6)	Middle Patapsco Confining Unit
24 to 25			< 1	X	X											
25 to 26			< 1	X	X										25-31.1 ft, CLAY and SILT, high plasticity, stiff; dry to moist, light gray (2/5YR 7/1) with red mottling (2.5YR 4/6)	
26 to 27			< 1	X	X											
27 to 28	25-30	30/60	< 1	X	X											
28 to 29			< 1	X	X											
29 to 30			< 1	X	X											
30 to 31			< 1	X	X											
31 to 32			< 1		X											
32 to 33	30-35 ft	60/60	< 1		X											
33 to 34			< 1		X										31.1-35 ft, SILT, low plasticity, high dilatancy; wet, gray (7.5YR 7/1)	End of direct-push boring @ 35 ft
34 to 35			< 1		X											

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TGI – Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis

Rev: 3

Rev Date: June 22, 2022

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 5, 2018	All	Combined aspects of generic Sediment Sample Collection TGI (Rev 0, June 18, 2018) and Stormwater Sampling TGI (Rev 0, August 29, 2018). Added surface water collection guidance and made this TGI PFAS-specific. Added stormwater and surface water sections; made PFAS- specific	Shannon Dunn
	1	March 27, 2020	15, 16	Revised the depth criteria to 0.5 to 1 feet for shallow surface water and >1 for deeper surface water	Shannon Dunn
	2	October 15, 2020	15, 16	Added Air Force preference to sample surface water at surface for Air Force investigations.	Erika Houtz
	3	June 22, 2022	All	Updated with new TGI Template	

Approval Signatures

Prepared by: 6/22/2022

Joshua Roberts, Staff Geologist, PG
(Preparer)

Date

Reviewed by: 6/22/2022

Shannon Dunn, Assistant Vice President
(Subject Matter Expert)

Date

1 Introduction

This Technical Guidance Instruction (TGI) describes the procedure for collection of sediment, surface water, and stormwater samples for per- and polyfluoroalkyl substances (PFASs) analysis.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This Technical Guidance Instruction (TGI) describes the collection of sediment, surface water, and stormwater samples, including field screening and logging of sediment samples. Sediment samples will be collected using a hand-held dredge, push cores, and/or stainless-steel scoop or trowel (the proper technique will be selected in the field depending on site conditions) for the laboratory analysis of sediment chemistry samples. Surface water and stormwater samples will be collected using direct-fill methods or peristaltic pumps. The general procedures to be utilized in obtaining sediment, surface water, and stormwater samples are outlined below. The intent of this TGI is to provide instructions for sampling during United States Army Environmental Command (USAEC) PFASs Preliminary Assessment and Site Inspection (PA/SI) at various installations. It also covers specific considerations for PFASs due to their unique chemical and physical properties, low detection limits, and regulatory standards.

This TGI may change depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this TGI will be approved in advance by the Project Manager.

4 Personnel Qualifications

All field personnel must have the appropriate training required by Arcadis as described in the project Site Safety and Health Plan (SSHP). Arcadis field sampling personnel will be trained in proper sampling procedures under the guidance of an experienced field geologist, engineer, or technician. Arcadis field sampling personnel will also be versed in the relevant TGIs and standard operating procedures (SOPs) necessary to successfully complete the desired field work.

5 Equipment List

The following materials will be available, as required, during sampling. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Site plan with proposed sampling locations;
- Relevant work plan (e.g., Programmatic Quality Assurance Project Plan [PQAPP]); SSHP;
- Health and Safety equipment, as required by the site SSHP and task-specific Job Safety Analysis; Sediment Sampling Equipment:
    - Boat with outboard motor and associated equipment (as necessary);
    - Global Positioning System (GPS) unit;
    - Navigation chart(s) for on-water activities (if available and as applicable);
    - Stainless-steel hand-held dredge (6-inch x 6-inch Ekman or Petite Ponar);
    - Lexan™ tubes (4-inch) and PFAS-free plastic caps;
    - Stainless-steel bowl;
    - Stainless-steel spatula, scoop, bent spoon, or trowel;
    - Steel core driver (i.e., slide hammer);
    - YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, oxidation reduction potential (ORP), and dissolved oxygen (DO);
    - Supplemental turbidity meter;
    - Stainless-steel probe rod – for evaluating bottom softness when wading to sampling locations
    - Polypropylene twine/rope
    - Hacksaw with stainless steel blade;
    - Tape measure;
    - Stainless steel, polyvinyl chloride (PVC) or high-density polyethylene (HDPE) yard stick for measuring water depth;
    - Stainless-steel extension rod (if necessary to extend reach of scoop or trowel);
    - Rubber boots or rubber waders (only non-coated rubber, other more high-tech waterproof material is not permitted);

    - Life jacket or other personal flotation device (PFD) as necessary based on water depth (note, these will likely have PFAS-containing materials so need to be careful to avoid cross- contamination when using).
- Surface Water Sampling Equipment:
    - If not using direct-fill method:
        - ISCO Model 150 peristaltic pump;
        - Rechargeable marine or car battery (for peristaltic pump);
        - Dedicated HDPE and silicon tubing (Teflon® or polytetrafluoroethylene [PTFE] tubing is prohibited);
        - Stainless steel rod (1/4-inch diameter x 4-feet long or similar) to support HDPE sampling tubing;
        - HDPE zip ties (nylon zip ties are not allowed) to attach tubing to rod;
        - YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO;
        - Supplemental turbidity meter;
        - Pail or bucket with closable lid for pump discharge;
    - Rubber boots or rubber waders (only non-coated rubber, other more high-tech waterproof material is not permitted);
    - Life jacket or other PFD as necessary based on water depth (note, these will likely have PFAS-containing materials so need to be careful to avoid cross-contamination when using).
- Stormwater Sampling Equipment:
    - Wrench, socket, manhole cover hook or magnetic manhole cover remover for access;
    - Approximately 1-inch outer diameter Lexan™ pipe long enough to extend from bottom of storm drain to at least 2 feet above the manhole;
    - HDPE zip ties (nylon zip ties are not allowed) to attach tubing to the Lexan™ pipe;
    - Tape measure;
    - ISCO Model 150 peristaltic pump;
    - Rechargeable marine or car battery (for peristaltic pump);
    - Dedicated HDPE and silicon tubing (Teflon® or PTFE tubing is prohibited);
    - YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO;
    - Supplemental turbidity meter;
    - Pail or bucket with closable lid for pump discharge.
- Appropriate sample containers and labels:
    - Labeled sample bottles: see the TGI - Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a) for PFAS-specific considerations;
    - 1-quart and 1-gallon polyethylene bags (Ziploc® brand only) to hold ice and samples;
    - Appropriate blanks (field reagent blanks supplied by the laboratory);
    - Packing and shipping materials;

- Chain-of-Custody (COC) Forms; see the Sample Chain of Custody Standard Operating Procedure (SOP) for reference (Arcadis 2017a);
- Appropriate transport containers (coolers) with ice and appropriate labeling, no blue ice; Decontamination/Water Management:
- PFAS-free decontamination fluids and equipment
  - HDPE or PVC brushes and squirt bottles
  - Stainless steel bowl
  - HPDE buckets to hold decontamination fluids
  - Alconox® or Liquinox® (other detergents are prohibited)
  - Methanol or isopropyl alcohol (for sediment sampling equipment decontamination only)
  - Distilled or laboratory-supplied deionized water
  - Laboratory-provided PFAS-free water
- See the TGI - Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a) or the TGI - Groundwater and Soil Sampling Equipment Decontamination (Arcadis 2017b) for additional guidance;
- Portable field hand washing setup;
- Non-hazardous drum labels as required for investigation-derived waste handling: see the TGI - Investigation-Derived Waste Handling and Storage for details (Arcadis 2017c);

- Field Notes:
  - Pens, pencils, and/or Sharpies® for writing;
  - Appropriate field forms;
  - Clipboards, field binders, field notebook, and field note pages that are not waterproof;
  - Digital camera. Other
  - Garbage bags;
  - Paper towels;
  - Duct and packing tape;
  - Dedicated low-density polyethylene (LDPE) plastic sheeting to prevent sample contact with the ground;
  - Field clothing made of cotton or other natural fibers that is well laundered (i.e., washed at least 5 times);
  - PFAS-free sunscreen and insect repellant.

6 Cautions

6.1 Utility Clearance

Sediment sampling requires a minimum of three reliable lines of evidence for utility clearance to demonstrate that sample locations are clear of subsurface utilities. A site visit for public utility line clearance at the proposed boring

locations will be conducted at least 72 hours prior to work commencing. As applicable, utility maps will be reviewed during field reconnaissance of the proposed inspection locations to determine if any are co-located with public utility lines. Arcadis will also contract an independent geophysical survey company to verify, if possible, that proposed boring locations are not co- located with existing underground utility/substructure features. See the Utility Location and Clearance Arcadis Health and Safety Standard (Arcadis 2017d), including Supplement 6 Utility Location Procedures for Aquatic Work Activities, for reference.

6.2 PFAS-Specific General Sampling Considerations

This section provides a summary of methods and procedures applicable to the collection of environmental samples for field screening or laboratory analysis during PFAS site characterization activities. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS- containing materials and cross-contamination potential. For example, Teflon™ and other fluoropolymer containing materials are found in pumps, tubing, and sample storage containers and therefore should be avoided if possible (Department of Environment Regulation [DER], Western Australia 2016; New Hampshire Department of Environmental Services [NHDES] 2016). Certain field documentation materials such as waterproof paper or field books, adhesive paper products, and some writing utensils (grouped as non-Sharpie® markers) are also prohibited items during PFAS sampling (DER 2016; NHDES 2016).

New nitrile gloves should be donned before any of the following activities:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or PFAS-free water bottles;
- Handling clean sample tubing or connecting tubing;
- Handling QC samples including field blanks and equipment blanks.

Additionally, new nitrile gloves should also be donned after handling of any non-dedicated sampling equipment; contact with contaminated surfaces; and whenever judged necessary by field personnel. When in doubt change your gloves.

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on Masonite, plastic, or aluminum clip boards. Other requirements for field notes include:

- Keep field notes, writing implements, and electronic data collection tablets away from samples and sampling materials; and
- Do not write on sampling bottles unless they are closed.

Tables 1 and 2 in Attachment 1 provides recommendations for PFAS Site Inspection equipment. Table 1 provides a summary of materials that have been approved for site inspection; this list is expected to grow longer as industry experience increases. Table 2 provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross- contamination potential and it is recommended that these materials be prohibited for sample collection. For materials that are suspected of containing PFASs and/or retaining PFASs, these recommendations are considered preliminary and subject to change.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFASs, field personnel are typically advised to err on the side of caution by strictly following field wear guidelines and decontamination procedures as specified in the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a).The most important consideration during PFAS-related sampling is to prevent contact between sample media and suspect PFAS sources.

6.3 PFAS-Specific Sediment Sampling

Because of the potential presence of PFASs in equipment typically used to collect samples, consideration for other sampling materials that contact sediment through the sampling process is necessary. Each piece of equipment that comes into direct contact with the sediment needs to be evaluated to determine if there are either PFAS-containing materials present, which could be a source of cross-contamination and cause false positives, or if PFASs adhere to the material, which has the potential to cause low bias sample results. For each additional piece of equipment that may introduce contamination, an equipment blank should be collected to confirm that materials in the sample equipment do not cause false positives by introducing PFASs. Equipment blanks are particularly important for any device/component where PFASs may be present or cannot be verified as being a non-PFAS containing material. Other quality assurance methods may be implemented to avoid materials that could result in potential losses associated with PFASs adhering to surfaces.

The following additional notes are provided regarding sediment sampling materials:

- Lexan™ liner sleeves are made of polycarbonate and they are not expected to contain PFASs based on review of the Safety Data Sheet (Sabic 2016).
- Studies evaluating the use of stainless steel indicate that PFASs do not strongly sorb to stainless- steel (Obal et al. 2012). Therefore, stainless-steel sleeves and equipment should be acceptable for collection of sediment samples for PFAS analysis.

6.4 PFAS-Specific Surface Water and Stormwater Sampling

As described for sediment sampling, the potential presence of PFASs in equipment that may come in contact with the target water sample must be evaluated as part of the sample planning process to maintain sample integrity.

Note that if high concentrations of PFASs related to Class B firefighting foams are expected in a surface water sample, it has been recommended to collect and shake a small portion of the sample at the time of sample collection (USACE 2016; Arcadis 2018a). If foaming is noted within the sample, it indicates elevated concentrations of PFASs may be present and the sample should be proactively diluted at the laboratory prior to analysis. The foaming should be noted on the sample COC form. It is recommended to collect sampling equipment blanks following foam observation to confirm the effectiveness of decontamination procedures.

While permissible during fog or intermittent showers, surface water samples should not be collected during steady, prolonged rainfall. Avoid entraining sediment in surface water samples. If accessing the sample location from water, approach slowly from downstream to avoid disturbing the bottom.

7 Health and Safety Considerations

Field activities associated with sediment, surface water, and stormwater sampling and description will be performed in accordance with a site-specific SSHP, a copy of which will be present on site during such activities. Additional health and safety discussions are specifically discussed below.

7.1 Sediment Sampling

- Walk established paths whenever possible to avoid slip/trip hazards. Take your time and watch your footing.
- A PFD may be required to complete sediment sampling. Review the Arcadis Water Operations Health and Safety Standard and the SSHP to determine if a PFD is required.
- To the extent possible, maintain three points of physical contact (i.e., two feet and one hand, or one foot and two hands) when entering and exiting a stream channel.
- Ensure the state One Call has been completed and the Arcadis Utilities and Structures Checklist is completed before sampling.
- Take breaks as needed to avoid repetitive use injury or muscle strain and take turns with co- workers as needed.
- Do not touch sediments with bare hands or detect odors by placing sediments close to your nose.
- STOP WORK when conditions change or become unsafe and discuss if/how to proceed safely before resuming work.
- If boats are required for sampling, the following considerations should be made:
    - Good housekeeping and three-points of physical contact should be maintained when entering/exiting the boat to prevent falls or trips
    - Boat operator will be properly trained
    - To avoid impact with other water traffic, ensure navigational lighting is functional (if applicable). Be vigilant and maintain situational awareness of other water traffic.

7.2 Surface Water Sampling

- A PFD may be required to complete surface water sampling. Review the Arcadis Water Operations Health and Safety Standard and the SSHP to determine if a PFD is required.
- Always have three points of contact when entering and exiting a stream channel, if necessary.
- If boats are required for sampling, the following considerations should be made:
    - Good housekeeping and three-points of physical contact should be maintained when entering/exiting the boat to prevent falls or trips
    - Boat operator will be properly trained
    - To avoid impact with other water traffic, ensure navigational lighting is functional (if applicable). Be vigilant and maintain situational awareness of other water traffic.

7.3 Stormwater Sampling

- The ability to safely access the stormwater sampling vaults or manholes should be verified prior to sampling. Confined space entry is not allowed.

8 Procedure

8.1 Sediment Sampling

Sediment samples will be collected by one of the following methods considered most appropriate for the site conditions.

- Hand-held scoop or trowel – for shallow water depths (e.g., < 2 feet) that are nearshore and that sediment conditions preclude sampling by push core or grab sampler
- Push core – for sampling in deeper water (e.g., > 2 feet) or offshore
- Petite Ponar Grab Sampler – for sampling in deeper water offshore with coarse sediment or hard bottom.

Sampling Mobilization/Prep

- Don personal protective equipment (PPE) as discussed in Section 5.2 and the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a).
- Mobilize to sampling location.
    - If accessing by wading, approach slowly from a downstream direction to limit disturbance of the bottom and resulting suspension of sediment into the surface water at sampling location.
    - If accessing by boat, maneuver to the target sample location using GPS and secure the vessel in place.
- Identify the proposed sample location in the field notebook along with other appropriate information (e.g., location, date, time, personnel, weather).
- Verify all dedicated sample gear has been properly decontaminated as discussed in Section 10.
- Measure and record water depth at the sampling location.

Sample Collection by Stainless Steel Scoop or Trowel

- Attach stainless steel scoop, bent spoon, or trowel to a stainless-steel extension rod (if needed) and lower vertically downward through the water column until it reaches the bottom. Collect sediment from the top 2 inches (5 centimeters [cm]) of the bottom surface.
- Retrieve the scoop, bent spoon, or trowel. Slowly decant overlying water and take care to prevent fine sediment from being poured out with the water. Inspect recovered sediment to confirm it does not contain vegetation (e.g., grass, leaves, sticks or similar undecomposed organic material). Use the stainless-steel trowel to remove any vegetation prior to filling sample bottles. If the sample contains too much vegetation to be removed effectively, collect another sediment sample from the bottom.
- Place the sediment in a decontaminated stainless-steel bowl.
- Photograph the grab sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Photos of the sample will include the grab

sample ID, date, and time, written on loose paper with a Sharpie® marker. The photo will also include a view of a tape measure for scale.

- Describe lithology of recovered sediment in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b).
- Homogenize the sediment with a stainless-steel mixing spoon until the sediment is of uniform color.
- Collect sediment samples. If additional sediment is needed to fill the bottles, collect additional sample volume approximately 1-2 feet upstream from the first to minimize disturbance.
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use the supplemental turbidity meter to measure turbidity.

Sample Collection by Push Core

- Lower section of clean LexanTM tube (at least as long as the target sediment penetration depth plus the water depth) until it contacts the top of the sediment.
- Push LexanTM tube with a straight vertical entry into the sediment to a depth of approximately 4 inches (10 cm) below the sediment surface. If necessary, drive the tube a few more inches down into the sediment either by hand or using a steel core driver to obtain a plug at the bottom of the core that will prevent the sediment from falling out during core retrieval. Note that only the top 2 inches (5 cm) of soil will be used for laboratory sampling.
- Place a cap made of PFAS-free materials (e.g., HDPE, silicon) on the top of the sediment tube and slowly pull the tube from the sediment, twisting it slightly as it is removed (if necessary)
- Before the tube is fully removed from the water, place a PFAS-free cap on the bottom end of the tube while it is still submerged. Ensure that the bottom end cap fits tightly and will not inadvertently slip off. Remove the tube from the water.
- Keeping the tube upright, wipe the bottom end dry and double check that the bottom cap is tight. If necessary (e.g., walking away from the sampling area to a more secure area to fill sample jars), keep one hand beneath the bottom cap to prevent the cap from falling off. Measure the length of sediment recovered and evaluate the integrity of the core.
- While keeping the core upright, use a hacksaw to make a horizontal cut in the tube approximately 2 - 3 inches above the sediment and carefully drain water from the core to prepare it for inspection and sampling.
    - Note: If possible, use a section of Lexan TM tubing short enough to allow for sampling without cutting the core. This is only possible in shallow water conditions, as the Lexan TM tubing should be at least long enough to keep the top of the tube above water.
- Slowly decant overlying water and take care to prevent fine sediment from being poured out with the water. Inspect recovered sediment to confirm it does not contain vegetation (e.g., grass, leaves, sticks or similar undecomposed organic material). Use the stainless-steel trowel to remove any vegetation prior to filling sample bottles. If the sample contains too much vegetation to be removed effectively, collect another sediment sample from the bottom.

- Using a stainless-steel bent spoon, scoop, or trowel, place the top 2 inches (5 cm) of sediment in a decontaminated stainless-steel bowl.
- Photograph the grab sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Photos of the sample will include the grab sample ID, date, and time written on loose paper with a Sharpie® marker. The photo will also include a view of a tape measure for scale.
- Describe the lithology of recovered sediment in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b).
- Homogenize the sediment with a stainless-steel mixing spoon until the sediment is of uniform color.
- Collect sediment samples. If additional sediment is needed to fill the bottles, collect additional sample volume approximately 1-2 feet upstream from the first to minimize disturbance
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use supplemental turbidity meter to measure turbidity.

Sample Collection by Petite Ponar Grab Sampler

- Use polypropylene twine/rope with the dredge or similar PFAS-free approved material.
- Set the stainless-steel Petite Ponar grab sampler dredge and slowly lower the open dredge from the side of the boat until it is just above the top of the sediment surface. Then drop the open dredge into the sediment.
- Once the dredge has been allowed to settle into the bottom sediment, pull hard on the rope, or send the messenger to trigger the dredge and close the sediment inside.
- Retrieve the dredge onto the boat.
- Inspect the sample for acceptability in accordance with the following criteria:
    - Sampler is not overfilled with sample such that the sediment surface presses against the top of the sampler or is extruding through the top of the sampler.
    - Overlying water is present above the sediment (indicates minimal leakage)
    - At least 4 inches (10 cm) of sediment penetration depth has been achieved.
- Tilt the dredge over slightly to drain the overlying water to prepare the sediment for inspection and sampling, being careful not to disturb the recovered sediment. Also take care to prevent fine sediment from being poured out with the water.
- Inspect recovered sediment to confirm it does not contain vegetation (e.g., grass, leaves, sticks or similar undecomposed organic material). Use the stainless-steel trowel to remove any vegetation prior to filling sample bottles if possible, to do so with minimum disturbance of the recovered sediment. If the sample contains too much vegetation to be removed effectively without disturbing sediment, collect another sediment sample from the bottom.
- Using a stainless-steel bent spoon, scoop, or trowel, place the top 2 inches (5 cm) of sediment in a decontaminated stainless-steel bowl.

- Photograph the grab sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Photos of the sample will include the grab sample ID, date, and time written on loose paper with a Sharpie® marker. The photo will also include a view of a tape measure for scale.
- Describe the lithology of recovered sediment in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b).
- Homogenize the sediment with a stainless-steel mixing spoon until the sediment is of uniform color.
- If additional sediment volume is needed to fill sample bottles, redeploy the dredge 1 – 2 feet upstream from the previous sampling location.
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use supplemental turbidity meter to measure turbidity.

Laboratory Sample Collection/Management, Post-Sampling

- Fill the sample bottle for PFAS analysis first, then fill bottles for any remaining analyses.
- Don clean nitrile gloves and use a stainless-steel trowel to fill clean labeled bottles supplied by the laboratory for the required analyses with sediment. Collect lab samples from the top 5 cm of the recovered 10 cm interval only. Do not overfill bottles.
- Make sure caps remain on PFAS sample bottles until immediately prior to filling. Caps must remain in the hand of the sampler until replaced on the bottle.
- Once the PFAS sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
- Collect QC samples at the frequency specified in Quality Assurance Project Plan (QAPP) Addendum Worksheet #20. QC sample locations are to be selected based on consultation with the Arcadis Regional Lead (RL). Note, if using waders to access sampling locations, collect equipment blank off of the waders.
- Record the label information and time of sampling in the field notes and sampling forms.
- Fill out the laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
- Place the sample bottles in a sealed Ziploc© bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.

8.2 Surface Water Sampling

Sampling Mobilization/Prep

- Don PPE as discussed in Section 5.2 and the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a).

- Mobilize to sampling location.
    - If accessing by wading, approach slowly from downstream direction to limit disturbance of bottom and resulting suspension of sediment into the surface water at the sampling location.
    - If accessing by boat, maneuver to the target sample location using GPS and secure the vessel in place.
- Identify the proposed sample location in the field notebook along with other appropriate information (e.g., location, date, time, personnel, weather).
- Verify all dedicated sample gear has been properly decontaminated as discussed in Section 10.
- Measure and record water depth at the sampling location.
- Do not sample surface water when it is raining. Fog or intermittent showers are okay, but not steady rainfall. Avoid entraining sediment in surface water samples.

Shallow Surface Water (0.5 – 1 feet)

- Cut a length of new HDPE tubing to the appropriate size for desired sampling depth and pump location and attach to stainless steel rod using HDPE zip ties. Insert a new length of silicon tubing into the peristaltic pump and connect HDPE tubing on intake side and a shorter length of new HDPE tubing on discharge side.
- Direct pump discharge into pail/bucket during sampling.
- For general PFAS investigation, lower the HPDE tubing on intake side of pump to the desired depth in the water column. For water depths < 1 ft, place tubing intake at approximately mid- depth of the water column.
- For Air Force investigations, place the HDPE tubing on intake at the surface. Collect samples from the water surface.
- Do not disturb sediment at bottom of water body with sampling equipment, as this could cause suspension of sediment into the surface water that could introduce cross contamination into the sample.
- Verify pump flow direction and turn on pump.
- Once water fills the tubing and begins flowing out of the discharge end turn off pump and prepare to sample.
- Don fresh set of nitrile gloves. Disconnect HDPE tubing from silicon tubing on discharge end. Keep silicon tubing in clean gloved hand and do not allow it to contact any surfaces or equipment. Turn on pump and fill sample bottle to the neck directly from silicon tubing, headspace is acceptable. Do not rinse PFAS sample bottles during sampling.
- Only use labelled HDPE bottles that are supplied by the laboratory. Make sure the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface, and keep cap in gloved hand opposite of sample collection, do not touch the inside of the cap.
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on the sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use supplemental turbidity meter to measure turbidity.

Deeper Surface Water (>1 feet)

- Don fresh set of nitrile gloves immediately prior to collecting samples. Use nitrile glove with long cuff that covers the forearm, as this will help avoid submerging clothing or skin during sampling.

- Only use labelled HDPE bottles that are supplied by the laboratory. Do not rinse PFAS sample bottles prior to collecting sample. Do not remove cap prior to or after sample collection. Do not place the cap on any surface, and keep cap in gloved hand opposite of sample collection, do not touch the inside of the cap.
- Facing the upstream direction (if the surface water body is flowing), place sample container in freshly gloved hand and gently submerge the sample container beneath the water surface with the cap on. For Air Force investigations, the bottle should be submerged at the water surface.
- Tilt the container so the mouth is angled slightly upward, then with the other gloved hand gently unscrew the cap, open it a crack and allow water to flow slowly down the inner wall of the container filling it. For Air Force investigations, the mouth should be at the surface.
- Do not submerge hands below top of gloves during sampling such that clothing or bare skin of sampling personnel comes into contact with the surface water.
- When the sample container is full, replace and tighten the cap while the container is still submerged, then remove it from the water.
- Measure surface water pH, conductivity, temperature, and turbidity at sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use supplemental turbidity meter to measure turbidity.

Laboratory Sample Management, Post-Sampling

- Once the PFAS sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
- Collect QC samples at the frequency specified in the QAPP Addendum Worksheet #20. QC sample locations are to be selected based on consultation with the Arcadis RL. Note, if using waders to access sampling locations, collect equipment blank off of the waders.
- Record the label information and time of sampling in the field notes and sampling forms.
- Fill out the laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
- Place sample bottles in a sealed Ziploc® bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.

8.3 Stormwater Sampling

The following general guidelines apply when sampling stormwater.

- Sampling should be started from the manhole farthest downstream and work upstream. This mitigates the impact of subsequent samples if anything on the bottom is disturbed and migrates downstream.
- Care should be taken not to disturb the bottom sediments in catch basin sumps or other storm water sampling locations.

- Stormwater samples should only be collected from active flow. Stormwater will not be collected from pools or standing water.
- Use the following procedure to collect grab stormwater samples.
- Verify all dedicated sample gear has been properly decontaminated as discussed in Section 10.
- Mobilize to stormwater sampling location.
- Confirm that active flow is entering the sampling space.
- Measure the depths from the top of the manhole to the top of the stormwater surface and to the bottom of the stormwater system with a tape measure (do this downstream from the spot where the sample will be collected).
- Subtract the depth of the water surface from the depth of the stormwater system. This is the thickness of the stormwater column. Divide the thickness by two. Add the result to the depth of the stormwater surface. This is the sampling depth.
- Strap the HDPE sampling tubing to the Lexan TM pipe using the HDPE zip ties.
- Place a HDPE zip tie on the Lexan TM pipe that marks the sampling depth, as measured above. This HDPE zip tie will be used as a marker to guide how far to insert the pipe and tubing into the manhole. The HDPE zip tie marker will prevent over inserting the Lexan TM pipe and tubing and thus prevent disturbing the deposited sediment in the stormwater system.
- Attach the other end of the tubing (the end that will not be placed into the stormwater for sampling) to the peristaltic pump.
- Collect active flow sample.
    - Slowly lower the Lexan TM pipe and tubing into the stormwater system to the sample collection depth, using the marker HDPE zip tie as a guide.
- Verify pump flow direction and turn on pump.
- Once water fills the tubing and begins flowing out of the discharge end turn off pump and prepare to sample.
- Don fresh set of nitrile gloves. Disconnect HDPE tubing from silicon tubing on discharge end. Keep silicon tubing in clean gloved hand and do not allow it to contact any surfaces or equipment. Turn on pump and fill sample bottle to the neck directly from silicon tubing, headspace is acceptable. Do not rinse PFAS sample bottles during sampling.
- Only use labelled HDPE bottles that are supplied by laboratory. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface, and keep cap in gloved hand opposite of sample collection, do not touch the inside of the cap.
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.

Use supplemental turbidity meter to measure turbidity.

Laboratory Sample Management, Post-Sampling

- Once the PFAS sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
- Collect QC samples at the frequency specified in the QAPP Addendum Worksheet #20. QC sample locations are to be selected based on consultation with the Arcadis RL. Note, if using waders to access sampling locations, collect equipment blank off of the waders.
- Record the label information and time of sampling in the field notes and sampling forms.
- Fill out the laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
- Place sample bottles in a sealed Ziploc® bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.

9 Waste Management

Investigation-derived waste (IDW) including excess sediment, surface water, stormwater and decontamination fluids will be collected and placed in Department of Transportation approved containers, segregated by waste streams: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c). All containers will be labeled as non-hazardous unless otherwise instructed by the Project Manager. Containerized IDW will be stored on site until it is profiled and subsequently transported to an approved facility for disposal or recycling. Waste manifests for all IDW suspected to have come into contact with PFAS should clearly note the presence of PFAS. Additional IDW sampling and management details will be provided in the site-specific QAPP Addendum and will be consistent with applicable Army policies and Army post requirements. Personal protective equipment (e.g., gloves, disposable clothing, disposable equipment) resulting from personnel cleaning procedures and soil sampling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

The supervising field lead will be responsible for documenting sampling events to record all relevant information in a clear and concise format. The record of sampling events should include:

- Sample dates
- Project name and location

- Project number, client, and site location
- Sampling details (e.g., field measured water quality parameters, standing water column depth)
- Sediment core log
- Type of tools used
- Weather conditions

Field staff should ensure COC Forms are properly completed, and verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537 list) are required for analysis and note on the COC.

11 Decontamination

To avoid cross-contamination during sampling, all reusable sampling equipment will be cleaned between sampling locations as follows. Repeat these steps twice at all locations suspected of containing a Class B firefighting foam source.

Sediment Sampling

With Organic Solvent Rinse (Preferred Method)

- Don new pair of nitrile gloves prior to decontamination
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only)
- Double-rinse in deionized or distilled water
- Rinse once with methanol or isopropyl alcohol
- Rinse once with PFAS-free water
- Collect all rinsate in a sealed pail for disposal
- Allow time to air dry prior to re-use

Without Organic Solvent Rinse (Contingency Method)

- Don new pair of nitrile gloves prior to decontamination
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only);
- Single-rinse in deionized or distilled water;
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only);
- Double-rinse in deionized or distilled water and single-rinse with PFAS-free water;
- Collect all rinsate in a sealed pail for disposal;
- Allow time to air dry prior to re-use.

Surface Water/Stormwater Sampling

- Don new pair of nitrile gloves prior to decontamination
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only);
- Double-rinse in deionized or distilled water;
- Collect all rinsate in a sealed pail for disposal;

- Allow time to air dry prior to re-use.

See additional specifics in P-04, TGI - Groundwater and Soil Sampling Equipment Decontamination in PQAPP **Appendix A.**

12 Quality Assurance

In general, the following quality assurance and quality control (QA/QC) samples should be collected:

- Equipment blanks
- Field (i.e., reagent) blanks
- Field duplicates
- Matrix spike/matrix spike duplicate

Details on QC sampling requirements (e.g., frequency of collection, types of QA/QC samples) are provided in the PQAPP and will be outlined in various Site-specific sampling scopes of work in the QAPP Addendum. Additionally, detailed procedures related to equipment and field (i.e., reagent) blank sample collection are outlined in the Equipment and Reagent Blank Sample Collection TGI (Arcadis 2018c).

Refer to QC requirements for the project to ensure that appropriate QA/QC samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles
- Bottle caps must remain in the hand of the sampler until replaced on the bottle
- Labels must be completed after the caps have been placed back on each bottle
- Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc®-type bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

13 References

Arcadis. 2018a. TGI – Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance. Rev.

2. October 15.

Arcadis. 2018b. TGI – Soil Description. Rev. #2. February 16.

Arcadis. 2018c. TGI – Equipment and Reagent Blank Sample Collection for PFAS. Rev. #0. October 2. Arcadis. 2017a. SOP – Sample Chain of Custody, Rev. #1. May 23.

Arcadis. 2017b. TGI – Groundwater and Soil Sampling Equipment Decontamination, Rev. #0.

February 23.

Arcadis. 2017c. TGI – Investigation-Derived Waste Handling and Storage, Rev. #0. February 23. Arcadis. 2017d. Utility Location and Clearance, Rev. #16. March 17.

Arcadis. 2016. Arcadis ENV Quality Procedure QP#: 3.06 Field Activities Documentation, Revision Letter:

C. November.

Department of Environment Regulation (DER). Government of Western Australia. 2016. Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS).

Contaminated Sites Guidelines. February.

Massachusetts Department of Environmental Protection (MassDEP). 2017. DRAFT Fact Sheet, Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. January.

New Hampshire Department of Environmental Services (NHDES). 2016. Perfluorinated Compound (PFC) Sample Collection Guidance. November.

Obal, T., Robinson, A., Chia, S.C. 2012. Aqueous sample stability: PFOS, PFOA and other fluorinated compounds. REMTECH 2012: The Remediation Technologies Symposium, Banff, AB, Canada, 17- 19 Oct 2012. Environmental Services Association of Alberta, Edmonton, AB.

Sabic. 2016. Article Safety Data Sheet for Generic SFS-PC Lexan™ Film/Sheet. Revised May 12.

United States Army Corps of Engineers (USACE). 2016. DRAFT – Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling. Revision: 1. March.

ATTACHMENT 1

Table 1 and Table 2: PFAS Inspection Material Recommendations

Table 1: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Inspections

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to inspections	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Sharpie®	--	NHDES 2016; USACE 2016; MassDEP 2017
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to inspections	DER 2016
Alconox®, Liquinox® or Citranox® followed by deionized water or PFAS-free water rinse	Alconox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodicalevaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

Table 2: Summary of Equipment and Materials Not Recommended for PFAS Site Inspections

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon® or polytetrafluoroethylene (PTFE)-containing or coated field equipment (e.g., tubing, bailers, tape, plumbing paste)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it®-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Non-Sharpie® markers		x		NHDES 2016
Decontamination				
Some detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

Note: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for useduring the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

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TGI – Vertical Aquifer Profile (VAP) Sampling

Rev: 2.0

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Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	June 22, 2018	All	Original SOP	Joe Quinnan
	1	May 11, 2020	Multiple	Added content to Personnel Qualifications, references to Geoprobe SP-16 and SP-22, Attachment 3, and updated references /formatting	Marc Killingstad
	2	June 15, 2022	Multiple	Combined with PFAS-specific VAP TGI and dye/tracer procedures.	Patrick Curry

Approval Signatures

Prepared by:		6/15/2022
	Patrick Curry (Preparer)	Date
Reviewed by:		6/15/2022
	Marc Killingstad (Subject Matter Expert)	Date

1 Introduction

This Arcadis Technical Guidance Instruction (TGI) describes proper vertical aquifer profile (VAP) sampling procedures using a variety of methods and approaches. This document has been developed to emphasize drilling and sampling procedures used to collect groundwater samples from boreholes installed via direct push technology (DPT), hollow stem auger (HSA), and rotary-sonic (sonic) methods and includes the use of visible tracer in drilling fluid to obtain representative samples during vertical profiling.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

Vertical aquifer profile (VAP) borings are typically advanced via DPT, HSA, or sonic drilling techniques to collect single or multiple depth-discrete groundwater samples using low-flow or grab sampling methodologies. This can be combined with retrieval of continuous soil cores and lithologic logging, as well as collection of single or multiple depth-discrete dry and saturated soil samples.

When possible, co-locate or bias VAP groundwater sampling intervals towards potential discrete transport zones (and target slow advection zones when feasible) as indicated by soil logging observations or permeability measurements (e.g., point slug tests, Geoprobe® hydraulic profiling tool [HPT] [preferred],

Waterloo APS™ [alternate]). Permeability measurements coupled with contaminant concentration allows estimationof relative flux and mass discharge to evaluate potential risk to downgradient receptors. In the absence ofpermeability measurements, field soil lithological logging observations may be used to interpret hydrostratigraphy and select sampling intervals.

The intent of this TGI is to provide VAP instructions including specific considerations for per- and polyfluoroalkyl substances (PFAS) due to their unique chemical and physical properties, low detection limits, and regulatory standards. It also covers field procedures for using nontoxic fluorescent tracer (e.g., fluorescein dye) in drilling fluid during drilling to assist in determining when sufficient purging has been performed prior to collecting screening-level groundwater samples during the drilling process. Screening level groundwater samples may be obtained by evacuating water from the drill casing or from intervals of geologic formations isolated by inflatable packers. This procedure improves the quality of screening-level groundwater samples by providing a technical basis to determine when purging has sufficiently removed drill water prior to collecting screening-level groundwater samples.

Multiple VAP samples can be collected through temporary wells, drilling rod tooling (e.g., Geoprobe® Screen Point 16 [SP-16]/Screen Point 22 [SP-22] Groundwater Samplers or SP-60 Sonic Groundwater Sampler or Cascade's Sonic Push-Ahead or Packer Isolation Groundwater Profilers) or via combined hydraulic profiling and sampling tools (e.g., Geoprobe® HPT-Groundwater Sampling System [HPT-GWS] or Waterloo APS™). They can be analyzed quickly via on-site mobile lab or expedited off-site fixed lab analysis to provide adaptive high-resolution quantitative groundwater concentration data. The vertical frequency of groundwater sampling within a formation will be determined relative to the scale of variability demonstrated in site hydrostratigraphy and outlined in the FIP/Work Plan. Thin aquifers with transport zones only tens of feet thick (or less) can be sampled at intervals as close as 3 to 5 feet. In aquifers with transport zones substantially thicker (e.g., more than 50 feet), sample spacing of 5 to 20 feet may be adequate. It is important to note that field data be evaluated to verify that sampling intervals provide sufficient resolution to meet data quality objectives (DQOs) (See **Section 7**).

4 Personnel Qualifications

In general, VAP activities will be performed by persons who have been trained in proper drilling and sampling procedures under the guidance of an experienced field geologist, engineer, or technician. Arcadis personnel overseeing, directing, or supervising VAP activities shall have previous related experience (minimum of 2 years) in drilling and groundwater sampling. Drilling subcontractors will need current applicable drilling licenses.

Arcadis field personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilization, the field team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the field team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

The following equipment and materials must be available for VAP sampling

- Site plan with proposed sampling locations
- Relevant work plan (or equivalent)
- Health and Safety Plan (HASP)
- Field Tablet with appropriate Fulcrum app for logging groundwater sampling.
- NOTE: *As of June 2022, several digital logging applications are available through the FieldNow™ program and the Fulcrum app. A future revision of this TGI, likely in early 2023, will emphasize digital logging methods and groundwater sampling. FieldNow™ is discussed further in Section 10.*
- Appropriate health and safety equipment, as specified in the site HASP
    - Drilling Equipment
    - Drill rig (to be provided by drilling subcontractor). Type (e.g., roto-sonic, direct push) to be determined based on site-specific details
    - Traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area,if not provided by the drillers

      NOTE: *Prior to mobilizing to the site, Arcadis personnel will contact the drilling subcontractor or in-house driller (as appropriate) to confirm that appropriate sampling equipment will be provided in quantities capable of achieving estimated target depths. Typical equipment/materials providedby the driller could include*

        - Acetate or plastic liners
        - Appropriate length of drilling rods and tooling
        - Drilling and sampling equipment decontamination materials,
        - Decontamination pad materials, if required. See **Section 6.3** below for more information
- Sampling Equipment
    - Appropriate groundwater sampling equipment (e.g., disposable bailers for volumetric sampling,peristaltic pump for shallow groundwater sampling, submersible bladder pump for deeper sampling). Refer to *the TGI – Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells* (Arcadis 2020a) for necessary equipment
    - Direct push groundwater samplers (e.g., Geoprobe® SP-22) or roto-sonic sampling devices (e.g.,Cascade Push Ahead/Packer Isolation Groundwater Profiler or Geoprobe® SP-60 Sonic Groundwater Sampler) (to be provided by drilling subcontractor)
    - Appropriate soil sampling equipment (e.g., stainless steel spatulas, knife, metal trowel)

- Dedicated plastic sheeting (preferably high-density polyethylene [HDPE]) or other clean surface toprevent sample contact with the ground
- Multi-parameter water quality probe (e.g., conductivity, temperature, pH, dissolved oxygen,oxidation reduction potential, and turbidity meter)
- Water level meter
- Appropriate sample containers and labels
  - Labeled sample bottles: see the *TGI – Poly- and Perfluorinated Alkyl Substances (PFAS)Field Sampling Guidance* (Arcadis 2017a) for PFAS-specific considerations
  - Ziplock-style bags to hold ice and samples
  - Appropriate blanks (field reagent blanks supplied by the laboratory)
  - Packing and shipping materials
  - Chain-of-Custody (COC) Forms; see the *Sample Chain of Custody* for reference (Arcadis2017b)
  - Appropriate transport bottles (coolers) with ice and appropriate labeling, no blue ice

- Decontamination Equipment
  - Equipment cleaning materials: see the *TGI – Poly- and Perfluorinated Alkyl Substances (PFAS)Field Sampling Guidance* (Arcadis 2017a) or the *TGI – Groundwater and Soil Sampling Equipment Decontamination* (Arcadis 2020b) as applicable
  - Drum labels as required for investigation derived waste handling: see the *TGI – Investigation-Derived Waste Handling and Storage* for details (Arcadis 2017c)
- Documentation/Field Notes
  - Electronic data collection device (smart phone or tablet) as applicable
  - Pens, pencils, and/or Sharpie® brand pens for writing
  - Digital camera
  - Any other appropriate field forms
- Tracer Equipment (as needed)
  - Sodium fluorescein (also known as fluorescein or uranine dye) tracer (to be added to drilling water to produce a vibrant yellow-green color); 38 grams of dye will be added to each 500 gallons of drilling water (potable water) to achieve target applied tracer concentration of 20 milligrams per liter (mg/L)
  - Bottles for retaining dyed drilling water samples and preparing visual dye standards (clear, colorless, 40 mL unpreserved VOA bottles or equivalent)
  - Graduated cylinders (50 mL and 1 L)
  - Scale for measuring mass of dye to the nearest 1 gram
  - Bottles for groundwater samples to be analyzed for tracer dye (if necessary) and chemicals of concern (COCs)

- Poly storage tank (typically 550-to-1,000-gallon capacity)
- Potable water source
- Generator
- Utility pump for mixing dye
- Pump for groundwater purging and sampling
- Flashlight or other portable lighting device
- Blue ice (for tracer dye samples)

6 Cautions

Field activities associated with borehole advancement and VAP groundwater sampling will be performed in accordance with the HASP, a copy of which will be present on site during such activities. Field staff (including subcontractors) will be aware of and understand the associated physical and health hazards.

6.1 Utility Clearance

The appropriate drilling authorities will be contacted and a site visit for public utility line clearance at the proposed boring locations will be conducted at least 72 hours prior to work commencing. As applicable, utility maps will be reviewed during field reconnaissance of the proposed investigation locations to determine if any are co-located with public utility lines. Arcadis will also contract an independent geophysical survey company to verify that proposed boring locations are not co-located with existing underground utility/substructure features, as necessary. Arcadis will clear locations with soft dig methods to assess the presence of underground utilities as necessary.

See the *Utility Location and Clearance Arcadis Health and Safety Standard* (Arcadis 2020c) for reference.

6.2 PFAS-Specific General Sampling Considerations

This section provides a summary of methods and procedures applicable to the collection of environmental samples for field screening or laboratory analysis during PFAS site characterization activities. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. For example, Teflon™ and other fluoropolymer containing materials are found in pumps, tubing, and sample storage containers and, therefore, will be avoided if possible (Department of Environment Regulation [DER], Western Australia 2016; New Hampshire Department of Environmental Services [NHDES] 2016). Certain field documentation materials such as waterproof paper or field books, adhesive paper products, and some writing utensils (grouped as non-Sharpie® markers) are also prohibited items during PFAS sampling (DER 2016; NHDES 2016).

Attachment 1 (Tables 1 and 2) provides recommendations for PFAS Site Investigation equipment. Table 1 provides a summary of materials that have been approved for site investigation; this list is expected to grow longer as industry experience increases. Table 2 provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross-

contamination potential, and it is recommended that these materials be prohibited for samplecollection. For materials that are suspected of containing and/or retaining PFAS, these recommendations are considered preliminary and subject to change.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFAS, field personnel are typically advised to err on the side of caution by strictly following field wear guidelines and decontamination procedures as specified in the *TGI - Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance* (Arcadis 2022).The most important consideration during PFAS related VAP sampling is to prevent contact between sample media and suspect PFAS sources.

6.3 PFAS-Specific Groundwater Sampling

The potential presence of material containing PFAS in equipment that may come into contact with the target water sample must be evaluated as part of the sample planning process to maintain sample integrity. For example, low-flow sampling with a peristaltic pump will be conducted using silicone or HDPE tubing; Teflon™ tubing is prohibited (DER 2016). If a bladder pump is used to collect samples, the bladder and other internal parts (e.g., check balls, O-rings, compression fittings) will not contain Teflon™, and bladder and O-rings will be changed between samples (DER 2016).

Note that if high concentrations of PFAS related to Class B firefighting foams are expected in a groundwater sample, it has been recommended to collect and shake a small portion of the sample at the time of sample collection (USACE 2016; Arcadis 2017a). If foaming is noted within the sample, it indicates elevated concentrations of PFAS may be present and the sample will be proactively diluted at the laboratory prior to analysis, and the foaming will be noted on the sample COC form. It is recommended to collect sampling equipment blanks following foam observation to confirm the effectiveness of decontamination procedures.

6.4 Use of Tracer in Drilling Fluid

Field staff (including subcontractors) will be aware of tracer hazards and understand the associated health hazards. Please be sure to read the SDS (included as Attachment 2) for fluorescein dye. Note that some individuals can experience a mild allergic reaction to skin contact with fluorescein. Protective gloves will be worn during dye handling and mixing activities, and rinse bottles will be readily available for washing affected areas in case of accidental contact.

7 Health and Safety Considerations

To ensure the safety of the field personnel, field activities associated with VAP will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. Review all site-specific and procedural hazards as they are provided in the HASP and review relevant Job SafetyAnalysis (JSA) documents in the field each day prior to beginning work.

Appropriate personal protective equipment (PPE) will be always worn in line with the task and the site-specific HASP. Verify staff has required health and safety training and personal protection

equipment in accordance with the HASP and JSAs. At a minimum, all staff will have level D PPE with chemical resistant gloves.

8 Procedure

The specific procedure for advancing VAP borings will be developed after careful review and consideration of project DQOs and clearly detailed in the FIP/Work Plan. Typically, VAP borings are conducted in boreholes adjacent to soil borings previously completed to develop stratigraphic and relative permeability profiles of the aquifer to determine sampling depth intervals that target transport zones. Prior boreholes typically consist of soil borings with detailed soil descriptions or Geoprobe® HPT borings. The primary advantage of completing stratigraphic/permeability profiles in advance of VAP sampling is to gain an understanding of hydrofacies trends to ensure that the most appropriate intervals and sampling methods are used. For sonic or HSA drilling, VAP samples are typically collected from the same borehole as soil samples. In the absence of a co-located boring, sample depth intervals can be determined based upon lithologic logging of soil cores, either from a separate adjacent borehole or from the same borehole. HPT drilling will be completed consistent with the *TGI – Geoprobe Hydraulic Profiling Tool (HPT)* (Arcadis 2022a), and soil lithologic logging will be performed in accordance with *TGI – Soil Description* (Arcadis 2022b).

NOTE: *Waterloo APS™ can be utilized as an alternative to HPT to provide permeability profiles, but it is more time consuming than HPT; therefore, it is not considered the preferred tool for permeability profiling.*

8.1 Direct Push Vertical Aquifer Profile Sampling

Direct push tooling is ideal for shallow unconsolidated aquifers and requires minimal water for drilling, reducing the potential for sample dilution/cross-contamination. For sites with shallow groundwater in unconsolidated formations (e.g., at less than 100 feet bgs), the typical approach is to collect VAP groundwater samples nominally every 5 to 10 feet with a bias to the more permeable transport zones.

When a zone of interest is identified, either by using permeability measurements (preferred) or logging soil, a screen point sampling device such as Geoprobe® SP-16 or SP-22 (see **Attachment 3**) can be driven to the target interval and the screen opened to collect a groundwater sample. In poorly sorted aquifers with appreciable amounts of silt, VAP sampling from an adjacent borehole after completing initial permeability profiling (e.g., Geoprobe® HPT or point slug tests) is typically more efficient and cost effective. In the absence of permeability profiling tools (e.g., HPT), VAP sampling can be performed based on soil lithological observations alone, either from a separate borehole or in the same borehole. However, VAP sample collection can be more efficient when conducted from an adjacent borehole, particularly if a bottom-up sampling approach is used. See Section 8.1.1.

Combined permeability profiling and sampling tools such as the Geoprobe® HPT-GWS (or Waterloo APS™ as an alternate) can be used to collect groundwater samples based on permeability measurements from the same borehole at deeper depths where the process is more cost-effective; otherwise at shallower depths, separate permeability profiling prior to VAP sampling is preferred. This is most effective in well-sorted sand and gravel when small volumes are required for analysis, since these tools provide limited volumes for purging and sample collection. Use of these combined tools (HPT-GWS or Waterloo APS™) for PFAS sites is not recommended because low detection and regulatory thresholds for PFASs require more extensive purging to decontaminate the sampling equipment (i.e., insufficient data are available to confirm the volume of purging required to eliminate cross-contamination with PFAS).

It is recommended that DPT drilling for VAP sampling be completed using a dual-tube drilling approach. An outer casing is advanced with the screen point sampling device to limit the potential for cross-contamination between sampling intervals. Pre-calculated volume purging and monitoring for water quality parameter stabilization can be performed consistent with low-flow sampling to help determine when purge water is representative of the groundwater formation.

There are two general methods for completing VAP sampling: bottom-up and top-down. With bottom-up sampling, a greater purge volume is required to ensure a representative groundwater sample; however, the overall time savings is significant relative to top-down sampling, where more time is required per borehole to lower the tooling, retract it, and decontaminate it between subsequent sampling intervals. However, the top-down method minimizes any potential for cross-contamination and is the preferred approach for PFAS projects due to the low detection limits and regulatory levels associated with PFASs.

8.1.1 Bottom-Up VAP Sampling

Bottom-up VAP sampling involves advancing dual-tube direct push casing to the deepest target depth with either a solid drive tip (without collecting soil cores) or acetate liners for collection of continuous soil cores to provide a lithological log for the entire boring. This is followed by lowering the groundwater sampling screen through the outer casing to the bottom of the borehole and collecting multiple VAP groundwater samples at different depths as the casing and screen is retracted up the borehole.

Using this approach, the external casing is retracted to allow borehole collapse around the sampling screen while isolating it from the section above that is still covered by the external casing.

NOTE: *Bottom-up VAP sampling is not recommended when there is a potential for dense non-aqueous phase liquid (DNAPL), the highest concentrations are expected to be at the bottom of the formation, or the borehole goes through multiple confining units. Bottom-up is not recommended for PFAS sampling due to potential cross-contamination concerns associated with lack of decontamination between sample intervals.*

The advantages of this approach are: (1) when combined with soil core collection, groundwater sampling depth intervals can be pre-selected based on lithologic observations to target the transport zones, especially in the absence of any co-located permeability measurements, and (2) the entire process is much more time-efficient per borehole as the sampling equipment is not pulled, decontaminated, and then drilled to the next interval. However, additional purging (i.e., 3to 5 casing volumes) is required to assure a representative groundwater sample. Bottom-up sampling also does not allow for post-grouting of the borehole since when the groundwater sampling device is pulled up to the next VAP sampling interval, the sidewalls of the open borehole below collapse.

8.1.2 Top-Down VAP Sampling

Top-down VAP sampling involves advancing dual-tube direct push casing with either a solid drive tip (without collecting soil cores) or a plastic liner for soil core retrieval from target depth interval followed by lowering the screen point sampling screen to target depth and pulling up the outer casing to expose the screen. After purging and sample collection, the screen point device is pulled back up and decontaminated. A solid drive tip or plastic liner is lowered back into the borehole and the entire assembly is then advanced to the next depth interval. Thus, top-down sampling requires pulling the tooling after each sample interval, decontaminating the tooling, re-setting the groundwater sampler, and advancing the tooling to the next planned interval.

The advantages of this approach are that it allows grouting of the borehole from the bottom of the borehole and

reduces the potential for cross-contamination from adjacent sampling intervals.

The primary disadvantage is that the entire process is much less time-efficient per borehole since the tooling must be retracted and re-advanced every time.

NOTE: *Top-down is the preferred method for PFAS VAP sampling.*

8.2 Sonic Drilling VAP Sampling

For sites with deep unconsolidated aquifers, bedrock/weathered bedrock, or otherwise challenging drilling conditions (e.g., presence of dense tills, caliche, cobbles), sonic drilling will be necessary to complete VAP. Like direct push, groundwater profilers can be used with sonic rigs to collect multiple depth-discrete groundwater samples biased towards transport zones based on soil lithological cores. The configuration of individual samplers varies based on their manufacturer by different drilling contractors (e.g., Cascade Push Ahead/Packer Isolation Groundwater Profiler or Geoprobe® SP-60).

The overall strategy of sonic drilling VAP sampling is consistent with direct push VAP sampling; however, drilling with sonic or some rotary methods can require the introduction of drilling fluid/water that can potentially affect the integrity of the groundwater sample. If possible, sonic drilling for VAP borings will be conducted without the use of drilling water. If, for example, the geology is known for flowing sands or VAP is required deep below the water table, drilling water will be used to keep the core barrel free inside the outer drill casing. In this case it is recommended that a visible dye be used to spike the drilling water to assist with purging of the VAP interval. The VAP interval is then purged until the visible dye is no longer visible, or less the 10% of the starting concentration. For more on drilling with visible dye, see Section 8.2.3. Sonic VAP sampling is typically performed in a top-down manner using either a push ahead sampling device or a packer system.

8.2.1 Push-Ahead Groundwater Profiler

Push-ahead groundwater sampling devices are available through Cascade Drilling and other sonic drillers and consists of a stainless-steel sheathed “screen” threaded to the base of the sonic drill rod. The device is driven ahead of the sonic casing into the undisturbed formation to the prescribed sample depth interval. Once the point is at the specified interval, the threaded portion between the profiler and rod is partially unthreaded to expose the water ports to allow native formation water to enter the profiler. A groundwater sample is then obtained using either a stainless-steel bailer or pump with tubing depending on the DQOs. The interval is typically purged until relatively free of fine-grained material.

The disadvantage of using this device is that groundwater samples are obtained from undisturbed native formation with unknown soil lithology, so sampling is conducted “blind”. Therefore, it is recommended that a pre-existing lithological log from an adjacent borehole is used to determine sampling depth intervals.

8.2.2 Packer Isolation Groundwater Profiler

Packer Isolation groundwater profilers (e.g., Packer Isolation groundwater profiler from Cascade, Geoprobe ® SP-60 Sonic Groundwater Profiler) work by driving the casing over the soil core, retrieving the soil core barrel, and then lowering a stainless screen and packer assembly to the base of the sonic casing. The sonic outer casing is then extracted to expose the screen to the formation, and the packer is inflated within the casing above the screen to isolate the screened interval from any water that might be above the packer in the sonic casing. A groundwater sample can then be collected from the screen.

The biggest advantage of this device is that groundwater sampling depth intervals can be determined based on lithological logs obtained from the same borehole.

A disadvantage is that a large volume of purge water may need to be removed to clear the borehole of water introduced from above.

8.2.3 Drilling with Visible Dye

Potable water is commonly used as a drilling fluid during drilling to remove cuttings of geologic materials from the borehole (e.g., coring or roller-bit rotary drilling), cool the drill bit (e.g., sonic drilling), and/or maintain sufficient hydraulic pressure within the drilling tools to prevent heaving of aquifer solids into the drill casing(s).

Typically, if groundwater sampling is performed during drilling, the purge volume to be removed is at least as much as was lost during drilling. However, accurately determining the volume of water lost to the formation, or to specific intervals of the borehole, is not always feasible or possible.

To ensure that groundwater samples accurately represent groundwater quality of the surrounding formation and are not significantly influenced by unrecovered drilling fluid, fluorescein dye can be added to the drilling water to visually confirm when unimpacted native groundwater enters the borehole and can be sampled.

The target concentration of dye is approximately 20 mg/L, which is greater than two (2) orders of magnitude above its visual threshold (approximately 0.1 mg/L) and over five (5) orders of magnitude above its typical laboratory detection limit (less than 0.001 mg/L). Once the drilling tool has been advanced to the prescribed depth for groundwater sampling, water will be pumped from the borehole until the discharge water is relatively clear of fluorescein. The goal of purging is to reach the clarity of a prepared visual standard, indicating that the discharge water is comprised of at least 95 percent formation water and less than 5 percent drilling water. Groundwater samples will then be collected for COC analysis.

If the visual standard is still not reached after a reasonable period and volume of purging, then COC sampling can still be performed, provided that samples of the dyed drilling water and groundwater are also sent for fluorescein analysis. The fluorescein data can then be used to calculate a correction factor to be applied to COC analytical results.

8.2.3.1 Set-Up Procedures

a. Dye Batch Preparation

- Prior to initiating drilling activities, measure the proper mass of powdered dye for mixing with drilling water - 38 grams of fluorescein (provided by Ozark Underground Laboratory) will be added to every 500 gallons of water to yield an average tracer concentration of approximately 20 mg/L.
- If the drilling water “batch” is larger or smaller than 500 gallons, the same ratio of dye to drilling water will be used.
- Measure the mass of dye using a scale with an accuracy of +/- 1 gram.
- Add the dye to the drilling water batch tank while also adding the potable water to provide agitation to assist in mixing the dye.
- A utility pump is also recommended to mix the tracer with the drilling water by recirculating water in the tank for at least 15 minutes.

- Place 40 mL of the dyed drilling water into a 50 mL graduated cylinder for use in preparing the visual standard discussed below.
- Collect four (4) additional 40 ml unpreserved VOA vials of drilling water from each batch of drilling water – label all four of these vials "DW1" for the first batch of drilling water, "DW2" for the second batch, etc. These samples will be archived for potential use in preparing other standards with other dilutions (optional) or for submittal for laboratory analysis, if necessary.

b. Preparation of Visual Standard: A visual standard will be prepared for each batch of dyed drilling water, as follows.

- Pour the 40 mL volume of dyed drilling water from the 50 mL graduated cylinder into a 1 L graduated cylinder.
- Add 760 mL of un-dyed potable water (from the same potable water source used to prepare the dyed drilling water) to the 1 L graduated cylinder to produce 800 mL of "visual standard".
- Fill one 40-mL unpreserved VOA vial with visual standard solution and label this "VS1" for the visual standard from the first batch of drilling water, "VS2" for the visual standard from the second batch of drilling water, etc.
- These visual standards represent a 95% dilution of the drill water and will provide a visual standard to verify that sufficient purging has been performed to remove at least 95% of the drilling water from a given interval, indicating that the purge water consists of at least 95% formation water.
- Discard the remaining fluid within the graduated cylinder using an appropriate container.
- Photograph the "DW" samples and the "VS" sample from each batch of drilling water with adequate, consistent light, against a white background.
- Keep all the dyed drilling water ("DW") samples and visual standard ("VS") samples in a cooler to keep them dark as the dye will degrade with exposure to light.

8.2.3.2 Drilling Procedures

- Fresh drilling water from the dyed drilling water batch tank will be used during drilling operations. In general, a positive head will be maintained during drilling, which should prevent dilution of the drilling water by formation water. However, any water upwelling from the casing during drilling will be contained in a tub positioned over the borehole. As needed, recovered water in the tub will be pumped to a frac tank.
- The drilling water source will be sampled for chlorine and pH at the start of the project. Chlorine, if present in detectable quantities, will consume fluorescein; therefore, wait a period of at least four (4) hours between dye addition and sampling (and use) of the drilling fluid. Below pH values of about 5, fluorescein will have reduced fluorescence. Depending on the source of the drilling fluid and project objectives, the source water may also be sampled for COCs and fluorescein.
- In open sunlight, fluorescein photodegrades rapidly. If the tracer batch tank is translucent, use 1-millimeter (mm) thick black plastic to cover the tank during the day to minimize photodegradation of the tracer batch water.
- After tracer addition, each batch of drilling fluid will be sampled at least once for fluorescein.
- At the end of the day, any excess tracer batch water can be stored for use on the following day, or it may be disposed of as investigation derived waste. Alternatively, fluorescein concentrations can be reduced to below

visible concentrations with granular activated carbon, UV-oxidation, chemical oxidants, or direct exposure to sunlight for several days.

- The field geologist will record the amount of drilling water lost to the formation during drilling of each sampling depth interval.
- At the end of the project, any excess tracer batch water can be disposed of as investigation derived waste. Alternatively, fluorescein concentrations can be reduced to below visible concentrations with granular activated carbon, UV-oxidation, chemical oxidants, or direct exposure to sunlight for several days. Depending on project and regulatory requirements, excess batch water with fluorescein concentrations below the visible limit could be discharged to a sanitary sewer or other discharge location.

8.2.3.3 Purging and Sampling Procedures

- After a groundwater sampling interval is reached, purging and screening-level groundwater sampling will be performed.
- The target sample interval will be purged using a pump, and during purging, purge water will be periodically collected in a 40-mL unpreserved VOA vial and compared to the visual standard ("VS" sample) prepared from the drilling water used to drill that depth interval.
- If the purge water contains significant suspended particulates/turbidity, it may be necessary to allow particulates to settle before comparing the purge water sample to the visual standard.
- Purging will continue until ***one*** of the following two conditions is met:

    1) Purge water clarity (in terms of remaining dye content) matches or exceeds the clarity of the visual standard, indicating that the purge water consists of at least 95% formation water.

        a. In this case, the purge water sample and the associated visual standard will be photographed against a white background to document that the purging goal has been reached.

OR

    2) A different practical purging limit has been reached, based on purge volume or time

        a. In this case, the purge water sample and the associated visual standard will be photographed against a white background to document the degree of purge water visual clarity that was attained

        b. Also, a sample of the purge water will be collected in a 40 mL unpreserved VOA; this sample and one of the vials of dyed drilling water will be submitted to Ozark Underground Laboratories for quantitative analysis of fluorescein. These samples will be shipped in a cooler with reusable "Blue Ice" rather than wet ice. The analytical results for fluorescein will be used to calculate a COC correction factor, as discussed below (see Section 8.2.3.4).

- After purging has been completed, screening-level groundwater samples will be collected from the discharge end of the pump tubing for COC analysis in accordance with the approved work plan.

8.2.3.4 Calculation of Correction Factor

- If the purge water does not reach the goal indicated by the visual standard ("VS" sample), a sample of the drilling water and a sample of the purge water (obtained immediately prior to sampling for COC analysis) will be sent for laboratory analysis of fluorescein.
- Representative COC concentrations in groundwater (C_{gw}) can then be calculated as:

$$C_{gw} = C_m [F_d / (F_d – F_s)]$$

where: C_m = measured COC concentration, as reported by the lab

F_d = fluorescein concentration in drilling water

F_s = fluorescein concentration in groundwater sample

- The term $[F_d / (F_d – F_s)]$ is the COC correction factor.

8.3 Boring Abandonment

Upon completion, each top-down borehole is backfilled with bentonite grout from the terminal end of the boring upward. The top portion of each boring is sealed with asphalt or concrete to match the existing grade. Each bottom-up borehole is typically abandoned by the collapse as the rods are retraced.

Borehole abandonment requirements in some geographies dictate top-down sampling; this should be verified in advance of work and outlined in the FIP/Work Plan. See also *TGI for Monitoring Well and Borehole Decommissioning.*

9 Waste Management

Investigation derived waste (IDW) (e.g., soil cuttings and decontamination water generated during cleaning procedures) will be collected and contained on site in appropriate containers: see the *TGI – Investigation- Derived Waste Handling and Storage* for details (Arcadis 2020d). All IDW generated during field activities will be placed in Department of Transportation approved containers, sealed, and labeled. Containerized IDW will be stored on site until it is profiled and subsequently transported to an approved facility for disposal or recycling.

Personal protective equipment (e.g., gloves, disposable clothing, disposable equipment) resulting from personnel cleaning procedures and soil sampling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled containers for appropriate disposal.

Waste manifests for all IDW suspected to have come into contact with PFAS will clearly note the potential presence of PFAS.

Additional IDW sampling and management details will be provided in the site-specific FIP/Work Plan/QAPP addendum and will be consistent with applicable client and state requirements.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

The supervising field lead will be responsible for documenting drilling events and for recording all relevant information in a clear and concise format. The record of drilling events will include (at a minimum):

- Start and finish drilling dates
- Project name and location
- Project number, client, and site location
- VAP boring number and depths
- Depth to water
- Type of VAP performed and associated tools
- Core barrel size
- Names of contractor's drillers, inspectors, or other people onsite
- Weather conditions

Field staff will ensure COC Forms are properly completed and will verify which analytes (including PFAS analytes) are required for analysis and note on the COC.

Waterproof field books must not be used for field notes. Instead, it's recommended that field notes be on loose paper on Masonite, plastic, or aluminum clip boards and/or electronic data collection tablets (as required). Other requirements for field notes include:

- Keep field notes, writing implements, and electronic data collection tablets away from samples and sampling materials; and,
- Do not write on sampling bottles unless they are closed.

11 Quality Assurance

In general, the following quality assurance and quality control (QA/QC) samples will be collected:

- Equipment blanks
- Field duplicates
- Field (i.e., reagent) blanks

- Matrix spike/matrix spike duplicate

Details on QC sampling requirements (e.g., frequency of collection, types of QA/QC samples) are provided in the QAPP and/or FIP/Work Plan. Additionally, detailed procedures related to equipment and field (i.e., reagent) blank sample collection are outlined in the *TGI for Equipment and Reagent Blank Sample Collection for PFAS Analysis*.

In general, equipment blanks should be collected from every piece of downhole equipment that could come into contact with soil or groundwater during sample collection. This includes the profiling tools (e.g., Geoprobe® SP-16, Geoprobe® SP-22, Geoprobe® SP-60, Cascade Packer Isolation Groundwater Profiler).

To avoid cross-contamination during drilling and sampling, reusable equipment such as hand tools will be cleaned using a non-phosphate soap free of VOCs, double-rinsed in potable water, and allowed to air dry prior to re-use. Drive casings and other drilling equipment will be steam cleaned or replaced with new equipment between boreholes. The drilling equipment will be cleaned in an area designated by the supervising engineer or geologist that is located outside of the work zone.

Prior to initiating field activities, water sources to be used during drilling activities will be sampled to verify those sources are PFAS-free to the extent possible.

Refer to quality control requirements for the project to ensure that appropriate quality assurance and quality control (QA/QC) samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples will be collected in laboratory-supplied HDPE bottles
- Bottle caps must remain in the hand of the sampler until replaced on the bottle
- Labels must be completed after the caps have been placed back on each bottle
- Samples must be stored in appropriate transport bottles (coolers) with ice (Ziplock-type bags for use as ice containers) with appropriate labeling
- Do not use blue ice except for shipping fluorescein samples
- Store PFAS samples in a separate cooler from other types of samples

11.1 Equipment Blanks (if relevant)

QA/QC sampling typically includes daily collection of equipment blanks using the laboratory-supplied water, or in the case of PFAS sampling, “PFAS-free” water. For peristaltic pump tubing, laboratory supplied water will be poured into a clean HDPE sample bottle and then pumped through new HDPE tubing using the peristaltic pump (with new silicone tubing). Equipment blanks will also be collected from the water used by drillers, as well as any downhole tooling to ensure absence of any cross-contamination. Drilling water sources must be submitted for analysis of all COCs before work commences for VAP as discussed above. See *also TGI for Poly- and Perfluorinated Alkyl Substances (PFAS) Potable Water Sampling Guidance*.

11.2 Field Duplicates

QA/QC sampling typically includes the collection of one field duplicate for every 10 or 20 samples collected. Each duplicate sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-provided sample bottle. Do not indicate to the laboratory which sample the duplicate replicates (i.e., it will be given a blind reference on the COC and sample name such as “Dup 1”).

11.3 Field Blanks

QA/QC sampling for typically includes the submission of one laboratory supplied field blank per day. The reagent field blank sample is brought to the site in a laboratory-supplied sample bottle. Field staff transfer the laboratory-supplied reagent blank to an empty sample bottle. This reagent fieldblank will be placed in the same cooler as the other PFAS samples.

11.4 Matrix Spikes (optional in some cases)

QA/QC sampling includes submitting a sample to be used as a matrix spike if the project requires it. If a separate sample bottle is required, an additional sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-supplied sample bottle.

11.5 Laboratory Analytical QA/QC

- Internal laboratory QA/QC will consist of one laboratory blank and one laboratory control sample (or blank spike) per batch of samples, and additional QA/QCs as indicated by the laboratory QA/QC procedures. Isotope dilution will be used for quantification with isotope-labeled surrogate standards, as available.
- For groundwater and surface water samples, extract the entire groundwater and surface water sample and at least two sampling bottle solvent rinsates for analysis to increase sample accuracy. Avoid sub-sampling an aliquot of the sample bottle.
- Soil samples will be analyzed in their entirety or thoroughly homogenized before extraction and analysis.
- As part of the internal QA/QC, relative percent difference will be calculated between samples and corresponding field or laboratory duplicates. The laboratory quality assurance portion of the laboratory certificates will be reviewed to verify that all calculations/recoveries were within acceptable limits as established by the laboratory method.
- In January 2017, the U.S. Department of Defense and U.S. Department of Energy Quality Systems Manual (QSM) 5.1 (U.S. Department of Defense 2017) was finalized and introduced laboratory guidance for the measurement of PFAS in matrices other than drinking water. This guidance is not a detailed procedural method such as an U.S. Environmental Protection Agency method, but it does recommend best practices around the analysis of PFAS. Laboratories are not required to comply with QSM 5.1 until 2019, although the recommendations around PFAS analysis are similar to what most laboratories are already implementing. Arcadis recommends that any request for PFAS analysis in

groundwater or soil should specifically reference the need to comply with Table B-15 in the QSM 5.1 (i.e., Per- and Polyfluoroalkyl Substances (PFAS) Using Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS) With Isotope Dilution or Internal Standard Quantification in Matrices Other Than Drinking Water); however, this list can be modified to support project specific deliverables.

12 References

Arcadis U.S., Inc. (Arcadis). 2010. SOP – Use of Visible Tracer in Drilling Fluid to Obtain Representative Groundwater Samples During Drilling. September.

Arcadis. 2017a. TGI – Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance. April 27.

Arcadis. 2017b. SOP – Sample Chain of Custody, Rev. #1. May 23.

Arcadis. 2017c. TGI – Investigation-Derived Waste Handling and Storage, Rev. #0. February

Arcadis. 2018. TGI – Soil Description, Rev. #2. February 16.

Arcadis. 2020a. TGI – Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells, Rev. #1. May 7.

Arcadis. 2020b. TGI – Groundwater and Soil Sampling Equipment Decontamination, Rev. #1. May 8.

Arcadis. 2020c. Utility Location and Clearance, Rev. #17. May 13, 2020.

Arcadis. 2020d. TGI – Investigation- Derived Waste Handling and Storage

Department of Environment Regulation (DER). Government of Western Australia. 2016. Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS). Contaminated Sites Guidelines. February.

Massachusetts Department of Environmental Protection (MassDEP). 2017. DRAFT Fact Sheet, Guidance on Sampling and Analysis for PFAS at Disposal Sites Regulated under the Massachusetts Contingency Plan. January.

New Hampshire Department of Environmental Services (NHDES). 2016. Perfluorinated Compound (PFC) Sample Collection Guidance. November.

Obal, T., Robinson, A., Chia, S.C. 2012. Aqueous sample stability: PFOS, PFOA and other fluorinated compounds. REMTECH 2012: The Remediation Technologies Symposium, Banff, AB, Canada, 17-19 Oct 2012. Environmental Services Association of Alberta, Edmonton, AB.

Sabic. 2016. Article Safety Data Sheet for Generic SFS-PC Lexan™ Film/Sheet. Revised May 12.

United States Army Corps of Engineers (USACE). 2016. DRAFT – Standard Operating Procedure 047: Per/Poly Fluorinated Alkyl Substances (PFAS) Field Sampling. Revision: 1. March.

U.S. Department of Defense (DoD). 2017. Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.1. In conjunction with the U.S. Department of Energy. January.

United Nations Environment Programme (UNEP). 2015. PFAS analysis in water for the Global Monitoring Plan of the Stockholm Convention, Set-up and guidelines for monitoring. Jana Weiss, Jacob de Boer,Urs Berger, Derek Muir, Ting Ruan, Alejandra Torre, Foppe Smedes, Branislav Vrana, Fabrice Clavient, and Heidelore Fiedler. Division of Technology, Industry and Economics. Geneva. April.

ATTACHMENT 1

Table 1 and Table 2: PFAS Investigation Material Recommendations

Table 1: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Investigations

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to investigation	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Sharpie®	--	NHDES 2016; USACE 2016; MassDEP 2017
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to investigation	DER 2016
Alconox®, Liquinox® or Citranox® followed by deionized water or PFAS-free water rinse	Alconox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

Table 2: Summary of Equipment and Materials Not Recommended for PFAS Site Investigations.

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon® or polytetrafluoroethylene (PTFE)-containing or coated field equipment (e.g., tubing, bailers, tape, plumbing paste)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Non-Sharpie® markers		x		NHDES 2016
Decontamination				
Some detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

N**ote**: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

ATTACHMENT 2

Safety Data Sheet (SDS) Fluorescein

SAFETY DATA SHEET (SDS)
REVISION DATE: 03/03/2016

HUE CORPORATION

Color your everything, may your Hue come true

SECTION I. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

PRODUCT IDENTIFIER:

PRODUCT NAME ..... **HUE URANINE CONC** (Also known as Fluorescein)
PRODUCT NUMBER 1-C8-073PC
COLOR INDEX NAME ..... ACID YELLOW 073
COLOR INDEX NO 45350
C. A. S. # 518-47-8
CHEMICAL FAMILY..... XANTHENE

INTENDED USE OF THE PRODUCT:

FELT TIP, MARKER INKS, WATER BASED COATINGS AND LEAK DETECTION

NAME, ADDRESS AND TELEPHONE OF RESPONSIBLE PARTY:

HUE CORPORATION	TELEPHONE	714-389-3130
P.O. BOX 509	FAX	714-389-9731
TUSTIN, CA 92781	EMAIL	SUPPORT@HUECORPORATION.COM

EMERGENCY TELEPHONE NUMBER:

CHEMTREC (USA)	1-800-424-9300
CHEMTREC (OUTSIDE USA)	1-703-527-3887

SECTION 2. HAZARD(S) IDENTIFICATION

CLASSIFICATION OF THE SUBSTANCE OR MIXTURE:

GHS-US
ACUTE TOX. - INHALATION (CATEGORY 5)
EYE DAM./IRRITATION (CATEGORY 2B)
SKIN CORR./IRRITATION (CATEGORY 3)

GHS LABELING:

HAZARD PICTOGRAMS (GHS-US):	NO SYMBOL
SIGNAL WORD	WARNING
HAZARD STATEMENT(S)	H333 - MAY BE HARMFUL IF INHALED H320 - CAUSES EYE IRRITATION H316 - CAUSES MILD SKIN IRRITATION
PRECAUTIONARY STATEMENTS	P305 + 351 + P338 - IF IN EYES: RINSE CAUTIOUSLY WITH WATER FOR SEVERAL MINUTES. REMOVE CONTACT LENSES IF PRESENT AND EASY

TO DO. CONTINUE RINSING.
P337 + P313 - IF EYE IRRITATION OCCURS/PERSISTS:
GET MEDICAL ADVICE AND ATTENTION.
P261 - AVOID BREATHING DUST/FUMES/GAS/MIST/VAPORS/SPRAY
P264 - WASH FACE THOROUGHLY AFTER HANDLING.
P322 + P313 - IF SKIN IRRITATION OCCURS: GET MEDICAL ADVICE/ ATTENTION.
P304 + 312 - IF INHALED: CALL A POISON CENTER/DOCTOR/PHYSICIAN IF YOU FEEL UNWELL

OTHER HAZARDS NO DATA AVAILABLE
UNKNOWN ACUTE TOXICITY NO DATA AVAILABLE

SECTION 3. COMPOSITION / INFORMATION ON INGREDIENTS

DESCRIPTION OF MIXTURE: PROPRIETARY MIXTURE OF DYES.

SUBSTANCE:

NAME	C.A.S.#	WEIGHT 100%	GHS-US CLASSIFICATION
ACID YELLOW 073	518-47-8	100%	ACUTE TOX. - INHALATION (CATEGORY 5) EYE DAM./IRRITATION (CATEGORY 2B) SKIN CORR./IRRITATION (CATEGORY 3)

SECTION 4. FIRST AID MEASURES

FIRST AID MEASURES GENERAL:

INHALATION: REMOVE TO FRESH AIR. IF BREATHING IS DIFFICULT, GIVE OXYGEN AND GET IMMEDIATE MEDICAL ATTENTION.

SKIN: WASH WITH MILD SOAP AND WATER. IF IRRITATION OCCURS GET MEDICAL ATTENTION. IF CLOTHING IS CONTAMINATED, RE-MOVE AND WASH BEFORE REUSE.

EYES: FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES, HOLDING EYELIDS APART FOR THOROUGH IRRIGATION. GET IMMEDIATE MEDICAL ATTENTION.

INGESTION: INDUCE VOMITING - SEEK IMMEDIATE MEDICAL ATTENTION.

MOST IMPORTANT SYMPTOMS AND EFFECTS, ACUTE AND DELAYED:

THIS PRODUCT IS NOT HAZARDOUS AS DEFINED BY HAZARDOUS COMMUNICATION STANDARD. HOWEVER, AS WITH ALL CHEMICAL; HANDLE WITH CARE, AVOID EYE AND SKIN CONTACT, AVOID INHALATION OF DUSTS OR VAPORS. WASH THOROUGHLY AFTER HANDLING. KEEP CONTAINERS CLOSED.

SECTION 5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA:

WATER, DRY CHEMICAL, CARBON DIOXIDE, FOAM.

SPECIAL HAZARDS ARISING FROM SUBSTANCE OR MEDIA:

FIREFIGHTERS SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS TO GUARD AGAINST POTENTIALLY TOXIC AND IRRITATING FUMES. AVOID DUSTING. DUST CAN FORM EXPLOSIVE MIXTURES WITH AIR.

PROTECTION/ADVICE FOR FIREFIGHTER(S):

BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING.

SECTION 6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS:

REMOVE PERSONS FROM DANGER AREA.

ENVIROMENTAL PRECAUTIONS:

AVOID ANY UNCONTROLLED RELEASE OF MATERIAL. DO NOT EMPTY INTO DRAINS OR THE AQUATIC ENVIRONMENT.

EMERGENCY PROCEDURES:

NO ADDITIONAL INFORMATION

METHODS AND MATERIALS FOR CONTAMINENT AND CLEANING UP:

WHERE SPILLS ARE POSSIBLE, A COMPREHENSIVE SPILL RESPONSE PLAN SHOULD BE DEVELOPED AND IMPLEMENTED. AVOID ANY UNCONTROLLED RELEASE OF MATERIAL.

UTILIZE RECOMMENDED PROTECTIVE CLOTHING AND EQUIPMENT (SEE SECTION 8).
SPILLS SHOULD BE SWEPT UP USING AN ABSORBENT DUST CONTROL PRODUCT AND PLACED IN CONTAINERS. SPILL AREA CAN BE WASHED WITH WATER. COLLECT WATER FOR APPROVED DISPOSAL.
IN THE EVENT OF UNCONTROLLED RELEASE OF THIS MATERIAL, THE USER SHOULD DETERMINE IF THE RELEASE IS REPORTABLE UNDER APPLICABLE LAWS AND REGULATIONS.

SECTION 7. HANDLING AND STORAGE

PRECAUTIONS FOR SAFE HANDLING:

HANDLE WITH CARE. AVOID OVER EXPOSURE. USE NIOSH/OSHA APPROVED RESPIRATOR, WORK GLOVES, AND CLOTHING. WASH AFTER HANDLING. SENSITIVE INDIVIDUALS MAY EXPERIENCE RESPIRATORY ALLERGIES. MAY CAUSE SKIN IRRITATION. USE WITH LOCAL VENTILATION.

CONDITIONS FOR SAFE STORAGE, INCLUDING ANY INCOMPATIBILITIES:

USE PROCESS ENCLOSURES, LOCAL EXHAUST VENTILATION OR OTHER ENGINEERING CONTROLS TO KEEP AIRBORNE LEVELS BELOW RECOMMENDED EXPOSURE LIMITS.

KEEP AWAY FROM HEAT. KEEP AWAY FROM SOURCES OF IGNITION.

KEEP AWAY FROM STRONG OXIDIZING AND REDUSING AGENTS.

SPECIFIC END USES:

FELT TIP, MARKER INKS, WATER BASED COATINGS AND LEAK DETECTION

SECTION 8. EXPOSURE CONTROLS /PERSONAL PROTECTION

CONTROL PARAMETERS:

INGREDIENTS WITH LIMIT VALUES THAT REQUIRE MONITORING AT THE WORKPLACE - NOT REQUIRED

EXPOSURE CONTROLS:

APPROPRIATE ENGINEERING CONTROLS - THE USUAL PRECAUTIONARY MEASURES ARE TO BE ADHERED TO WHEN HANDLING CHEMICALS.

PERSONAL PROTECTIVE EQUIPMENT:

HAND PROTECTION	WEAR IMPERMEABLE RUBBER OR PLASTIC GLOVES
EYE PROTECTION	TIGHTLY SEALED SAFETY GOGGLES OR FULL FACE SIDE SHIELDS.
SKIN AND BODY	APRON, COVERALLS AND NON-LEATHER SOLED WORK SHOES. WASH DYE CONTAMINATED CLOTHES AND SKIN WITH MILD SOAP AND DETERGENTS.
RESPIRATORY	WEAR OSHA/NIOSH APPROVED DUST MASK/RESPIRATOR
HYGIENE MEASURES	HANDLE IN ACCORDANCE WITH GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES. WASH HANDS AFTER HANDLING MATERIAL.
OTHER PROTECTION	DELUGE SAFETY SHOWER AND EYE WASH STATION SHOULD BE LOCATED NEAR WORK AREA.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

INFORMATION ON BASIC PHYSICAL AND CHEMICAL PROPERTIES :

APPEARANCE, COLOR, ODOR	YELLOW POWDER, NO ODOR
pH	8.0 - 9.0
MELTING POINT/FREEZING POINT	ND
INITIAL BOILING POINT/BOILING RANGE	0.00
FLASHPOINT	NORMALLY STABLE, NOT COMBUSTIBLE NOR FLAMMABLE
EVAPORATION RATE	NO DATA
FLAMMABILITY (SOLID,GAS)	NORMALLY STABLE, NOT COMBUSTIBLE NOR FLAMMABLE
UPPER EXPLOSIVE LIMITS	NA
LOWER EXPLOSIVE LIMITS	NA
VAPOR PRESSURE	NA
VAPOR DENSITY	NA
RELATIVE DENSITY	NA
SOLUBILITY IN WATER	SOLUBLE
PARTITION COEFFICIENT N-OCTANOL/WATER	NO DATA

AUTO-IGNITION TEMPERATURE	NO DATA
DECOMPOSITION TEMPERATURE	NO DATA
VISCOSITY, DYNAMIC	NO DATA
VISCOSITY, CINEMATIC	NO DATA
EXPLOSIVE PROPERTIES	N/A
OXIDIZING PROPERTIES	NA
OTHER INFORMATION	NA

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY	STABLE UNDER NORMAL STORAGE AND HANDLING CONDITIONS.
CONDITIONS TO AVOID	OXIDIZING & REDUCING AGENTS MAY DESTROY COLOR.
INCOMPATIBLE MATERIALS	OXIDIZING & REDUCING AGENTS MAY DESTROY COLOR.
HAZARDOUS DECOMPOSITION PRODUCTS	CO, CO2, OXIDES OF NITROGEN AND OTHER POTENTIALLY TOXIC FUMES.

SECTION 11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL EFFECTS :

ORAL (ANIMAL	GREATER THAN 7,000 MG/KG - RAT
DERMAL (ANIMAL)	NA
EFFECTS TO EYES (ANIMAL)	EYES - RABBIT, NOT IRRITATING
SKIN IRRITATION (ANIMAL)	SKIN - RABBIT, SLIGHT IRRITANT

SKIN CORROSION/IRRITATION	NOT CLASSIFIED
SERIOUS EYE DAMAGE/IRRITATION	CAUSES EYE IRRITATION
RESPIRATORY OR SKIN SENSITIZATION	NOT CLASSIFIED
GERM CELL MUTAGENICITY	NOT CLASSIFIED
CARCINOGENICITY	NOT CLASSIFIED
REPRODUCTIVE TOXICITY	NOT CLASSIFIED
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE)	MAY CAUSE DROWSINESS OR DIZZINESS.
ASPIRATION HAZARD	NOT CLASSIFIED
INHALATION	MAY CAUSE DROWSINESS OR DIZZINESS.
EYE CONTACT	CAUSES SERIOUS EYE IRRITATION.
INGESTION	INGESTION MAY CAUSE NAUSEA, VOMITING AND DIARRHEA

SECTION 12. ECOLOGICAL INFORMATION

TOXICITY	NA
PERSISTENCE AND DEGRADABILITY	NA
BIOACCUMULATIVE POTENTIAL	NA
MOBILITY IN SOIL	LC-50 (LETHAL CONCENTRATION) UG = MICROGRAMS/LITER CHANNEL CATFISH - 2,267,000 UG/LITER RAINBOW TROUT - 1,372,000 UG/LITER BLUEGILL - 3,433,000 UG/LITER
OTHER ADVERSE EFFECTS	NA

SECTION 13. DISPOSAL CONSIDERATION

WASTE DISPOSAL RECOMMENDATION :

EMPTY BAGS THOROUGHLY. CARRY OUT THE PROPER RECYLING, REUSAGE OR DISPOSAL.
PLEASE REFER TO THE RELEVANT EU REGULATIONS, IN PARTICULAR THE GUIDELINES/DECISIONS OF THE COUNCIL REGARDING HANDLING OF WASTES (E.G. 75/442/EEC, 91/689/EEC, 94/67/EC, 94/904/EC) AS IMPLEMENTED IN NATIONAL REGULATIONS.

REGIONAL RECOMMENDATION :

BURY OR INCINERATE ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS.

CONTAINERS SHOULD NOT BE REUSED WITHOUT PROFESSIONAL CLEANING AND RECONDITIONING.
OBSERVE ALL LABELED SAFEGUARDS UNTIL CLEANED, RECONDITIONED OR DESTROYED.

PLEASE REFER TO SECTION 8 (EXPOSURE CONTROLS /PERSONAL PROTECTION) OF THIS SDS.

SECTION 14. TRANSPORTATION INFORMATION

UN NUMBER	NONE
UN PROPER SHIPPING NAME	NONE

DEPARTMENT OF TRANSPORTATION (DOT) : NOT HAZARDOUS FOR TRANSPORTATION

TRANSPORT HAZARD CLASS(ES)

HAZARD LABLES (DOT) :

PACKING GROUP (DOT)	NA
DOT SPECIAL PROVISIONS	NA

ADDITIONAL INFORMATION:

OVERLAND TRANSPORT	NONE
TRANSPORT BY SEA	NONE
AIR TRANSPORT	NONE
DOT QUANTITY LIMITATIONS PASSENGER AIRCRAFT	NA
DOT QUANTITY LIMITATIONS CARGO AIRCRAFT	NA

SECTION 15. REGULATORY INFORMATION

US FEDERAL REGULATIONS:

THE SUBSTANCES IS LISTED ON UNITED STATES TSCA (TOXIC SUBSTANCE CONTROL ACT) INVENTORY.

US STATE REGULATIONS:

NONE

CHEMICAL IDENTITY:

518-47-8	TSCA	DSL	NDSL	EINECS	ELINCS	ENCS	CHINA	KECL	PICCS	AICS
	X	-	-	-	-	-	-	-	-	-

TSCA STATUS	IN COMPLIANCE
E C CLASSIFICATION	(67/548/EEC - 88/379/EEC) N/A
EINECS NUMBER	
REACH CLASSIFICATION	
R PHRASES	
ADDITIONAL REGULATORY INFORMATION	

SECTION 16. OTHER INFORMATION

INDICATION OF CHANGES:

NA

OTHER INFORMATION:

NA

GHS FULL TEXT PHRASES:

MAY BE HARMFUL IF INHALED	H333
CAUSES EYE IRRITATION	H320
CASUES MILD SKIN IRRITATION	H316

	HEALTH	FLAMMABILITY	REACTIVITY	PERSONAL PROT
H. M. I. S. CLASSIFICATION:	1	0	0	D

HMIS CODE: **4** - SEVERE HAZARD, **3** - SERIOUS HAZARD, **2** - MODERATE HAZARD, **1** - SLIGHT HAZARD, **0** - MINIMAL HAZARD

SAFETY DATA SHEET (SDS)
REVISION DATE: 03/03/2016

ALL INFORMATION AND DATA APPEARING ON THIS SDS ARE BELIEVED TO BE RELIABLE AND ACCURATE. HOWEVER, IT IS THE USER' S RESPONSIBILITY TO DETERMINE THE SAFETY, TOXICITY, AND SUITABILITY FOR USE OF THE PRODUCT DESCRIBED. SINCE THE ACTUAL USE BY OTHERS IS BEYOND OUR CONTROL, NO GUARANTEE, EXPRESSED OR IMPLIED, IS MADE BY HUE CORPORATION.
USER ASSUMES ALL RISK AND RESPONSIBILITY.

ATTACHMENT 3

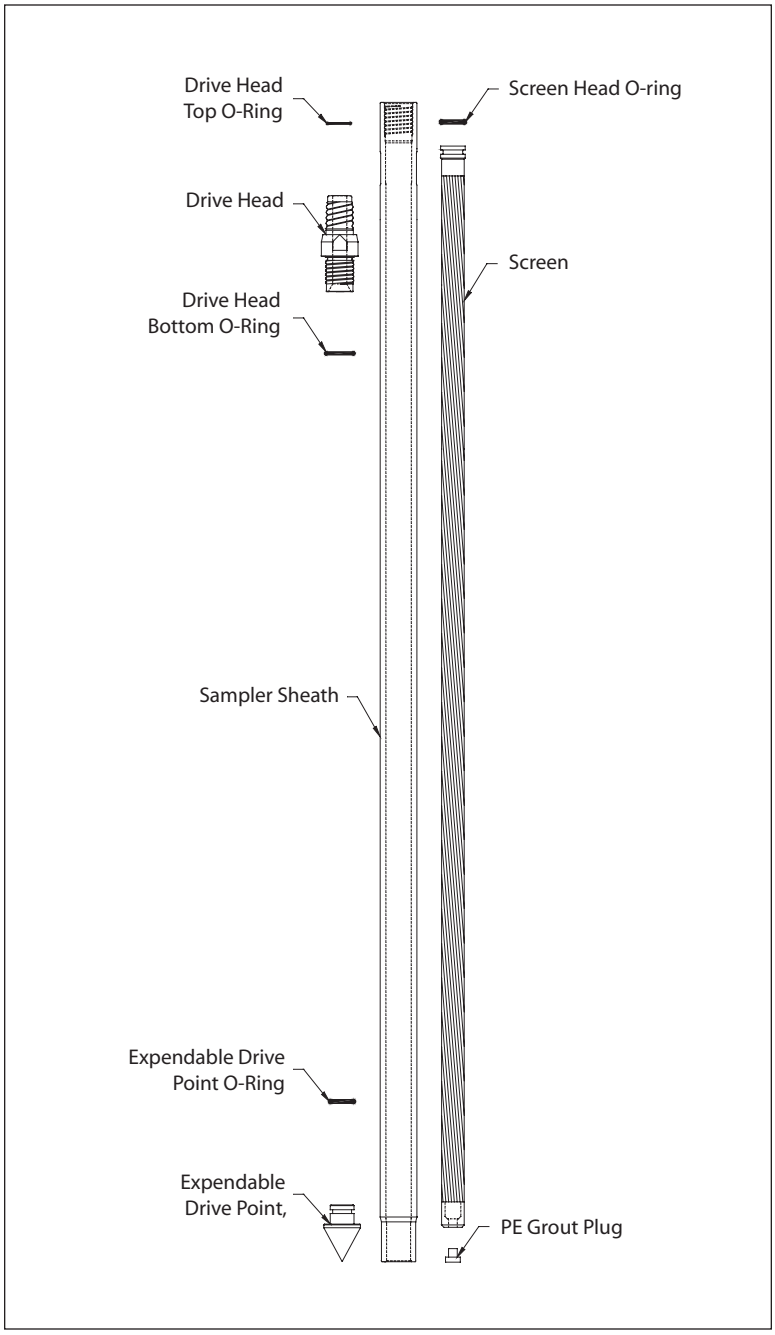
SOPs Geoprobe® Screen Point 16 and Screen Point 22 Groundwater Samplers

GEOPROBE® SCREEN POINT 16 GROUNDWATER SAMPLER

STANDARD OPERATING PROCEDURE

Technical Bulletin No. MK3142

PREPARED: November, 2006



GEOPROBE® SCREEN POINT 16 GROUNDWATER SAMPLER PARTS

Geoprobe® and Geoprobe Systems®, Macro-Core® and Direct Image® are Registered Trademarks of Kejr, Inc., Salina, Kansas

Screen Point 16 Groundwater Sampler is manufactured under U.S. Patent 5,612,498

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1.0 OBJECTIVE

The objective of this procedure is to drive a sealed stainless steel or PVC screen to depth, deploy the screen, obtain a representative water sample from the screen interval, and grout the probe hole during abandonment. The Screen Point 16 Groundwater Sampler enables the operator to conduct abandonment grouting that meets American Society for Testing and Materials (ASTM) Method D 5299 requirements for decommissioning wells and borings for environmental activities (ASTM 1993).

2.0 BACKGROUND

2.1 Definitions

Geoprobe®: A brand name of high quality, hydraulically powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling and monitoring, soil conductivity and contaminant logging, grouting, and materials injection.

Screen Point 16 (SP16) Groundwater Sampler: A direct push device consisting of a PVC or stainless steel screen that is driven to depth within a sealed, steel sheath and then deployed for the collection of representative groundwater samples. The assembled SP16 Sampler is approximately 51.5 inches (1308 mm) long with an OD of 1.625 inches (41 mm). Upon deployment, up to 41 inches (1041 mm) of screen can be exposed to the formation. The Screen Point 16 Groundwater Sampler is designed for use with 1.5-inch probe rods and machines equipped with the more powerful GH60 Hydraulic Hammer. Operators with GH40 Series hammers may chose to use this sampler in soils where driving is difficult.

Rod Grip Pull System: An attachment mounted on the hydraulic hammer of a direct push machine which makes it possible to retract the tool string with extension rods or flexible tubing protruding from the top of the probe rods. The Rod Grip Pull System includes a pull block with rod grip jaws that are bolted directly to the machine. A removable handle assembly straddles the tool string while hooking onto the pull block to effectively grip the probe rods as the hammer is raised. A separate handle assembly is required for each probe rod diameter.

2.2 Discussion

In this procedure, the assembled Screen Point 16 Groundwater Sampler (Fig. 2.1A) is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface with a Geoprobe® direct push machine. Additional probe rods are added incrementally and advanced until the desired sampling interval is reached. While the sampler is advanced to depth, O-ring seals at each rod joint, the drive head, and the expendable drive point provide a watertight system. This system eliminates the threat of formation fluids entering the screen before deployment and assures sample integrity.

Once at the desired sampling interval, extension rods are sent downhole until the leading rod contacts the bottom of the sampler screen. The tool string is then retracted approximately 44 inches (1118 mm) while the screen is held in place with the extension rods (Fig. 2.1B). As the tool string is retracted, the expendable point is released from the sampler sheath. The tool string and sheath may be retracted the full length of the screen or as little as a few inches if a small sampling interval is desired.

There are three types of screens that can be used in the Screen Point 16 Groundwater Sampler. Two of the these, a stainless steel screen with a standard slot size of 0.004 inches (0.10 mm) and a PVC screen with a standard slot size of 0.010 inches (0.25 mm), are recovered with the tool string after sampling. The third screen is also manufactured from PVC with a standard slot size of 0.010 inches (0.25 mm), but is designed to be left downhole when sampling is complete. This disposable screen has an exposed screen length of approximately 43 inches (1092 mm). The two screens that are recovered with the sampler both have an exposed screen length of approximately 41 inches (1041 mm).

(continued on following page)

An O-ring on the head of the stainless steel screens maintains a seal at the top of the screen. As a result, any liquid entering the sampler during screen deployment must first pass through the screen. PVC screens do not require an O-ring because the tolerance between the screen head and sampler sheath is near that of the screen slot size.

The screens are constructed such that flexible tubing, a mini-bailer, or a small-diameter bladder pump can be inserted into the screen cavity. This makes direct sampling possible from anywhere within the saturated zone. A removable plug in the lower end of the screens allows the user to grout as the sampler is extracted for further use.

Groundwater samples can be obtained in a number of ways. A common method utilizes polyethylene (TB25L) or Teflon® (TB25T) tubing and a Check Valve Assembly (GW4210). The check valve (with check ball) is attached to one end of the tubing and inserted down the casing until it is immersed in groundwater. Water is pumped through the tubing and to the ground surface by oscillating the tubing up and down.

An alternative means of collecting groundwater samples is to attach a peristaltic or vacuum pump to the tubing. This method is limited in that water can be pumped to the surface from a maximum depth of approximately 26 feet (8 m). Another technique for groundwater sampling is to use a stainless steel Mini-Bailer Assembly (GW41). The mini-bailer is lowered down the inside of the casing below the water level where it fills with water and is then retrieved from the casing.

The latest option for collecting groundwater from the SP16 sampler is to utilize a Geoprobe® MB470 Series Mechanical Bladder Pump (MBP)*. The MBP may be used to meet requirements of the low-flow sampling protocol (Puls and Barcelona 1996, ASTM 2003). Through participation in a U.S. EPA Environmental Technology Verification study, it was confirmed that the MB470 can provide representative samples (EPA 2003).

**The Mechanical Bladder Pump is manufactured under U.S. Patent No. 6,877,965 issued April 12, 2005.*

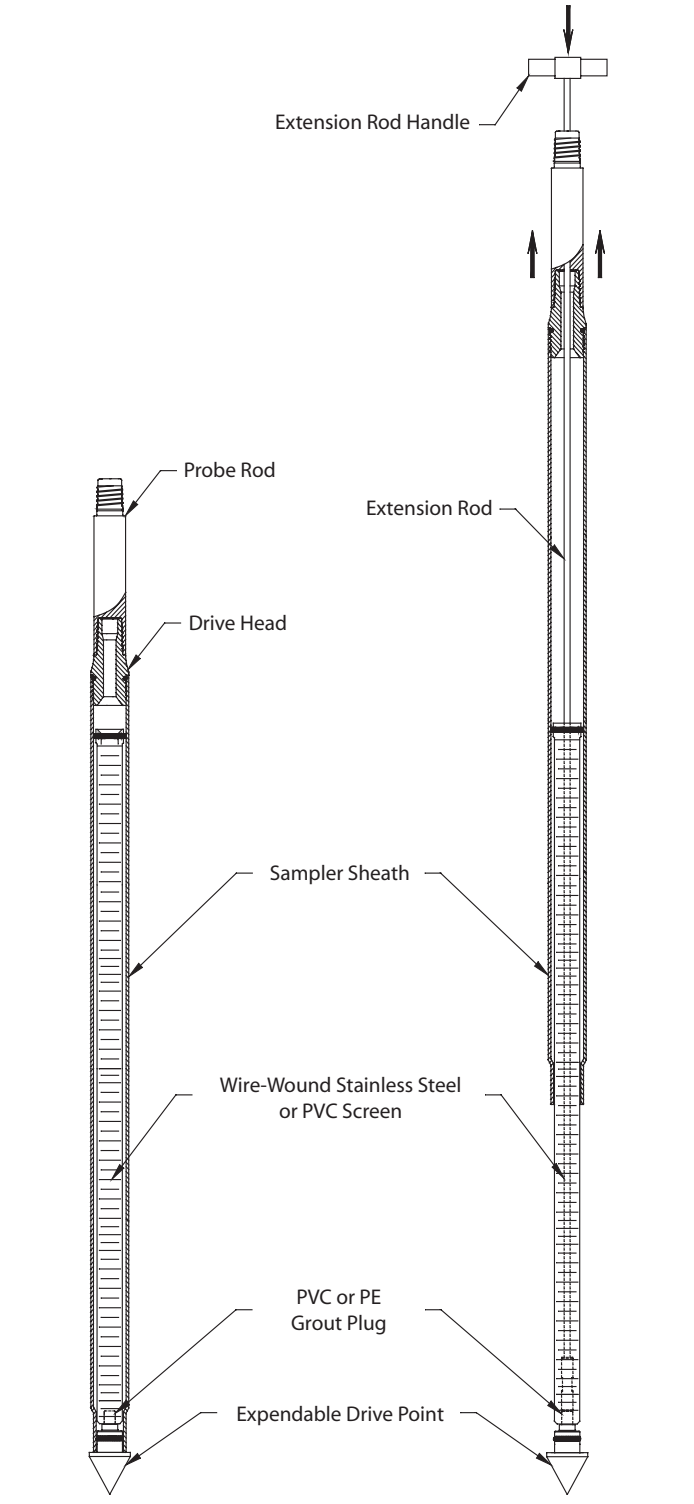


FIGURE 2.1
Screen Point 16 Groundwater Sampler

3.0 TOOLS AND EQUIPMENT

The following tools and equipment can be used to successfully recover representative groundwater samples with the Geoprobe® Screen Point 16 Groundwater Sampler. Refer to Figures 3.1 and 3.2 for identification of the specified parts. Tools are listed below for the most common SP16 / 1.5-inch probe rod configurations. Additional parts for optional rod sizes and accessories are listed in Appendix A.

SP16 Sampler Parts	**Part Number**
SP16 Sampler Sheath	15187
SP16 Drive Head, 0.5-inch bore, 1.5-inch rods*	18307
SP16 O-ring Service Kit, 1.5-inch rods *(includes 4 each of the O-ring packets below)*	15844
O-rings for Top of SP16 Drive Head, 1.5-inch rods only (Pkt. of 25)	*15389*
O-rings for Bottom of SP16 Drive Head (Pkt. of 25)	*13196*
O-rings for GW1520 Screen Head (Pkt. of 25)	*GW1520R*
O-rings for SP16 Expendable Drive Point (Pkt. of 25)	*GW1555R*
Screen, Wire-Wound Stainless Steel, 4-Slot*	GW1520
Grout Plugs, PE (Pkg. of 25)	GW1552K
Expendable Drive Points, steel, 1.625-inch OD (Pkg. of 25)*	GW1555K
Screen Point 16 Groundwater Sampler Kit, 1.5-inch Probe Rods *(includes 1 each of: 15187, 18307, 15844, GW1520, GW1535, GW1540, GW1555K, and GW1552K)*	15770

Probe Rods and Probe Rod Accessories	**Part Number**
Drive Cap, 1.5-inch probe rods, threadless, (for GH60 Hammer)	12787
Pull Cap, 1.5-inch probe rods	15090
Probe Rod, 1.5-inch x 60-inch*	11121

Extension Rods and Extension Rod Accessories	**Part Number**
Screen Push Adapter	GW1535
Grout Plug Push Adapter	GW1540
Extension Rod, 60-inch*	10073
Extension Rod Coupler	AT68
Extension Rod Handle	AT69
Extension Rod Jig	AT690
Extension Rod Quick Link Coupler, pin	AT695
Extension Rod Quick Link Coupler, box	AT696

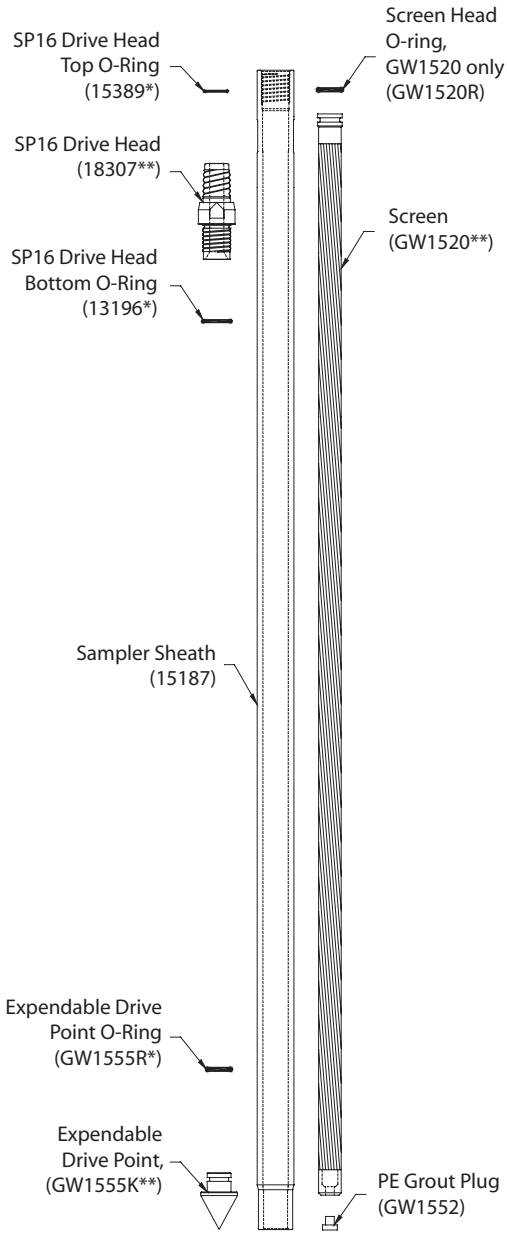
Grout Accessories	**Part Number**
Grout Nozzle, for 0.375-inch OD tubing	GW1545
High-Pressure Nylon Tubing, 0.375-inch OD / 0.25-inch ID, 100-ft. (30 m)	11633
Grout Machine, self-contained*	GS1000
Grout System Accessories Package, 1.5-inch rods	GS1015

Groundwater Purging and Sampling Accessories	**Part Number**
Polyethylene Tubing, 0.375-inch OD, 500 ft.*	TB25L
Check Valve Assembly, 0.375-inch OD Tubing*	GW4210
Water Level Meter, 0.438-inch OD Probe, 100 ft. cable*	GW2000
Mechanical Bladder Pump**	MB470
Mini Bailer Assembly, stainless steel	GW41

Additional Tools	**Part Number**
Adjustable Wrench, 6.0-inch	FA200
Adjustable Wrench, 10.0-inch	FA201
Pipe Wrenches	NA

* See Appendix A for additional tooling options.

** Refer to the Standard Operating Procedure (SOP) for the Mechanical Bladder Pump (Technical Bulletin No. MK3013) for additional tooling needs.



* Included in the SP16 O-ring Service Kit (15844)
** Part numbers show most common tool configuration. See Appendix A for alternative parts.

FIGURE 3.1
SP16 Sampler Parts

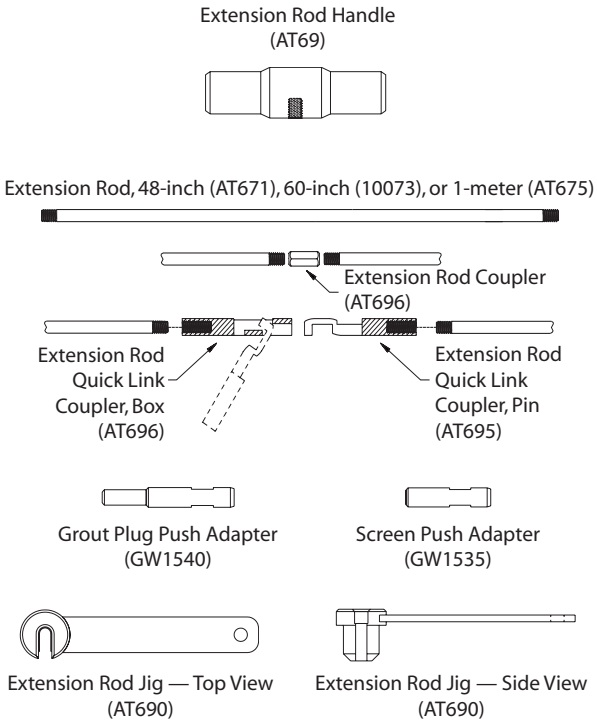


FIGURE 3.2
Geoprobe® Extension Rods and Accessories

4.0 OPERATION

4.1 Basic Operation

The SP16 sampler utilize a stainless steel or PVC screen which is encased in an alloy steel sampler sheath. An expendable drive point is placed in the lower end of the sheath while a drive head is attached to the top. O-rings on the drive head and expendable point provide a watertight sheath which keeps contaminants out of the system as the sampler is driven to depth.

Once the sampling interval is reached, extension rods equipped with a screen push adapter are inserted down the ID of the probe rods. The tool string is then retracted up to 44 inches (1118 mm) while the screen is held in place with the extension rods. The system is now ready for groundwater sampling. When sampling is complete, a removable plug in the bottom of the screen allows for grouting below the sampler as the tool string is retrieved.

4.2 Sampler Options

The Screen Point 15 and Screen Point 16 Groundwater Samplers are nearly identical. Subtle differences in the design of the SP16 sampler make it more durable than the earlier SP15 system. Operators of GH60-equipped machines should always utilize SP16 tooling. Operators of machines equipped with GH40 Series hammers may also choose SP16 tooling when sampling in difficult probing conditions.

A 1.75-inch OD Expendable Drive Point (17066K) and Disposable PVC Screen (16089) provide two useful options for the SP16 sampler. The 1.75-inch drive point may be used when soil conditions make it difficult to remove the sampler after driving to depth. The disposable PVC screen may be left downhole after sampling (when regulations permit) to eliminate the time required for screen decontamination.

4.3 Decontamination

In order to collect representative groundwater samples, all sampler parts must be thoroughly cleaned before and after each use. Scrub all metal parts using a stiff brush and a nonphosphate soap solution. Steam cleaning may be substituted for hand-washing if available. Rinse with distilled water and allow to air-dry before assembly.

4.4 SP16 Sampler Assembly (Figure 4.1)

Part numbers are listed for a standard SP16 sampler using 1.5-inch probe rods. Refer to Page 6 for screen and drive head alternatives.

1. Place an O-ring on a steel expendable drive point (GW1555K). Firmly seat the expendable point in the necked end of a sampler sheath (15187).

2. Install a PE Grout Plug (GW1552) in the bottom end of a Wire-wound Stainless Steel Screen (GW1520). Place a GW1520R O-ring in the groove on the top end of the screen.

3. Slide the screen inside of the sampler sheath with the grout plug toward the bottom of the sampler. Ensure that the expendable point was not displaced by the screen.

4. Install a bottom O-ring (13196) on a Drive Head (18307 or 15188). Thread the drive head into the sampler sheath using an adjustable wrench if necessary to ensure complete engagement of the threads. Attach a Drive Cap (12787 or 15590) to the top of the drive head.

   NOTE: The 18307 drive head should be used whenever possible as the smaller 0.5-inch ID provides a greater material cross-section for increased durability.

Sampler assembly is complete.

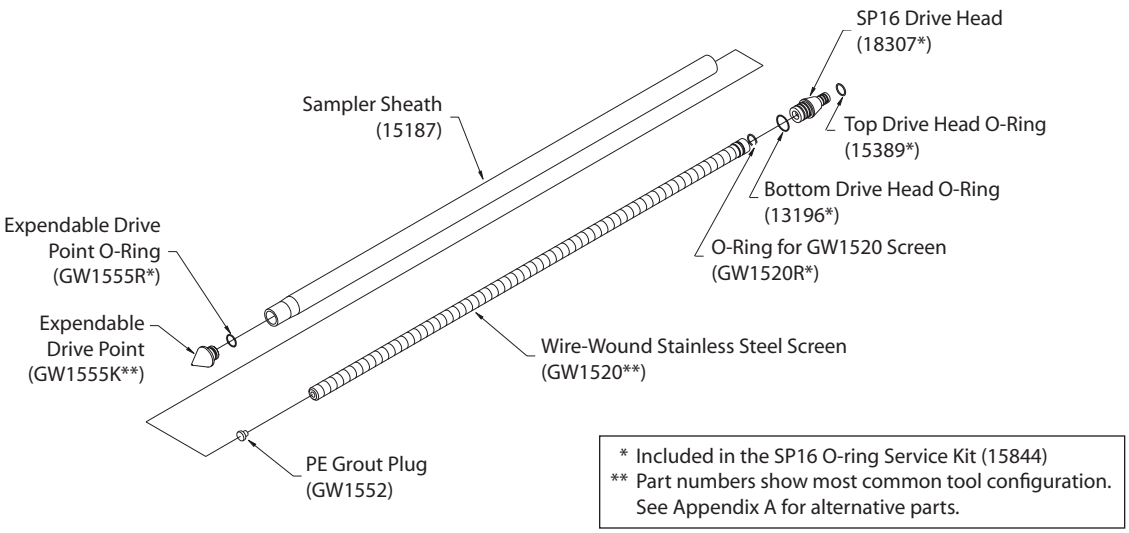


FIGURE 4.1
Screen Point 16 Groundwater Sampler Assembly

4.5 Advancing the SP16 Sampler

To provide adequate room for screen deployment with the Rod Grip Pull System, the probe derrick should be extended a little over halfway out of the carrier vehicle when positioning for operation.

1. Begin by placing the assembled sampler (Fig. 2.1.A) in the driving position beneath the hydraulic hammer of the direct push machine as shown in Figure 4.2.

2. Advance the sampler with the throttle control at slow speed for the first few feet to ensure that the sampler is aligned properly. Switch to fast speed for the remainder of the probe stroke.

3. Completely raise the hammer assembly. Remove the drive cap and place an O-ring in the top groove of the drive head. Distilled water may be used to lubricate the O-ring if needed.

Add a probe rod (length to be determined by operator) and reattach the drive cap to the rod string. Drive the sampler the entire length of the new rod with the throttle control at fast speed.

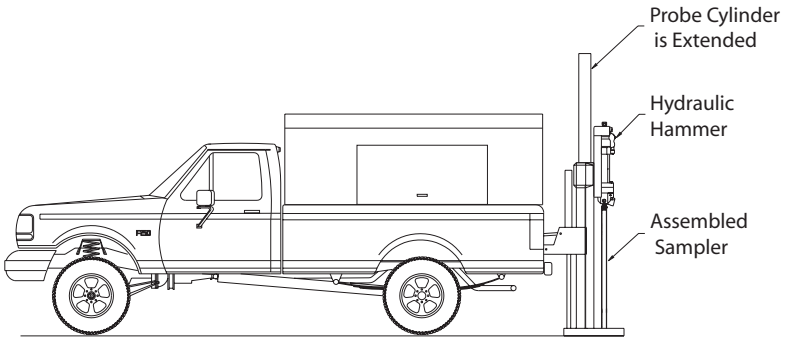


FIGURE 4.2
Screen Point 16 Groundwater Sampler in Driving Position

4. Repeat Step 3 until the desired sampling interval is reached. Approximately 12 inches (305 mm) of the last probe rod must extend above the ground surface to allow attachment of the puller assembly. A 12-inch (305 mm) rod may be added if the tool string is over-driven.

5. Remove the drive cap and retract the probe derrick away from the tool string.

4.6 Screen Deployment

1. Thread a screen push adapter (GW1535) on an extension rod of suitable length (AT671, 10073, or AT675). Attach a threaded coupler (AT68) to the other end of the extension rod. Lower the extension rod inside of the probe rod taking care not to drop it down the tool string. An extension rod jig (AT690) may be used to hold the rods.

2. Add extension rods until the adapter contacts the bottom of the screen. To speed up this step, it is recommended that Extension Rod Quick Links (AT695 and AT696) are used at every other rod joint.

3. Ensure that at least 48 inches (1219 mm) of extension rod protrudes from the probe rod. Thread an extension rod handle (AT69) on the top extension rod.

4. Maneuver the probe assembly into position for pulling.

5. Raise (pull) the tool string while physically holding the screen in place with the extension rods (Fig. 4.3.B). A slight knock with the extension rod string will help to dislodge the expendable point and start the screen moving inside the sheath.

   Raise the hammer and tool string about 44 inches (1118 cm) if using a GW1520 or GW1530 screen. At this point the screen head will contact the necked portion of the sampler sheath (Fig. 4.3.C.) and the extension rods will rise with the probe rods. Use care when deploying a PVC screen so as not to break the screen when it contacts the bottom of the sampler sheath.

   The Disposable Screen (16089) will extend completely out of the sheath if the tool string is raised more than 45 inches (1143 mm). Measure and mark this distance on the top extension rod to avoid losing the screen during deployment.

6. Remove the rod grip handle, lower the hammer assembly, and retract the probe derrick. Remove the top extension rod (with handle) and top probe rod. Finally, extract all extension rods.

7. Groundwater samples can now be collected with a mini-bailer, peristaltic or vacuum pump, tubing bottom check valve assembly, bladder pump, or other acceptable small diameter sampling device.

   When inserting tubing or a bladder pump down the rod string, ensure that it enters the screen interval. The leading end of the tubing or bladder pump will sometimes catch at the screen head giving the illusion that the bottom of the screen has been reached. An up-and-down motion combined with rotation helps move the tubing or bladder pump past the lip and into the screen.

4.7 Abandonment Grouting for GW1520 and GW1530 Screens

The SP16 Sampler can meet ASTM D 5299 requirements for abandoning environmental wells or borings when grouting is conducted properly. A removable grout plug makes it possible to deploy tubing through the bottom of GW1520 and GW1530 screens. A GS500 or GS1000 Grout Machine is then used to pump grout into the open probe hole as the sampler is withdrawn. The following procedure is presented as an example only and should be modified to satisfy local abandonment grouting regulations.

1. Maneuver the probe assembly into position for pulling. Attach the rod grip puller to the top probe rod. Raise the tool string approximately 4 to 6 inches (102 to 152 cm) to allow removal of the grout plug.

2. Thread the Grout Plug Push Adapter (GW1540) onto an extension rod. Insert the adapter and extension rod inside the probe rod string. Add extension rods until the adapter contacts the grout plug at the bottom of the screen. Attach the handle to the top extension rod. When the extension rods are slightly raised and lowered, a relatively soft rebound should be felt as the adapter contacts the grout plug. This is especially true when using a PVC screen.

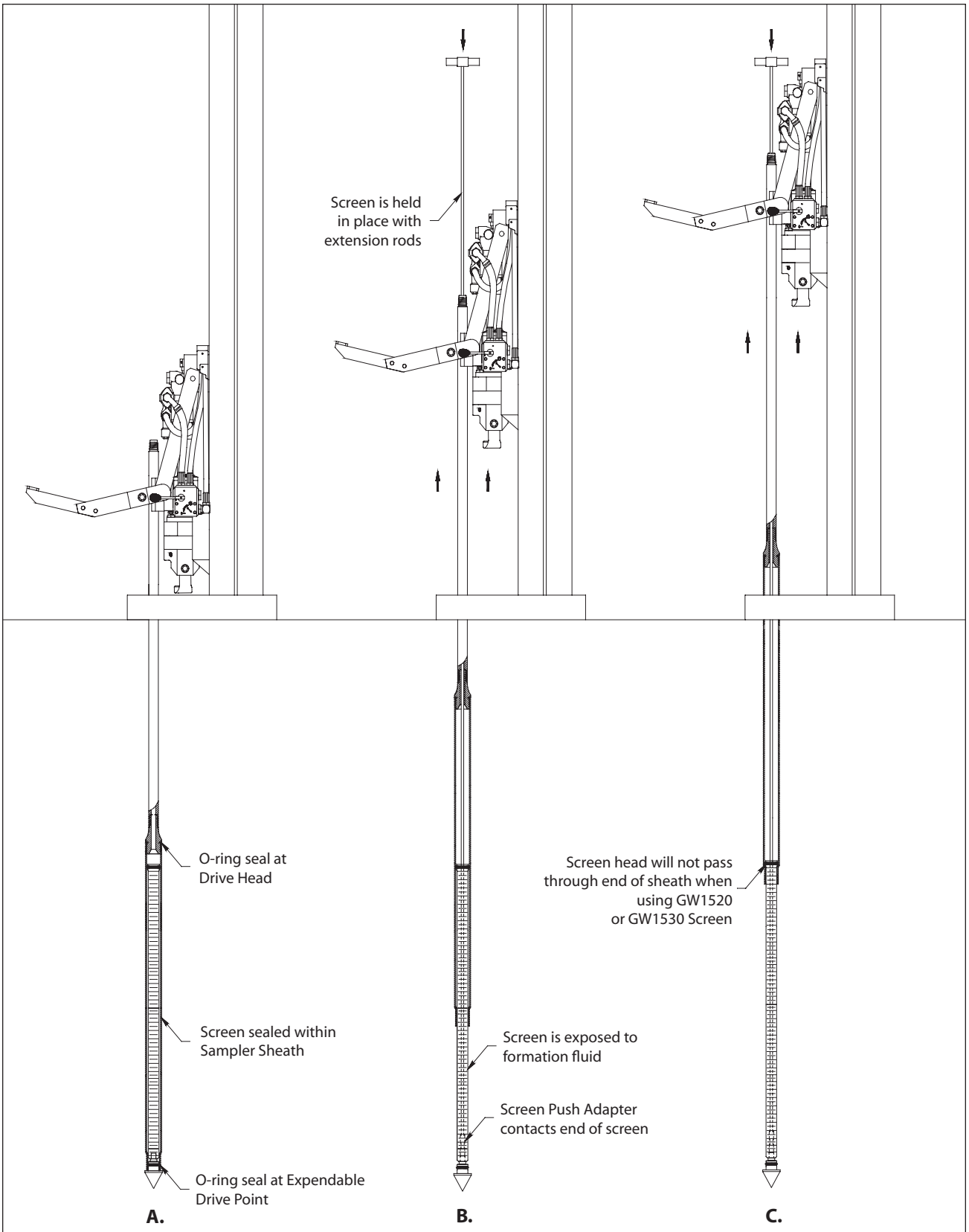


FIGURE 4.3
Screen Deployment for SP16 Sampler

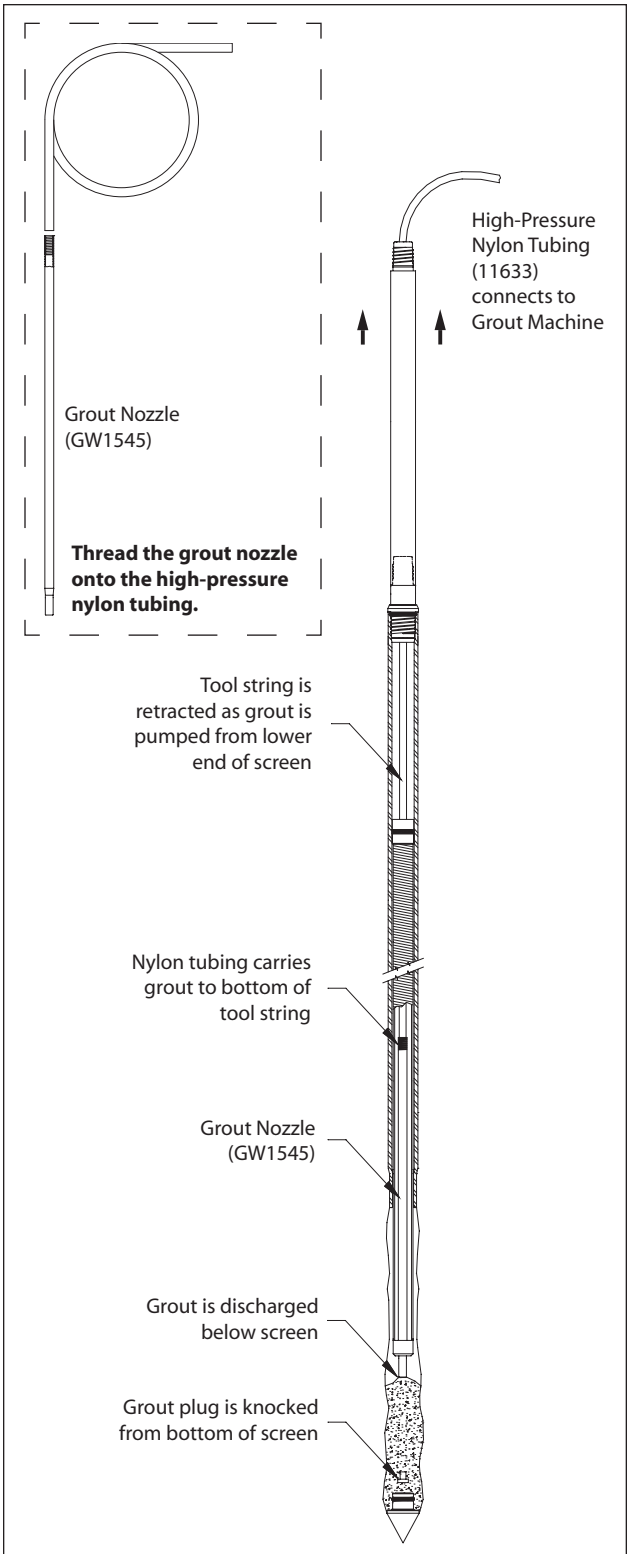


FIGURE 4.4
Grouting the SP16 Sampler With a GW1520 or GW1530 Screen

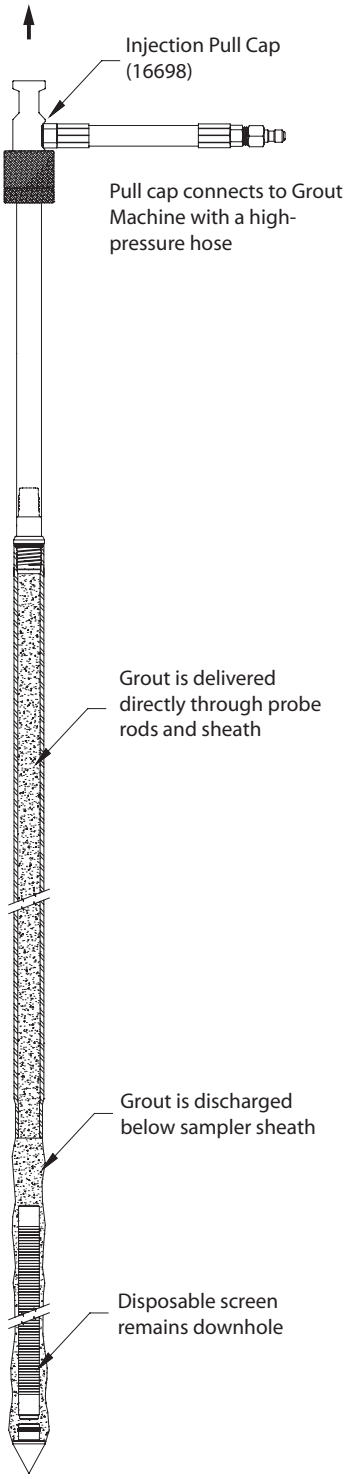


FIGURE 4.5
Grouting the SP16 Sampler With a 16089 Disposable Screen

3. Place a mark on the extension rod even with the top of the probe rod. Apply downward pressure on the extension rods and push the grout plug out of the screen. The mark placed on the extension rod should now be below the top of the probe rod. Remove all extension rods.

   Note: When working with a stainless steel screen, it may be necessary to raise and quickly lower the extension rods to jar the grout plug free. When the plug is successfully removed, a metal-on-metal sensation may be noted as the extension rods are gently "bounced" within the probe rods.

4. A Grout Nozzle (GW1545) is now connected to High-Pressure Nylon Tubing (11633) and inserted down through the probe rods to the bottom of the screen (Fig. 4.4). It may be necessary to pump a small amount of clean water through the tubing during deployment to jet out sediments that settled in the bottom of the screen. Resistance will sometimes be felt as the grout nozzle passes through the drive head. Rotate the tubing while moving it up-and-down to ensure that the nozzle has reached the bottom of the screen and is not hung up on the drive head.

   Note: *All probe rods remain strung on the tubing as the tool string is pulled. Provide extra tubing length to allow sufficient room to lay the rods on the ground as they are removed. An additional 20 feet is generally enough.*

5. Operate the grout pump while pulling the first rod with the rod grip pull system. Coordinate pumping and pulling rates so that grout fills the void left by the sampler. After pulling the first rod, release the rod grip handle, fully lower the hammer, and regrip the tool string. Unthread the top probe and slide it over the tubing placing it on the ground near the end of the tubing.

6. Repeat Step 5 until the sampler is retrieved. Do not bend or kink the tubing when pulling and laying out the probe rods. Sharp bends create weak spots in the tubing which may burst when pumping grout. Remember to operate the grout pump only when pulling the rod string. The probe hole is thus filled with grout from the bottom up as the rods are extracted.

7. Promptly clean all probe rods and sampler parts before the grout sets up and clogs the equipment.

4.8 Abandonment Grouting for the 16089 Disposable Screen

ASTM D 5299 requirements can also be met for the SP16 samplers when using the 16089 disposable screen. Because the screen remains downhole after sampling, the operator may choose either to deliver grout to the bottom of the tool string with nylon tubing or pump grout directly through the probe rods using an Injection Pull Cap (16698). A GS500 or GS1000 Grout Machine is needed to pump grout into the open probe hole as the sampler is withdrawn. The following procedure is presented as an example only and should be modified to satisfy local abandonment grouting regulations.

1. Maneuver the probe assembly into position for pulling with the rod grip puller.

2. Thread the screen push adapter onto an extension rod. Insert the adapter and extension rod inside the probe rod string. Add extension rods until the adapter contacts the bottom of the screen. Attach the handle to the top extension rod.

3. The disposable screen must be extended at least 46 inches (1168 mm) to clear the bottom of the sampler sheath. Considering the length of screen deployed in Section 4.7, determine the remaining distance required to fully extend the screen from the sheath. Mark this distance on the top extension rod.

4. Pull the tool string up to the mark on the top extension rod while holding the disposable screen in place.

   The screen is now fully deployed and the sampler is ready for abandonment grouting. Apply grout to the bottom of the tool string during retrieval using either flexible tubing (as described in Section 4.7) or an injection pull cap (Fig. 4.5). This section continues with a description of grouting with a pull cap.

5. Remove the rod grip handle and maneuver the probe assembly directly over the tool string. Thread an Injection Pull Cap (16698) onto the top probe rod and close the hammer pull latch over the top of the pull cap.

6. Connect the pull cap to a Geoprobe® grout machine using a high-pressure grout hose.

7. Operate the pump to fill the entire tool string with grout. When a sufficient volume has been pumped to fill the tool string, begin pulling the rods and sampler while continuing to operate the grout pump. Considering the known pump volume and sampler cross-section, time tooling withdrawal to slightly "overpump" grout into the subsurface. This will ensure that all voids are filled during sampler retrieval.

   The grouting process can lubricate the probe hole sufficiently to cause the tool string to slide back downhole when disconnected from the pull cap. Prevent this by withdrawing the tool string with the rod grip puller while maintaining a connection to the grout machine with the pull cap.

4.9 Retrieving the Screen Point 16 Sampler

If grouting is not required, the Screen Point 16 Sampler can be retrieved by pulling the probe rods as with most other Geoprobe® applications. The Rod Grip Pull System should be used for this process as it allows the operator to remove rods without completely releasing the tool string. This avoids having the probe rods fall back downhole when released during the pulling procedure. A standard Pull Cap (15164) may still be used if preferred. Refer to the Owner's Manual for your Geoprobe® direct push machine for specific instructions on pulling the tool string.

5.0 REFERENCES

American Society of Testing and Materials (ASTM), 2003. D6771-02 Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations. ASTM, West Conshocken, PA. (www.astm.org)

American Society of Testing and Materials (ASTM), 1993. ASTM 5299 *Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.* ASTM West Conshohocken, PA. (www.astm.org)

Geoprobe Systems®, 2003, *Tools Catalog, V.6.*

Geoprobe Systems®, 2006, *Model MB470 Mechanical Bladder Pump Standard Operating Procedure (SOP), Technical Bulletin No. MK3013.*

Puls, Robert W., and Michael J. Barcelona, 1996. Ground Water Issue: Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures. EPA/540/S-95/504. April.

U.S. Environmental Protection Agency (EPA), 2003. Environmental Technology Verification Report: Geoprobe Inc., Mechanical Bladder Pump Model MB470. Office of Research and Development, Washington, D.C. EPA/600R-03/086. August.

Appendix A
ALTERNATIVE PARTS

The following parts are available to meet unique soil conditions. See section 3.0 for a complete listing of the common tool configurations for the Geoprobe® Screen Point 16 Groundwater Sampler.

SP16 Sampler Parts and Accessories	**Part Number**
SP16 Drive Head, 0.625-inch bore, 1.5-inch rods	15188
Expendable Drive Points, aluminum, 1.625-inch OD (Pkg. of 25)	GW1555ALK
Expendable Drive Points, steel, 1.75-inch OD (Pkg. of 25)	17066K
Screen, PVC, 10-Slot	GW1530
Screen, Disposable, PVC, 10-Slot	16089

Groundwater Purging and Sampling Accessories	**Part Number**
Polyethylene Tubing, 0.25-inch OD, 500 ft	TB17L
Polyethylene Tubing, 0.5-inch OD, 500 ft	TB37L
Polyethylene Tubing, 0.625-inch OD, 50 ft	TB50L
Check Valve Assembly, 0.25-inch OD Tubing	GW4240
Check Valve Assembly, 0.5-inch OD Tubing	GW4220
Check Valve Assembly, 0.625-inch OD Tubing	GW4230
Water Level Meter, 0.375-inch OD Probe, 100-ft. cable	GW2001
Water Level Meter, 0.438-inch OD Probe, 200-ft. cable	GW2002
Water Level Meter, 0.375-inch OD Probe, 200-ft. cable	GW2003
Water Level Meter, 0.438-inch OD Probe, 30-m cable	GW2005
Water Level Meter, 0.438-inch OD Probe, 60-m cable	GW2007
Water Level Meter, 0.375-inch OD Probe, 60-m cable	GE2008

Grouting Accessories	**Part Number**
Grout Machine, auxiliary-powered	GS500

Probe Rods, Extension Rods, and Accessories	**Part Number**
Probe Rod, 1.5-inch x 1-meter	17899
Probe Rod, 1.5-inch x 48-inch	13359
Drive Cap, 1.5-inch rods (for GH40 Series Hammer)	15590
Rod Grip Pull Handle, 1.5-inch Probe Rods (for GH40 Series Hammer)	GH1555
Extension Rod, 48-inch	AT671
Extension Rod, 1-meter	AT675

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems®.

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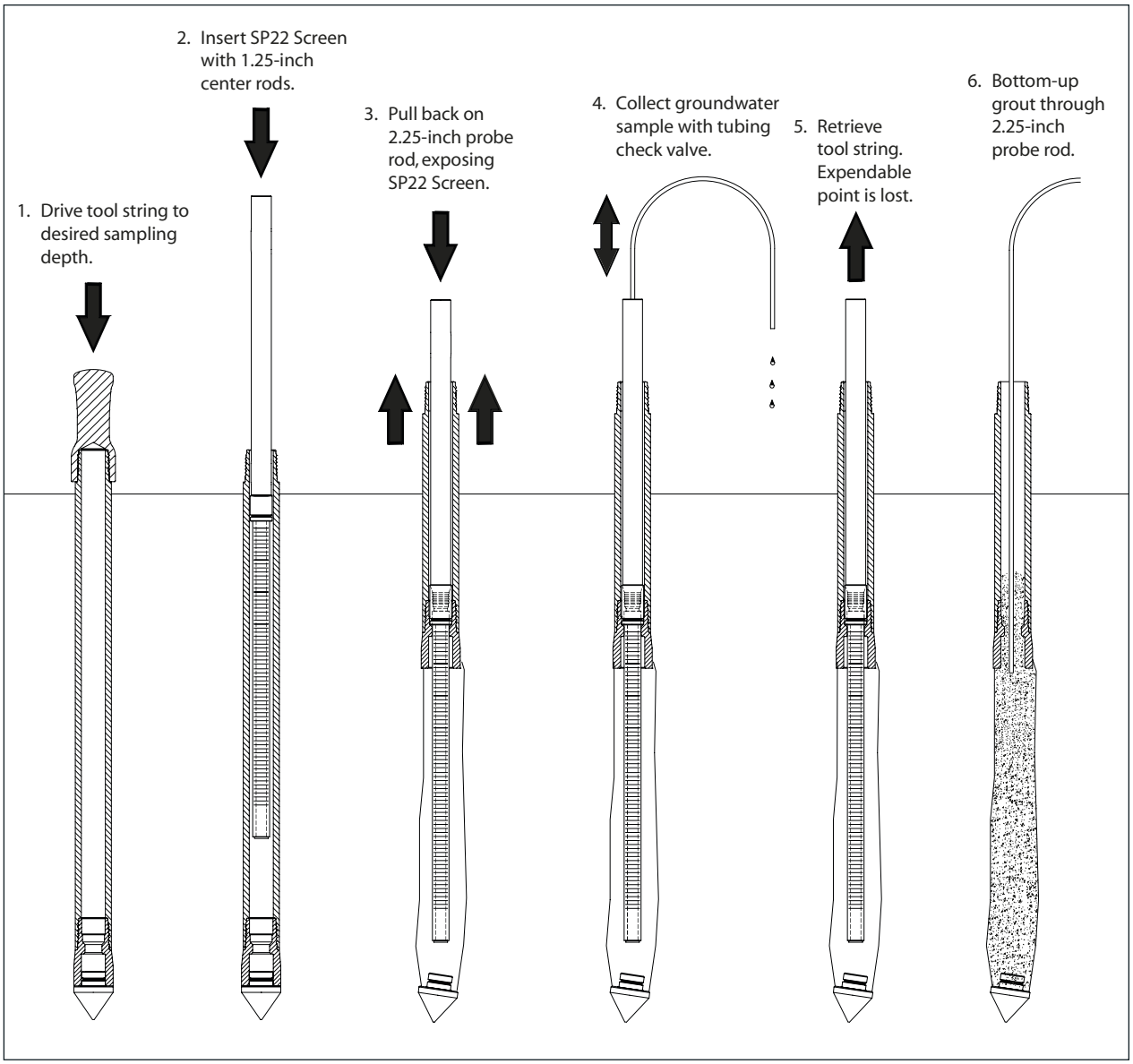
GEOPROBE® SCREEN POINT 22 GROUNDWATER SAMPLER

STANDARD OPERATING PROCEDURE

Technical Bulletin No. MK3173

PREPARED: April 2010



OPERATION OF THE GEOPROBE® SCREEN POINT 22 GROUNDWATER SAMPLER

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Screen Point 22 Groundwater Sampler is manufactured under U.S. Patent 5,612,498

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1.0 OBJECTIVE

The objective of this procedure is to deploy a stainless steel or PVC screen at depth, obtain a representative water sample from the screen interval, and grout the probe hole during abandonment. The Screen Point 22 Groundwater Sampler enables the operator to conduct abandonment grouting that meets American Society for Testing and Materials (ASTM) Method D 5299 requirements for decommissioning wells and borings for environmental activities (ASTM 1993).

2.0 BACKGROUND

2.1 Definitions

Geoprobe®: A brand name of high quality, hydraulically powered machines that utilize static force and percussion or rotation to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform activities such as soil core and soil gas sampling, groundwater sampling and monitoring, soil conductivity and contaminant logging, grouting, and materials injection.

Screen Point 22 (SP22) Groundwater Sampler: A direct push device consisting of a PVC or stainless steel screen that is lowered (post-run) to depth within a sealed string of steel probe rods and then deployed for the collection of representative groundwater samples. Upon deployment, up to 48 inches (1219 mm) of screen can be exposed to the formation. There is also an optional 12-inch screen that can be used. The Screen Point 22 Groundwater Sampler is designed for use with 2.25-inch probe rods and machines equipped with the more powerful GH60 and GH80 series hydraulic hammers. Operators with GH40 series hammers may choose to use this sampler in soils where driving is easier.

Rod Grip Pull System: An attachment mounted on the hydraulic hammer of a direct push machine which makes it possible to retract the tool string with probe rods or fiexible tubing protruding from the top of the probe rods. The Rod Grip Pull System includes a pull block with rod grip jaws that are bolted directly to the machine. A removable handle assembly straddles the tool string while hooking onto the pull block to effectively grip the probe rods as the hammer is raised. A separate handle assembly is required for each probe rod diameter.

2.2 Discussion (Fig. 2.1)

In this procedure, 2.25-inch probe rods are advanced into the subsurface with a Geoprobe® subsurface machine (Fig. 2.1, Step 1). While the tool string is advanced to depth, O-ring seals at each rod joint, the expendable point holder, and the expendable drive point provide a watertight system. This eliminates the threat of formation fiuids entering the screen before deployment and assures sample integrity.

Once the leading end of the 2.25-inch probe rods reaches the desired sampling interval, an SP22 screen is lowered to the bottom of the rods using a string of either 1.25-inch outside diameter (OD) light-weight center rods, 1.25-inch probe rods, or 0.75-inch schedule 40 fiush-thread PVC riser (Fig. 2.1, Step 2). The 2.25-inch rods are then retracted while the SP22 screen is held in place with the 1.25-inch rods or PVC riser (Fig 2.1, Step 3). As the 2.25-inch tool string is retracted, the expendable point is released from the expendable point holder. The tool string and expendable point holder may be retracted the full length of the screen or as little as a few inches if a small sampling interval is desired.

The SP22 Sampler can also be used with the Geoprobe® DT22 system. (Fig. 2.2)

(continued on following page)

Expendable Drive Points
The SP22 system utilizes an SP22 Expendable Point Holder (33764) and standard 2.45-inch (62-mm) OD steel Expendable Drive Points for 2.25-inch probe rods (AT2015K). Extended Shank Expendable Drive Points (19442) are available for soft soil conditions where standard points may be advanced out of the point holder during percussion. A third option is to use a part number 43128 SP22 Expendable Point Holder along with 1.625-inch (41-mm) steel Expendable Drive Points (GW1555K). These smaller drive points are more economical to purchase and ship, but must not be used with GH80 Series Hydraulic Hammers as they may not stay seated during percussion.

Screens
Two types of screens have been developed for use in the Screen Point 22 Groundwater Sampler - a stainless steel screen with a standard slot size of 0.004 inches (0.10 mm) and a PVC screen with a standard slot size of 0.010 inches (0.25 mm). These screens are available in nominal 48- and 12-inch lengths. Effective screen lengths for the 48- and 12-inch PVC screens are 48 inches (1219 mm) and 12 inches (305 mm), while 48- and 12-inch stainless steel screens have effective screen lengths of 43 inches (1092 mm) and 14 inches (356 mm) respectively. Both types of screens are recovered with the tool string after sampling.

The SP22 PVC Screen Head Adapter (37871) provides yet another screen option for the SP22 sampler. Using this adapter, a section of slotted 0.75-inch Schedule 40 PVC pipe may be lowered through the 2.25-inch probe rods using a string of fiush-threaded 0.75-inch Schedule 40 PVC Riser. An SP22 PVC Screen Plug (38968) is installed in the leading end of the slotted pipe prior to use. The slotted pipe may be cut and the screen plug installed to provide custom screen lengths .

An O-ring is located at the top of each stainless screen and on the screen adapters. When a screen is deployed, this O-ring maintains a seal between the top of the screen and the inner wall of the probe rods or expendable point holder as indicated in Figure 2.1. As a result, any liquid entering the tool string must first pass through the screen.

Screens are constructed such that equipment can be inserted into the screen cavity for sample collection as noted in the following section and illustrated in Figure 2.1, Step 4. This makes direct sampling possible from anywhere within the saturated zone.

The inner rod string and screen are generally removed prior to grouting through the 2.25-inch rod string as shown in Figure 2.1, Steps 5-6. However, a removable plug in the lower end of the screens allows for grouting through fiexible tubing extending out the bottom of the screen as with the Geoprobe® SP15/16 Groundwater Samplers if desired.

Sample Collection
Groundwater samples can be obtained from the SP22 screen in a number of ways. A common method utilizes 0.375-inch OD polyethylene (TB25L) or Tefion® (TB25T) tubing and a check valve assembly. The check valve (with check ball) is attached to one end of the tubing and inserted down the casing until it is immersed in groundwater. Water is then pumped through the tubing and to the ground surface by oscillating the tubing up and down.

An SP22 Check Valve Assembly (37893) is recommended if sampling through 1.25-inch light-weight center rods. The SP22 Check Valve Assembly is approximately 20 inches long to enable it to pass through the stepped diameters at each rod joint that may cause problems for other, shorter check valves.

An alternative means of collecting groundwater samples is to attach a peristaltic or vacuum pump to tubing that is inserted through the inner rods to within the SP22 screen. This method is limited in that water can be pumped to the surface from a maximum depth of approximately 26 feet (8 m). Another technique for groundwater sampling is to use a stainless steel Mini-Bailer Assembly (GW41). The mini-bailer is lowered down the inside of the casing below the water level where it fills with water and is then retrieved from the casing.

The latest option for collecting groundwater from the SP22 Sampler is to utilize a Geoprobe® MB470 Series Mechanical Bladder Pump (MBP)*. The MBP may be used to meet requirements of the low-fiow sampling protocol (Puls and Barcelona 1996, ASTM 2003). Through participation in a U.S. EPA Environmental Technology Verification study, it was confirmed that the MB470 can provide representative samples (EPA 2003).

**The Mechanical Bladder Pump is manufactured under U.S. Patent No. 6,877,965 issued April 12, 2005.*

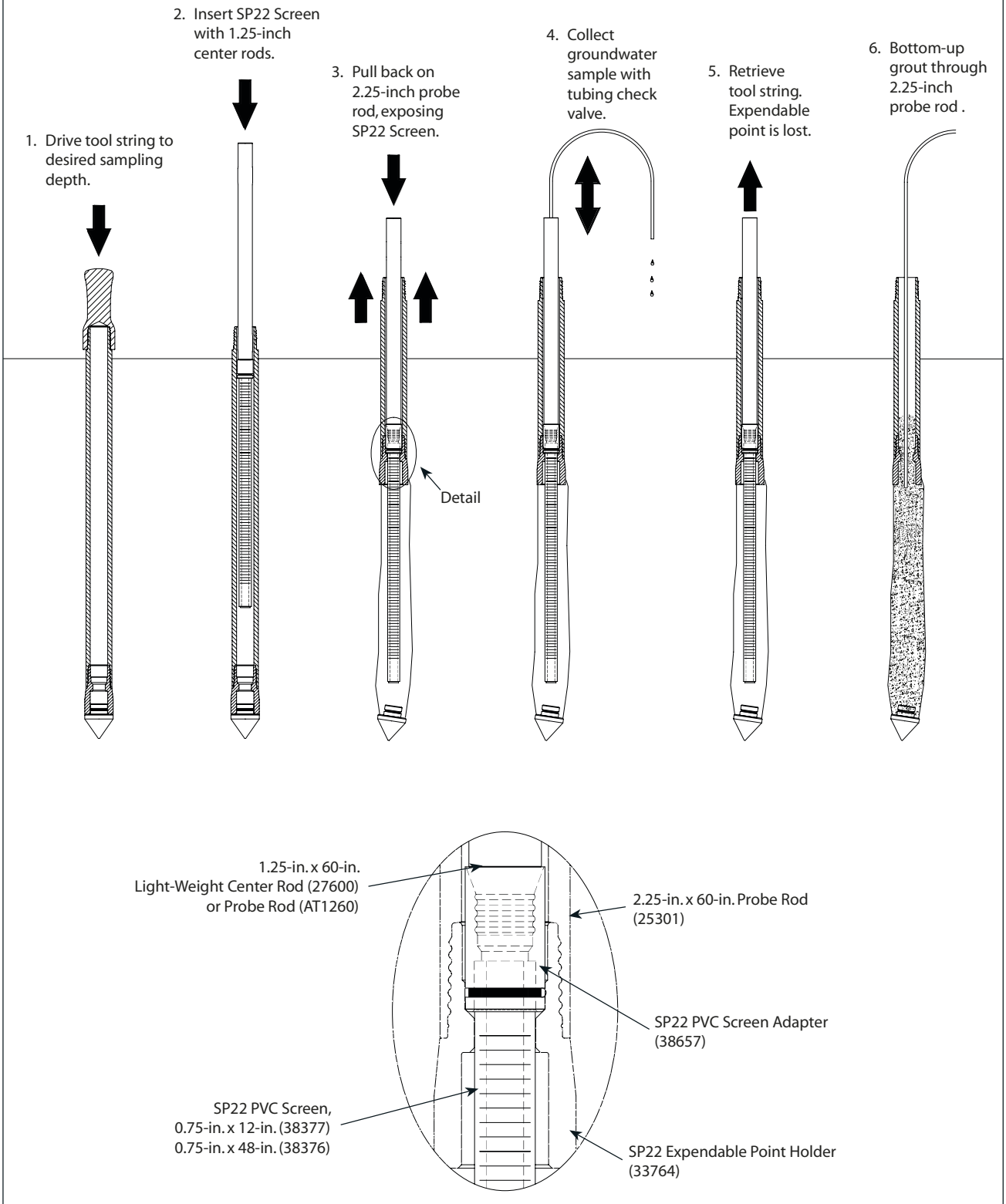
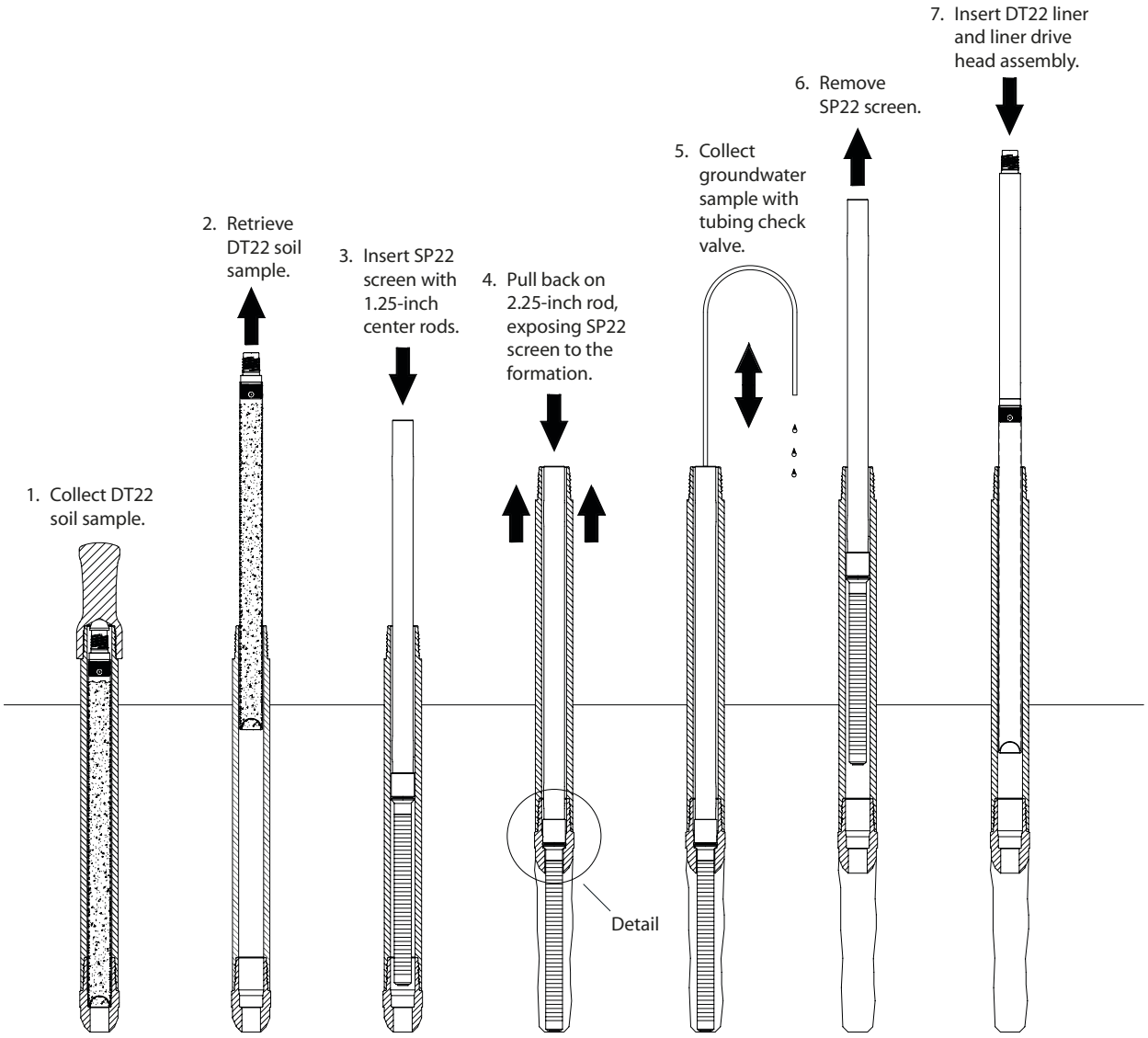


FIGURE 2.1
Screen Point 22 Groundwater Sampler - 0.75-inch PVC Screen Option



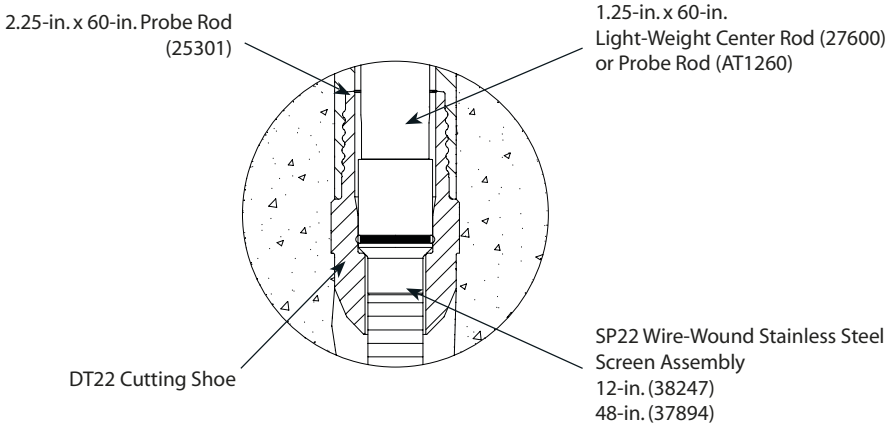


FIGURE 2.2
Screen Point 22 Groundwater Sampler Operation with DT22 Sampling System

3.0 TOOLS AND EQUIPMENT

The following tools and equipment can be used to successfully recover representative groundwater samples with the Geoprobe® Screen Point 22 Groundwater Sampler. Refer to Figures 3.1 and 3.2 for identification of the specified parts. Tools are listed below for the most common SP22 / 2.25-inch probe rod configurations. Additional rod sizes and accessories are available. Contact Geoprobe Systems® for information regarding tools and equipment options.

SP22 Sampler Parts	**Part Number**
SP22 Screen, Wire-Wound Stainless Steel, 4-Slot (48-in.)	37894
SP22 Screen, Wire-Wound Stainless Steel, 4-Slot (12-in.)	38247
Grout Plugs, PE (Pkg. of 25)	GW1552K
SP22 Screen, PVC, 10-Slot, 0.75-in. x 48-in	38376
SP22 Screen, PVC, 10-Slot, 0.75-in. x 48-inch, Kit (includes 2 each of 38376 and 38429)	*38664*
SP22 Screen, PVC, 10-Slot, 0.75-in. x 12-in	38377
SP22 Screen, PVC, 10-Slot 0.75-in. x 12-in., Kit (includes 2 each of 38377 and 38429)	*38667*
SP22 PVC Screen Plug	38968
SP22 PVC Screen Plug Kit (includes 10 of 38968)	*38530*
SP22 PVC Screen Adapter, 0.75-in. PVC x 1.25-in. Probe Rod Box	38657
SP22 PVC Screen Head Adapter, 0.75-in. (for fiush-threaded 0.75-in. Schedule 40 PVC)	37871
SP22 O-ring Kit (Pkg. of 10 O-rings for SP22 PVC screen adapters and stainless steel screens)	37853
O-rings, 0.75-in. PVC Riser (Pkg. of 25)	GW4401R
SP22 Expendable Point Holder, 2.25-in. Probe Rods, AT2045K and 19442 Points	33764
SP22 Expendable Point Holder, 2.25-in. Probe Rods, GW1555 Points*	43128

Outer Casing (2.125-inch Probe Rods) and Inner Rod String	**Part Number**
Probe Rod, 2.25-in. x 60-in.	25301
Expendable Drive Points, Steel, 2.45-in. OD (Pkg. of 25)	AT2015K
Expendable Drive Points, Steel, 2.45-in. OD, extended shank	19442
Expendable Points, steel, 1.625-in. OD (Pkg. of 25)*	GW1555K
Drive Cap, 2.25-in. Probe Rods, Threadless, (for GH60 and GH80 Series Hammers)	31530
O-Rings, 2.25-in. Probe Rods (Pkg. of 25)	AT2100R
Rod Grip Handle, 2.25-in. Probe Rods, (for GH60 and GH80 Series Hammers)	29385
Light-Weight Center Rod, 1.25-in. x 60-in.	27600
Probe Rod, 1.25-in. x 60-in.	AT1260
O-ring, 1.25-in. rods (Pkg. of 25)	AT1250R
Rod Grip Handle, 1.25/1.5-in. Rods, (for GH60 and GH80 Series Hammers)	15554
PVC Riser, 0.75-in. Schedule 40 x 60-inch	11747
PVC Pipe, 0.75-in. Schedule 40 x 60-inch, 10-Slot	17474

Grout Accessories	**Part Number**
High-Pressure Nylon Tubing, 0.375-in. OD / 0.25-in. ID, 100-ft. (30 m)	11633
Grout Machine, Auxiliary-Powered	GS2200
Grout System Accessories Package, 2.25-in. rods	GS1015

Groundwater Purging and Sampling Accessories	**Part Number**
Polyethylene Tubing, 0.375-in. OD, 500 ft	TB25L
Check Valve Assembly, 0.375-in. OD Tubing x 20 in. Long	37893
Water Level Meter, 0.438-in. OD Probe, 100 ft. cable	GW2000
Mechanical Bladder Pump**	MB470
Mini Bailer Assembly, Stainless Steel	GW41

* Not for use with GH80 Series Hydraulic Hammers

** Refer to the Standard Operating Procedure (SOP) for the Mechanical Bladder Pump (Technical Bulletin No. MK3013) for additional tooling needs.

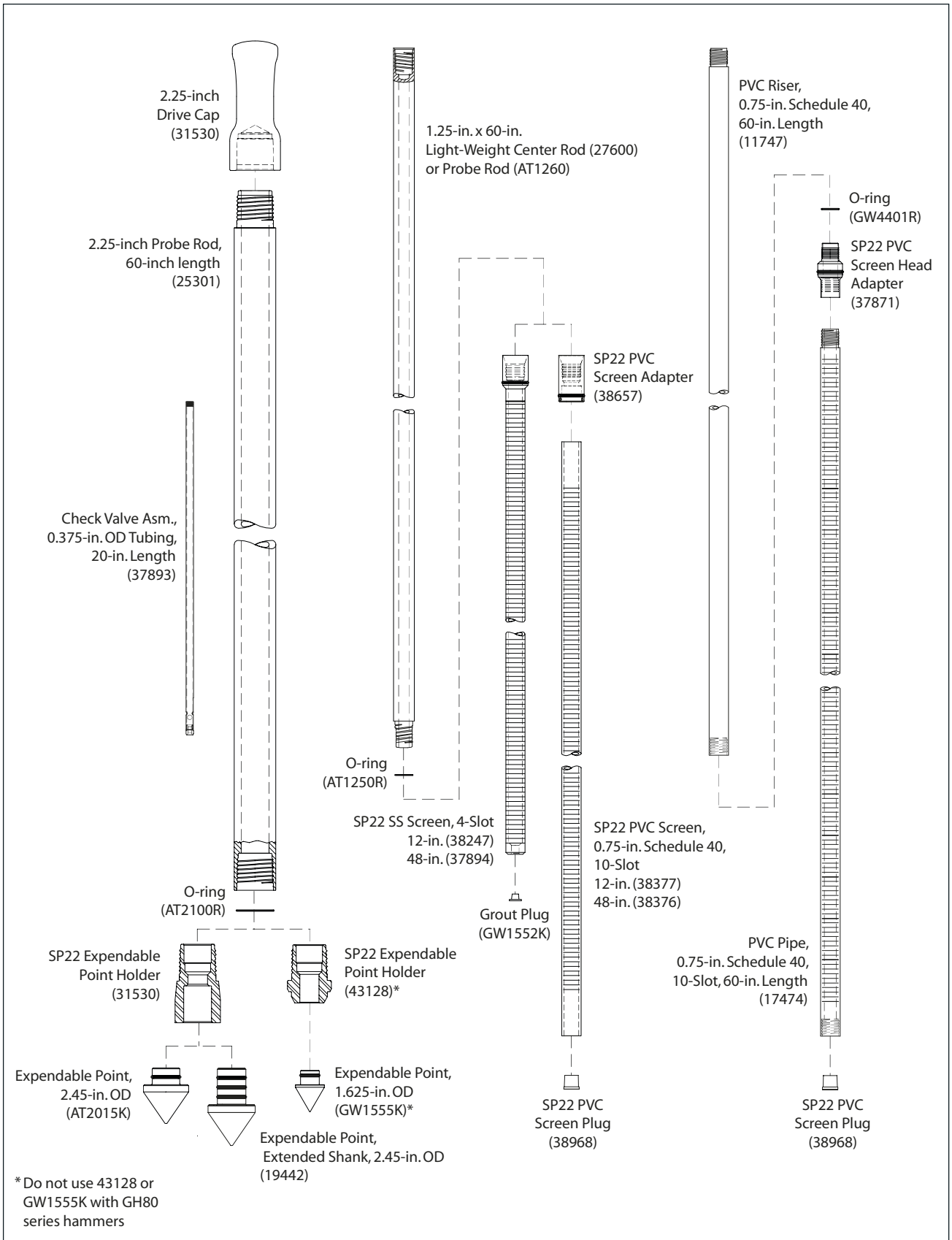


FIGURE 3.1
SP22 Sampler Parts

4.0 OPERATION

4.1 Basic Operation

The SP22 Sampler utilizes a stainless steel or PVC screen which is lowered (post-run) through an alloy steel 2.25-inch OD probe rod tool string. An expendable drive point is placed in an expendable point holder on the leading 2.25-inch probe rod prior to advancement (Fig. 4.1). This expendable point is removed and stays in the subsurface as the rods are pulled back to exposes the SP22 screen. O-rings on the probe rods , the expendable point holder, and the expendable drive point provide a watertight tool string which keeps contaminants out of the system as the 2.25-inch rods are driven to depth in preparation for installation of the SP22 screen.

Once the sampling interval is reached with the 2.25-inch probe rods, the stainless steel or PVC screen is lowered through the rods using 1.25-inch probe rods, 1.25-inch light-weight center rods, or 0.75-inch PVC riser pipe. The 2.25-inch tool string is then retracted while the screen is held in place with the inner rods or riser. The system is now ready for groundwater sampling. When sampling is complete, the inner rods and screen are removed for grouting during retrieval or the 2.25-inch rods. Alternatively, a removable plug is located in the bottom of the screens to allow grouting directly through the inner tool string with high-pressure tubing during retrieval.

4.2 Decontamination

In order to collect representative groundwater samples, all sampler parts must be thoroughly cleaned before and after each use. Scrub all metal parts using a stiff brush and a nonphosphate soap solution. Steam cleaning may be substituted for hand-washing if available. Rinse with distilled water and allow to air-dry before assembly.

4.3 Lead Rod Assembly (Fig. 4.1)

1. Place an O-ring on the expendable point holder.
2. Thread expendable point holder into the 2.25-inch probe rod.
3. Place an O-ring on a steel expendable drive point.
4. Firmly seat the expendable point in the expendable point holder.
5. Place 2.25-inch Drive Cap (31530) on the top of the 2.25-inch probe rod. The lead rod assembly is now ready to be driven to depth.

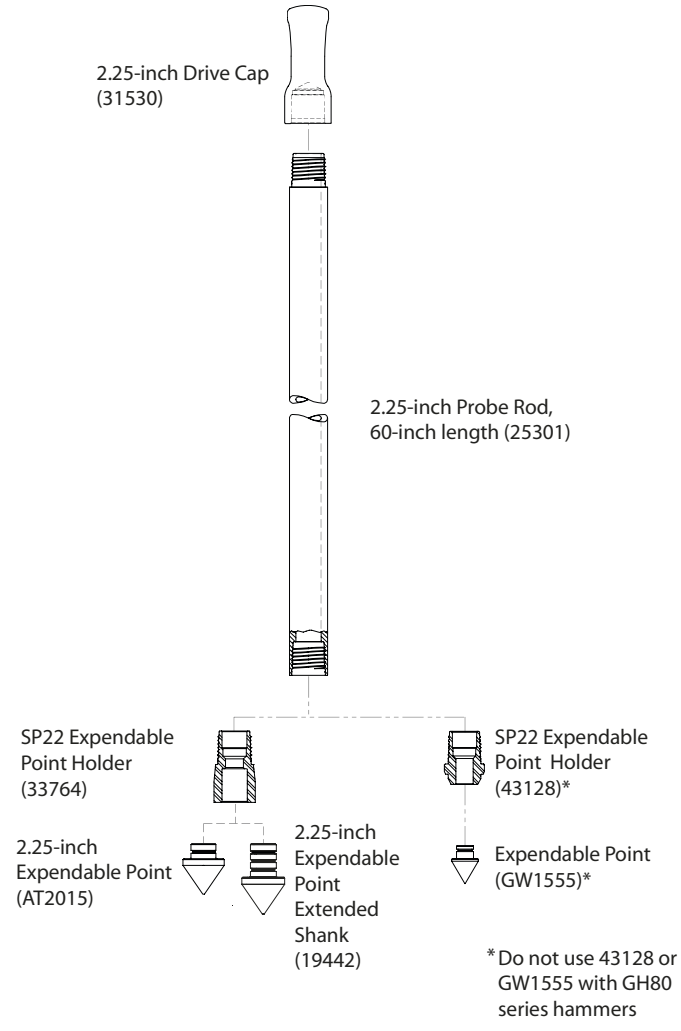


FIGURE 4.1
Lead Rod Assembly for the SP22 Groundwater Sampler

4.4 Advancing the Tool String (Fig. 4.2, step 1)

To provide adequate room for screen deployment with the Rod Grip Pull System, the probe derrick should be extended a little over halfway out of the carrier vehicle when positioning for operation.

1. Drive first 2.25-inch probe rod (as assembled in section 4.3).

2. Advance the tool string at a slow speed for the first few feet to ensure that the string is aligned properly.

3. Completely raise the hammer assembly. Remove the drive cap and place an O-ring in the top groove of the driven probe rod. Distilled water may be used to lubricate the O-ring if needed.

Add a probe rod (length to be determined by operator) and reattach the drive cap to the rod string. Drive the tool string the entire length of the new rod.

4. Repeat Step 3 until the desired sampling interval is reached. Approximately 12 inches (305 mm) of the last probe rod must extend above the ground surface to allow attachment of the puller assembly. A 12-inch (305 mm) rod may be added if the tool string is over-driven.

5. Remove the drive cap and retract the probe derrick away from the tool string.

4.5 Screen Deployment (Fig 4.2, step 2 - 4)

1. Attach an SP22 stainless steel or PVC screen to a 1.25-inch probe rod, 1.25-inch light-weight center rod, or 0.75-inch fiush-thread PVC riser using an SP22 PVC Screen Adapter (38657) or SP22 PVC Screen Head Adapter (37871) as shown in Figure 3.1. Note that the 38657 screen adapter is connected to the SP22 PVC screen using the setscrews provided with the adapter.

and lower it into the driven casing.

2. Lower the screen into the 2.25-inch probe rod casing and add rods or riser until the screen head contacts the bottom of the tool string.

3. Ensure that at least 48 inches (1219 mm) of rods or riser protrudes from the top 2.25-inch probe rod.

4. Maneuver the probe assembly into position for pulling.

5. Raise (pull) the outer 2.25-inch tool string while physically holding the screen in place with the inner 1.25-inch rods or 0.75-inch riser. A slight knock with the inner tool string will help to dislodge the expendable point and start the screen moving inside the probe rod.

Raise the hammer and outer tool string to expose the desired length of screen. The inner rods will begin raising with the outer rods when the screen adapter contacts the necked portion of the expendable point holder or DT22 Cutting Shoe. Use care when deploying a PVC screen so as not to break the screen when it contacts the expendable point.

6. Remove the rod grip handle, lower the hammer assembly, and retract the probe derrick. Remove the top 2.25-inch probe rod.

7. Groundwater samples can now be collected with a mini-bailer, peristaltic or vacuum pump, tubing bottom check valve assembly, bladder pump, or other acceptable small diameter sampling device.

When inserting tubing or a bladder pump down the rod string, ensure that it enters the screen interval. The leading end of the tubing or bladder pump will sometimes catch at the screen head giving the illusion that the bottom of the screen has been reached. An up-and-down motion combined with rotation helps move the tubing or bladder pump past the lip and into the screen.

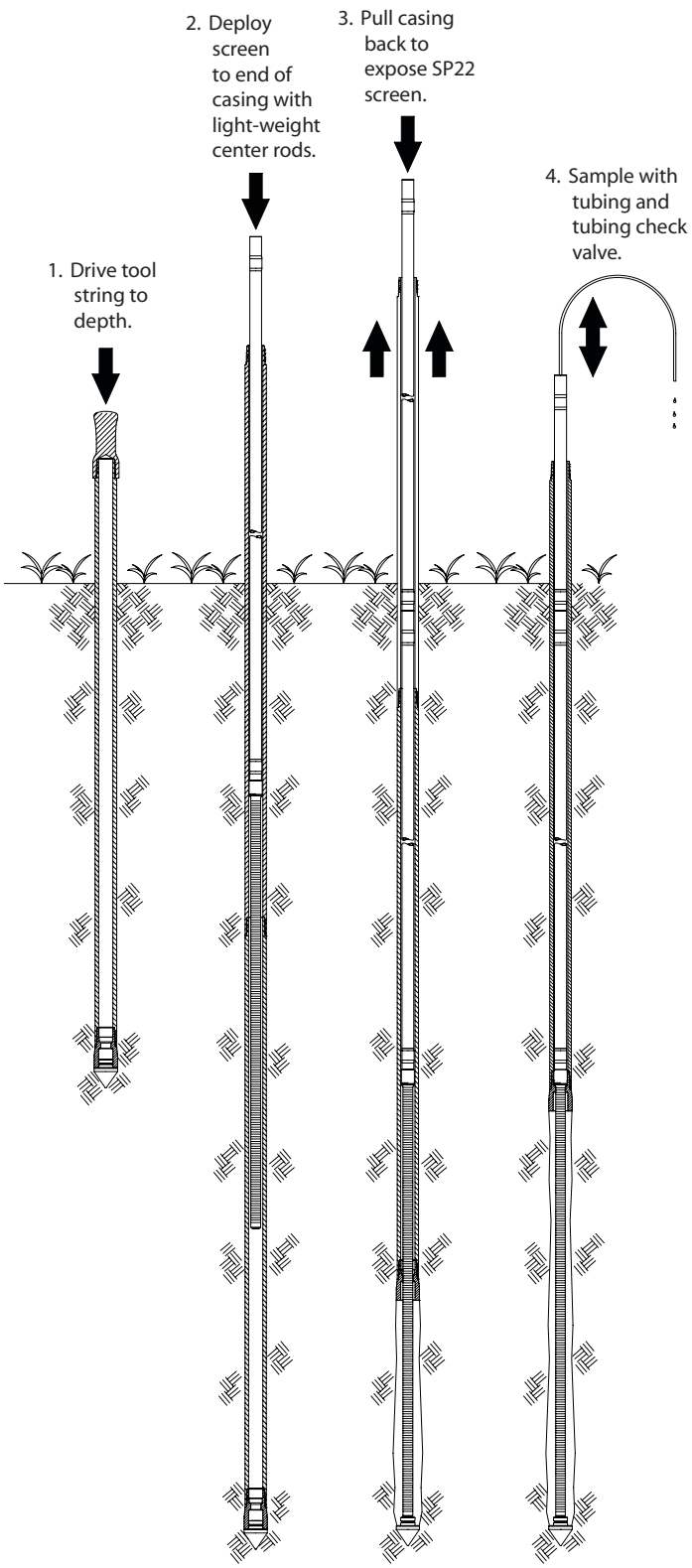


FIGURE 4.2
Screen Deployment for SP22 Sampler

4.6 Abandonment Grouting for SP22 Screens

The SP22 Sampler can meet ASTM D 5299 requirements for abandoning environmental wells or borings when grouting is conducted properly. A removable grout plug makes it possible to deploy tubing through the bottom of the SP22 screens, but the easiest method is to remove the inner string of rods; including the SP22 screen. A Grout Machine is then used to pump grout into the open probe hole as the outer casing is withdrawn. The following procedure is presented as an example only and should be modified to satisfy local abandonment grouting regulations. (Figure 4.3)

1. Maneuver the probe assembly into position for pulling.

2. High-Pressure Nylon Tubing (11633) is inserted down through the probe rods through the bottom of the expendable point holder (Fig. 4.3).

   Note: *All probe rods remain strung on the tubing as the tool string is pulled. Provide extra tubing length to allow sufficient room to lay the rods on the ground as they are removed. An additional 20 feet is generally enough.*

3. Operate the grout pump while pulling the first rod with the rod grip pull system. Coordinate pumping and pulling rates so that grout fills the void left by the sampler. After pulling the first rod, release the rod grip handle, fully lower the hammer, and regrip the tool string. Unthread the top probe and slide it over the tubing placing it on the ground near the end of the tubing.

4. Repeat Step 5 until the tool string is retrieved. Do not bend or kink the tubing when pulling and laying out the probe rods. Sharp bends create weak spots in the tubing which may burst when pumping grout. Remember to operate the grout pump only when pulling the rod string. The probe hole is thus filled with grout from the bottom up as the rods are extracted.

5. Promptly clean all probe rods and sampler parts before the grout sets up and clogs the equipment.

4.7 Retrieving the Screen Point 22 Sampler

If grouting is not required, the Screen Point 22 Sampler can be retrieved by pulling the probe rods as with most other Geoprobe® applications. The Rod Grip Pull System should be used for this process as it allows the operator to remove rods without completely releasing the tool string. This avoids having the probe rods fall back downhole when released during the pulling procedure. A standard Pull Cap (33622) may still be used if preferred. Refer to the Owner's Manual for your Geoprobe® direct push machine for specific instructions on pulling the tool string.

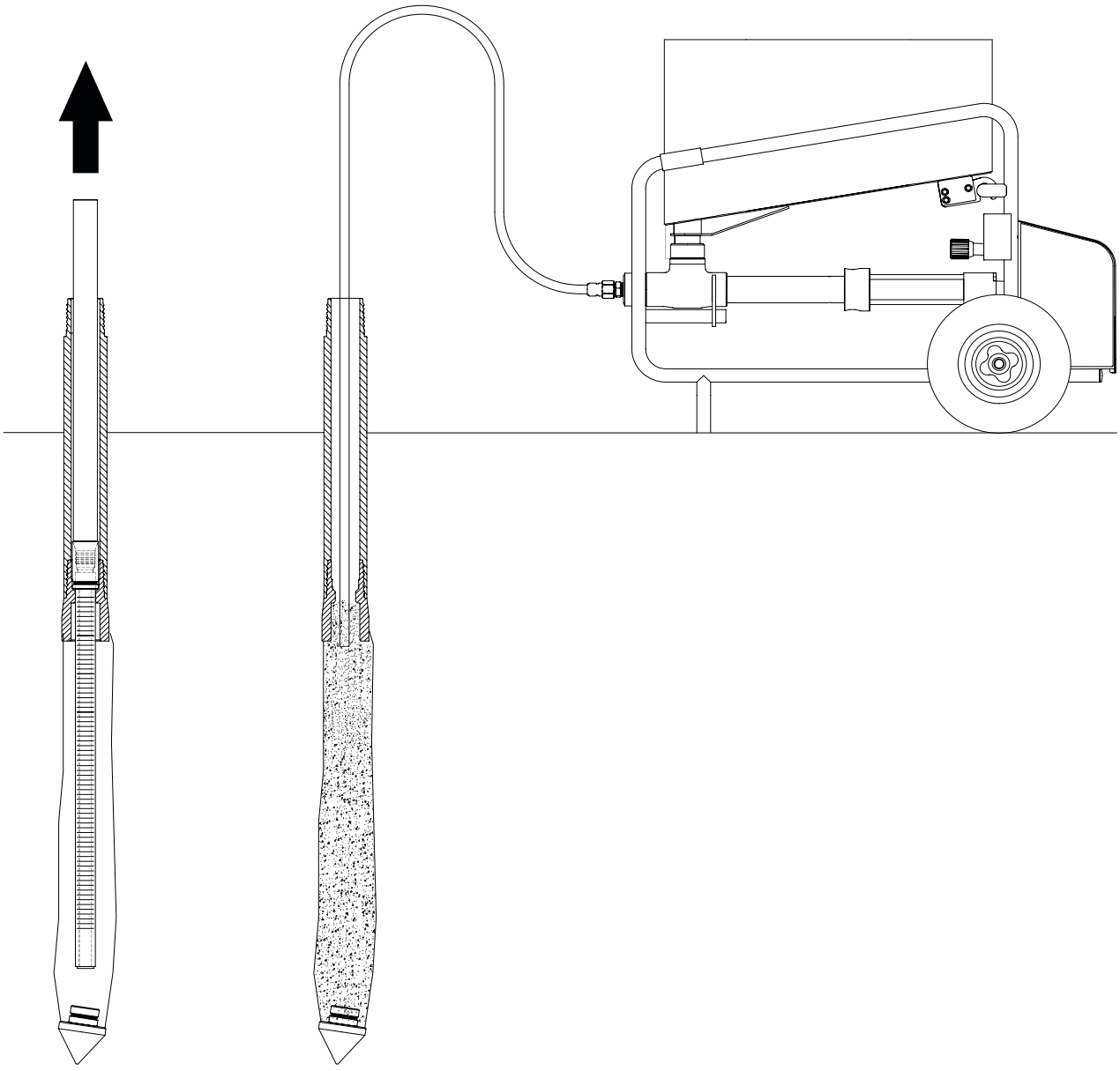


FIGURE 4.3
Abandonment Grouting for the SP22 Sampler

5.0 REFERENCES

American Society of Testing and Materials (ASTM), 2003. D6771-02 Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations. ASTM, West Conshocken, PA. (www.astm.org)

American Society of Testing and Materials (ASTM), 1993. ASTM 5299 *Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.* ASTM West Conshohocken, PA. (www.astm.org)

Geoprobe Systems®, 2003, *Tools Catalog, V.6.*

Geoprobe Systems®, 2006, *Model MB470 Mechanical Bladder Pump Standard Operating Procedure (SOP), Technical Bulletin No. MK3013.*

Puls, Robert W., and Michael J. Barcelona, 1996. Ground Water Issue: Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures. EPA/540/S-95/504. April.

U.S. Environmental Protection Agency (EPA), 2003. Environmental Technology Verification Report: Geoprobe Inc., Mechanical Bladder Pump Model MB470. Office of Research and Development, Washington, D.C. EPA/600R-03/086. August.

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems®.

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TGI – Solid Slug Testing

Rev: 7

Rev Date: March 1, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	1				
	2				
	3				
	4	March 5, 2015	All	New TGI template	Everett Fortner Marc Killingstad
	5	April 28, 2022	All	New TGI template; Updates to pneumatic slug testing guidance; Addition of forms	Everett Fortner Marc Killingstad
	6	March 1, 2023	6	Clarification on barometric pressure logger and slug	
	7	March 1, 2022	All	Annual review completed by SME. Document Revision Number and Document Date Updated.	

Approval Signatures

Prepared by: 3/1/2023

Everett H. Fortner III, PG (Preparer) Date

Reviewed by: 3/1/2023

Marc Killingstad, PE (Subject Matter Expert) Date

1 Introduction

Slug testing is a common field method used for estimating hydraulic conductivity. This Technical Guidance Instruction (TGI) document outlines field procedures for conducting such testing using a solid slug.

2 Intended Use and Responsibilities

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3 Scope and Application

The use of a solid slug allows for both falling- and rising-head slug tests to be completed. Solid slug(s) of a known volume are inserted and removed from the water column in a well in a near-instantaneous manner. The water level response is observed using a data-logging pressure transducer with manual measurement backup or using just a manual water level meter for slow recovering wells with fully submerged screens.

4 Personnel Qualifications

Field personnel performing the testing are required to have the following qualifications:

- Sufficient "hands-on" experience necessary to successfully complete the slug test field work. Training requirements for conducting slug tests including the review of this guidance and other applicable documents related to instrumentation.
- Demonstrate familiarity with the electronic data logging equipment (*see TGI – Water-Level Monitoring Using Data Logging Instruments*).
- Completed current health and safety training in accordance with the project health and safety plan (e.g., 40-hour Hazardous Waste Operations training and site-specific training, as appropriate)

5 Equipment List

The following materials will be available, as required, during slug testing using a solid slug:

- Job safety analysis and site Health and Safety Plan
- Related project-specific requirements and plans
- Personal protective equipment, as required by the site Health and Safety Plan
- Solid slug(s) of known volume
- Pressure transducer and barometric pressure logger (if necessary)
- Pressure transducer software
- Laptop computer, smart device (phone or tablet), and/or data transfer device
- Rope or cables (for deep wells) (chemical resistant, low stretch [stainless steel or Kevlar] is optimal)
- Water level meter
- Measuring tape
- Spring-loaded clamps and zip ties
- Decontamination equipment
- Slug test field form (paper or digital)
- Field tablet and/or daily logs
- Waterproof marker

6 Cautions

- Pressure Transducers/Data Loggers (see TGI – Water-Level Monitoring Using Data Logging Instruments)
    - Ensure that all rental instruments and tapes have been calibrated and checked prior to use.
    - Small-diameter pressure transducers (typically 0.5 to 0.75 in) are available that cover a range of pressures. Install the pressure transducer at a reasonable distance below (approximately 3 to 5 feet) the targeted drawdown estimated for the well to prevent noise. Do not install the pressure transducer closer than 6 inches from the base of the well to eliminate the possibility of fouling the transducer with material accumulated at the bottom of the well. To prevent pressure transducer malfunction or damage, do not submerge pressure transducers in excess of the operating range, and do not insert objects in the sensor opening.

- For vented pressure transducers/data loggers, test functionality with a field test of readings using a bucket or barrel filled with water. Submerge the pressure transducer, accurately measure the water head above the pressure transducer sensor and compare the measurement to the reading. If the measurements don't generally agree, there may be an issue with the instrument.
- Non-vented transducers, which record a combined pressure of barometric and the water column above the pressure transducer, can be tested in the same fashion as the vented pressure transducer (outlined above). The water column above the pressure transducer can be checked by subtracting out current atmospheric pressure.
- In general, when testing the pressure transducers, check the pressure transducer general response to changing heads by raising the pressure transducer a certain distance, observing the change in head, and then measuring the distance manually. Additionally, water level meters will be in good working condition and calibrated to true depth and ensuring that there are no breaks or splices in the cable.
- Pressure transducers will be set in the well at least 15 minutes prior to testing to allow to the instrument to thermally equilibrate with groundwater, collect static water-level measurements, and ensure that the pressure transducer cable will not stretch during testing.
- Logarithmic or head-change settings will not be used to log data, only linear.
- Prior to testing, secure pressure transducer cables at the wellhead to prevent movement that may affect measurements. Mark a reference point, such as masking tape, on the down-hole transducer cable or securing line and check regularly to detect slippage.
- A barometric pressure transducer will be utilized, regardless of in-well pressure transducer type (vented or non-vented) if a slug test is expected to take more than four hours for full recovery. Barometric trends in long-term data sets may need to be evaluated or removed from the data set.

- Data Management
  - Data management is critical to prevent any loss. Use caution not to overwrite any previously recorded files and remember, data backup is always necessary. Multiple tests at the same well do not require for the pressure transducer to be reset and the same log can run throughout the duration of all tests. Upload data collected via smart device by email or cloud server to reduce the risk of data loss (e.g., computer failure).
- Slug Volume
  - Solid slugs will be calibrated to determine their accurate volume(s) for theoretical displacement. In most cases, rental slugs offer economic and data quality benefits over field-built slugs. The length and diameter of the solid slug will be measured in the field and noted in the field logs to accurately estimate theoretical displacement.
- Initial Displacement and Recovery
  - When performing slug tests, the general rule of thumb for initial displacement is between 1 and 3 feet and/or generally less than 25% of the effective screen length. For high conductivity formations, initial displacements will be small (0.3 – 0.7 ft) to avoid remobilizing fines and to limit turbulence.
  - Water levels will need to be recorded to within 80% to 95% recovery. In addition, duplicate tests will be completed only after the first test has recovered by at least 95%.

- Equipment Care
    - Keep sensitive electronic equipment away from devices that generate significant magnetic fields. For example, do not place pressure transducers near electric power generators or electric pump motors. Likewise, radio signals may cause pressure transducers or computers to malfunction.
- Decontamination
    - Make sure all equipment that enters the test well (slug, water-level meter, pressure transducer) is decontaminated before use. If testing multiple wells, start with the least contaminated and progress to the most contaminated.
- Non-Aqueous Phase Liquids (NAPL)
    - Slug tests are not recommended in wells where Non-Aqueous Phase Liquids are present. Consult TKI Aquifer Testing and Characterization Focus Group lead for guidance.

7 Health and Safety Considerations

The site-specific HASP will be used to ensure that the tests are conducted in a safe manner and will include a Job Safety Analysis (JSA). The following specific health and safety issues will be considered when conducting slug tests:

- Appropriate PPE with minimum of Level D will be worn to avoid contact with site chemicals of concern during slug test.
- Well covers will be carefully removed to avoid potential contact with insects or animals. Well caps will be vented or tethered to avoid potential eye injury in case of gas buildup in the well.

8 Procedure

1. Decontaminate all down-well equipment: pressure transducer and cable, slug(s), rope or cable, water level meter in accordance with project specific requirements. In general, wells will be tested from least contaminated to more contaminated, if possible or applicable.
2. Select a solid slug according to a target initial displacement using the table below. A general guideline is that initial displacements are between 1 and 3 feet, but will depend on the anticipated response (i.e., smaller initial displacements will be chosen for formations with high hydraulic conductivity). When utilizing the FieldNow® – Slug Test Field Log, the bailer size and length and the well diameter can be entered, and a theoretical displacement will be automatically calculated.
3. Measure depth to water and well total depth. Determine the water column length.
    a. Multiple depth to waters will be measured and any trends will be noted.
    b. The "static" depth to water will be representative of the water level after the well equalizes with atmosphere.
4. Review the well construction log to determine screened interval and confirm depth to bottom. If discrepancies exist, consult with project hydrogeologist.
5. Program the pressure transducer to record water levels at the following suggested frequencies. Note that the lithologic descriptions and datalogger memory will be used to select the highest measurement frequency possible.

a. In hydrogeologic settings where high hydraulic conductivity is expected, water levels will be measured at 0.5-second intervals or the highest frequency available. This measurement frequency will be selected for gravels and sands.
b. In hydrogeologic settings where low hydraulic conductivity is expected, water levels may be measured at 1-second intervals. This measurement frequency will be selected for silts and clays.

6. If applicable, program the barometric pressure logger to record barometric pressure. The logger will be placed in the headspace of an adjacent well, or on grade, adjacent to the well being tested and kept protected from the elements (e.g., rain or sun)
7. Install the pressure transducer deep enough within the water column to not interfere with the testing equipment. Ideally the transducer will be 3 to 5 feet lower than the maximum depth of the slug testing equipment not closer than 6 inches above the well bottom. Remember to use measurements and not the well bottom as silt can clog the pressure transducer sensor. Secure the pressure transducer cable to the well casing or other static object.
8. View the measured water level in real time. Wait for the water levels to stabilize. Note that the temperature of the pressure transducer will require to equilibrate to groundwater temperatures to ensure accurate water-level measurements (at least 15 minutes).
9. After static measurements and equilibration (15 minutes), re-measure the depth to water.
10. Measure the slug and rope assembly length and mark the rope at a length as follows:

    Rope Mark #1 = Depth to Potentiometric Surface from TOC

    Rope Mark #2 = Depth to Potentiometric Surface from TOC + Length of Slug + Safety Factor (Safety Factor = 10% of the Length of Slug)

    When deployed, Rope Mark #2 will be at the well top of casing, and the slug will be totally submerged. If insufficient water column is available to cover the slug assembly top, note the theoretical length of the slug to be inserted into the water column. Upon removal, measure the wet slug length.
11. Slowly insert the slug assembly into the well and stop just above the potentiometric surface Rope Mark #1.
12. With slack in the rope and the slug being suspended above the water column, place the Rope Mark #2 at the top of casing. Clamp the non-slug end of the rope to a static object.
13. Quickly drop the slug into the water column.
14. Observe the water level response on the laptop computer and/or measure depth to water, being careful not to interfere with the pressure transducer cable. Several manual depth to water measurements will be made throughout the test (typically 2 to 3 in the first 30 seconds to 1 minute, one reading a minute for the next 5 to 10 minutes, and every 2 to 5 minutes thereafter). If the water level meter is used as the primary measurement technique, the measurement frequency will need to be increased as practicable.
15. Allow sufficient time for water level to recover to static level. If completing one test (just a falling head test or just a rising head test), then 80% recovery is sufficient. Duplicate tests are highly recommended, and the next test will be completed after the first test has recovered to greater than 95%. A third test at a displacement of twice the initial is recommended.

    Percent Recovery=((current displacement)/(maximum displacement))*100

    This calculation can be used to determine the depth to water that will be needed before conducting a duplicate test. For example, if your theoretical maximum displacement is 1.92 ft and 95% recovery is needed then 1.82 feet of recovery is necessary to conduct a duplicate test which means the depth to water or be less than or equal to 0.10 feet below the static water level.

16. Quickly remove the slug assembly from the water column. The slug assembly will be left in the well above the static water level in order to limit pressure cable disturbance until the testing is complete and the water levels have equilibrated to the target level.
17. Repeat both the falling- and rising-head slug tests for data reproducibility by repeating steps 12 and 13, if applicable. If possible, complete a third test with a slug or combination of slugs that equates to twice or half the volume as the original.
18. Save all data files to the laptop and finalize any field notes.
19. Review the data collected to determine the reasonableness of the preliminary results and compare the pressure transducer results to the water level meter results. The observation of apparently anomalous results will be discussed with senior project staff prior to additional testing or leaving the field site. The water level record for each test will show static conditions, the insertion or removal of the slug(s), and the water level response. Make notes on the field form and notebook concerning any irregularities.
20. Decontaminate all down-well equipment in accordance with project plans.

9 Waste Management

Rinse water, PPE, and other waste materials generated during equipment decontamination will be placed in appropriate containers and labeled. Containerized waste will be disposed of, consistent with appropriate waste management procedures for investigation-derived waste.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Field personnel will complete a Slug Test Field Log form for each test. The digital field form is available through the FieldNow® Application titled *FieldNow – Slug Test Field Log*. A hardcopy example is included in the attachments. As previously noted, it is generally recommended to conduct three tests per well (the original displacement, a duplicate, and double original displacement); therefore, one field log will be completed for each test. Multiple tests can be entered into the FieldNow® digital application for each well tested. Field equipment calibration, decontamination activities, and waste management activities will be recorded in the daily field log. Data that has been collected must be transmitted at the end of the day (notes/forms/data file). The files must be transmitted to the appropriate project file storage at the end of each day (via direct transfer or email to data manager). Work completed that day and any relevant observations noted during the daily activities as well as copies of the data mentioned above should be summarized and provided in an email. The appropriate team member will review the data for accuracy and provide feedback.

11 Quality Assurance

Review data collected during field testing to determine reasonableness/quality given site-specific conditions. Again, this can also be completed using the transducer in real-time viewing mode as the test progresses and resulting charts to confirm with project hydrogeologist. Compare the theoretical head displacement calculated from the slug volume or pressure to the observed displacement. If the data are questionable, the field equipment will need to be checked to confirm proper working order and the test may be repeated, if possible. Consult with the project hydrogeologist to work through issues encountered in the field and to help determine test validity. Any issues that may affect the data will be recorded in the daily field log for consideration by the project hydrogeologist.

12 References

Butler, J.J., Jr., 2019. The Design, Performance, and Analysis of Slug Tests (2nd Ed), CRC Press, Boca Raton, 280p.

Butler, J.J. Jr., 2020. Slug Test Strategies for Challenging Conditions. Presentation – Midwest Geosciences Webinar. December.

Kruseman, G.P. and N.A. de Ridder, 1994. Analysis and Evaluation of Pumping Test Data (2nd ed.), Publication 47, Intern. Inst. for Land Reclamation and Improvement, Wageningen, The Netherlands, 370p.

TGI – Soil Drilling and Sample Collection

Rev: #3

Rev Date: April 5, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 11, 2018	All	Updated and re-written as a TGI	Marc Killingstad
	1	May 12, 2020	None	Review – no changes necessary	Marc Killingstad
	2	April 8, 2022	All	Updated to new format and minor content (e.g., PFAS)	Chris Shepherd/Marc Killingstad
	3	April 5, 2023	All	Annual review completed by Marc Killingstad. Updated document revision number, document date; version control and signature page.	Marc Killingstad

Approval Signatures

Prepared by: 4/5/2023

Chris Shepherd (Preparer) Date

Reviewed by: 4/5/2023

Marc Killingstad (Subject Matter Expert) Date

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This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

This Technical Guidance Instruction (TGI) describes general drilling procedures and the methods to be used to field screen and collect soil samples for laboratory analysis in unconsolidated or weakly consolidated sediments. For soil description procedures, please refer to the *TGI - Soil Description*. For monitoring well installation in granular aquifers, please refer to the *TGI - Monitoring Well Installation*. For per- and polyfluoroalkyl substances (PFASs) drilling and soil sampling procedures, please refer to: *TGI – PFAS-Specific Drilling and Monitoring Well Installation, TGI – Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide*, and *TGI – Equipment and Reagent Blank Sample Collection for PFAS Analysis*.

Overburden (unconsolidated sediments) drilling is commonly performed using the hollow-stem auger drilling method. Other drilling methods suitable for overburden drilling, which are sometimes necessary due to site-specific geologic conditions, include: direct-push, drive-and-wash, spun casing, rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary with core barrel or roller bit. Direct-push techniques (e.g., Geoprobe or cone penetrometer) and hand tools may also be used. Drilling within consolidated materials such as fractured rock is commonly performed using water-rotary (coring or tri-cone roller bit), air rotary or rotasonic methods. For guidance when drilling in consolidated materials (i.e., bedrock), please refer to *the TGI – Bedrock Core Collection and Description.*

The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling depths, targeted chemicals, site or regional geologic knowledge, types of sampling to be conducted, required sample quality and volume, and cost.

Field screening of soil samples is commonly performed using a photoionization detector (PID) and/or a flame ionization detector (FID). These instruments are used to measure relative concentrations of volatile organic compounds (VOCs) for the selection of samples for further laboratory or field analysis. Field screening for dense non-aqueous phase liquids (DNAPL) may be performed using hydrophobic dye (Oil Red O or Sudan IV), which is pertinent at chlorinated solvent sites.

Collection of soil samples for laboratory analysis may be performed using a variety of techniques including grab samples, undisturbed cores, and composite or homogenized samples. Samples may require homogenization across a given depth interval, or several discrete grabs (usually five) may be combined into a composite sample. Samples for VOC analysis will not be homogenized or composited and are collected as discrete grab samples.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). Some lubricants (e.g., vegetable oil-based lubricants) may be acceptable, if the constituents won't interfere with the analyses.

4 Personnel Qualifications

Arcadis field personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or state/federal regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid,

cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, Arcadis field personnel will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP), Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Personnel responsible for overseeing drilling operations will have at least 16 hours of prior training overseeing drilling activities with an experienced geologist, environmental scientist, or engineer with at least 2 years of prior experience.

Arcadis personnel directing, supervising, or leading soil sampling activities will have a minimum of 1 year of previous environmental soil sampling experience. Field employees with less than 6 months of experience will be accompanied by a supervisor (as described above) to ensure that proper sample collection techniques are employed.

Additionally, the Arcadis field team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

The following materials will be available, as required, during soil boring drilling, field screening, andsampling activities:

- Site-specific HASP and health and safety documents identified in the HASP
- FIP/work plan that includes site map with proposed boring locations, fieldsampling plan (with corresponding depths, sample analyses, sample volume required, and sample holding time), and previous boring logs (as available)
- Appropriate personal protective equipment (PPE), as specified in the HASP
- Including but not limited to disposable chemical resistant gloves and Level D PPE
- Traffic cones, delineators, and caution tape as appropriate for securing the work area as specified in the Traffic Safety Plan (TSP)
- Photoionization detector (PID), flame ionization detector (FID) or other air/soil screening equipment, asneeded, in accordance with the HASP or workplan
- Sampling equipment:
- Drilling equipment required by *ASTM D1586*, when performing split-spoon sampling including clean sample sleeves
- Disposable plastic liners, when drilling with direct-push equipment
- Stainless steel hand auger and stainless-steel spade if using manual methods
- Appropriate soil sampling equipment (e.g., stainless steel spatulas/spoons/bowls, knife)
- Sealable plastic bags (e.g., Ziploc®)

- Air-tight sample containers and 8-oz. glass Mason jars or driller's jars
- Aluminum foil
- Appropriate sample blanks (trip blank supplied by the laboratory), as specified in the FSP
- Soil sample containers and labels (supplied by the laboratory) appropriate for the analytical method(s) with preservative, as needed (parameter-specific)
- Sample labels
- Indelible ink pens
- Engineer's ruler or survey rod
- Plastic sheeting (e.g., Weatherall Visqueen)
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials
- Decontamination equipment (buckets, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels) in accordance with the *TGI for Groundwater and Soil Sampling Equipment Decontamination*
- Forms/notes:
    - Tablet with digital forms, etc., if appropriate
    - Appropriate soil boring log (**Attachment 1**)
    - Chain-of-custody forms
    - Field notebook
    - Digital camera (or smart phone with camera)
- Drums or other containers appropriate for soil and decontamination water, as specified by the site investigation-derived waste (IDW) management plan, and appropriate drum labels

6 Cautions

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service in accordance with the work plan, client requirements, and Arcadis guidance. See appropriate guidance forproper utility clearance protocol. Work will be performed in accordance with the Arcadis *Utility Location and Clearance Health and Safety Standard* and the *Utilities and Structures Checklist* will be completed before beginning any intrusive work.

Prior to beginning field work, the project technical team will ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members. An internal call with the project technical team to review the FIP/work plan scope and objectives is strongly recommended prior to mobilization to ensure that the field work will be effectively and efficiently executed.

Some regulatory agencies have specific requirements regarding borehole abandonment and grout mixtures. Determine whether the oversight agency has any such requirements prior to finalizing the

drilling plan.

If DNAPL is known or expected to exist at the site, refer to the project specific documents (e.g., DNAPL Contingency Plan) for additional details regarding drilling to reduce the potential for inadvertent DNAPL remobilization.

Similarly, if light non-aqueous phase liquid (LNAPL) is known or expected to be present as “perched” layers above the water table, refer to the DNAPL Contingency Plan. Follow the general provisions and concepts in the DNAPL contingency plan during drilling above the water table at known or expected LNAPL sites.

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions. Water used for drilling, decontamination of drilling/sampling equipment, or grouting boreholes uponcompletion will be of a quality acceptable for project objectives. Testing of water supply will be considered.

Specifications of materials used for backfilling the borehole will be obtained, reviewed and approved to meet project quality objectives. Bentonite is not recommended where DNAPL is likely to be present or in groundwater with high salinity. In these situations, neat cement grout is preferred.

Store and/or stage empty and full sample containers and coolers out of direct sunlight. Sample container threads should be wiped down with a clean, nonabrasive material (e.g., paper towels) to better ensure the sample container is properly sealed. Be careful not to over-tighten lids with Teflon® liners or septa. Over-tightening can impair the integrity of the seal and cancause the glass to shatter and create a risk for hand injuries.

NOTE: *Field logs and some forms are considered to be legal documents. All field logs and forms will therefore be filled out in indelible ink. Do not use permanent marker or felt-tipped pens for labels on sample container or sample coolers. Permanent markers could introduce volatile constituents into the samples.*

NOTE: *An Arcadis employee that is appropriately trained at the correct level of internal hazardous materials/DOT (Department of Transportation) shipping must complete an Arcadis shipping determination to address applicable DOT and IATA (International Air Transport Association) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.*

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel. Review all site-specific and procedural hazards as they are provided in the HASP, and review Job SafetyAnalysis (JSA) documents in the field each day prior to beginning work.

Prior to drilling, utility clearance must be performed (see Section 5). Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and thesite-specific HASP.

Working outside at sites with suspected contamination may expose field personnel to hazardous materials such as contaminated groundwater or NAPL (e.g., oil). Other potential hazards include biological hazards (e.g., stinging insects, ticks in long grass/weeds, etc.), and potentially the use of sharp cutting tools (scissors, knife). Only use non-toxic peppermint oil spray for stinging insect nests. Review client-specific health and safety requirements, which may preclude the useof fixed/folding-blade knives

and use appropriate hand protection.

If thunder or lightning is present, discontinue drilling and sampling until 30 minutes have passed after the last occurrence of thunder or lightning.

8 Procedure

The procedures for drilling and the methods to be used to field screen and collect soil samples for laboratory analysis are presented below:

8.1 Drilling Procedures

8.1.1 Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area.
    a. Verify utilities were cleared (see Section 5) and use soft dig technique to clear borehole, if applicable
    b. Clean sampling equipment in accordance with the FIP/work plan prior to drilling
2. Advance boring to target depth:
    a. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent) using the appropriate tooling (e.g., split-barrel sampler) and sample containers
        i. Split-barrel or drive-ahead samples are obtained during drilling
        ii. A common sampling method that produces high-quality soil samples with relatively littlesoil disturbance is described in *ASTM D1586 – Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils* (ASTM D1586).
    b. Always change disposable gloves before handling the sampling equipment
    c. Collect, document, and store samples for laboratory analysis as specified in the FIP/work plan (or equivalent; see below for additional details on sample collection procedures)
    d. Field screen samples as specified in the FIP/work plan (or equivalent; see below for additional details on field screening procedures)
    e. Rotasonic drilling produces soil cores that, for the most part, are relatively undisturbed, but note that when drilling in consolidated or finer-grained sediment the vibratory action during core barrel advancement may create secondary fractures or breaks. The core is retrieved by vibrating the soil/rock into a separate core bag, typically in 5-foot or 10-foot increments. The soil cores may consolidate or expand during retrieval, depending on soils, etc.
    f. Dual-rotary removes cuttings by compressed air or water/mud and allow only a

generalassessment of geology unless separate coring tools and techniques are used

g. Decontaminate equipment between samples in accordance with the FIP/work plan (or equivalent)

3. Describe each soil sample as outlined in the appropriate project records (refer to the description procedures outlined in the *TGI - Soil Description*)

    a. Record descriptions on the soil boring log (**Attachment 1**) and/or field notebook

    b. When possible, photo document the samples (e.g., soil cores, split-barrels)

    c. During soil boring advancement, document all drilling events in field notebook, including blow counts (i.e., the number of blows from a soil sampling drive weight [140 pounds] required to drive the split-barrel sampler in 6-inch increments) and work stoppages

    d. Blow counts will not be available if rotasonic, dual-rotary, or direct-push methods are used; however, if standard penetration testing is required during rotasonic drilling, an automatic drop hammer may be used in conjunction with the method to switch from core barrel advancement to standard penetration testing

    e. If soils are screened with a PID/FID or another instrument, document the measurement in accordance with the work plan

4. The drilling contractor will be responsible for obtaining accurate and representative samples, informing the supervising Arcadis geologist of changes in drilling pressure, drilling penetration rates, and keeping a separategeneral log of soils encountered, including blow counts

    a. The term “samples” means soil materials from particular depth intervals, whether or not portions of these materials are submitted for laboratory analyses

    b. Records will also be kept of occurrences of premature refusal due to boulders, construction materials that may have been used as fill, etc.

    c. Where a boring cannot be advanced to the desired depth, the boring will be abandoned, and an additional boring will be advanced at an adjacent location to obtain the required sample in accordance with the work plan

    d. Where it is desirable to avoid leaving vertical connections between depth intervals (e.g., if DNAPL or perched LNAPL are known or expected to exist at the site), the borehole will be sealed using cement and/or bentonite (see **Section 5** above)

    e. Multiple refusals may lead to a decision by the supervising geologist to abandon that sampling location

8.1.2 Direct-Push Method

The direct-push drilling method may also be used to complete soil borings. Examples of this technique include Geoprobe®, Diedrich Environmental Soil Probe (ESP) System, or AMS PowerProbe.

Environmental probe systems typically use a hydraulically operated percussion hammer.

Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff to medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual tube liner for samplingsoil

(dual tube sampling system).

The outside diameter (OD) of the outer casing ranges from 2.25 to 6 inches and the OD of the inner sampling tube diameter ranges from 1.4 to 4.5 inches. The outer casing isolates overlying soil and permits the unit to continue to probe at depth. The dual tube sampling system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, a single rod system may be used that does notprovide a cased boring and which limits tremie-grouting from the bottom up.

Direct-push drilling can generally achieve target depths 100 feet or less depending on the site geology. The known or expected site conditions (e.g., presence of NAPL) will be evaluated when selecting the typeof direct-push sampling system to be employed.

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area
    a. Verify utilities were cleared (see Section 5) and use soft dig technique to clear borehole, if applicable
    b. Clean sampling equipment in accordance with the FIP/work plan prior to drilling
2. Advance soil boring to target depth.
    a. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent) using clean/disposable sampling equipment (plastic liners)
    b. Always change disposable gloves before handling the sampling equipment
    c. Collect, document, and store samples for laboratory analysis as specified in theFIP/work plan (or equivalent; see below for additional details on sample collection procedures)
    d. Field screen samples as specified in the FIP/work plan (or equivalent; see below for additional details on field screening procedures)
3. Decontaminate equipment between samples in accordance with the FIP/work plan (or equivalent)
4. Describe samples in accordance with the procedures outlined in **Step 3** under ***Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods*** above (refer to the description procedures outlined in the *TGI - Soil Description*)

8.1.3 Manual Methods

Manual methods may also be used to complete shallow soil borings. Examples of this technique include using a spade, spoon, scoop, hand auger, or slide hammer. Manual methods are typically used to collect surface soil samples (0 to 6 inches) or to complete soil borings/collect soil samples from a depth of 5 feet or less.

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area
2. Clear the ground surface of brush, root mat, grass, leaves, or other debris
3. Use a spade, spoon, scoop, hand auger, or slide hammer to collect a sample of the required depth interval
4. Use an engineer's ruler or survey rod to verify that the sample is collected to the correct depth and

record the top and bottom depths from the ground surface

5. To collect samples below the surface interval, remove the surface interval first; then collect the deeper interval
    a. To prevent the hole from collapsing, it may be necessary to remove a wider section from the surface or use cut polyvinyl chloride (PVC) pipe to maintain the opening
    b. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent) and transfer to the appropriate, laboratory-supplied container
    c. Collect, document, and store samples for laboratory analysis as specified in the FIP/work plan (or equivalent; see below for additional details on sample collection procedures)
    d. Field screen samples as specified in the FIP/work plan (or equivalent; see below for additional details on field screening procedures)
6. Decontaminate equipment between samples in accordance with the FIP/work plan (orequivalent)
7. Describe samples in accordance with the procedures outlined in **Step 3** under ***Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods*** above (refer to the description procedures outlined in the *TGI - Soil Description*)

8.2 Field Screening Procedures

8.2.1 PID and FID Screening

Soils are typically field screened with a PID or FID for a relative measure of the total VOCs at sites where VOCs are known or suspected to exist. PIDs and FIDs require calibration in accordance with the work plan(s) and manufacturer's specifications and PIDs should be calibrated based on the target chemicals. The PID employs an ultraviolet lamp to measure VOCs and the ionizationenergy (IE) of the site constituents need to be considered when selecting the type of lamp (e.g., 10.6 eV, 11.7 eV) that will be used. In general, any compound with an IE lower than that of the lamp photons canbe measured. The FID has a wide linear range and responds to almost all VOCs.

Field screening is performed using one (or both) of the following two methods:

1. Upon opening the sampler, the soil is split open and the PID or FID probe is placed in the opening and covered with a clean, gloved hand. Such readings will be obtained at several locations along the lengthof the sample.
2. A portion of the collected soil is placed in a jar, which is covered with aluminum foil, sealed, and allowed to warm to room temperature (see below). After warming, the cover is removed, the foil is pierced withthe PID or FID probe, and a reading is obtained.

Prior to usage, the PID or FID must be calibrated according to the manufacturer's specifications at a minimum frequencyof once per day prior to collecting PID or FID readings. The PID will be calibrated to a benzene-related compound (isobutylene) or other appropriate gas, while the FID will be calibrated to methane. The time, date, and calibration procedure must be clearly documented in the field notebook and/or the calibration form.

If at any time the PID or FID results appear erratic or inconsistent with field observations, then the instrument will be recalibrated.

If calibration is difficult to achieve, then the PID's lamp will be checked for dirt or moisture and cleaned, or technical assistance will be required. Maintenance and calibration records will be kept as part of the field quality assurance program.

Initial PID readings will be recorded on the soil boring log (**Attachment 1**) and/or in the field notes. The soil sample will be separated from the slough material (if any) by using disposable gloves and a pre-cleaned stainless-steel spoon or tool.

For the second method, a representative portion of the sample will be placed in a pre-cleaned air-tight container (as quickly as possible to avoid loss of VOCs), filling the container half full to allow for the accumulation of vapors above the soil. An aluminum foil seal will be placed between the glass and cap and the cap will be screwed on tightly. Unless the screening will be performed immediately after the sample is placed in the container, the sample containers will be stored in a cooler chilled to approximately4ºC until screening can be performed.

The headspace of the container will be measured using a PID or FID as follows:

1. Samples will be taken to a warm workspace and allowed to equilibrate to room temperature for atleast one hour.
2. Prior to measuring the soil vapor headspace concentration, the container will be shaken.
3. The headspace of the sample will then be measured directly from the container by piercingthe aluminum foil seal with the probe of the PID or FID and measuring the relative concentration of VOCs in the headspace of the soil sample. The initial (peak) reading must be recorded.

8.2.2 NAPL Screening

To screen for the potential presence of non-aqueous phase liquid (NAPL) in soil, drilling procedures must allow for high-quality porous media samples to be taken. Split-barrel samplers or direct-push samplers will be collected continuously ahead of the auger, drill casing/rods, or probe rods. Upon opening each split-barrel sampler or direct-push plastic liner sleeve, the soil will immediately be evaluated for the presence of visible NAPL and odors. If suspected NAPL is immediately visible in the sample, its depth will benoted.

Additionally, the soil will be screened for the presence of organic vapors using a PID or FID, in accordance with the work plan, if applicable. During screening, the soil will be split open using a clean spatula or knife and the PID or FID probe will be placedin the opening and covered with a clean, gloved hand (**Method 1** above). Such readings will be obtained along the entire length of the sample. Alternatively, **Method 2** for PID/FID screening (outlined above) may also be performed. If the PID or FID examination reveals the presence of organic vapors above 100 parts permillion (ppm), the sample will undergo further detailed evaluation for visible NAPL.

The assessment for NAPL will include the following tests/observations:

- Evaluation for Visible NAPL Sheen or Free-Phase NAPL in Soil Sampler
    - NAPL sheen will be a colorful iridescent appearance on the soil sample
    - NAPL may also appear as droplets or continuous accumulations of liquid with a color typically ranging from yellow to brown to black, depending on the type of NAPL
    - Creosote DNAPL (associated with wood-treating sites) and coal tar DNAPL (associated with manufactured gas plant [MGP] sites) are typically black and have a characteristic, pungent odor
    - Pure chlorinated solvents may be colorless in the absence of hydrophobic dye. Solvents mixed

with oils may appear brown

- Particular care will be taken to fully describe any sheens observed, staining, discoloration, droplets (blebs), or NAPL saturation

- Soil-Water Pan Test
  - A portion of the selected soil interval with the highest PID or FID reading above 100 ppm will be placed in a disposable polyethylene dish along with a small volume of potable or distilled water
  - The dish will be gently tilted back and forth to mix the soil and water, and the surface of the water will be viewed in natural light to observe the development of a sheen, if any
  - A small quantity of Oil Red O or Sudan IV hydrophobic dye powder should be added in accordance with the work plan, and the soil and dye will be manually mixed for approximately 30 to 60 seconds and smeared in the dish tocreate a paste-like consistency
  - A positive test result will be indicated by a sheen on the surface of the water and/or a bright red color imparted to the soil following mixing with dye
- Soil-Water Shake Test
  - A small quantity of soil (up to 15 cc) will be placed in a clear, colorless, jar containing an equal volume of potable or distilled water (40-mL vials are well suited to this purpose, but not required)
  - After the soil settles into the water, the surface of the water will be evaluated for a visible sheen under natural light
  - The jar will be closed and gently shaken for approximately 10 to 20 seconds
  - Again, the surface of the water will be evaluated for a visible sheen or a temporary layer of foam
  - A small quantity (approximately 0.5 to 1 cc) of Oil Red O or Sudan IV powder will be placed in the jar in accordance with the work plan
  - The sheen layer, if present, will be evaluated for a reaction to the dye (change to bright red color)
  - The jar will be closed and gently shaken for approximately 10 to 20 seconds
  - The contents in the closed jar will be examined under natural light for visible bright red dyed liquid inside the jar

- A positive test result will be indicated by the presence of a visible sheen or foam on the surface ofwater, a reaction between the dye and the sheen layer upon first addition of the dye powder, a bright red coating on the inside of the vial (particularly above the water line), or red-dyed droplets within the soil

NOTE: *If NAPL is obviously present upon opening the soil sampler or evaluating the soil sample within the split-spoon sampler or direct-push liner sleeve, it is not necessary to perform a soil-water pan test or soil-water shake test. In addition, it is not necessary to perform both a soil-water pan test and a soil-water shake test; either test method is acceptable. The pan test may be preferred in some circumstances because the presence of a sheen may be easier to see on a wider surface. Further, these tests will only be performed if specified in the work plan(s).*

NOTE: *When using hydrophobic dye in the tests above, color will be assessed outdoors under natural light during the period between sunrise and sunset, regardless of the degree of cloud cover. The hydrophobic dye Safety Data Sheets (SDS) will be incorporated into the HASP and reviewed prior to use and the dyes will be carefully handled and disposed in accordance with regulations, if applicable*.

8.3 Soil Sample Collection for Laboratory Procedures

If not specifically identified in the FIP/work plan, soil samples will be selected for laboratory analysis based on:

1. Their position in relation to identified source areas
2. The visual presence of source residues (e.g., NAPL or staining)
3. The relative levels of total VOCs based on field screening measurements
4. The judgment of the field coordinator
5. Moisture content or relative position with regard to apparent groundwater table/saturation

Samples designated for laboratory analysis will be placed in the appropriate containers.

Sample containers for VOC analysis will be filled first immediately following soil core retrieval to reduce loss of VOCs.

If samples will be collected for other analyses, a sufficient amount of the remaining soil willthen be homogenized as described below and sample containers will be filled for other parameters.

VOC samples will be collected as discrete samples using a small diameter core sampler (e.g., En Core® Sampler, Terra Core™ Sampler).

The En Core® Sampler is a disposable volumetric sampling device that collects, stores and delivers soil samples without in-field chemical preservation. The En Core® Sampler requires the use of a reusable T-handle.

The Terra Core™ Sampler is a one-time use transfer tool, designed to collect soil samples and transfer them to the appropriate containers for in-field chemical preservation (e.g., methanol).

The small diameter core samplers will be used according to the manufacturer's instructions (e.g., En Novative Technologies). Some regulatory agencies have specific requirements regarding VOC sample

collection. Determine whether the oversight agency has specific requirements prior to commencing sampling and collect samples at appropriate interval as specified in the FIP/work plan (or equivalent). Samples may require homogenization across a given depth interval, or several discrete grabs (usually five) may be combined into a composite sample.

NOTE: *Samples for VOC and PFAS analysis will NOT be homogenized or composited and will be collected asdiscrete samples as described above*.

The procedure for mixing samples is provided below.

1. Mix the materials in a stainless steel (or appropriate non-reactive material) bowl using a stainless-steel spoon (or disposable equivalents)

a. When dealing with large sample quantities, use disposable plastic sheeting and a shovelor trowel

b. NOTE: *When preparing samples for metals analyses, do not use disposable aluminum(or metal tools or trays other than stainless steel), as it may influence the analytical results*

2. Flatten the pile by pressing the top without further mixing

3. Divide the circular pile by into four equal quarters by dividing out two diameters at right angles

4. Mix each quarter individually using appropriate non-reactive bowls, spoons and/or sheeting

5. Mix two quarters (as described above) to form halves, then mix the two halves to form a composite orhomogenized sample

6. Place composite or homogenized sample into specified containers

7. Remaining material will be disposed of in accordance with project requirements and applicableregulations

8. Sample containers will be labeled with sample identification number, date, and time of collection andplaced on ice in a cooler (target 4° Celsius)

9. Samples selected for laboratory analysis will be documented (chain-of-custody forms), handled, packed, and shipped in accordance with the procedures outlined in the FIP/work plan (or equivalent).

8.4 Soil Boring Abandonment

All soil borings need to be abandoned in accordance with ***TGI for Monitoring Well and Soil Boring Decommissioning***. See Attachment E of the TGI for specifics.

9 Waste Management

Investigative-Derived Waste (IDW) generated during drilling activities, including soil and excess drilling fluids (if used), and decontamination liquids, will be stored on site in appropriately labeled containers and disposed of properly. Disposable materials will be stored and disposed of separately. Containers must be labeled at the time of collection and will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, PPE). Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage,* the procedures identified in the FIP/work plan or QAPP as well as

state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field log.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Management of the original documents from the field will be completed in accordance with the site- specific QAPP.

In general, drilling activities will be documented on appropriate field/log forms as well as in a proper field notebook. All field data will be recorded digitally or with indelible ink. Field forms, logs/notes (including daily field and calibration logs), digital records, and chain-of-custody records will be maintained by the field team lead. Any deviations or omissions from this TGI should be documented.

Initial field logs and chain-of-custody records will be transmitted to the Arcadis CPM and Technical Lead at the end of each day unless otherwise directed by the CPM. The field teamleader retains copies of the field documentation.

Additionally, all documents (and photographs) will be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of drilling activities, soil descriptions, soil boring information, and quantities of materials used.

In addition, the locations of soil borings will be documented photographically and in a site sketch. If appropriate, a measuring wheel or engineer's tape will be used to determine approximate distances between important site features.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

11 Quality Assurance

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate TGI.

Field-derived quality assurance blanks will be collected as specified in the FIP/work plan and/or site- specific QAPP, depending on the project quality objectives. Typically, field rinse blanks (equipment blanks) will be collected when non-dedicated equipment (e.g., split-spoon sampler, stainless steel spoon) is used during soil sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminants from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities and during transport to the laboratory.

Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook.

12 References

ASTM D1586 - *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. ASTM International. West Conshohocken, Pennsylvania.

13 Attachments

Attachment 1. Soil Boring Log Form

Attachment 1

Soil Boring Log Form

BORING LOG

ARCADIS

Boring ID:		**Project Name:**		**Page:**	
Permit ID:		**Date Started:**		**Ground Elevation:**	
Site Address:		**Date Completed:**		**Vertical Datum:**	
City, State:		**Total Depth:**		**Northing:**	
Drilling Co:		**Depth to Water:**		**Easting:**	
Driller:		**Hole Diameter:**		**Horizontal Datum:**	
Drilling Method:		**Core Device:**		**Prepared by:**	
Boring Status:		**Drilling Fluid:**		**Reviewed by:**	

Drilling Information				Primary Texture										Soil Description (Udden-Wentworth System)	Field Notes
				Fines		Sand					Gravel				
Drilling Depth (ft bgs)	Core Interval (ft)	Core Recovery (inches)	PID Reading (ppm)	clay	silt	very fine	fine	medium	coarse	very coarse	granule	pebble	cobble	boulder	Depth interval (ft), Moisture, PRIMARY TEXTURE, Modifier/Minor Texture, Sorting, Angularity, Consistency, Plasticity, Color - Only Record Sand Density with Standard Penetration Tests Minor Texture Modifiers: Trace (<10%), Little (10 to 20%), Some (21 to 35%), And (36 to 50%)	Driller's Observations, Particle Size Percentages, Geologic Formation, Field Screening Results, Sample Interval etc.

BORING LOG

ARCADIS

Boring ID: _____ **Project Name:** _____ **Page:** /

Drilling Information				Primary Texture											Soil Description (Udden-Wentworth System)	Field Notes
				Fines		Sand					Gravel					
Drilling Depth (ft bgs)	Core Interval (ft)	Core Recovery (inches)	PID Reading (ppm)	clay	silt	very fine	fine	medium	coarse	very coarse	granule	pebble	cobble	boulder	Depth interval (ft), Moisture, PRIMARY TEXTURE, Modifier/Minor Texture, Sorting, Angularity, Consistency, Plasticity, Color - Only Record Sand Density with Standard Penetration Tests Minor Texture Modifiers: Trace (<10%), Little (10 to 20%), Some (21 to 35%), And (36 to 50%)	Driller's Observations, Particle Size Percentages, Geologic Formation, Field Screening Results, Sample Interval etc.

BORING LOG

ARCADIS

Boring ID: _____ **Project Name:** _____ **Page:** /

Drilling Information				Primary Texture											Soil Description (Udden-Wentworth System)	Field Notes
				Fines		Sand					Gravel					
Drilling Depth (ft bgs)	Core Interval (ft)	Core Recovery (inches)	PID Reading (ppm)	clay	silt	very fine	fine	medium	coarse	very coarse	granule	pebble	cobble	boulder	Depth interval (ft), Moisture, PRIMARY TEXTURE, Modifier/Minor Texture, Sorting, Angularity, Consistency, Plasticity, Color - Only Record Sand Density with Standard Penetration Tests Minor Texture Modifiers: Trace (<10%), Little (10 to 20%), Some (21 to 35%), And (36 to 50%)	Driller's Observations, Particle Size Percentages, Geologic Formation, Field Screening Results, Sample Interval etc.

Arcadis U.S., Inc.
630 Plaza Drive, Suite 200
Highlands Ranch
Colorado 80129
Phone: 720 344 3500
Fax: 720 344 3535
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Attachment B

Field Forms

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GROUNDWATER SAMPLING LOG

Page ____ of ____

Project No. _____ Well ID _____ Date _____

Project Name/Location _____ Weather _____

Measuring Pt. Description _____ Screen Setting (ft-bmp) _____ Casing Diameter (in.) _____ Well Material ____ PVC ____ SS

Static Water Level (ft-bmp) _____ Total Depth (ft-bmp) _____ Water Column/ Gallons in Well _____

MP Elevation _____ Pump Intake (ft-bmp) _____ Purge Method: _____ Centrifugal _____ Submersible _____ Other _____ Sample Method _____

Pump On/Off _____ Volumes Purged _____

Sample Time: Label _____ Start _____ End _____ Replicate/ Code No. _____ Sampled by _____

Time	Minutes Elapsed	Rate (gpm) (mL/min)	Depth to Water (ft)	Gallons Purged	pH	Cond. (mMhos) (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temp. (°C) (°F)	Redox (mV)	Appearance	
											Color	Odor

Constituents Sampled	Container	Number	Preservative

Well Casing Volumes

Gallons/Foot 1" = 0.04 1.25" = 0.06 1.5" = 0.09 2" = 0.16 2.5" = 0.26 3" = 0.37 3.5" = 0.50 4" = 0.65 6" = 1.47

Well Information

Well Location: _____ Well Locked at Arrival: Yes / No

Condition of Well: _____ Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Stick Up Key Number To Well: _____

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INSTRUMENT CALIBRATION LOG

Project Name: _____ Date: _____

Project Number: _____

Calibrating Personnel: _____

Time of Calibration: _____

Weather Conditions: _____

Barometric Pressure: _____ mm Hg

Calibrant	Instrument	Initial Reading	Value Entered	Final Reading	Time	Temperature
pH 7.00						
pH 4.00						
Conductivity (_____)						
Turbidity (1.0 NTU)						
Turbidity (10.0 NTU)						
DO (mg/L)						
DO%						
ORP (mV)						
_____						
_____						
_____						

Notes:

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WATER LEVEL MEASUREMENT FORM

Page _____ of _____

Project Name: _____ Date: _____

Project Number: _____ Weather: _____

Field Personnel: _____

Well Casing Volumes

gallon/foot				
	1-¼" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65
	1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

Well ID	Time	Measuring Point	TSD (ft)	DTP (ft)	DTW (ft)	Notes

Notes:

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INVESTIGATION DERIVED WASTE LOG

Page _____ of _____

Project Name/Location _____ Date _____

Project/No. _____ Weather _____

Technician _____ Project Manager _____

Date	Container Number	Container Type (drum, rolloff, tank)	Container Capacity	Container Description (OT, CT, etc.)	Media (SO, GW)	Content Description	Source	Volume from Source	Storage Location

NOTES:

PHOTOGRAPH LOG

Date: _____

Site Name: _____ Project No.: _____

Street: _____ City/State: _____

Photo #	Direction of View	Description

WELL ABANDONMENT LOG

Site Name/Location				Recorded By	
Project No.		Well ID		Date	
Total Depth (ft)		Construction Material		Casing Diameter (in)	
Start Time		End Time		Well Volume (gallon)	
Method: Overdrill (ft)		Grout/Chips		Bags of Material	
Contractor		Driller		Helper	

	Well Casing Volume Conversion Factor				
gallon/foot	1" = 0.04	1-¼" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65
		1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

Time	Notes

NR = Not Recorded

TSD = Total Sound Depth

bgs = below ground surface

PID = Photo Ionization Detector

ppm = part per million

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SAMPLE/CORE LOG

Boring/Well _____ Project/No. _____ Page _____ of _____

Site Location _____ Drilling Started _____ Drilling Completed _____

Total Depth Drilled _____ feet Hole Diameter _____ inches Type of Sample / Coring Device _____

Length and Diameter of Coring Device _____ Sampling Interval _____ feet

Land-Surface Elev. _____ feet ☐ Surveyed ☐ Estimated Datum _____

Drilling Fluid Used _____ Drilling Method _____

Drilling Contractor _____ Driller _____ Helper _____

Prepared by _____ Hammer Weight _____ Hammer Drop _____ ins.

Sample/Core Depth (ft below land surface)		Core Recovery (ft)	PID Reading (ppm)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
From	To				

ARCADIS Design & Consultancy for natural and built assets

SAMPLE/CORE LOG (CONT.D)

Boring/Well _____ Page _____ of _____

Prepared by _____

Sample/Core Depth (ft below land surface)		Core Recovery (ft)	PID Reading (ppm)	Time/Hydraulic Pressure or Blows per 6 inches	
From	To				

ARCADIS Design & Consultancy for natural and built assets

SAMPLE/CORE LOG

Boring/Well _____ Project/No. _____ Page _____ of _____

Site Location _____ Drilling Started _____ Drilling Completed _____

Total Depth Drilled _____ feet Hole Diameter _____ inches Type of Sample / Coring Device _____

Length and Diameter of Coring Device _____ Sampling Interval _____ feet

Land-Surface Elev. _____ feet ☐ Surveyed ☐ Estimated Datum _____

Drilling Fluid Used _____ Drilling Method _____

Drilling Contractor _____ Driller _____ Helper _____

Prepared by _____ Hammer Weight _____ Hammer Drop _____ ins.

Sample/Core Depth (ft below land surface)		Core Recovery (ft)	PID Reading (ppm)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
From	To				

ARCADIS Design & Consultancy for natural and built assets

SAMPLE/CORE LOG (CONT.D)

Boring/Well _____ Page _____ of _____

Prepared by _____

Sample/Core Depth (ft below land surface)		Core Recovery (ft)	PID Reading (ppm)	Time/Hydraulic Pressure or Blows per 6 inches	Sample/Core Description
From	To				

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SOIL/SEDIMENT SAMPLE LOG

Sample ID _____ Project/No. _____

Date _____ Sampling Personnel _____

Time _____ _____

Weather _____ _____

DESCRIPTION OF SAMPLE LOCATION:

_____ Soil _____ Sediment

Location _____ Name of Water Body _____

Sample depth (ft) _____ Location _____

Soil type _____ Depth of water _____

_____ Velocity of water _____

Substrate description _____

Description of vegetation _____

_____

FIELD PARAMETERS:

Sample Method _____

Sample Description _____

_____

Color _____

Odor _____

Salinity _____

CONTAINER DESCRIPTION: From _____ Lab _____

Number	Container	Analysis
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

TOTAL: ☐

SOIL-VAPOR SAMPLE LOG

Sample ID _____ Project/No. _____

Date _____ Sampling Personnel _____

Time _____ _____

Weather _____ _____

DESCRIPTION OF SAMPLE LOCATION:

_____ Outdoor	_____ Indoor
Location _____	Location _____
Est. depth to water (ft): _____	Basement: yes / no
Soil type: _____	Room size (ft x ft): _____
_____	Floor material: cement / wood / dirt
Odor: _____	Slab Thickness (ft): _____
Color: _____	Visible cracks?: yes / no
	Sub-slab material: dirt / gravel

PROBE INSTALLATION:

Date: _____

Method: _____

Diameter: _____

Depth: _____

Packing material: _____

Location Sketch:

PURGE:

Date: _____

Time: _____

Rate: _____

Volume: _____

SAMPLE COLLECTION:

Sample Time: _____

Sample Rate: _____

Sample Volume: _____

CONTAINER DESCRIPTION:

_____ L Summa Canister

SURFACE WATER SAMPLE LOG

Sample ID _____ Project/No. _____

Date _____ Sampling Personnel _____

Time _____

Weather _____

DESCRIPTION OF SAMPLE LOCATION:

Name of Water Body _____ Velocity _____

Depth of Water _____

Other Comments _____

Substrate Description _____

Location _____

_____

Description of Nearby Vegetation _____

FIELD PARAMETERS:

Sample Method _____

Sample Description _____

_____

Temperature (°C/°F) _____ pH _____

Dissolved Oxygen _____ SC _____

Salinity _____

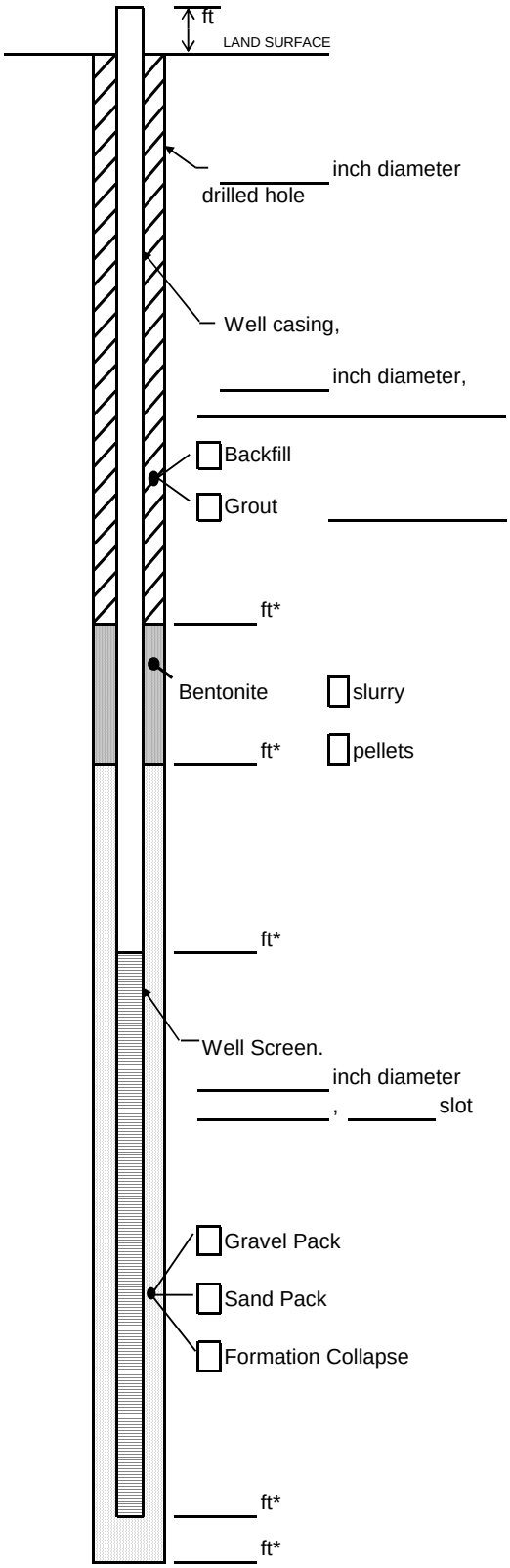
CONTAINER DESCRIPTION: From _____ Lab _____ ARCADIS

Bottle Type	Analysis	Preservative

WELL CONSTRUCTION LOG

(Unconsolidated)

ARCADIS Design & Consultancy for natural and built assets



Measuring Point is
Top of Well Casing
Unless Otherwise Noted.
* Depth Below Land Surface

Project _____ Well _____

Town/City _____

County _____ State _____

Permit No. _____

Land-Surface (LS) Elevation and Datum:

_____ feet ☐ Surveyed

☐ Estimated

Installation Date(s) _____

Drilling Method _____

Drilling Contractor _____

Drilling Fluid _____

_____

Development Technique(s) and Date(s)

_____

_____

_____

Fluid Loss During Drilling _____ gallons

Water Removed During Development _____ gallons

Static Depth to Water _____ feet below M.P.

Pumping Depth to Water _____ feet below M.P.

Pumping Duration _____ hours

Yield _____ gpm Date _____

Specific Capacity _____ gpm/ft

Well Purpose _____

_____

_____

Remarks _____

_____

_____

_____

Prepared by _____

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WELL DEVELOPMENT LOG

Site/Well No. _____

Project _____ Project No. _____ Page ____ of 1

Site Location _____ Date _____

Weather _____ Development Time Begin _____ End _____

Evacuation Data

Measuring Point _____

MP Elevation (ft) _____

Land Surface Elevation (ft) _____

Sounded Well Depth (ft bmp) _____

Depth to Water (ft bmp) _____

Water-Level Elevation (ft) _____

Water Column in Well (ft) _____

Casing Diameter/Type _____

Gallons in Well _____

Sample Pump Intake Setting (ft bmp) _____

Pumping Rate (gpm) _____

Evacuation Method _____

Field Parameters

Color _____

Odor _____

Appearance _____

Well Volume	Total Gallons Removed	pH (s.u.)	Conductivity (mS/cm or umhos/cm)	Turbidity (NTU)	Temperature (^{o}F/^{o}C)	Remarks
Initial						
1st						
2nd						
3rd						
4th						
5th						
6th						
7th						
8th						
9th						
10th						

Development Personnel: _____

Notes: _____

Well Casing Volumes (gallon/feet)

1-¼" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65
1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

bmp	below measuring point	ml	mililiter	NTU	Nephelometric Turbidity Units
°C	Degrees Celsius	mS/cm	Milisiemens per centimeter	PVC	Polyvinyl chloride
ft	feet	msl	mean sea-level	s.u.	Standard units
gpm	Gallons per minute	N/A	Not Applicable	umhos/cm	Micromhos per centimeter
mg/L	Miligrams per liter	NM	Not Measured	VOC	Volatile Organic Compounds

ARCADIS Design & Consultancy for natural and built assets

IN-SITU GROUNDWATER PARAMETER LOG

Client: _____ Project #: _____ Date: _____

Location: _____ City: _____ State: _____

Location #: _____ Instrument: _____

Technician: _____ Project Mngr: _____

Well	Time	DTW (ft bmp)	DO%	DO (mg/L)	DO (Charge*) (25-75)	Redox (ORP) (mV)	pH	SC (µS/cm)	Temp (°C)

Notes:

_____

_____

_____

_____

* DO CHARGE MUST BE 25 - 75 FOR PROPER OPERATION OF DO PROBE

Attachment C

Laboratory Standard Operating Procedures and Certifications

Pace ANALYTICAL SERVICES	**ENV-SOP-WCOL-0158 v05_PFAS by Method 1633**
	Effective Date: 08/14/2024

Management Approval:
Matthew Miller Approved on 8/12/2024 12:26:26 PM
Ziyad Rajabi Approved on 8/13/2024 1:50:05 PM
Erin Boyd Approved on 8/14/2024 1:14:22 PM

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1.0 SCOPE & APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure for the determination of per- and polyfluoroalkyl substances (PFAS) in Table 1 in aqueous (all non-potable water and leachate) and solid (soil, biosolids, sediment) samples by liquid chromatography/mass spectrometry (LC-MS/MS).

The method calibrates and quantifies PFAS analytes using isotopically labeled standards. Where linear and branched isomers are present in the sample and either qualitative or quantitative standards containing branched and linear isomers are commercially available, the PFAS analyte is reported as a single analyte consisting of the sum of the linear and branched isomer concentrations.

The instrumental portion of this method is for use only by analysts experienced with LC-MS/MS or under the close supervision of such qualified persons. The laboratory must demonstrate the ability to generate acceptable results using the procedure in Sections 11.3.1 and 11.4.

By their very nature, many components of PFAS present analytical challenges unique to this class of analytes. For example, PFAS analytes readily adhere to the walls of the sample containers and may also stratify in the container.

1.1 Target Analyte List and Limits of Quantitation (LOQ)

The target analytes that can be determined by this SOP and the associated LOQ is provided in Table 1, Appendix A.

LOQs are established in accordance with Pace policy and SOPs for method validation and for the determination of detection limits (DL) and quantitation limits (LOQ). DL and LOQ are routinely verified and updated when needed. The current LOQ for each target analyte that can be determined by this SOP as of the effective date of this SOP is provided in Table 1, Appendix A. LOQ is equivalent to Minimum Level of Quantitation (ML).

DL and LOQ are always adjusted to account for actual amounts used and for dilution.

2.0 SUMMARY OF METHOD

Environmental samples are prepared and extracted using method-specific procedures. Sample extracts are subjected to cleanup procedures designed to remove interferences. Analyses of the sample extracts are conducted by LC-MS/MS in the multiple reaction monitoring (MRM) mode. Sample concentrations are determined by isotope dilution or extracted internal standard quantification (see Section 9.2.1) using isotopically labeled compounds added to the samples before extraction.

Individual PFAS analytes are identified through peak analysis of the quantification and confirmation ions, where applicable.

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Quantitative determination of target analyte concentrations is made with respect to an isotopically labeled PFAS standard; the concentrations are then used to convert raw peak areas in sample chromatograms to final concentrations.

Results for target analytes are recovery corrected by the method of quantification (i.e., either isotope dilution or extracted internal standard quantification, see Section 9.2.1). Isotopically labeled compound recoveries are determined by comparison to the responses of one of seven non-extracted internal standards (a.k.a., the "recovery" standards) and are used as general indicators of overall analytical quality.

The quality of the analysis is assured through reproducible calibration and testing of the extraction, cleanup, and LC-MS/MS systems.

- **Extraction**
    - **Aqueous samples** are spiked with isotopically labeled standards (EIS), extracted using solid-phase extraction (SPE) cartridges and undergo cleanup using carbon before analysis.
    - **Solid samples** are spiked with EIS, extracted into basic methanol, and cleaned up by carbon and SPE cartridges before analysis.

3.0 INTERFERENCES

Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and elevated baselines causing misinterpretation of chromatograms. Specific selection of reagents and solvents is required.

Clean all equipment prior to, and after each use to avoid PFAS cross-contamination. Typical cleaning solvents used include water, methanol, and methanolic ammonium hydroxide. The residual PFAS content of disposable plasticware and filters must be verified by batch/lot number and may be used without cleaning if PFAS levels are less than half the LOQ.

Prior to use, glassware must be solvent rinsed and then air dried. A solvent rinse procedure using methanolic ammonium hydroxide (1%) and methanol is recommended.

All parts of the SPE manifold must be cleaned between samples by rinsing with methanolic ammonium hydroxide (1%) and air drying prior to use. Smaller parts, like the needles, adapters, reservoirs, and stopcocks associated with the manifold should be rinsed with tap water prior to rinsing with methanolic ammonium hydroxide (1%) and air drying. After loading the samples but prior to elution procedures, the chamber should be rinsed with methanolic ammonium hydroxide (1%).

All materials used in the analysis must be demonstrated to be free from interferences by running method blanks (Section 11.1.1) at the beginning and with each extraction batch (samples started through the extraction process on a given analytical batch to a maximum of 20 field samples).

Reagent water (Section 8.1) can be used to simulate water samples and Ottawa sand and/or reagent-grade sand (Section 7.2) can be used to simulate soils. The laboratory must verify that the source product used does not contain PFAS in detectable amounts.

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Interferences co-extracted from samples will vary considerably from source to source, depending on the diversity of the site being sampled. Interfering compounds may be present at concentrations several orders of magnitude higher than the native PFAS. Because low levels of PFAS are measured by this method, elimination of interferences is essential. The cleanup steps given in Section 9.3 can be used to reduce or eliminate these interferences and thereby permit reliable determination of the PFAS at the levels shown in Table 1. The most frequently encountered interferences are fluoropolymers; however, when analyzing whole fish samples, bile salts (e.g., Taurodeoxycholic Acid [TDCA]) can interfere in the chromatography. For this reason, analysis of a standard containing TDCA is required as part of establishing the initial chromatographic conditions (see Sections 8.2.7 and 9.2.3).

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **Extracted Internal Standard (EIS) quantification** – The response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities.
- **Isotope dilution (ID) quantitation** – A means of determining a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. The labeled PFAS are spiked into each sample and allow identification and correction of the concentration of the native compounds in the analytical process.
- **Isotopically labeled compound –** An analog of a target analyte in the method which has been synthesized with one or more atoms in the structure replaced by a stable (non-radioactive) isotope of that atom. Common stable isotopes used are 13C (Carbon-13) or Deuterium (D or 2H). These labeled compounds do not occur in nature, so they can be used for isotope dilution quantitation or other method-specific purposes.
- **Minimum Level of quantitation (ML)** – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. The ML represents the lowest concentration at which an analyte can be measured with a known level of confidence. It may be equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.

5.0 HEALTH & SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has 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.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and

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environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001)

- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 .SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

The laboratory provides containers for the collection of samples upon client request. Refer to *Sample Container Shipping* SOP [Admin SOP ENV-SOP-WCOL-0006] for procedures related to preparation of bottle kits for the test method(s) associated with this SOP.

The laboratory performs samples collection for samples to be analyzed by this SOP in accordance with *Field Services* SOP [FS SOP ENV-SOP-WCOL-0013]. Refer to this SOP for these instructions.

Container Type, Minimum Sample Amount, Preservation, and Holding Time Requirements:

Matrix	Container Size & Type	Required Sample Amount[1]	Preservation	Holding Time
Aqueous (non-potable water) containing <100 mg/L SS	2 x 500 mL linerless HDPE 1 x 125 mL linerless HDPE[3]	500 mL	Thermal: 0-6°C OR ≤ -20°C Chemical: None	Collection to Prep: 28 or 90 Prep To Analysis: 28[4] or 28
Aqueous (leachate)	2 x 125 mL linerless HDPE	100 mL	Thermal: 0-6°C OR ≤ -20°C Chemical: None	Collection to Prep: 28 or 90 Prep To Analysis: 28 or 28
Solid (soil and sediment)	3 oz/ 90 mL linerless polypropylene straight sided	5 g	Thermal: 0-6°C OR ≤ -20°C Chemical: None	Collection to Prep: 90 Prep To Analysis: 28[5]
Solid (biosolid)	3 oz/ 90 mL linerless polypropylene straight sided	0.5 g	Thermal: 0-6°C OR ≤ -20°C Chemical: None	Collection to Prep: 90 Prep To Analysis: 28

[1]Aqueous sample containers should be filled only to the appropriate gradation marked on the container, or to the shoulder of the container if no gradations are provided. To allow room for expansion during freezing (if necessary), aqueous sample containers should not be overfilled.

[2]Miniumum amount needed for each discrete analysis. Solid and biosolid sample amounts reflect the dry sample weight.

[3]Needed for percent suspended solids and screening analyses.

[4]In the single lab validation, issues were observed with certain perfluorooctane sulfonamidoethanols and perfluorooctane sulfonamidoacetic acids after 7 days.

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[5]*Samples may need to be extracted as soon as possible if NFDHA is an important analyte. The onus is on the client to indicate if NFDHA is an important analyte, prior to shipment. If no such designation is given, follow stated hold time.*

Note: Project-specific requirements dictate which storage condition applies. The storage condition to be used for each project must be formally documented in written form (QAPP or otherwise) before samples are received. Without any prior indication from the client, the lab will store all aqueous and solid samples at 0-6°C until extraction, with a 28-day preparation holding time.

Thermal preservation is checked and recorded on receipt in accordance with *Sample Receiving* SOP [Admin SOP ENV-SOP-WCOL-0007]. Chemical preservation is checked and recorded at time of receipt or prior to sample preparation.

After receipt, samples are stored at 4 ± 2°C or ≤ 20°C until sample preparation. Prepared samples (extracts, digestates, distillates, other) are stored at 4 ± 2°C until sample analysis.

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

NOTE: Refer to the Major Operational Equipment List [QA Control Log ENV-FRM-WCOL-0213] for specific details regarding the equipment utilized during this procedure.

7.1 Equipment

Due to the possibility of adsorption of analytes onto glass, HDPE containers are used for all standard, sample, and extraction preparations. Any time a new lot of SPE cartridges, solvents, cryovials, or autosampler vials are used, it must be demonstrated that a MB is reasonably free of contamination and that the criteria in Section 11.1.1 are met.

Sample Preparation

- Oven – Capable of maintaining a temperature of 105 ± 5 ºC
- Analytical balance – Capable of weighing 0.0001 g
- Top loading balance – Capable of weighing 0.01 g
- Calibrated mechanical variable volume pipettes with disposable HDPE or polypropylene tips (10 µL to 5 mL) – used for preparation of calibration standards and spiked samples
- Point of Use water preparation system – Millipore Synergy – Used for QC samples to verify the systems are PFAS free
- Ultrasonic mixer (sonicator)
- pH Paper, range 0-14 - (Whatman® PanpehaTM or equivalent), 0.5-unit readability
- Analog or digital vortex mixer, single or multi-tube (Fisher Scientific 02-215-452, or equivalent)
- Volumetric flasks, Class A

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- 15- and 50-mL conical polypropylene tubes with polypropylene screw caps for preparing and storing extract solutions and for collection of eluents (Fisher Scientific 05-527-90 and 14-432-22, or equivalent)
- Variable speed mixing table (VWR Model 3500 Orbital Shaker, or equivalent)

Filtration

- Silanized glass wool (Pyrex 3950 or equivalent)
- Disposable syringe filter, 25-mm, 0.2-µm Nylon membrane, Phenomenex AF0-1207-52 or equivalent
- Glass fiber filter, 47 mm, 1 µm, PALL 61631 or equivalent
- Centrifuge (Thermo Scientific ST-40 or equivalent), capable of reaching at least 3000 rpm
- Syringe (BD 309646 or equivalent), polypropylene/HDPE, 5 mL
- Disposable glass and plastic pipets

Solid-Phase Extraction

- Solid Phase Extraction (SPE) cartridges (Phenomenex 8B-S038-SCH, 150 mg WAX, or equivalent)
- SPE reservoirs – 60 mL, Phenomenex part# AH0-7189, or equivalent
- SPE adapter caps – Phenomenex Part# AH0-7191 (Adapter cap for 1, 3, 6mL SPE tubes)
- Vacuum manifold for SPE Cartridges – Sigma-Aldrich Cat# 57265: Visiprep SPE Vacuum manifold, or equivalent
- Disposable liners for Visiprep Manifold – Millipore-Sigma part# 57059 / Restek part# 28310-VM, or equivalent
- Vacuum tubing – 1/4” ID, 5/8” OD, 3/16” wall; Fisher Scientific part# 14-176-6B or equivalent
- Vacuum Pump – Sufficient capacity to maintain a vacuum of approximately 10 to 15 inches of mercury for extraction cartridges. Millipore model# WP6111560, 115V, 60Hz, 3.5A

Evaporation

- Automatic or manual solvent evaporation system – TurboVap® LV or equivalent
- Evaporation/concentrator tubes, 60 mL clear glass, 30 x 125 mm, without caps – Fisher cat# 02-993-275; Caps: Qorpak item # CAP-00178; Tubes with Caps: Qorpak item# GLC-07878; or equivalent

Instrument

- High-performance liquid chromatograph (HPLC) equipped with tandem quadrupole mass spectrometer – Agilent 6495C, Sciex 4500/5500, or equivalent
- Agilent Zorbax RRHD Eclipse Plus C18, 2.1 x 50 mm (1.8 µm) analytical column (Agilent Part # 959757-902), or equivalent

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- Guard cartridge/column – Phenomenex SecurityGuard cartridges (AJ0-7597), or equivalent
- Trap/delay column – Phenomenex Luna 5µm C18 100Å LC column 30 x 3mm (part# 00A-4252-Y0), or equivalent

7.2 Supplies

Due to the possibility of adsorption of analytes onto glass, HDPE containers are used for all standard, sample, and extraction preparations. Any time a new lot of SPE cartridges/tubes, solvents, cryovials, or autosampler vials are used, it must be demonstrated that a MB is reasonably free of contamination and that the criteria in Section 11.1.1 are met.

- Reference matrix: Aqueous – reagent water
- Reference matrix: Solid – Ottawa sand
- Bottles – HDPE or glass, with linerless HDPE or polypropylene caps. Various sizes. QEC item # 6212-Q016/BC-150-PACE (500 mL), 6212-Q008/BC-280-PACE (250 mL), 6213-U004/BC-500-PACE (125 mL), 6213-U002/BC-400-PACE (60 mL)
- Screw top vials, 250uL PP, and Cap, 9mm, clear, thin PP/silicone septa – used in sample analysis and pre-screening (Agilent Cat # 5190-2243 and 5191-8151), or equivalent
- Polypropylene vials – for storage (Wheaton W985872: 2mL cryovials), or equivalent
- Single step filter vials – Restek Thomson SINGLE StEP® Standard Filter Vials, 0.2 µm Nylon membrane, with Black Preslit caps Cat # 25891 or equivalent; used in sample pre-screening
- Extract/Standard storage containers – 15-mL, 8-mL, or 4-mL narrow-mouth HDPE container - Thermo Scientific item# 2002-9050, 2002-9025, 2002-9125; 2.0-mL screw-top polypropylene cryogenic vials – Grainger item# 6EMV1;1.5-mL snap-cap polypropylene microcentrifuge tubes - Fisher item# 05-408-129; or equivalent
- Large volume conical-bottom PP centrifuge bottles – VWR Cat #89091-000 or equivalent

8.0 REAGENTS & STANDARDS

NOTE: Other volumes of standards and reagents may be prepared to account for expected usage. As long as all ratios are kept constant, this is not considered a deviation from the approved procedure.

NOTE: All stored reagents and standards must be labeled as required by the Preparation and Documentation of Laboratory Standards and Reagents SOP [QA SOP ENV-SOP-WCOL-0083], the Contingency and Emergency Preparedness Plan [HS SOP ENV-SOP-WCOL-0015], the Safety Manual [Corp Manual COR-MAN-HSE], and the Laboratory Quality Manual [ENV-MAN-WCOL-0001].

NOTE: Reagents may be purchased from any approved vendor that can provide a certificate of analysis. All standards must be prepared using certified reference materials. Follow manufacturer expiration date unless stated otherwise below.

8.1 Reagents

Reagents prepared by the laboratory may be stored in either glass or HDPE containers. Proper cleaning procedures (Section 3) must be followed prior to using the containers.

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- Acetic acid – ACS grade or equivalent, store at room temperature; Fisher cat# A38C-212 or equivalent
    - Acetic acid (0.1%) - dissolve acetic acid (1 mL) in reagent water (1 L), store at room temperature, replace after 3 months
- Acetonitrile – UPLC grade or equivalent, verified before use, store at room temperature; Fisher A996-4 or equivalent
- Ammonium acetate – LC/MS grade or equivalent, store at 2-8° C, replace 2 years after opening date; Fisher A637-500 or equivalent
- Ammonium hydroxide – certified ACS+ grade or equivalent, 30% in water, store at room temperature; Fisher A470-250 or equivalent
    - Aqueous ammonium hydroxide (3%) – add ammonium hydroxide (10 mL, 30%) to reagent water (90 mL), store at room temperature, replace after 3 months
    - Methanolic ammonium hydroxide (0.3%) – add ammonium hydroxide (1 mL, 30%) to methanol (99 mL), store at room temperature, replace after 1 month
    - Methanolic ammonium hydroxide (1%) – add ammonium hydroxide (3.3 mL, 30%) to methanol (97 mL), store at room temperature, replace after 1 month
    - Methanolic ammonium hydroxide (2%) – add ammonium hydroxide (6.6 mL, 30%) to methanol (93.4 mL), store at room temperature, replace after 1 month
- Carbon – EnviCarb® 1-M-USP or equivalent, verified by lot number before use, store at room temperature. Sigma 57210-U
- Eluent B – Acetonitrile, Ultra LCMS grade or equivalent; Fisher A996-4 or equivalent
- Eluent A – 2 mM ammonium acetate in 95:5 water/acetonitrile. Aliquot 0.4 mL of aqueous 5M ammonium acetate in 949.6 mL of water and 50 mL of acetonitrile. Alternatively, dissolve 0.154 g of neat ammonium acetate into 950 mL of water and 50 mL of acetonitrile. Store at room temperature, shelf life is 2 months.
- Formic acid – greater than 96% purity or equivalent, store at room temperature; Acros 147930010 or equivalent
    - Formic acid (aqueous, 0.1 M) – dissolve formic acid (4.6 g / 3.77 mL) in reagent water (1 L), store at room temperature, replace after 2 years
    - Formic acid (aqueous, 0.3 M) – dissolve formic acid (13.8 g / 11.31 mL) in reagent water (1 L), store at room temperature, replace after 2 years
    - Formic acid (aqueous, 5% v/v) – mix 5 mL formic acid with 95 mL reagent water, store at room temperature, replace after 2 years
    - Formic acid (aqueous, 50% v/v) – mix 50 mL formic acid with 50 mL reagent water, store at room temperature, replace after 2 years
    - Formic acid (methanolic 1:1, 0.1 M formic acid/methanol) – mix equal volumes of methanol and 0.1 M formic acid, store at room temperature, replace after 2 years.

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- Methanol – HPLC grade or better, 99.9% purity, store at room temperature; Fisher A452-4 or equivalent
- Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid – add ammonium hydroxide (0.33 mL, 30%), reagent water (0.167 mL) and acetic acid (0.0625 mL) to methanol (9.44 mL), store at room temperature, replace after 1 month. This solution is used to prepare the instrument blank (Section 11.2.1) and sample extract dilutions.
- Reagent water – Laboratory reagent water, test by lot/batch number for residual PFAS content.

8.2 Standards

Prepare standard solutions from materials of known purity and composition or purchase as solutions or mixtures with certification to their purity, concentration, and authenticity. Observe the safety precautions in Section 5.

Purchase of commercial standard solutions or mixtures is highly recommended for this method; however, when these are not available, preparation of stock solutions from neat materials may be necessary. If the chemical purity is 98% or greater, the weight may be used without correction to calculate the concentration of the standard.

When not being used, store standard solutions in the dark at 4 °C, unless the vendor recommends otherwise, in tightly sealed screw-capped vials. Place a mark on the vial at the level of the solution so that solvent loss by evaporation can be detected. Replace the solution if solvent loss has occurred.

Note: ^{18}O-mass labeled perfluoroalkyl sulfonates may undergo isotopic exchange with water under certain conditions, which lowers the isotopic purity of the standards over time.

The laboratory must maintain records of the certificates for all standards for traceability purposes. Copies of the certificates should be provided as part of the data packages in order to check that proper calculations were performed.

- **Extracted Internal Standard (EIS)**

  Isotopically labeled compounds; prepare the EIS solution containing the isotopically labeled compounds listed in Table 2 as extracted internal standards in methanol from stock standards. An aliquot of EIS solution is added to each sample prior to extraction. The list of isotopically labeled compounds in Table 2 represents the compounds that were available at the time this method was validated. Other isotopically labeled compounds may be used as they become available. Prepare the EIS Standard according to the table below:

Component	Aliquot for 2.2 mL Prep	Aliquot for 6.6 mL Prep
MPFAC-HIF-ES	1.1 mL	3.3 mL
Methanol	1.1 mL	3.3 mL

- **Non-Extracted Internal Standard (NIS)**

  Prepare the NIS solution containing the isotopically labeled compounds listed in Table 2 as non-extracted internal standards in methanol from stock standards. An aliquot of NIS solution is added to each sample prior to instrumental analysis. Prepare the NIS Standard using the Wellington Laboratories stock, according to the table below:

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Component	Aliquot for 2.2 mL Prep	Aliquot for 6.6 mL Prep
MPFAC-HIF-IS	1.1 mL	3.3 mL
Methanol	1.1 mL	3.3 mL

- **Native Standards Solutions**

  Prepare spiking solutions containing the method analytes listed in Table 3 in methanol from Wellington stock standards. The solution(s) is used to prepare the calibration standards and to spike the known reference QC samples that are analyzed with every batch. Quantitative standards containing a mixture of branched and linear isomers must be used for method analytes if they are commercially available. Currently, these include PFOS, PFHxS, NMeFOSAA, and NEtFOSAA. Prepare the Primary Dilution Standards (PDS) according to the table below. A set of 10X-dilute PDS solutions (10X PDS A, 10X PDS B, 10X PDS C, 10X PDS D) is then created from the original PDS solutions, as noted below the table. Finally, a separate PDS solution is prepared according to the table below and used for Initial Calibration Verification purposes. This ICV PDS is prepared either from a separate, second source (or separate manufacturer lot) than that used for the original PDS/10XPDS solutions. If a second source or lot is unavailable, a separate preparation using the same stocks is acceptable.

All values in mL	PDS A	PDS B	PDS C	PDS D
PFAC-MXH	1.1			
PFAC-MXI	1.1			
PFAC-MXJ		1.1		
PFAC-MXF			1.1	
PFAC-MXG				1.1
Methanol[1]	0.55	1.1	0.275	1.65
Final Volume	2.75	2.2	1.375	2.75

Note: PDS B and PDS C should routinely be prepared at double volume (4.4 mL and 2.75 mL, respectively) to support preparation of the ICAL standard set. 10X PDS Mixes are prepared by diluting 200 µL each of PDS A, B, C, and D with 1.2 mL of MeOH for a final volume of 2 mL. Alternately, create four separate solutions by diluting 200 µL of PDS A, B, C, or D with 1.8 mL of MeOH for a final volume of 2 mL each. The ICAL L1-L4 solutions described below are prepared using a single 10X PDS solution.

- **ICV PDS Preparation** – Prepare ICV standards using the Absolute Standards 1633 PFC Mix (catalogue # 63735), following the tables below.

All values in µL	ICV PDS
1633 PFC Mix	100
Methanol[1]	900
Final Volume	1000

[1] *Methanolic Ammonium Hydroxide (1%)*

- **ICV Standard Preparation** – prepare the final ICV analytical standard using the ICV PDS and following the table below:

Component	Aliquot for ICV STD (µL)

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ICV PDS	10
EIS	20
NIS	20
Water	80
Acetic Acid	12.5
Methanol[1]	1857.5
Final Volume	2000

[1] *Methanolic Ammonium Hydroxide (1%)*

- **Calibration Standard Solutions**

  A series of calibration solutions containing the target analytes and the EIS and NIS is used to establish the initial calibration of the analytical instrument. The concentration of the method analytes in the solutions varies to encompass the working range of the instrument, while the concentrations of the EIS and NIS remain constant. The calibration solutions are prepared using methanolic ammonium hydroxide (1%), water, acetic acid and the method analyte and isotopically labeled compound standard solutions. After dilution, the final solution will match the solvent mix of sample extracts, which contain methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid (Section 8.1). Calibration standard solutions do not undergo solid phase extraction/cleanup. Prepare the calibration standard solutions according to the table below:

Component[1]	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
10X PDS MIX	12.5	25	62.5	156.25						
PDS A/B/C/D					31.25	62.5	156.25	312.5	625	781.25
EIS	50	50	50	50	50	50	50	50	50	50
NIS	50	50	50	50	50	50	50	50	50	50
Water	200	200	200	200	200	200	200	200	200	200
Acetic Acid	31.25	31.25	31.25	31.25	31.25	31.25	31.25	31.25	31.25	31.25
Methanol[2]	4656.25	4643.75	4606.25	4512.5	4543.75	4418.75	4043.75	3418.75	2168.75	1543.75
Final Volume	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

[1] *All values listed are µL*

[2] *Methanolic Ammonium Hydroxide (1%)*

Concentrations for calibration solutions are presented in Table 3. A minimum of six contiguous calibration standards are required for a valid analysis when using a linear calibration model, with at least five of the six calibration standards being within the quantitation range (e.g., from the LOQ to the highest calibration standard). If a second- order calibration model is used, then a minimum of seven calibration standards are required, with at least six of the seven calibration standards within the quantitation range. The lowest level calibration standard must meet a signal-to-noise ratio of 3:1 and be at a concentration less than or equal to the Limit of Quantitation (LOQ). All initial calibration requirements listed in Section 9.2 must be met.

Note: Additional calibration standards, at levels lower than the lowest calibration standard listed in the method, may be added to accommodate a lower limit of quantitation if the instrument sensitivity allows. Calibration standards at the high end of the calibration may be eliminated if the linearity of the instrument is exceeded or at the low end if those calibration standards do not meet the S/N ratio criterion of 3:1, so long as the required number of calibration points is met.

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All analytes with commercially available stable isotope analogues must be quantified using isotope dilution.

- **Qualitative Standards**

  Standards that contain mixtures of the branched and linear isomers of the method analytes and that are used for comparison against suspected branched isomer peaks in field samples. These qualitative standards are not required for those analytes where the quantitative standards in Section 8.2 already contain the branched and linear isomers. Qualitative standards that are currently commercially available include PFOA, PFNA, PFOSA, NMeFOSA, NEtFOSA, NEtFOSE, and NMeFOSE. Create an intermediate standard containing all the qualitative standards at a concentration of 1 µg/mL (40uL of each stock into 2mL FV in MeOH) and use that to prepare the check standard according to the table below. Use the following Wellington Laboratories catalogue items to prepare the intermediate standard: T-PFOA, P355TMHxA (PFNA isomer), P4MOA (PFNA isomer), ipPFNA, br-FOSA, br-NMeFOSA, br-NEtFOSA, br-NMeFOSE, br-NEtFOSE.

Component	Aliquot for Isomer Check STD (µL)
Isomer Intermediate STD	20
EIS STD	20
NIS STD	20
Water	80
Acetic Acid	12.5
Methanol[1]	1847.5
Final Volume	2000

- **Instrument Blank**

  A solvent blank is analyzed at the beginning of each analytical sequence, to demonstrate clean instrumental background, and after samples containing high levels of target compounds (e.g., calibration, CCV) to monitor carryover from the previous injection. The instrument blank consists of clean reagent fortified with the EIS and NIS for quantitation purposes. Prepare the IBLK using Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid solution and an appropriate volume of EIS and NIS; alternatively, prep the IBLK from 934 uL of 1% Methanolic ammonium hydroxide, 40 uL of reagent water, 6.25 uL of acetic acid, and 10 uL each of EIS and NIS.

- **Bile Salts Check Standard containing Taurodeoxycholic Acid (TDCA)**

  TDCA is used to evaluate the chromatographic program relative to the risk of an interference from bile salts in samples. A solution is prepared at a concentration of 10 ng/mL in the same solvent as the calibration standards and is analyzed with each calibration and at the beginning of each analytical sequence Using Cayman Chemical item# 15935 (or equivalent), create a stock standard and use it to create an intermediate standard with a concentration of 1 µg/mL. Use the intermediate standard to prepare the Bile Salts Check Standard according to the table below.

Component	Aliquot for Bile Salts Check STD (µL)
Intermediate TDCA Standard	100
EIS STD	100

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NIS STD	100
Water	400
Acetic Acid	62.5
Methanol[1]	9237.5
Final Volume	10000

[1] *Methanolic Ammonium Hydroxide (1%)*

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Support Equipment

Incubators, water baths, refrigerator units, freezer units, bottle top dispensers, pipettes, thermometers, and ovens are maintained and verified as required by the Equipment and Instrumentation SOP [QA SOP ENV-SOP-WCOL-0080].

The balance is verified at the beginning of each analytical day using a certified weight set. Refer to the Equipment and Instrumentation SOP [QA SOP ENV-SOP-WCOL-0080] for balance verification procedures and acceptance criteria.

9.1.2 Instrument Set Up

9.1.2.1 Routine Instrument Operating Conditions

All maintenance activities are listed in daily maintenance logs that are assigned to each instrument.

9.2 Calibration

Mass Calibration – The mass spectrometer must undergo mass calibration to ensure accurate assignments by the instrument. This mass calibration must be performed at least annually to maintain instrument sensitivity and stability. Mass calibration must be repeated on an as-needed basis (e.g., QC failures, ion masses fall outside of the instrument required mass window, major instrument maintenance, or if the instrument is moved). Mass calibration must be performed using the calibration compounds and procedures prescribed by the manufacturer. The procedures used for mass calibration and mass calibration verification must evaluate an ion range that encompasses the ion range (Q1 and Q2 m/z) of the analytes of interest of this method.

Mass Calibration Verification – A mass calibration verification must be performed following mass calibration, prior to standard and sample analyses. Mass verification checks must also be performed after any subsequent mass calibrations. The laboratory must follow the instructions for the individual instrument software to confirm the mass calibration, mass resolution and peak relative response. Mass calibration verification must be performed using standards whose mass range brackets the masses of interest (quantitative and qualitative ions). Check the instrument mass resolution to ensure that it is at least unit resolution. Unit resolution is demonstrated when the value of the peak width at half-height is within 0.5 ± 0.1 amu or Da.

Multiple Reaction Monitoring (MRM) is required to achieve better sensitivity with the mass spectrometer than full-scan analysis. The ions to be monitored (quantitation and confirmation

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transitions, also referred to as precursor and product ions) for each native compound, EIS, and NIS are given in Table 2.

The chromatographic conditions should be optimized for compound separation and sensitivity. The same optimized operating conditions must be used for the analysis of all standards, blanks, IDOCs, MDL and LCS standards, and samples. Different instruments may require slightly different operating conditions. Modification of the solvent composition of the standard or extract by increasing the aqueous content to prevent poor peak shape is not permitted. The peak shape of early eluting compounds may be improved by increasing the volume of the injection loop or increasing the aqueous content of the initial mobile phase composition.

Retention Time (RT) calibration – After RT windows have been empirically confirmed for each analyte, once per ICAL and at the beginning of the analytical sequence, the position of each method target analyte, EIS analyte, and NIS analyte peak shall be set using the midpoint standard of the ICAL curve when ICAL is performed. When ICAL is not performed, the initial CCV retention times or the midpoint standard of the ICAL curve can be used to establish the RT window position.

Native target analyte, EIS analyte, and NIS analyte RTs must fall within 0.4 minutes (24 sec) of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the analytical batch. All branched isomer peaks identified in either the calibration standard or the qualitative standard must fall within in the retention time window for that analyte.

For all target analytes with exact corresponding isotopically labeled analogs, target analyte peaks must elute within ±0.1 minutes (±6 sec) of the associated EIS.

When establishing the chromatographic conditions, it is important to consider the potential interference of bile salts during analyses of samples. Inject the Bile Salt Check standard (Sections 8.2., 9.2.3) during the retention time calibration process and adjust the conditions to ensure that TDCA does not coelute with any of the target analytes, EIS, or NIS standards. Analytical conditions must be set to allow a separation of at least 1 minute between TDCA and PFOS.

9.2.1 Calibration Design

Prior to the analysis of samples, and after the mass calibration check has met all criteria in Section 9.1.2, each LC-MS/MS system must be calibrated at a minimum of 6 standard concentrations (Section 8.2 and Table 3). This method procedure calibrates and quantifies 40 PFAS target analytes, using the isotopically labeled compounds added to the sample prior to extraction, by one of two approaches:

- Isotope Dilution quantification (ID), whereby the response of the target compound is compared to the response of its isotopically labeled analog; twenty-four target compounds are quantified in this way.

- Extracted Internal Standard quantification (EIS), whereby the response of the target compound is compared to the response of the isotopically labeled analog of another compound with chemical and retention time similarities; sixteen target compounds are quantified in this way.

Initial calibration is performed using a series of at least six solutions, with the concentrations of at least five of the six calibration standards being within the quantification

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range. If a second-order calibration model is used, one additional concentration is required. The initial calibration solutions contain the entire suite of EIS, NIS, and target compounds. Calibration is verified at least once every ten field samples with a calibration verification (CV/CCV) standard, performed by analysis of a mid-level calibration solution. Calibration verification uses the mean RRs or RFs determined from the initial calibration to calculate the analyte concentrations in the verification standard.

Note: Six is the minimum number of calibration standards that must be used in the initial calibration; however, the laboratory may use more standards, as long as the criteria in Section 9.2.3 can be met.

Each LC-MS/MS system must be calibrated whenever the laboratory takes corrective action that might change or affect the initial calibration criteria, or if either the CCV or ISC acceptance criteria have not been met.

9.2.2 Calibration Sequence

Calibration standards must be analyzed in sequence from lowest to highest concentration to minimize the chance that carryover from a higher concentration standard will boost the area of a lower concentration standard. A typical sequence for days when calibration is required is shown below.

Description[1]	Comment
ICAL L1	
ICAL L2	
ICAL L3	
ICAL L4	
ICAL L5	
ICAL L6	
ICAL L7	
ICAL L8	
ICAL L9	
ICAL L10	
IBLK	Must be <1/2 LOQ
ICV	%R must be 70 – 130%
ISOMER CHECK	
BILE SALTS CHECK	TDCA must be resolved by ≥1 min from PFOS
CCV (ISC)	%R must be 70-130%; begins and ends Analytical Sequence

[1]*See Table 3 for calibration concentrations.*

9.2.3 Calibration Evaluation

If the criteria for initial calibration are not met, inspect the system for problems and take corrective actions to achieve the criteria. This may require the preparation and analysis of fresh calibration standards. All initial calibration criteria must be met before any samples or required blanks are analyzed.

Instrument Sensitivity – Sufficient instrument sensitivity is established if a signal-to-noise ratio ≥ 3:1 can be achieved when analyzing the lowest concentration standard within the quantitation range that the laboratory includes in its assessment of calibration linearity (see Table 3).

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9.2.3.1 Curve Fit

One of the following two approaches must be used to evaluate the linearity of the instrument calibration. Weighting (typically 1/x or 1/x2) is allowed for linear and non-linear regressions. If a weighted or non-weighted regression is used, it may not be forced through zero.

If these criteria cannot be met, the analyst will have difficulty meeting ongoing QC criteria. It is recommended that corrective action is taken to reanalyze the ICAL standards, restrict the range of calibration, or select an alternate method of calibration.

If more than the minimum number of standards are analyzed and levels are excluded from the calibration, only the lowest or highest standards may be excluded, except as noted here. The removal of calibration levels from the interior of the curve is allowed only when there is sound technical reason for doing so and when the level is removed for all analytes; for example, when it can be proven that the wrong standard was analyzed for the calibration level or there is obvious evidence that the instrument malfunctioned during injection of the standard. The removal of any calibration level from the interior of the curve must be approved by the department supervisor/manager. Management approval and the rationale for the level removal must be documented and kept with the technical record.

Replacing a calibration standard may sometimes be needed to correct for a technical problem that occurred during analysis such as power failure, incomplete injection of the standard, or a similar situation. Replacement of one standard, when analyzed within 24 hours of original analysis time and replacing all analytes in the original standard, is permitted. The replacement of the standard must be approved by the department supervisor/manager; approval and the reason for replacement must be documented and kept with the technical record.

9.2.3.2 Relative Error

Option 1: Calculate the relative standard deviation (RSD) of the RR or RF values of the initial calibration standards for each native compound and isotopically labeled compound. The RSD must be ≤ 20% to establish instrument linearity.

Option 2: Calculate the relative standard error (RSE) of the initial calibration standards for each native compound and isotopically labeled compound. The RSE for all method analytes must be ≤ 20% to establish instrument linearity.

9.2.3.3 Initial Calibration Verification

As part of the IDOC, each time a new Analyte PDS is prepared, and once after each ICAL, analyze an ICV sample prepared from a second source (different from the source of the ICAL standards). If a second vendor is not available, then a different lot of the standard from the same vendor should be used. The ICV should be prepared and analyzed just like a CCV. Acceptance criteria for the ICV are identical to the CCVs: the calculated concentration for each analyte must be within ± 30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, correct the problem and rerun the ICV. If the problem

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persists, repeat the ICAL. Samples are not to be analyzed until the ICAL has been verified by acceptable ICV accuracy. The lab will add additional target analytes to the ICV mix as second source standards become commercially available.

Qualitative Isomer Check – Calibration standards for PFOS, PFHxS, NMeFOSAA and NEtFOSAA contain both branched and linear isomers. For target compounds which have multiple chromatographic peaks due to branched and linear isomers, but for which quantitative standards are not available, a qualitative isomer check is analyzed with each calibration event and at the beginning of each analysis sequence to demonstrate the peak shape and retention time of the branched isomers. See Section 10.1 for integration information.

Bile Salts Check – The laboratory must analyze a Bile Salts Check standard (Section 8.2) after the initial calibration, and prior to the analysis of samples, to check for interferences caused by bile salts. If an interference is present, the chromatographic conditions must be modified to eliminate the interference from TDCA (e.g., changing the retention time of TDCA such that it is resolved from PFOS by at least one minute), and the initial calibration repeated. This requirement only applies when analyzing tissue samples and/or when following DoD QSM Table B-24 prescriptions.

9.2.3.4 Continuing Calibration Verification

After a passing MS resolution and a successful initial calibration is achieved and prior to the analysis of any samples, the calibration is verified by injecting an aliquot of the appropriate concentration ICAL standard, analyzed with the same conditions used during the ICAL. CCV is performed at the beginning of each analytical sequence (fulfilled by the Instrument Sensitivity Check; see below), after every ten samples, and at the end of the analytical sequence. In this context, a “sample” is defined as a field sample. MBs, CCVs, LCSs, MSs, FDs, TBs and MSDs are not counted as samples. All CCV analyses are performed using the mid-level ICAL standard, except for the daily Instrument Sensitivity Check, as noted below.

Calculate concentration for each native and EIS compound in the CCV using the equation in Section 10.3. The recovery of native and EIS compounds for the CCVs must be within 70 – 130%. If the CCV criteria are not met, recalibrate the LC-MS/MS according to Section 9.2. Alternately, the analyst may immediately analyze two CCVs for confirmation. If both confirmation CCV analyses meet the recovery criteria, analysis may proceed; however, the analyst must rerun any samples that were analyzed after the failing CCV and before the 2 passing CCVs. If either of the 2 confirmation CCV analyses fails to meet the acceptance criteria, recalibrate the LC-MS/MS according to Section 9.2.

If an individual target compound recovery in a CCV is above the upper control limit and all associated samples are ND for that compound, the data for those samples may be reported. In such cases, a narrative statement must be included in the report indicating the specific compound result that was biased high in the CCV, and that samples were ND for that compound and thus reportable.

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Instrument Sensitivity Check (ISC) – An ISC at the concentration of the lowest calibration standard within the quantitation range is required to be analyzed at the beginning of the analytical run (Section 9.4). The signal-to-noise ratio (Section 10.1.1) of the ISC must be greater than or equal to 3:1. Recovery of the native and EIS compounds for the ISC must be within 70-130%. If the requirements cannot be met, the problem must be corrected before analyses can proceed.

9.3 Sample Preparation

This section describes the sample preparation procedures for aqueous samples with <100 mg/L Suspended Solids (Section 9.3.3) and solid samples (soil, sediment or biosolid; Section 9.3.4). For solid samples and aqueous samples that contain particles, percent solids are determined using the procedures in Section 9.3.2. This section also describes the solid phase extraction (SPE, Section 9.3.5) and extract cleanup protocols for all matrices (Sections 9.3.6 – 9.3.7).

Note: The laboratory may choose to pre-screen some samples prior to performing the analysis, following the protocol described in Appendix C. For aqueous samples, use the secondary container provided for suspended solids to perform the pre-screening. If high levels of PFAS are present in the sample, a lower volume is required for analysis.

Do not use any fluoropolymer articles or task wipes in these extraction procedures. Use only HDPE or polypropylene wash bottles and centrifuge tubes. Reagents and solvents for cleaning syringes may be kept in glass containers.

9.3.1 Homogenization & Subsampling

The laboratory may subsample the aqueous samples as described in Appendix D; however, subsampling must meet project-specific requirements. The laboratory must notify the client that subsampling has occurred. Subsampling is acceptable for samples which exceed the 100 mg/L SS method application limit, samples which require greater than a 10X dilution for over-range detections or are known/expected to be highly contaminated, and samples which fail the acceptance criteria for EIS compounds (see Section 9.4.2). Any time subsampling is required, no less than 2% of the typical extracted volume (or mass) may be subsampled. In cases where less than 2% of an aqueous sample is required for subsample (i.e., less than 10 mL, or less than 2 mL for leachates), serial dilution must be employed.

9.3.2 Determination of Percent Solids

Percent solids analysis must be performed on all solid samples prior to preparation and analysis. Determination of Suspended Solids (SS) in aqueous samples may be omitted based on visual inspection of the sample by a trained analyst. If, upon visual inspection, an aqueous sample contains SS at a level the analyst deems likely to clog the SPE cartridge, that sample shall be centrifuged following the procedures in Appendix F. Alternatively, the procedure in the following paragraph may be followed.

Suspended Solids in aqueous liquids and multi-phase samples consisting of mainly an aqueous phase – aqueous samples will be logged in for both DM1633 and TSS analysis. The TSS analysis will follow the Method SM2540D protocol, with the analyst filtering ≥50 mL of aqueous sample, and the LOQ being adjusted accordingly. This should provide an LOQ of ≤100 mg/L. Any aqueous sample returning a SS content of >100 mg/L shall be

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diluted following the prescriptions in Section 9.4.2. Samples containing 100-499 mg/L SS will be subsampled and prepared at a 5X dilution; samples containing 500-999 mg/L SS will be subsampled and prepared at a 10X dilution; samples containing 1000-1999 mg/L will be subsampled and prepared at a 20X dilution. If a sample contains SS ≥2000 mg/L, continue the dilution series for 50, 100, 200, 500, 1000, or 2000X dilutions, as needed. If an aqueous sample contains >20,000 mg/L SS, the lab should contact the client and consider resampling or preparing by alternate means (i.e., as a biosolid).

Percent Solids in solid samples (excluding tissues) – Along with DM1633, all solid samples will be logged in for both a percent solids analysis following SM2540 and a pre-extraction percent solids check following the protocol below. The percent solids check will be used to guide solid sample processing (see Section 9.3.4).

- Weigh 5 to 10 g of sample to three significant figures (0.01 g) in a tared crucible
- Dry a minimum of 12 hours at 110 ± 5 °C. Cool in a desiccator.
- Weigh beaker with dried sample. Calculate percent solids using the equation below:

$$\%\ solids = \frac{weight\ of\ sample\ aliquot\ after\ drying\ (g)}{weight\ of\ sample\ aliquot\ before\ drying\ (g)}\ x\ 100$$

9.3.3 Aqueous Sample Processing

This method is applicable to aqueous samples containing up to 100 mg/L SS per sample. Therefore, aqueous sample preparation cannot begin until the analyst has visually inspected each sample and determined the best protocol for each sample, as discussed above. TSS analysis may or may not be part of that protocol. This procedure requires the preparation of the entire sample. Smaller sample volumes may be analyzed for samples containing SS greater than specified for this method, or when unavoidable due to high level of PFAS. Typical sample size is 500 mL; however, sample size may vary, depending on project requirements, applicable regulations, and sample characteristics. The sample is to be analyzed in its entirety and should not be filtered. Leachate samples are analyzed using a 100 mL sample volume. Therefore, they must not be included in the same sample preparation batch as aqueous samples analyzed using 500 mL sample volumes.

Homogenize the sample by inverting the sample 3 – 4 times. Do not filter the sample. The standard procedure is to analyze the entire sample, plus a basic methanol rinse of the container. Refer to Appendix F for container rinse protocols for aqueous samples requiring centrifugation.

The volume of the aqueous sample analyzed is determined by weighing the full sample bottle and then the empty sample bottle. Weigh each sample bottle (with the lid) to the nearest 0.1 g. For aqueous samples requiring centrifugation, sample volume should be measured following the protocols in Appendix F.

Prepare a method blank and two LCSs using PFAS-free water in HDPE bottles. Select a volume of water that is typical of the samples in the batch. Spike one LCS sample with native standard solution at 2x the LOQ (25 µL each of 10XPDS A/B/C/D). This aliquot

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(LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (30 µL each of PDS A/B/C/D). This aliquot will serve as the traditional LCS. If any of the samples in an extraction batch require centrifugation, the batch QC samples (MB, LLLCS, LCS) must also be taken through the same protocols, including sample transfer, centrifugation, and container rinsing protocols.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples with native standard solution (Section 8.2) at a concentration equivalent to the mid-level calibration point.

Spike a 50 µL aliquot of EIS solution (Section 8.2) directly into the sample in the original bottle (or subsampled bottle) as well as to the bottles prepared for the QC samples. Mix by swirling or inverting the sample container.

Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid (Section 8.1) or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The sample is now ready for solid-phase extraction (SPE) and cleanup (Sections 9.3.5). Analyst must make sure to record extraction manifold ID# and manifold position for each QC sample and field sample being extracted.

9.3.4 Solid Sample (excluding tissues) Processing

Mix the sample in its original jar. If it is impractical to mix the sample within its container transfer the sample to a larger container. Mix the sample thoroughly, stirring from the bottom to the top and in a circular motion along the sides of the jar, breaking particles up by pressing against the side of the container. The homogenized sample should be even in color and have no separate layers. Store the homogenized material in its original container or in multiple smaller containers. Determine the percent solids as per Section 9.3.2.

Note: The target sample weight for sediment or soil is 5 g dry weight. The target sample weight for biosolids is 0.5 g dry weight. Small amounts of reagent free water used for method blanks (10% of sample weight or less) can be added to unusually dry samples. This is an option, not a requirement.

Check the LIMS system for the percent solids check data associated with the samples to be prepared. Using the percent solids check data and the calculation below, weigh out an aliquot of each solid sample, not dried, into a 50 mL polypropylene centrifuge tube. Sample mass should be within ±0.2 g of target mass for soil and sediment samples, and within ±0.02 g of target mass for biosolids samples. Sample aliquot should provide 5 g dry weight (WiDry below) for soil and sediment or 0.5 g dry weight for biosolids. Because biosolid samples are analyzed with a 0.5 g sample mass, they must not be included in the same sample preparation batch as solid samples analyzed with 5 g sample masses.

$$Solid\ Sample\ Target\ Mass\ (g) = \frac{Wi_{Dry}\ (g)}{\%\ solids\ (decimal)}$$

Prepare batch QC samples using 5 g of reference solid (Section 7.2) wetted with 2.5 g of reagent water for the method blank and two LCSs (use 0.5 g of reference solid with 0.25 g of reagent water for biosolid extraction batches). The addition of reagent water to the sand provides a matrix closer in composition to real-world samples. Spike one LCS

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sample with native standard solution at 2x the LOQ (25 µL each of 10XPDS A/B/C/D). This aliquot (LLLCS) will serve to verify the LOQ. Spike the other LCS sample at a concentration near the mid-level calibration point (30 µL each of PDS A/B/C/D). This aliquot will serve as the traditional LCS.

Note: If matrix spikes are required for a specific project, spike the field sample bottles designated for use as MS/MSD samples with native standard solution (Section 8.2) at a concentration equivalent to the mid-level calibration point.

Spike a 50 µL aliquot of EIS solution (Section 8.2) directly into each centrifuge tube containing the aliquoted field and QC samples. Vortex or shake the sample to disperse the standard and allow to equilibrate for approximately 30 minutes.

Add 10 mL of 0.3% methanolic ammonium hydroxide (Section 8.1) to each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 2800 rpm for 10 minutes and transfer the supernatant to a clean 50 mL polypropylene centrifuge tube.

Add 15 mL of 0.3% methanolic ammonium hydroxide to the remaining solid sample in each centrifuge tube. Vortex to disperse, then shake for 30 minutes on a variable speed mixing table. Centrifuge at 2800 rpm for 10 minutes and decant the supernatant from the second extraction into the centrifuge tube with the supernatant from the first extraction.

Add another 5 mL of 0.3% methanolic ammonium hydroxide to the remaining sample in each centrifuge tube. Shake by hand to disperse, centrifuge at 2800 rpm for 10 minutes and decant the supernatant from the third extraction into the centrifuge tube with supernatant from the first and second extractions.

Using a 10 mg scoop, add 10 mg of carbon (Section 8.1) to the combined extract, mix by occasional hand shaking for no more than five minutes and then centrifuge at 2800 rpm for 10 minutes. Immediately decant the extract into a 60-mL glass or plastic evaporation or concentrator tube.

Dilute to approximately 35 mL with reagent water. A separate concentrator tube marked at the 35 mL level may be kept for a visual reference to get the approximate volume, but a close accounting of all water present in the sample should be maintained by the analyst regardless. Samples containing more than 50% water may yield extracts that are greater than 35 mL in volume; therefore, do not add water to these. Adding water to the sample extract is recommended for dry solid samples. Determine the water content in the sample as follows (percent moisture is determined from the % solids):

$$Water\ Content\ in\ Sample = \frac{Sample\ Weight\ (g)\ x\ Moisture\ (\%)}{100} + water\ added\ earlier$$

Or, if the Target Solid Sample Mass equation was used and the target sample mass was aliquoted for extraction as calculated, determine the water content in the sample as follows (use 0.5 instead of 5 for biosolid samples):

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$$Water\ Content\ in\ Sample\ (g)\ =\ Recorded\ Solid\ Sample\ Mass\ (g) - 5$$

Concentrate each extract at approximately 55 ºC with a N2 flow of approximately 1.2 L/min to a final volume that is based on the water content of the sample (see table below). Allow extracts to concentrate for 25 minutes, then mix (by vortex if the volume is < 20 mL or using a glass pipette if the volume is > 20 mL). Continue concentrating and mixing every 10 minutes until the extract has been reduced to the required volume as specified in the table below. If the extract volume appears to stop dropping, the concentration must be stopped and the volume at which it was stopped recorded. The concentrated extract must still contain some methanol, about 5-10 mL. The pre-cleanup extract (last paragraph of this section) should contain no more than 20% methanol. The laboratory has flexibility to modify the volumes used to achieve this goal. In some situations, the laboratory may prefer not to add water in the step above ("dilute to approximately 35mL reagent water"). The following table provides guidance to help determine the final extract volume, based on the water content of the original solid sample. A good rule of thumb is to make the "Concentrated Final Volume" 7-10 mL above the "Water Content in Sample" value.

Water Content in Sample[1]	Concentrated Final Volume
< 5 g	12 mL
5 – 8 g	12-15 mL
8 – 9 g	15-18 mL
9 – 10 g	16-19 mL

[1]Determined from the % solids results determined in Section 9.3.2, and includes any water added to the sample or extract in the steps above.

Note: Slowly concentrating extracts, in 1 mL increments, is necessary to prevent excessive concentration and the loss of neutral compounds (methyl and ethyl FOSEs and FOSAs) and other highly volatile compounds. The extract must be concentrated to remove the methanol as excess methanol during SPE clean-up results in poor recovery of C13 and C14 carboxylic acids and C10 and C12 sulfonates. If all the methanol is evaporated, the neutral compounds are likely to have poor recovery; if too much methanol is in the final concentrated extract, then the longer-chain compounds are likely to have poor recovery.

Add 40 - 50 mL of reagent water to the extract and vortex. Check that the pH is 6.5 ± 0.5. If necessary, adjust pH with 50% formic acid (Section 8.1) or ammonium hydroxide (or with 5% formic acid and 3% aqueous ammonium hydroxide). The extract is now ready for solid-phase extraction (SPE) and cleanup (Sections 9.3.5 and 9.3.7).

9.3.5 Solid Phase Extraction

All matrices (including batch QC) must undergo SPE and carbon cleanup to remove interferences. The SPE cartridge conditioning and sample loading process described below is for use with all matrices; SPE cartridge elution and any additional extract treatment is matrix specific and may be found in Sections 9.3.6 and 9.3.7.

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Note: Carbon cleanup is required. Carbon cleanup may remove analytes if the sample has a very low organic carbon content (this is unusual for non-drinking water environmental samples). This will be apparent if the isotope dilution standard recoveries are significantly higher on the reanalysis. If the laboratory can demonstrate that the carbon cleanup is detrimental to the sample analysis (by comparing results when skipping the carbon cleanup during reanalysis), then the carbon cleanup may be skipped for that specific sample. Carbon cleanup is performed prior to the SPE process for solid samples.

Pack clean silanized glass wool to half the height of the WAX SPE cartridge barrel (Section 7.1).

Set up the vacuum manifold with one WAX SPE cartridge plus a reservoir and reservoir adaptor for each cartridge for each sample and QC aliquot.

Pre-condition the cartridges by washing them with 15 mL of 1% methanolic ammonium hydroxide followed by 5 mL of 0.3M formic acid (Section 8.1). Do not allow the WAX SPE to go dry. Discard the wash solvents.

Pour the sample into the reservoir (do not use a pipette), taking care to avoid splashing while loading. Adjust the vacuum and pass the sample through the cartridge at approximately 5 mL/min. Retain the empty sample bottle for later rinsing (Section 9.3.6 and 9.3.7). Discard eluate.

Note: For aqueous samples, in the event the SPE cartridge clogs during sample loading, first attempt to rinse and dry the clogged cartridge, following protocol in the following paragraph. The cartridge is then ready for elution. Place a second cartridge in the appropriate manifold location and pre-condition as above. Continue loading the remaining sample aliquot on the second cartridge, using the same reservoir. Proceed to next step.

Rinse the walls of the reservoir with 5 mL reagent water (twice) followed by 5 mL of 1:1 0.1M formic acid/methanol (Section 8.1) and pass those rinses through the cartridge using vacuum. Dry the cartridge by pulling air through. Discard the rinse solution. Continue to the elution and concentration steps based on the matrix.

9.3.6 Elution, Cleanup, and Filtration of Aqueous Sample Extracts

Note: If two cartridges were used, each cartridge must separately be submitted to the elution steps described below. Elute both cartridges into the same collection tube, using 5 mL of elution solvent for each. One of the elution aliquots must be used to perform the sample bottle rinse prior to eluting the cartridge. Using a gentle stream of Nitrogen and 55 ºC water bath to concentrate the ~10 mL of combined eluate to ~5 mL, then follow the carbon cleanup and filtration steps below. This concentration step is only applicable to situations where two SPE cartridges were eluted, each with 5 mL of elution solvent.

Place clean collection tubes inside the manifold, ensuring that the extract delivery needles do not touch the walls of the tubes. Resume vacuum and ensure a proper seal is achieved. DO NOT add NIS to these collection tubes.

Add 5 mL of 1% methanolic ammonium hydroxide (Section 8.1) to the sample bottle. Cap the bottle and rotate to ensure all internal surfaces of each bottle are rinsed; avoid vigorous shaking when rinsing the 500 mL aqueous sample bottles with only 5 mL of methanol –

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any evaporation/vaporization will contribute to loss of extract here. After rinsing the inside of the sample bottle, pour the rinse from the bottle or use a plastic transfer pipette to transfer the rinse to the SPE reservoir, using it to wash the walls of the reservoir. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

Note: Air dry the empty sample bottle after the rinse is transferred. Weigh the empty bottle with the cap on and subtract that from the weight of the bottle with sample, determined in Section 9.3.3.

Add 25 µL of concentrated acetic acid to each sample eluted in the collection tubes and vortex to mix. Add 10 mg of carbon (Section 8.1) to each sample and batch QC extract, using a 10 mg scoop. Shake by hand occasionally for no more than 5 minutes. It is important to minimize the time the sample extract is in contact with the carbon. Immediately vortex (30 seconds) and centrifuge at 2800 rpm for 10 minutes.

Remove the plunger from a 5-mL polypropylene syringe and place a syringe filter (25-mm filter, 0.2-µm nylon membrane) onto the syringe; repeat to prepare one syringe for each sample in the prep batch. Add 50 µL NIS solution (Section 8.2) to a clean collection tube for each sample prepared. Carefully decant the sample supernatant into the syringe barrel. Replace the plunger and filter the entire extract into the new collection tube containing the NIS. Repeat for all samples in the prep batch. Vortex to mix and transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

Note: Avoid attaching the filter to the syringe before removing the plunger from the syringe barrel, as the syringe disk filters can be compromised by the sudden vacuum created when the plunger is removed.

9.3.7 Elution and Filtration of Solid Sample Extracts

Place a clean collection tube in the manifold rack for each sample and QC aliquot, ensuring the extract delivery needles are not touching the walls of the tubes. Resume vacuum and ensure a proper seal is achieved.

Rinse the inside of the evaporation/concentrator tube using 5 mL of 1% methanolic ammonium hydroxide (Section 8.1). Then, using a plastic transfer pipette, transfer the rinse to the SPE reservoir, washing the walls of the reservoir. Allow the elution solvent to soak the SPE sorbent for 2 minutes, then use vacuum to pull the elution solvent through the cartridge and into the collection tubes in a slow, dropwise manner.

Add 25 µL of concentrated acetic acid to each sample extract in its collection tube and swirl to mix. Remove the plunger from a 5-mL polypropylene syringe and place a syringe filter (25-mm filter, 0.2-µm nylon membrane) onto the syringe; repeat to prepare one syringe for each sample in the prep batch. Add 50 µL NIS solution (Section 8.2) to a clean collection tube for each sample prepared. Carefully decant the sample supernatant into the syringe barrel. Replace the plunger and filter the entire extract into the new collection tube containing the NIS. Repeat for all samples in the prep batch. Vortex to mix and transfer a portion of each extract into an autosampler vial for LC-MS/MS analysis. Cap the collection tubes containing the remaining extracts and store at 0 - 6 °C.

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Note: Avoid attaching the filter to the syringe before removing the plunger from the syringe barrel, as the syringe disk filters can be compromised by the sudden vacuum created when the plunger is removed.

9.4 Analysis

Analysis of sample extracts for PFAS by LC-MS/MS is performed running manufacturer's data acquisition software. The mass spectrometer is run with unit mass resolution in the multiple reaction monitoring (MRM) mode.

Perform mass calibration, establish the operating conditions (Section 9.1.2), and perform an initial calibration (Section 9.2) prior to analyzing samples.

Only after all performance criteria are met may blanks, MDLs, IPRs/LCSs, and samples be analyzed.

9.4.1 Example Analytical Sequence

After a successful initial calibration has been completed, an example analytical sequence for a batch of samples analyzed during the same analysis period is as follows. The volume injected for samples and QCs must be identical to the volume used for calibration (Section 9.2). Standards and sample extracts must be brought to room temperature and vortexed prior to aliquoting into an instrument vial to ensure homogeneity of the extract.

- Instrument Sensitivity Check / CCV
- Isomer Check Standard
- Bile Salts Check Standard
- Instrument Blank
- Method Blank
- Low-level LCS (LLLCS)
- LCS
- Samples (10 or fewer)
- CCV
- Instrument Blank
- Samples (10 or fewer)
- CCV
- Instrument Blank

If the results are acceptable, the closing calibration verification solution may be used as the opening solution for the next analytical sequence.

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If the response exceeds the calibration range for any sample, extracts are diluted as per Section 9.4.2 to bring all target responses within the calibration range.

Note: If the analytes that exceed the calibration range in the original analysis are known to not be of concern for the specific project (e.g., are not listed in a discharge permit), then the laboratory may consult with the client regarding the possibility of reporting that sample from the undiluted analysis.

9.4.2 Sample Dilutions

If the measured concentration for any compound exceeds the calibration range of the system, dilute a subsample of the sample extract with the methanolic ammonium hydroxide and acetic acid solution in Section 8.1 by a factor no greater than 10x and analyze the diluted extract. If the responses for each applicable EIS in the diluted extract meet the S/N and retention time requirements in Sections 10.1.1 and 10.1.2, and the EIS recoveries from the analysis of the diluted extract are greater than 5% (uncorrected for the dilution), then the compounds associated with those EISs may be quantified using isotope dilution. Use the EIS recoveries from the original analysis to select the dilution factor, with the objective of keeping the un-adjusted EIS recoveries in the dilution above that 5% lower limit (i.e., if the EIS recovery of the affected analyte in the undiluted analysis is 50%, then the sample should not be diluted more than 10:1). To account for the dilution, adjust the EIS and NIS recoveries as well as reported compound concentrations, detection limits, and LOQs.

If the EIS responses in the diluted extract do not meet the S/N and retention time requirements listed in Sections 10.1.1 and 10.1.2, then the compound cannot be measured reliably by isotope dilution in the diluted extract. In such cases, the lab must subsample a smaller aliquot of any affected aqueous sample and dilute it to 500 mL with reagent water or prepare a smaller aliquot of soil, biosolid, or sediment sample. The reduced sample volume (or mass) chosen for the re-extraction should match the dilution applied to the original extract (i.e., if the original aqueous sample extract was analyzed at a 10X dilution, 50 mL should be subsampled for the re-extraction). To account for the dilution, adjust the reported compound concentrations, detection limits, and LOQs.

If the recovery of any isotopically labeled compound is outside of the acceptance limits (Appendix B) in the original, undiluted analysis, a diluted aqueous sample or smaller aliquot (for solids) must may be analyzed.

10.0 Data Analysis & Calculations

10.1 Qualitative Identification

A native or EIS/NIS compound is positively identified in a standard, blank, sample, or QC sample when all criteria in Sections 10.1.1 through 10.1.3 are met.

10.1.1 Signal-to-noise Ratio (S/N)

Peak responses must be at least three times the background noise level (S/N 3:1). The S/N ratio must be 10:1 if no confirmation ion is used for the analyte. If the S/N ratio is not met due to high background noise, the laboratory must correct the issue (e.g., perform instrument troubleshooting to check and if needed, replace, the transfer line, column, detector, liner, filament, etc.). If the S/N ratio is not met but the background is low, then the

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analyte is to be considered a non-detect. There must also be 10 scans acquired across the peak.

10.1.2 RT Criteria

Target analyte, EIS analyte, and NIS analyte RTs must fall within ± 0.4 minutes of the predicted retention times from the midpoint standard of the ICAL or initial daily CCV, whichever was used to establish the RT window position for the analytical batch. The retention time window used must be of sufficient width to detect earlier-eluting branched isomers. For all method analytes with exact corresponding isotopically labeled analogs, method analytes must elute within ± 0.1 minutes of the associated EIS.

10.1.3 Branched Isomer Integration

For concentrations at or above the method LOQ, the total (branched and linear isomer) quantification ion response to the total (branched and linear isomer) confirmation ion response ratio (ion ratio) must fall within ± 50% of the ratio observed in the mid-point initial calibration standard. If project-specific requirements involve reporting sample concentrations below the LOQ, the ion ratio must also fall within ± 50% of the ratio observed in the initial daily CCV.

The response of all isomers in the quantitative standards should be used to define ion ratios. In samples, the total response should include the branched isomer peaks that have been identified in either the quantitative or qualitative standard. If standards (either quantitative or qualitative) are not available for purchase, only the linear isomer can be identified and quantitated in samples. The ratio requirement does not apply for PFBA, NMeFOSE, NEtFOSE, PFMPA, and PFMBA because suitable secondary transitions are unavailable (not detectable or inadequate S/N).

10.1.4 Qualification

If the field sample result does not meet all criteria stated in Sections 10.1.1 through 10.1.3, and all sample preparation avenues (e.g., extract cleanup, sample dilution, etc.) have been exhausted, the result may only be reported with a data qualifier alerting the data user that the result could not be confirmed because it did not meet the method-required criteria and therefore should be considered an estimated value. If the criteria listed above are not met for the standards, the laboratory must stop analysis of samples and correct the issue.

10.1.5 Manual Integration

Manual integration is sometimes necessary to correct inaccurate automated integrations but must never be used to meet QC criteria or to substitute for proper instrument maintenance and/or method set-up. To assure that all manual integrations are justified and proper all manual integrations must be performed, documented, reviewed, and approved in accordance with corporate SOP ENV-SOP-CORQ-0006, *Manual Integration.* Refer to this SOP for guidance on manual integration techniques and required procedures.

10.2 Quantitative Identification

Concentrations of the target analytes are determined with respect to the extracted internal standard (EIS) which is added to the sample prior to extraction. The EIS is quantitated with respect to a NIS, as shown in Table 2, using the response ratios or response factors from the

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most recent multi-level initial calibration (Section 9.2). Other equations may be used if the laboratory demonstrates that those equations produce the same numerical result as produced by the equations below.

All results for aqueous samples will be reported in ng/L. All results for solid samples will be reported in ng/g, on a dry-weight basis, and the percent solids for each sample will be reported separately. All QC data will be reported with the sample results.

Unless specified otherwise by a regulatory authority or in a discharge permit, results for analytes that meet the identification criteria are reported down to the concentration of the LOQ (Section 11.3.1) established by the laboratory through calibration of the instrument. EPA considers the terms “reporting limit,” “quantitation limit,” “limit of quantitation,” and “minimum level” to be synonymous.

Results for each analyte found in each field sample or QC standard at or above the LOQ will be reported to 3 significant figures. Results for each analyte found in each field sample or QC standard below the LOQ will be reported as “<LOQ,” where LOQ is the concentration of the analyte at the LOQ, or as required by the regulatory/control authority or permit.

Results for each analyte found in a blank at or above the MDL will be reported to 2 significant figures. Results for each analyte found in a blank below the MDL will be reported as “<MDL,” where MDL is the concentration of the analyte at the MDL, or as required by the regulatory/control authority or permit.

Results for any analyte found in a sample or extract that has been diluted will be reported at the least dilute level for which the measured concentration is within the calibration range (e.g., above the LOQ for the analyte and below the highest calibration standard) and in which isotopically labeled compound recoveries are within their respective QC acceptance criteria. This may require reporting results for some analytes from different analyses.

Recoveries of all associated EIS compounds will be reported for all field samples and QC standards.

10.3 Calculations

See the Laboratory Quality Assurance Manual for equations for common calculations.

For the native analytes:

$$Concentration\,(ng/L\,or\,ng/g) = \frac{Area_N M_{EIS}}{Area_{EIS}(\overline{RR}\,or\,\overline{RF})}\,x\,\frac{1}{W_S}$$

Where:

AreaN = The measured area of the Q1 m/z for the native (unlabeled) PFAS

AreaEIS = The measured area at the Q1 m/z for the EIS. See note below.

MEIS = The mass of the EIS added (ng)

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(RR) = Average response ratio used to quantify target compounds by the isotope dilution method

(RF) = Average response ratio used to quantify target compounds by the extracted internal standard method

WS = Sample volume (L) or dry weight (g)

And for the EIS analytes:

$$Concentration\ (ng/L\ or\ ng/g) = \frac{Area_{EIS} M_{NIS}}{Area_{NIS} \overline{RF}_S} x \frac{1}{W_S}$$

Where:

$Area_{EIS}$ = The measured area at the Q1 m/z for the EIS

$Area_{NIS}$ = The measured area of the Q1 m/z for the non-extracted internal standard (NIS)

M_{NIS} = The mass of the added non-extracted internal standard (NIS) compound (ng)

W_S = Sample volume (L) or dry weight (g)

RF_s = Average response factor used to quantify the isotopically labeled compound by the non-extracted internal standard method

Results for native compounds are recovery corrected by the method of quantification. Extracted internal standard (EIS) recoveries are determined similarly against the non-extracted internal standard (NIS) and are used as general indicators of overall analytical quality.

11.0 QUALITY CONTROL & METHOD PERFORMANCE

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples.
Laboratory Control Sample / Ongoing Recovery and Precision Standard	LCS / OPR	1 per batch of 20 or fewer samples.
Low-Level Laboratory Control Sample / Low-Level Ongoing Recovery and Precision Standard	LLLCS / LLOPR	1 per batch of 20 or fewer samples.
Matrix Spike	MS	1 per batch of 20 or fewer samples.
Matrix Spike Duplicate	MSD	1 per batch of 20 or fewer samples.
Sample Duplicate	SD	1 per AFFF sample
Extracted Internal Standard	EIS	All CAL standards, batch QC and field samples.

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Non-extraction Internal Standards	NIS	All CAL standards, batch QC and field samples.

The minimum quality control requirements of this method consist of an initial demonstration of laboratory capability, analysis of samples spiked with isotopically labeled compounds to evaluate and document data quality, and analysis of standards and blanks as tests of continued performance. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

If the method is to be applied to a sample matrix other than water (e.g., soils, biosolids, sediments), the appropriate alternative reference matrix (Section 7.2) is substituted for the reagent water matrix in all performance tests.

The laboratory must make an initial demonstration of the ability to generate acceptable precision and recovery with this method. This demonstration is given in Section 11.4.

Analyses of method blanks (MBs) are required on an on-going basis to demonstrate the extent of background contamination in any reagents or equipment used to prepare and analyze field samples. The procedures and criteria for analyses of a MBs are described in Section 11.1.1.

The laboratory must spike all samples with isotopically labeled compounds to monitor method performance. This procedure is described in Section 11.3. When results of these spikes indicate atypical method performance for samples, the samples are diluted to evaluate whether the performance issue is caused by the sample matrix. Procedures for dilution are given in Section 9.4.2.

The laboratory must, on an ongoing basis, demonstrate that the analytical system is in control through calibration verification and the analysis of ongoing precision and recovery standards (LCS), spiked at low (LLLCS) and mid-level, and blanks. These procedures are given in Sections 9.2.4 and 11.1.2.

11.1.1 Method Blank (MB)

A method blank is analyzed with each extraction batch to demonstrate freedom from contamination. The matrix for the method blank must be similar to the sample matrix for the batch (e.g., reagent water blank or solids matrix blank [Section 7.2]).

Analyze the cleaned extract (Sections 9.3.6, 9.3.7) of the method blank aliquot before the analysis of the LCSs (Section 11.1).

If any PFAS is found in the MB 1) at a concentration greater than the LOQ for the analyte, 2) at a concentration greater than one-third (5% for Wisconsin) of the regulatory compliance limit, or 3) at a concentration greater than one-tenth the concentration in a sample in the extraction batch, whichever is greatest, analysis of samples must be halted, and the problem corrected. Other project-specific requirements may apply; therefore, the laboratory may adopt more stringent acceptance limits for the method blank at their discretion. If the contamination is traceable to the extraction batch, samples affected by the blank must be re-extracted and analyzed, provided enough sample volume is available and the samples are still within holding time.

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Note: For DoD (B-24) compliance, MBs must not show any analytes detected >½ LOQ, > 1/10th the amount measured in any associated sample, or 1/10th the regulatory limit, whichever is greatest.

If continued re-testing results in repeated blank contamination, the laboratory must document and report the failures (e.g., as qualifiers on results), unless the failures are not required to be reported as determined by the regulatory/control authority.

11.1.2 Laboratory Control Sample (LCS)/Ongoing Precision and Recovery (OPR)

Analyze the extract of the LCS/OPR to ensure the analytical process is under control.

Compute the percent recovery of the native compounds by the appropriate quantification method depending on the compound (Sections 9.2.1, 10.2, 10.3). Compute the percent recovery of each isotopically labeled compound by the non-extracted internal standard quantitation method and the equation below:

$$Recovery\ \% = \frac{Concentration\ Found\ (ng/mL)}{Concentration\ Spiked\ (ng/mL)}\ x\ 100$$

For the native compounds and isotopically labeled compounds, compare the recovery to the LCS limits. Analyte recoveries must be within in-house limits if project limits are not provided; otherwise, project limits must be met. Preliminary in-house acceptance criteria of 40-150% must be used for LCS analyses until in-house limits are generated in accordance with Section 14.5.4 of EPA Draft Method 1633. The lower in-house acceptance criteria for LCS recovery cannot be <40%.

If all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may proceed. If, however, any individual concentration falls outside of the given range, the extraction/concentration processes are not being performed properly for that compound. In this event, correct the problem, re-prepare, extract, and clean up the extraction batch and repeat the ongoing precision and recovery test.

11.1.3 Matrix Spike (MS)

Analysis of an MS may be required in each extraction batch. Assessment of method precision can be accomplished by preparation and analysis of a matrix spike duplicate (MSD). See Appendix E for MS/MSD, MS/FD sample selection guidance.

Note: For DoD (B-24) compliance, one MS/MSD pair is required per preparatory batch. For all other regulatory programs, follow project- or client-specific requirements.

Within each extraction batch, a minimum of one pair of sample bottles is spiked as MS/MSD for every 20 samples analyzed. MS/MSD samples are spiked in the same manner as the mid-level LCS.

Analyte recoveries may exhibit matrix effect. For matrix spike samples, acceptance criteria for recovery should match LCS limits. If the % recovery falls outside of the acceptable range, corrective action must occur. The initial corrective action will be to check all calculations. If the calculations are correct, check the recovery of that analyte in the LCS.

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If the recovery of the analyte in the LCS is within limits, then matrix interference has been demonstrated and the laboratory operation may proceed. Analytical reports will show qualifier flags in such cases.

If the recovery for any analyte is outside the acceptance criteria for the matrix spike and the LCS, the laboratory is out of control and corrective action will be taken. Corrective action may include repreparation and reanalysis of the batch. A narrative statement will be added to document the corrective action taken.

RPDs for MS/MSDs should be ≤30%. If the RPD falls outside of the acceptable range, corrective action must occur. The initial corrective action will be to check all calculations. If the calculations are correct, check the recovery of that analyte in the LCS. If the recovery of the analyte in the LCS is within limits, then matrix interference has been demonstrated and the laboratory operation may proceed. Analytical reports will show qualifier flags in such cases.

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix B for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Mass Calibration	MC	Annually and on as-needed basis
Mass Calibration Verification	MCV	After mass calibration
Initial Calibration	ICAL	Prior to analysis, and on as-needed basis
Initial Calibration Verification	ICV	Following each ICAL
Initial Blank	IBLK	Daily prior to analysis and after high standards
Qualitative Isomer Check	QIC	Daily prior to analysis
Bile Salts Check	BSC	Daily prior to DoD-complaint analysis
Instrument Sensitivity Check	ISC	Daily prior to analysis
Continuing Calibration Verification	CCV	After every 10 field samples
Continuing Calibration Blank	CCB	After each CCV
Retention Time Windows	RTW	After ICAL and at the beginning of analytical sequence.

11.2.1 Instrument Blank (IBLK)

One instrument blank (IBLK) is analyzed immediately following the highest ICAL standard analyzed, each analysis day prior to sample analysis, and following each bracketing CCV in a sequence, to check for carryover and instrument contamination. The concentration of each analyte must be ≤ 1/2 the LOQ. If the IBLK does not pass this requirement after the highest ICAL standard, the calibration must be performed using a lower concentration for the highest standard until the acceptance criteria is met. For daily IBLKs, if there are detections between the MDL and ½ LOQ, the IBLK is deemed acceptable, but the data will be appropriately qualified.

11.2.2 Qualitative Isomer Check

A qualitative identification standard (Section 8.2) containing all available isomers (branched and linear) is analyzed once daily at the beginning of the analytical sequence, to confirm the retention time of each linear and known branched isomer or isomer group.

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All required branched isomer peaks must be present and visibly resolved from their corresponding linear peak.

11.3 Method Performance

Routine method performance is validated through analysis of matrix-specific reference samples, including spikes and PTs. Ongoing method performance is monitored through QC samples analyzed alongside samples. The parameters monitored include percent recovery of EIS compounds, blank concentrations, and native compound recoveries.

The specifications contained in this method can be met if the apparatus used is calibrated and maintained properly. The standards used for initial calibration (Section 8.2), calibration verification (Sections 9.2.4), and for initial (Section 11.4) and ongoing (Section 11.1.2) precision and recovery may be prepared from the same source; however, the use of a secondary source for calibration verification is highly recommended whenever available. If standards from a different vendor are not available, a different lot number from the same vendor can be considered a secondary source. A LC-MS/MS instrument will provide the most reproducible results if dedicated to the settings and conditions required for determination of PFAS by this method.

To assess method performance on the sample matrix, the laboratory must spike all samples with the EIS solution (Section 8.2) and all sample extracts with the NIS spiking solution (Section 8.2). Analyze each sample according to the procedures in this SOP. Compute the percent recovery of the EIS compound concentration using the NIS quantitation method and the equation in Section 11.1.2. The recovery of each EIS and NIS compound must be assessed and be within the control limits; the lab must maintain records of these assessments. If the recovery of any compound falls outside of these limits, method performance is unacceptable for that compound in that sample. If the recovery cannot be brought within the normal range, water samples are diluted, and smaller amounts of soils, biosolids, sediments, and other matrices are prepared and analyzed, per Section 9.4.2.

NIS areas must be greater than 30% of the average area of the calibration standards in undiluted sample extracts and extracts that required additional NIS to be added. NIS areas corrected for the dilution factor must be greater than 30% of the average area of the calibration standards in diluted samples when additional NIS was not added during dilution of the extract.

EIS Preliminary inhouse acceptance criteria of 20-150% must be used until inhouse limits are generated as described below; the inhouse lower acceptance limit cannot be <20% for any EIS compound.

After the analysis of 30 samples of a given matrix type (water, soil, biosolids, etc.) for which the isotopically labeled compounds pass the tests in this section, compute the R and the standard deviation of the percent recovery (SR) for the isotopically labeled compounds only. Express the assessment as a percent recovery interval from R - 2SR to R + 2SR for each matrix. For example, if R = 90% and SR = 10% for five analyses of soil, the recovery interval is expressed as 70 to 110%. Update the accuracy assessment for each isotopically labeled compound in each matrix on a regular basis (e.g., after each five to ten new measurements).

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11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011 for general requirements and procedures for method validation.

Establish detection limits (DL) and limits of quantitation (LOQ) at initial method set up and verify the DL and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for DL and LOQ requirements and procedures.

11.4 Analyst Qualifications and Training

Employees that perform any step of this procedure must have a completed Read and Acknowledgment Statement for this version of the SOP in their training record. In addition, prior to unsupervised (independent) work on any client sample, analysts that prepare or analyze samples must have successful initial demonstration of capability (IDOC) and must successfully demonstrate on-going proficiency on an annual basis (see below for details). Successful means the initial and on-going DOC met criteria, documentation of the DOC is complete, and the DOC record is in the employee's training file.

IDOC - To establish the ability to generate acceptable precision and recovery, the laboratory must perform the following operations for each sample matrix type to which the method will be applied by that laboratory.

Extract, concentrate, and analyze four aliquots of the matrix type to be tested (Section 7.2), prepared in the same way as the mid-level LCS/OPR. At least one method blank, matching the matrix being analyzed, must be prepared with the IDOC batch. If more than one MB was prepared and analyzed with the IDOC batch, all blank results must be reported. All sample processing steps that are to be used for processing samples, including preparation and extraction, cleanup, and concentration (Sections 9.3.3 through 9.3.7), must be included in this test.

Using results of the set of four analyses, compute the average percent recovery (R) of the extracts and the relative standard deviation (RSD) of the concentration for each target and EIS compound.

For each native and isotopically labeled compound, compare RSD and R with the corresponding limits for initial precision and recovery. If RSD and R for all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may begin. If, however, any individual RSD exceeds the precision limit or any individual R falls outside the range for recovery, system performance is unacceptable for that compound. Correct the problem and repeat the test.

12.0 DATA REVIEW & CORRECTIVE ACTION

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

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The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to *Data Review* SOP [QA SOP ENV-SOP-WCOL-0075] for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix B for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range.

Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

13.0 Pollution Prevention & Waste Management

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are

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characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

A modification is a change to a reference test method made by the laboratory. For example, changes in stoichiometry, technology, quantitation ions, reagent or solvent volumes, reducing digestion or extraction times, instrument runtimes, etc. are all examples of modifications. Refer to Pace ENV corporate SOP ENV-SOP-CORQ-0011 (Method Validation and Instrument Verification) for the conditions under which the procedures in test method SOPs may be modified and for the procedure and document requirements.

In recognition of advances that are occurring in analytical technology, and to overcome matrix interferences, the laboratory is permitted certain options to improve separations or lower the costs of measurements. These options include alternative extraction, concentration, and cleanup procedures, and changes in sample volumes, columns, and detectors. Alternative determinative techniques and other changes are not allowed without prior review and approval.

Each time a modification is made to this method, the laboratory is required to repeat the procedure in Sections 11.3.1 and 11.4. If calibration will be affected by the change, the instrument must be recalibrated per Section 9.2. Once the modification is demonstrated to produce results equivalent or superior to results produced by this method as written, that modification may be used routinely thereafter, so long as the other requirements in this method are met (e.g., isotopically labeled compound recovery).

If a column or column system other than those specified in this method is used, that column or column system must meet all the requirements of this method.

The laboratory is required to maintain records of any modifications made to this method. These records include the following, at a minimum:

a) The names, titles, business addresses, and telephone numbers of the analyst(s) that performed the analyses and modification, and of the quality control officer that witnessed and will verify the analyses and modifications.

b) A listing of pollutant(s) measured, by name and CAS Registry number.

c) A narrative stating reason(s) for the modifications.

d) Results from all quality control (QC) tests comparing the modified method to this method, including:

i. Calibration (ICAL)

ii. Calibration verification (CCV)

iii. Initial Demonstration of Capability (IDOC)

iv. Isotopically labeled compound recovery (EIS/NIS)

v. Analysis of blanks (IBLK, MB)

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vi. Accuracy assessment (Section 11.3)

e) Data that will allow an independent reviewer to validate each determination by tracing the instrument output (peak height, area, or other signal) to the final result. These data are to include:

i. Sample numbers and other identifiers

ii. Extraction dates

iii. Analysis dates and times

iv. Analysis sequence/run chronology

v. Sample weight or volume

vi. Extract volume prior to each cleanup step

vii. Extract volume after each cleanup step

viii. Final extract volume prior to injection

ix. Injection volume

x. Dilution data, differentiating between dilution of a sample or extract

xi. Instrument Identification

xii. Column (dimensions, liquid phase, solid support, film thickness, etc.)

xiii. Operating conditions (temperatures, temperature program, flow rates)

xiv. Detector (type, operating conditions, etc.)

xv. Chromatograms, printer tapes, and other recordings of raw data

xvi. Quantitation reports, data system outputs, and other data to link the raw data to the results reported

15.0 RESPONSIBILITIES

- All PAS employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file.
- PAS supervisors and managers are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP the work area(s) they oversee.
- Local quality personnel are responsible for tracking the currency of the R&A on this SOP for employees at the locations they are assigned to and for notifying the department leaders of overdue assignments.
- All employees of PAS are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local Quality Manager and only when those deviations do not violate the Pace® Code of Ethics or

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Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual change to the SOP are not permitted. If a change is desired or necessary, employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Managemen*t and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI*.

- Local quality personnel are responsible for monitoring conformity to this SOP during routine internal audits of work areas that utilize this SOP and for communicating gaps and deviations found during monitoring to the work area supervisor, who is responsible for correction of the situation.

16.0 ATTACHMENTS

- Appendix A: Target Analyte Limits, Analytical Parameters, and Calibration
    - Table 1: Routine Analyte List Limits of Detection (LOD) and Limits of Quantitation (LOQ)[1]
    - Table 2: Identification and Quantification Information for Target Analytes, Extracted Internal Standards and Non-extracted Internal Standards
    - Table 3: Calibration Standard Concentrations (ng/mL)
- Appendix B: QC Summary
- Appendix C: Sample Pre-screening Instructions
- Appendix D: Aqueous Sample Subsampling Instructions
- Appendix E: MS/MSD, MS/FD sample Selection Protocols

17.0 REFERENCES

Note: Where reference exclude a date or edition, the latest edition of the referenced document adopted/recognized by the laboratory's accreditation bodies applies. Refer to the Laboratory Quality Manual [QAMP ENV-MAN-WCOL-0001] for details.

- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *SOP for SOP and SWI,* current version.
- ENV-TMP-CORQ-0007, *Quality Manual Template*, current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.
- ENV-MAN-WCOL-0001, Quality Assurance Manual, current version.
- "Working with Carcinogens," Department of Health, Education, & Welfare, Public Health Service, Centers for Disease Control, NIOSH, Publication 77-206, August 1977, NTIS PB-277256.
- "OSHA Safety and Health Standards, General Industry," OSHA 2206, 29 CFR 1910.

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- "Safety in Academic Chemistry Laboratories," ACS Committee on Chemical Safety, 1979.
- "Standard Methods for the Examination of Water and Wastewater," 18th edition and later revisions, American Public Health Association, 1015 15th St, NW, Washington, DC 20005, 1-35: Section 1090 (Safety), 1992.
- "Standard Practice for Sampling Water," ASTM Annual Book of Standards, ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, 1980.
- "Handbook of Analytical Quality Control in Water and Wastewater Laboratories," USEPA EMSL, Cincinnati, OH 45268, EPA 600/4-79-019, April 1979.
- "Less is Better: Laboratory Chemical Management for Waste Reduction," American Chemical Society, 1993. Available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.
- "Environmental Management Guide for Small Laboratories," USEPA, Small Business Division, Washington DC, EPA 233-B-00-001, May 2000.
- "The Waste Management Manual for Laboratory Personnel," American Chemical Society, 1990. Available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.
- SERDP. Single-Laboratory Validation Study of PFAS by Isotope Dilution LC-MS/MS. ER19-1409. January 26, 2022.
- DoD QSM (US Department of Defense Quality Systems Manual for Environmental Laboratories, Version 5.4, 2021)
- Woudneh, Million B., Bharat Chandramouli, Coreen Hamilton, Richard Grace, 2019, "Effects of Sample Storage on the Quantitative Determination of 29 PFAS: Observation of Analyte Interconversions during Storage", Environmental Science and Technology 53(21): 12576-12585.
- EPA. Draft Method 1633, Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS. August 2021.
- Standard Methods for the Examination of Water and Wastewater, 23rd Edition, 2017 – Total, Fixed, and Volatile Solids in Solid and Semisolid Samples, Method 2540.

18.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
Appendix B	Updated tables to reflect the final method 1633 per DoD requirements.

Document Succession: This version replaces the following document(s):

Document Number	Version	Document Title	Effective Date:
ENV-SOP-WCOL-0158	04	PFAS by Method 1633	04/19/2024

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Appendix A: Target Analyte Limits, Analytical Parameters, and Calibration

Table 1: Routine Analyte List Limits of Detection (LOD) and Limits of Quantitation (LOQ)[1]

Analyte	Aqueous (ng/L)		Leachate (ng/L)		Solid (ng/g)		Biosolid (ng/g)		AFFF by App. D (µg/L)	
	LOD	LOQ	LOD	LOQ	LOD	LOQ	LOD	LOQ	LOD	LOQ
PFBA	1.6	4	8	20	0.32	0.8	3.2	8	40	100
PFPeA	0.4	2	2	10	0.16	0.4	1.6	4	10	50
PFHxA	0.4	1	2	5	0.08	0.2	0.8	2	10	25
PFHpA	0.8	1	4	5	0.08	0.2	0.8	2	20	25
PFOA	0.8	1	4	5	0.08	0.2	0.8	2	20	25
PFNA	0.4	1	2	5	0.08	0.2	0.8	2	10	25
PFDA	0.4	1	2	5	0.08	0.2	0.8	2	10	25
PFUnA	0.8	1	4	5	0.08	0.2	0.8	2	20	25
PFDoA	0.4	1	2	5	0.08	0.2	0.8	2	10	25
PFTrDA	0.4	1	2	5	0.08	0.2	0.8	2	10	25
PFTeDA	0.8	1	4	5	0.08	0.2	0.8	2	20	25
PFBS	0.355	1	1.775	5	0.071	0.2	0.710	2	8.88	25
PFPeS	0.753	1	3.765	5	0.075	0.2	0.753	2	18.8	25
PFHxS	0.731	1	3.655	5	0.073	0.2	0.731	2	18.3	25
PFHpS	0.381	1	1.905	5	0.076	0.2	0.762	2	9.53	25
PFOS	0.742	1	3.71	5	0.074	0.2	0.742	2	18.6	25
PFNS	0.385	1	1.925	5	0.077	0.2	0.770	2	9.63	25
PFDS	0.386	1	1.93	5	0.077	0.2	0.772	2	9.65	25
PFDoS	0.388	1	1.94	5	0.078	0.2	0.776	2	9.7	25
4:2 FTS	1.5	4	7.5	20	0.3	0.8	3	8	37.5	100
6:2 FTS	4.56	5	22.8	25	0.608	0.8	6.08	8	114	125
8:2 FTS	1.536	4	7.68	20	0.307	0.8	3.072	8	38.4	100
PFOSA	0.4	1	2	5	0.04	0.2	0.4	2	10	25
NMeFOSA	0.8	1	4	5	0.04	0.2	0.4	2	20	25
NEtFOSA	0.4	1	2	5	0.08	0.2	0.8	2	10	25
NMeFOSAA	0.8	1	4	5	0.08	0.2	0.8	2	20	25
NEtFOSAA	0.8	1	4	5	0.16	0.2	1.6	2	20	25
NMeFOSE	2	10	10	50	0.8	2.0	8	20	50	250
NEtFOSE	2	10	10	50	0.8	2.0	8	20	50	250
HFPO-DA	2.4	4	12	20	0.8	1.0	8	10	60	100
ADONA	2.268	4	11.34	20	0.756	0.8	7.56	8	56.7	100
PFEESA	1.139	2	5.695	10	0.285	0.4	2.848	4	28.5	50
PFMPA	0.64	2	3.2	10	0.32	0.4	3.2	4	16	50
PFMBA	1.28	2	6.4	10	0.32	0.4	3.2	4	32	50
NFDHA	1.28	2	6.4	10	0.8	1.0	8	10	32	50
9Cl-PF3ONS	2.244	4	11.22	20	0.748	1.0	7.48	10	56.1	100
11Cl-PF3OUdS	2.268	4	11.34	20	0.756	0.8	7.56	8	56.7	100
3:3 FTCA	2	5	10	25	0.8	1.0	8	10	50	125
5:3 FTCA	10	25	50	125	4.0	5.0	40	50	250	625
7:3 FTCA	10	25	50	125	4.0	5.0	40	50	250	625

[1] Values as of effective date of this SOP. LOQ are subject to change, contact quality personnel for most current information.

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Table 2: Identification and Quantification Information for Target Analytes, Extracted Internal Standards and Non-extracted Internal Standards

Compound Name	CAS Number	Compound Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
Perfluorobutanoic acid	375-22-4	PFBA	213	169	NA	13C4-PFBA
Perfluoropentanoic acid	2706-90-3	PFPeA	263	218.9	69	13C5-PFPeA
Perfluorohexanoic acid	307-24-4	PFHxA	313	268.9	118.9	13C5-PFHxA
Perfluoroheptanoic acid	375-85-9	PFHpA	362.9	319	169	13C4-PFHpA
Perfluorooctanoic acid	335-67-1	PFOA	413	369	169	13C8-PFOA
Perfluorononanoic acid	375-95-1	PFNA	463	419	219	13C9-PFNA
Perfluorodecanoic acid	335-76-2	PFDA	513	469	219	13C6-PFDA
Perfluoroundecanoic acid	2058-94-8	PFUnA	563	518.9	269.1	13C7-PFUnA
Perfluorododecanoic acid	307-55-1	PFDoA	613	569	319	13C2-PFDoA
Perfluorotridecanoic acid	72629-94-8	PFTrDA	663.0	618.9	168.9	13C2-PFDoA
Perfluorotetradecanoic acid	376-06-7	PFTeDA	713	668.9	168.9	13C2-PFTeDA
Perfluorobutanesulfonic acid	375-73-5	PFBS	298.9	80	98.8	13C3-PFBS
Perfluoropentansulfonic acid	2706-91-4	PFPeS	349	80	98.9	13C3-PFHxS
Perfluorohexanesulfonic acid	355-46-4	PFHxS	398.9	80	99	13C3-PFHxS
Perfluoroheptanesulfonic acid	375-92-8	PFHpS	449	80	98.8	13C8-PFOS
Perfluorooctanesulfonic acid	1763-23-1	PFOS	499	80	99	13C8-PFOS
Perfluorononanesulfonic acid	68259-12-1	PFNS	549	80	98.8	13C8-PFOS
Perfluorodecanesulfonic acid	335-77-3	PFDS	599	80	98.8	13C8-PFOS
Perfluorododecanesulfonic acid	79780-39-5	PFDoS	698.9	80	99	13C8-PFOS
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	757124-72-4	4:2FTS	327	306.9	80.9	13C2-4:2FTS
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	27619-97-2	6:2FTS	427	406.9	80.9	13C2-6:2FTS
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	39108-34-4	8:2FTS	527	506.9	81	13C2-8:2FTS
Perfluorooctanesulfonamide	754-91-6	PFOSA	497.9	78	478	13C8-PFOSA
N-methyl perfluorooctanesulfonamide	31506-32-8	NMeFOSA	512	219	169	D3-NMeFOSA
N-ethyl perfluorooctanesulfonamide	4151-50-2	NEtFOSA	526	219	169	D5-NEtFOSA
N-methyl perfluorooctanesulfonamidoacetic acid	2355-31-9	NMeFOSAA	570	418.9	483	D3-NMeFOSAA
N-ethyl perfluorooctanesulfonamidoacetic acid	2991-50-6	NEtFOSAA	584	418.9	526	D5-NEtFOSAA
N-methyl perfluorooctanesulfonamidoethanol	24448-09-7	NMeFOSE	616	59.1	NA	D7-NMeFOSE

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Compound Name	CAS Number	Compound Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
N-ethyl perfluorooctanesulfonamidoethanol	1691-99-2	NEtFOSE	630	59.1	NA	D9-NEtFOSE
Hexafluoropropylene oxide dimer acid (GenX)	13252-13-6	HFPO-DA	285	169	184.9	13C3-HFPODA
4,8-Dioxa-3H-perfluorononanoic acid	919005-14-4	ADONA	377	251	85.1	13C3-HFPODA
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	756426-58-1	9Cl-PF3ONS	530.9	350.9	533→353	13C3-HFPODA
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	763051-92-9	11Cl-PF3OUdS	630.9	450.9	633→453	13C3-HFPODA
3-Perfluoropropyl propanoic acid (FPrPA)	356-02-5	3:3FTCA	241	177	117	13C5-PFPeA
2H,2H,3H,3H-Perfluorooctanoic acid (FPePA)	914637-49-3	5:3FTCA	341	237.1	217	13C5-PFHxA
3-Perfluoroheptyl propanoic acid (FHpPA)	812-70-4	7:3FTCA	441	317	337	13C5-PFHxA
Perfluoro(2-ethoxyethane)sulfonic acid	113507-82-7	PFEESA	315	135	83	13C5-PFHxA
Perfluoro-3-methoxypropanoic acid	377-73-1	PFMPA	229	85	NA	13C5-PFPeA
Perfluoro-4-methoxybutanoic acid	863090-89-5	PFMBA	279	85	NA	13C5-PFPeA
Nonafluoro-3,6-dioxaheptanoic acid	151772-58-6	NFDHA	295	201	85	13C5-PFHxA
Extracted Internal Standard (EIS) Compounds						
Perfluoro-n-[13C4] butanoic acid	N/A	13C4-PFBA	217	172	NA	13C3-PFBA
Perfluoro-n-[13C5] pentanoic acid	N/A	13C5-PFPeA	268	223	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4,6-13C5] hexanoic acid	N/A	13C5-PFHxA	318	273	NA	13C2-PFHxA
Perfluoro-n-[1,2,3,4-13C4] heptanoic acid	N/A	13C4-PFHpA	366.9	322	NA	13C2-PFHxA
Perfluoro-n-[13C8] octanoic acid	N/A	13C8-PFOA	421	376	NA	13C4-PFOA
Perfluoro-n-[13C9] nonanoic acid	N/A	13C9-PFNA	472	427	NA	13C5-PFNA
Perfluoro-n-[1,2,3,4,5,6-13C6] decanoic acid	N/A	13C6-PFDA	519	474	NA	13C2-PFDA
Perfluoro-n-[1,2,3,4,5,6,7-13C7] undecanoic acid	N/A	13C7-PFUnA	570	525	NA	13C2-PFDA
Perfluoro-n-[1,2-13C2] dodecanoic acid	N/A	13C2-PFDoA	615	570	NA	13C2-PFDA
Perfluoro-n-[13C2] tetradecanoic acid	N/A	13C2-PFTeDA	715	669.9	NA	13C2-PFDA
Perfluoro-1-[13C3] butanesulfonic acid	N/A	13C3-PFBS	301.9	80	NA	18O2-PFHxS
Perfluoro-1-[1,2,3-13C3] hexanesulfonic acid	N/A	13C3-PFHxS	402	80	NA	18O2-PFHxS
Perfluoro-1-[13C8] octanesulfonic acid	N/A	13C8-PFOS	507	79.9	NA	13C4-PFOS

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Compound Name	CAS Number	Compound Abbreviation	Parent Ion Mass	Quantification Ion Mass	Confirmation Ion Mass	Quantification Reference Compound
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] hexanesulfonic acid	N/A	13C2-4:2FTS	329	81	NA	18O2-PFHxS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] octanesulfonic acid	N/A	13C2-6:2FTS	429	81	NA	18O2-PFHxS
1H,1H,2H,2H-Perfluoro-1-[1,2-13C2] decanesulfonic acid	N/A	13C2-8:2FTS	529	81	NA	18O2-PFHxS
Perfluoro-1-[13C8] octanesulfonamide	N/A	13C8-PFOSA	505.9	78	NA	13C4-PFOS
N-methyl-d3-perfluoro-1-octanesulfonamide	N/A	D3-NMeFOSA	515	219	NA	13C4-PFOS
N-ethyl-d5-perfluoro-1-octanesulfonamide	N/A	D5-NEtFOSA	531	219	NA	13C4-PFOS
N-methyl-d3-perfluoro-1-octanesulfonamidoacetic acid	N/A	D3-NMeFOSAA	573	419	NA	13C4-PFOS
N-ethyl-d5-perfluoro-1-octanesulfonamidoacetic acid	N/A	D5-NEtFOSAA	589	418.9	NA	13C4-PFOS
N-methyl-d7-perfluorooctanesulfonamidoethanol	N/A	D7-NMeFOSE	623	59	NA	13C4-PFOS
N-ethyl-d9 -perfluorooctanesulfonamidoethanol	N/A	D9-NEtFOSE	639	59	NA	13C4-PFOS
Tetrafluoro-2-heptafluoropropoxy-13C3 -propanoic acid	N/A	13C3-HFPO-DA	287	169	NA	13C2-PFHxA
Non-Extracted Internal Standard (NIS) Compounds						
Perfluoro-n-[2,3,4-13C3] butanoic acid	N/A	13C3-PFBA	216	172	NA	NA
Perfluoro-n-[1,2-13C2] hexanoic acid	N/A	13C2-PFHxA	315	270	NA	NA
Perfluoro-n-[1,2,3,4-13C4] octanoic acid	N/A	13C4-PFOA	417	172	NA	NA
Perfluoro-n-[1,2,3,4,5-13C5] nonanoic acid	N/A	13C5-PFNA	468	423	NA	NA
Perfluoro-n-[1,2-13C2] decanoic acid	N/A	13C2-PFDA	515	470	NA	NA
Perfluoro-1-hexane[18O2] sulfonic acid	N/A	18O2-PFHxS	403	84	NA	NA
Perfluoro-n-[1,2,3,4-13C4] octanesulfonic acid	N/A	13C4-PFOS	503	80	NA	NA

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Table 3: Calibration Standard Concentration (ng/mL)

Compound	L1 (ISC)	L2	L3	L4	L5 (CCV)[1]	L6	L7	L8	L9	L10
Perfluoroalkyl carboxylic acids										
PFBA	0.4	0.8	2	5	10	20	50	100	200	250
PFPeA	0.2	0.4	1	2.5	5	10	25	50	100	125
PFHxA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFHpA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFOA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFNA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFDA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFUnA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFDoA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFTrDA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
PFTeDA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
Perfluoroalkyl sulfonic acids										
PFBS	0.0887	0.1774	0.4435	1.109	2.218	4.435	11.088	22.175	44.35	55.438
PFPeS	0.0941	0.1882	0.4705	1.176	2.353	4.705	11.763	23.525	47.050	58.813
PFHxS	0.0914	0.1828	0.457	1.143	2.285	4.57	11.425	22.850	45.7	57.125
PFHpS	0.0953	0.1906	0.4765	1.191	2.383	4.765	11.913	23.825	47.65	59.563
PFOS	0.0928	0.1856	0.464	1.16	2.32	4.64	11.6	23.2	46.4	58.0
PFNS	0.0962	0.1924	0.481	1.203	2.405	4.81	12.025	24.050	48.1	60.125
PFDS	0.0965	0.193	0.4825	1.206	2.413	4.825	12.063	24.125	48.25	60.313
PFDoS	0.097	0.194	0.485	1.213	2.425	4.85	12.125	24.25	48.5	60.625
Fluorotelomer sulfonic acids										
4:2FTS	0.375	0.75	1.875	4.688	9.375	18.75	46.875	93.75	187.5	NA
6:2FTS	0.38	0.76	1.9	4.75	9.5	19	47.5	95	190	NA
8:2FTS	0.384	0.768	1.92	4.8	9.6	19.2	48	96	192	NA
Perfluorooctane sulfonamides										
PFOSA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
NMeFOSA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
NEtFOSA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamidoacetic acids										
NMeFOSAA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
NEtFOSAA	0.1	0.2	0.5	1.25	2.5	5	12.5	25	50	62.5
Perfluorooctane sulfonamide ethanols										
NMeFOSE	1	2	5	12.5	25	50	125	250	500	625
NEtFOSE	1	2	5	12.5	25	50	125	250	500	625
Per- and polyfluoroether carboxylic acids										
HFPO-DA	0.4	0.8	2	5	10	20	50	100	200	250

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Compound	L1 (ISC)	L2	L3	L4	L5 (CCV)[1]	L6	L7	L8	L9	L10
ADONA	0.378	0.756	1.89	4.725	9.45	18.9	47.25	94.5	189	236.25
PFMPA	0.2	0.4	1	2.5	5	10	25	50	100	125
PFMBA	0.2	0.4	1	2.5	5	10	25	50	100	125
NFDHA	0.2	0.4	1	2.5	5	10	25	50	100	125
Ether sulfonic acids										
9Cl-PF3ONS	0.374	0.748	1.87	4.675	9.35	18.7	46.75	93.5	187	233.75
11Cl-PF3OUdS	0.378	0.756	1.89	4.725	9.45	18.9	47.25	94.5	189	236.25
PFEESA	0.178	0.356	0.89	2.225	4.45	8.9	22.25	44.5	89	111.25
Fluorotelomer Carboxylic Acids										
3:3FTCA	0.5	1	2.5	6.25	12.5	25	62.5	125	250	312.5
5:3FTCA	2.5	5	12.5	31.25	62.5	125	312.5	625	1250	1560
7:3FTCA	2.5	5	12.5	31.25	62.5	125	312.5	625	1250	1560
Extracted Internal Standard (EIS) Compounds										
13C4-PFBA	10	10	10	10	10	10	10	10	10	10
13C5-PFPeA	5	5	5	5	5	5	5	5	5	5
13C5-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C9-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C6-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C7-PFUnA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C3-PFBS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C3-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C8-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C2-4:2FTS	5	5	5	5	5	5	5	5	5	5
13C2-6:2FTS	5	5	5	5	5	5	5	5	5	5
13C2-8:2FTS	5	5	5	5	5	5	5	5	5	5
13C8-PFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D5-NEtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D3-NMeFOSAA	5	5	5	5	5	5	5	5	5	5
D5-NEtFOSAA	5	5	5	5	5	5	5	5	5	5
D7-NMeFOSE	25	25	25	25	25	25	25	25	25	25
D9-NEtFOSE	25	25	25	25	25	25	25	25	25	25
13C3-HFPODA	10	10	10	10	10	10	10	10	10	10
Non-Extracted Internal Standard (NIS) Compounds										

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Compound	L1 (ISC)	L2	L3	L4	L5 (CCV)[1]	L6	L7	L8	L9	L10
13C3-PFBA	5	5	5	5	5	5	5	5	5	5
13C2-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C5-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
13C2-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
18O2-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
13C4-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

[1] *This calibration point is used as the calibration verification (CCV)*

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Appendix B: QC Summary and Corrective Action Table: Method Acceptance Criteria

Table 4: QC Summary and Corrective Action

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Mass Calibration	Annually and on as-needed basis.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
Mass Calibration Verification	After each Mass Calibration performed.	Must meet manufacturer's acceptance criteria.	Identify and correct source of problem, repeat Mass Calibration.	None. Do not proceed with analysis.
ICAL	At instrument set up, after CCV failure and/or major maintenance.	Must meet one of the curve fit options presented in Section 9.2.3.	Identify and correct source of problem, repeat.	None. Do not proceed with analysis.
ICV	After Each ICAL.	All analytes must be within ± 30% of their true values. (%R)	Identify and correct source of problem, re-analyze. If repeat failure, repeat ICAL. Analysis may proceed if it can be demonstrated that the ICV exceedance has no impact on analytical measurements. For example, the ICV %R is high, CCV is within criteria, and the analyte is not detected in sample(s).	Qualify analytes with ICV out of criteria.
RT Window Position	Once per ICAL and at the beginning of the analytical window.	Position is set using the mid-point of the ICAL on the day ICAL is performed; otherwise, mid-level CCV is used.	NA	NA
RT Window Study	At method set-up and after major instrument maintenance	RT Window is ± 60 secs from RT position.	NA	NA

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QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
ISC	Daily before sample analysis.	All native compounds within ± 30% recovery.	See Section 9.2.4 for corrective actions based on circumstance. If problem persists, repeat ICAL.	No samples shall be analyzed until ISC has met acceptance criteria.
Qualitative Isomer Check	Once per ICAL and daily before sample analysis.	All required branched isomer peaks present and visibly resolved from linear peaks.	Identify and correct source of problem and reanalyze Isomer Check.	No samples shall be analyzed until Isomer Check has met acceptance criteria.
Bile Salts Check	Once per ICAL and daily before sample analysis.	Bile Salt peak detected >1 min outside RT window for PFOS.	Identify and correct source of problem and reanalyze Bile Salts Check.	No samples shall be analyzed until Bile Salts Check has met acceptance criteria.
CCV	Daily before sample analysis (ISC), after every 10 samples, and at end of analytical sequence.	All native and isotopically labelled compounds within ± 30% recovery.	See Section 9.2.4 for corrective actions based on circumstance. If problem persists, repeat ICAL.	Qualify analytes with CCV out of criteria.
Instrument Blank (IBLK) / CCB	Daily prior to analysis and after high standards, including CCV.	Must meet criteria specified in Section 11.2.1: all detections ≤1/2 LOQ.	Identify and correct source of contamination or performance issue. Reanalyze IBLK.	No samples shall be analyzed until IBLK has met acceptance criteria.
Extracted Internal Standards (EIS)	Every field sample, standard and QC sample.	Must meet criteria specified in Section 11.3. Preliminary acceptance range: 20-150% REC (based on calculated concentration).	If batch QC is acceptable, reanalyze to confirm. If confirmed, reprepare and reanalyze samples. If reprep is within acceptance, report reprep data. If failure is confirmed by reprep, qualify as matrix impacted.	Qualify outages and explain in case narrative.

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QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Non-extracted Internal Standards (NIS)	Every field sample, standard and QC sample.	Must meet criteria specified in Section 11.3. Preliminary acceptance criteria: >30% REC (based on response).	Troubleshoot instrument performance. Reanalyze samples.	Qualify outages and explain in case narrative.
Method Blank (MB)	1 per batch of 20 or fewer samples.	Must meet criteria specified in Section 11.1.1.	If IBLK is acceptable, reanalyze MB to confirm. If confirmed, reprepare and reanalyze associated impacted samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated to unacceptable MB.	Qualify outages and explain in case narrative.
LCS/LLLCS	1 pair per batch of 20 or fewer samples.	DoD: 40-150% until in-house limits generated; must meet criteria specified in Section 11.1.2.	If most recent ISC/CCV is acceptable, reanalyze LCS to confirm. If low-failure results are confirmed, reprepare and reanalyze associated samples (if sufficient sample remains). If insufficient sample remains for reprep, narrate and report data associated to low-failure LCS. If high-failure results are confirmed and sample(s) is ND for failing compound, narrate and report sample data.	Qualify outages and explain in case narrative.
MS/MSD	1 pair per batch of 20 or fewer samples.	DoD: RSD <30% between MS/MSD	If possible, reprep to confirm.	Qualify outages and explain in case narrative.
Sample Duplicate	1 per AFFF sample.	DoD: RSD <30% between parent/DUP	If possible, reprep to confirm.	Qualify outages and explain in case narrative.

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Table 5: DOC/LCS/LLLCS Acceptance Limits for Aqueous & Landfill Leachate Matrices

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-135	21	70-140
PFPeA	70-135	23	65-135
PFHxA	70-135	24	70-145
PFHpA	70-135	28	70-150
PFOA	65-155	27	70-150
PFNA	70-140	28	70-150
PFDA	65-140	26	70-140
PFUnA	70-135	29	70-145
PFDoA	70-130	21	70-140
PFTrDA	60-145	29	65-140
PFTeDA	70-145	27	60-140
PFBS	70-140	23	60-145
PFPeS	70-135	25	65-140
PFHxS	70-135	27	65-145
PFHpS	70-140	30	70-150
PFOS	70-140	29	55-150
PFNS	70-135	29	65-145
PFDS	70-135	30	60-145
PFDoS	45-135	35	50-145
4:2FTS	70-135	27	70-145
6:2FTS	70-135	32	65-155
8:2FTS	70-140	33	60-150
PFOSA	70-135	22	70-145
NMeFOSA	70-135	30	60-150
NEtFOSA	70-130	26	65-145
NMeFOSAA	65-140	32	50-140
NEtFOSAA	70-135	28	70-145
NMeFOSE	70-135	29	70-145
NEtFOSE	70-130	21	70-135
HFPO-DA	70-135	23	70-140
ADONA	70-135	23	65-145

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PFMPA	60-140	23	55-140
PFMBA	65-145	27	60-150
NFDHA	65-140	37	50-150
9Cl-PF3ONS	70-145	30	70-155
11Cl-PF3OUdS	50-150	35	55-160
PFEESA	70-135	25	70-140
3:3FTCA	70-130	23	65-130
5:3FTCA	70-130	24	70-135
7:3FTCA	55-130	34	50-145

Table 6: DOC/LCS/LLLCS Acceptance Limits for Solid & Biosolid Matrices

Target Analyte	DOC Mean Recovery (%)	DOC RSD (%)	LCS/LLLCS Recovery (%)
PFBA	70-140	17	70-140
PFPeA	70-140	26	60-150
PFHxA	70-135	23	65-140
PFHpA	70-140	21	65-145
PFOA	70-140	23	70-150
PFNA	65-145	24	70-155
PFDA	70-145	26	70-155
PFUnA	70-145	26	70-155
PFDoA	70-145	25	70-150
PFTrDA	55-160	26	65-150
PFTeDA	70-145	24	65-150
PFBS	60-145	25	65-145
PFPeS	65-140	29	55-160
PFHxS	65-145	28	60-150
PFHpS	70-140	27	65-155
PFOS	70-135	27	65-160
PFNS	70-140	27	55-140
PFDS	50-150	31	40-155
PFDoS	40-140	40	25-160
4:2FTS	70-135	27	60-150
6:2FTS	60-160	50	55-200

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8:2FTS	70-140	27	70-150
PFOSA	70-140	19	70-140
NMeFOSA	65-145	26	70-155
NEtFOSA	70-135	19	70-140
NMeFOSAA	65-145	31	65-155
NEtFOSAA	60-150	31	65-165
NMeFOSE	70-140	19	70-140
NEtFOSE	70-135	17	70-135
HFPO-DA	70-140	25	70-145
ADONA	70-155	26	70-160
PFMPA	70-140	25	30-140
PFMBA	55-145	33	60-150
NFDHA	45-145	27	60-155
9Cl-PF3ONS	65-135	23	70-150
11Cl-PF3OUdS	50-135	31	45-160
PFEESA	70-140	20	70-140
3:3FTCA	45-155	32	45-130
5:3FTCA	70-135	28	60-130
7:3FTCA	70-145	39	60-150

Table 7: Acceptance Limits for EIS and NIS Compounds in Aqueous & Landfill Leachate Matrices

Labeled Compound	Aqueous Recovery (%)	Landfill Leachate Recovery (%)
13C4-PFBA	5-130	5-130
13C5-PFPeA	40-130	40-130
13C5-PFHxA	40-130	40-130
13C4-PFHpA	40-130	40-130
13C8-PFOA	40-130	40-130
13C9-PFNA	40-130	40-130
13C6-PFDA	40-130	40-130
13C7-PFUnA	30-130	40-130
13C2-PFDoA	10-130	35-130
13C2-PFTeDA	10-130	25-130

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13C3-PFBS	40-135	40-130
13C3-PFHxS	40-130	40-130
13C8-PFOS	40-130	40-130
13C2-4:2FTS	40-200	40-220
13C2-6:2FTS	40-200	40-170
13C2-8:2FTS	40-300	40-145
13C8-PFOSA	40-130	40-130
D3-NMeFOSA	10-130	40-130
D5-NEtFOSA	10-130	35-130
D3-NMeFOSAA	40-170	35-130
D5-NEtFOSAA	25-135	30-130
D7-NMeFOSE	10-130	20-130
D9-NEtFOSE	10-130	20-130
13C3-HFPODA	40-130	40-130
13C3-PFBA	50-200	50-200
13C2-PFHxA	50-200	50-200
13C4-PFOA	50-200	50-200
13C5-PFNA	50-200	50-200
13C2-PFDA	50-200	50-200
18O2-PFHxS	50-200	50-200
13C4-PFOS	50-200	50-200

Table 8: Acceptance Limits for EIS and NIS Compounds in Solid & Biosolid Matrices

Labeled Compound	Solids Recovery (%)	Biosolids Recovery (%)
13C4-PFBA	8-130	5-130
13C5-PFPeA	35-130	35-130
13C5-PFHxA	40-130	40-130
13C4-PFHpA	40-130	40-130
13C8-PFOA	40-130	40-130
13C9-PFNA	40-130	40-145
13C6-PFDA	40-130	40-130
13C7-PFUnA	40-130	40-130
13C2-PFDoA	40-130	40-130

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13C2-PFTeDA	20-130	10-160
13C3-PFBS	40-135	40-150
13C3-PFHxS	40-130	40-140
13C8-PFOS	40-130	40-130
13C2-4:2FTS	40-165	40-300
13C2-6:2FTS	40-215	40-300
13C2-8:2FTS	40-275	40-300
13C8-PFOSA	40-130	20-140
D3-NMeFOSA	10-130	20-130
D5-NEtFOSA	10-130	20-130
D3-NMeFOSAA	40-135	30-150
D5-NEtFOSAA	40-150	20-140
D7-NMeFOSE	20-130	25-130
D9-NEtFOSE	15-130	20-130
13C3-HFPODA	40-130	40-130
13C3-PFBA	50-200	50-200
13C2-PFHxA	50-200	50-200
13C4-PFOA	50-200	50-200
13C5-PFNA	50-200	50-200
13C2-PFDA	50-200	50-200
18O2-PFHxS	50-200	50-200
13C4-PFOS	50-200	50-200

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Appendix C: Sample Pre-screening Instructions

Samples that are known or suspected to contain high levels of analytes may be pre-screened using the following procedure. These are example procedures using smaller sample aliquots spiked with EIS and NIS and no clean up procedures. Other pre-screening procedures may be used.

Aqueous Samples

1. Weight out 10 (±0.1) g of sample into a 50-mL centrifuge tube.

2. Add 100 µL of EIS to the sample and vortex to mix.

3. Filter 1 mL of the sample through 0.2-µm membrane filter into a microvial. Sample is ready for instrumental analysis.

Solid Samples

1. Weigh 1.0 (±0.1) g sample into 50-mL polypropylene centrifuge tubes.

2. Add 10 mL of 0.3% methanolic ammonium hydroxide to the sample. Vortex and mix on a shaker table (or equivalent) for 10 min. Allow to settle and/or centrifuge to produce a clear extract.

3. Filter using a filter vial:

   a. Add ~400 µL of clear extract from step 2 (e.g., by adding extract until it reaches the fill line).

   b. Use filter/plunger part and filter.

4. Transfer 200 µL of filtrate to a 1 mL polypropylene autosampler vial and dilute with 10uL of EIS and 790 µL of 0.3% methanolic ammonium hydroxide to a final volume of 1 mL. The extract is now approximately 50X dilute, relative to a solid sample prepared by the protocols in Section 9. Sample is ready for instrumental analysis.

Calculate results using the equivalent sample weight computed as follows:

$$Equivalent\ Weight = Sample\ weight\ (g) x\ \frac{0.2\ mL}{10\ mL}$$

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Appendix D: Aqueous Sample Subsampling Instructions

Note: Because some target analytes may be stratified within the sample (e.g., AFFF- contaminated media, surfactants), or adhere to the walls of the sample container, subsampling may only be done on a project-specific basis. Subsampling has been shown to increase uncertainty in PFAS analysis, especially on foaming samples.

If a reduced sample size is required, transfer a weighed subsample using the following subsampling procedure to a 60-mL HDPE bottle and dilute to approximately 60 mL using reagent water. This container is now considered the "sample bottle."

1. Gently invert sample 3-4 times being careful to avoid foam formation and subsample immediately (do not let stand).
2. If foam forms and more than 5 mL is required – pour sample, avoiding any foam.
3. If foaming forms and a volume less than 5 mL is required – pipette from ½ cm below the foam.
4. If no foam forms – pour or pipette based on volume required.

AFFF and FFF (F3) Concentrates

Samples composed of AFFF or F3 concentrate will be subsampled consistently, with approximately **0.02g of concentrate** aliquoted for each discrete sample preparation/analysis; each AFFF or F3 concentrate sample **must be prepared in duplicate**. After creating and documenting the subsample aliquot, add approximately 60 mL of reagent water, cap the vessel, and shake vigorously by hand for 20-30 seconds. After adding the reagent water and agitating, allow **at least 3 hours** for the subsample aliquot to fully dissolve in the water. If dissolution is incomplete after 3 hours, agitate again and wait another 3 hours; consider applying continuous agitation (orbital shaker) if full dissolution of the aliquot into water requires extended time. Following the extended dissolution time, prepared AFFF/F3 samples should be prepared and analyzed following the routine protocols for aqueous sample processing. Aqueous reporting limits (MDL/LOD/LOQ) will be used, with values adjusted to account for the actual sample aliquot, assuming 1 g/mL; this constitutes a 25000X adjustment factor for AFFF/F3 reporting limits, relative to nominal aqueous reporting limits.

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APPENDIX E: MS/MSD, MS/FD SAMPLE SELECTION PROTOCOL

Background: DOD QSM 5.4, Table B-24 requires that a matrix spike (MS) sample and a matrix spike duplicate (MSD) be prepped with every prep batch. Therefore, all aqueous prep batches must include an MS/MSD pair, if possible. Prep analysts will select samples to be used for this purpose following a hierarchy of preference, as defined below:

Note: Any kind of blank (FB, TB, EB, RB, etc.) or samples designated as "DUP" by the client will not be used for MS/MSD analysis.

1. First preference is to use client-designated samples as MS/MSD samples. This designation should show up on the prep list, under comments. It is possible that SR will miss adding this comment to the sample, but this designation will be present in the COC from the client, on the right side of the COC under "Remarks/Cooler ID." When a client designates a sample to be used for MS/MSD analysis, they will typically provide us with more than 2 bottles (often 4, sometimes as many as 6).

2. Lacking a client-designated MS/MSD sample, the next preference is to use any sample received with more than 2 bottles provided. If an analyst selects a set of samples for prep in which none of the samples are client-designated for MS/MSD, the analyst should check for any samples in the set that were received with 3 or more bottles. If there is a sample with 3 or more bottles, pull 3 of them and use one for the parent sample and spike the other two for analysis as MS/MSD samples.

3. If all samples in a particular prep batch were all received in just one bottle, analysis of an MS/MSD pair will not be possible. This should be an uncommon occurrence, as prep analysts will attempt to adjust batching to ensure that every prep batch contains an MS/MSD. In lieu of an MS/MSD pair, a mid-spiked LCSD may be prepared.

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APPENDIX F: AQUEOUS SAMPLE CENTRIFUGATION PROTOCOL

Background: Draft 3 of Draft Method 1633 states “Laboratories may develop other strategies for minimizing the disruptions due to SPE clogging and slow extractions,” and “a trained analyst should be able to distinguish samples with very low TSS and focus…on only those samples that might present a risk of clogging.” Therefore, whether an individual sample will require centrifugation for proper preparation will be determined and documented by the preparation analyst. Furthermore, the method states “If centrifugation is used to prevent samples with high TSS from clogging the SPE, the EISs must be spiked into the original sample container prior to centrifugation.” This protocol complies with that dictate.

Procedure:

1. Inspect the sample and consider the necessity of centrifuging. Consider any visible indications of particulate matter including settled solids collected on the bottom of the container, cloudiness and/or dark color of the sample, suspended solids within the sample, increased viscosity, etc. If uncertain, seek a second opinion from another analyst, supervisor, or operations director.

2. If, in the judgement of the preparation analyst, a sample requires centrifugation, contemporaneously make a note on the prep batch log indicating this fact.

3. Spike samples requiring centrifugation in the same manner and with the same standard volume as samples which will not be centrifuged.

4. Label a 500mL conical centrifuge bottle with the sample ID for each sample that will be centrifuged. Set them in an appropriate rack with the caps removed.

5. Vigorously shake the spiked sample and then quickly pour it into the labeled centrifuge bottle. Try to ensure that the original sample bottle is devoid of any solid material. Be careful to avoid spilling sample during the transfer process. Tightly cap each centrifuge bottle after transfers are complete.

6. Transfer capped centrifuge bottles to centrifuge, ensuring that the centrifuge carousel is symmetrically balanced. Close top and centrifuge at 3000 RPM for 6 minutes.

7. Remove centrifuge bottles and decant the centrifuged liquid off of the condensed solids, back into the original sample bottle. Try to avoid transferring any of the condensed solids from the centrifuge bottle back to the original sample bottle, while maximizing the amount of liquid decanted off of the solid portion.

8. Weigh the full, decanted original sample bottle and document in the LIMS prep batch.

9. Extract the decanted sample as normal alongside un-centrifuged samples, up to the bottle rinse and elution steps.

10. When the SPE cartridges have been dried, rinse the original sample bottle following the protocol in Section 9.3.6. Additionally, add 4mL of 1% methanolic ammonium hydroxide (1%-

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MeOH) to each centrifuge bottle to rinse the inside of the centrifuge bottles and the remaining solids, as well as the cap. If the condensed solids become re-suspended while rinsing the centrifuge bottles, re-centrifugation may be required. Using a transfer pipet or mechanical pipet, transfer the 1%-MeOH rinse from the centrifuge bottle into the SPE cartridge and elute with the original sample bottle rinse into a 15mL conical centrifuge tube.

11. Add an additional volume of MeOH to the elution of all batch QC samples (MB/LCS/LCSD) to match the volume used for elution for any centrifuged sample in the prep batch. Typically, this will mean that 4mL of clean MeOH will be added directly to the SPE reservoir and eluted with the normal bottle rinses.

12. After elution, all sample extracts (client and QC) with additional elution volume shall be concentrated to ~4.5mL and brought to a final volume of ~5 mL with 1%-MeOH. Use a reference elution tube to reconstitute to the appropriate volume, similarly to the protocol in Section 9.3.4 of this SOP. This extract concentration and reconstitution should be done BEFORE adding acetic acid and dispersive carbon for cleanup; batch QC and client samples with additional container rinse volume should be processed through the same dGCB cleanup steps, following the protocols in Section 9.3.6.

13. Determine initial sample volume using the weights measured in step 8 of this appendix and the protocol in Section 9.3.6 of this SOP.

14. Generate a Non-Conformance Memo (NCM) noting which samples in the prep batch included centrifugation in the extraction process and any additional observations and/or deficiencies that were noted during the centrifugation process.

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Pace ANALYTICAL SERVICES	**ENV-SOP-MTJL-0196 v05_TOC by Walkley-Black**
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1.0 SCOPE & APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure used by PAS-Mt. Juliet for the determination of Oxidizable Organic Carbon in soils using HACH technology by way of the Walkley Black method. This SOP has been modified to improve efficiency by heating samples.

1.1 Target Analyte List and Limits of Quantitation (LOQ)

Analyte	CAS #	LOQ Water (mg/L)	LOQ Solids (mg/kg)
Organic Carbon	NA	N/A	100

LOQ is established in accordance with PAS policies and procedures for method validation, determination of detection limits) LOD), and quantitation limits (LOQ).LOQs are routinely verified and updated when needed, refer to laboratory SOP ENV-SOP-MTJL-0016, Determination of LOD and LOQ, or however named, for additional information on LOQs. The current LOQ for each target analyte that can be determined by this SOP, as of the effective date of this SOP, is provided in Appendix A.

The reporting limit (RL) is the value to which analytes are reported as detected or non-detect in the final report. When the RL is less than the lower limit of quantitation (LLOQ), all detections and non-detects at the RL are qualitative. The LLOQ is the lowest point of the calibration curve used for each target analyte.

LOQ, and RL are always adjusted to account for actual amounts used and for dilution.

1.2 Reference Methods & Documents

This SOP is based upon the reference method Walkley Black. If the laboratory procedure is modified from the reference method, a list of modifications and rationale for the modification is provided in section 14.0. Modifications are permitted when allowed by the regulatory program for which test results will be used and when the modification has been validated comparable and equivalent to the reference method.

1.3 Application Range

The range of this method depends upon the concentration of samples. The analytical range of the spectrophotometer is between 1 µg/mL to 10 µg/mL.

1.4 State/Program Specific Requirements

State specific requirements, if they vary from the procedure in the SOP, are specified in Appendix B. Those requirements supersede Walkley Black when samples are analyzed from that state.

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2.0 SUMMARY OF METHOD

The Organic Carbon in an air or oven dried sample is oxidized using Potassium Dichromate and concentrated Sulfuric Acid at 135°C. The reaction product, Chromium, turns the sample solution a dark green color. The intensity of the green color is directly proportional to the amount of carbon oxidized and is quantified spectrophotometrically at 610nm.

3.0 INTERFERENCES

Ferrous Iron, Manganese, and Chloride may cause bias. Generally, amounts are small compared to the Organic Carbon present.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

5.0 HEALTH & SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has 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.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001)
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

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6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

PAS does not offer sample collection services for this test method. PAS advises customers to collect samples in accordance with a sampling plan and collection procedures appropriate meet regulatory, requirements and data quality objectives for the project. The minimum sample amounts required for the test are provided in this section.

PAS provides containers for the collection of samples upon client request. The routine container type and size provided in provided in the following table along with requirements for sample size, preservation and holding time. Refer to laboratory SOP ENV-SOP-MTJL-0064, Sample Shipping for procedures related to preparation of bottle kits.

Container Type, Minimum Sample Amount, Preservation, and Holding Time Requirements:

Matrix	Container Size & Type	Required Sample Amount[1]	Preservation	Holding Time
Soil	Glass Container	5g	Thermal: ≤6°C (not frozen) Chemical:N/A	28 days

[1] *Amount of sample required for each discrete test.*

Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP ENV-SOP-MTJL-0060, Sample Receiving. Chemical preservation is checked and recorded at time of receipt or prior to sample preparation.

After receipt, samples are stored at 6°C until sample preparation. Prepared samples (extracts, digestates, distillates, other) are stored at 6°C until sample analysis.

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

7.1 Equipment

- Balance, sensitive to 0.01g, various. VWR or equivalent
- Drying Oven, Curtin-Matheson Equatherm, or equivalent. Must maintain a constant temperature of 105 ± 5°C.
- Hot plate, Type 2200. Thermolyne, or equivalent.
- Spectrophotometer, DR6000. HACH, or equivalent.
- Calibrated IR gun.

7.2 Supplies

- Erlenmeyer flasks, 125mL. Fished 07-125-090, or equivalent.
- Volumetric Flasks, Class A. Fisher, assorted sizes.
- Graduated Cylinder, Class A. Fisher, assorted sizes.
- Pipette, Class A. Various. Assorted sizes capable of measuring 0.1mL to 10mL.

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- Centrifuge Tubes, Cellstar. Greiner, or equivalent.
- Boiling Chips, #D1069103. Chemware Ultrapure PFTE, or equivalent.

8.0 REAGENTS & STANDARDS

All reagents and standards must be recorded in the appropriate preparation log and assigned a unique number. See ENV-SOP-MTJL-0041, Standard Logger-Tree Operation. Additional information regarding reagent preparation can be found in the Standards Logger (Tree) digital archive system. All spiking solutions and surrogate standard solutions should be replaced at least every 6 months or sooner if a problem is detected, unless otherwise noted.

8.1 Reagents

- Potassium Hydrogen Phthalate (KHP), Fisher P243-100, or equivalent. Dried and desiccated.
- Concentrated Sulfuric Acid, Fisher A510SK212, or equivalent.
- 1N Potassium Dichromate.
- Sand, Ottawa or equivalent.

8.2 Standards

- 1000mg/L TOC stock standard.
- Laboratory Control Standard/SRM – Purchased from ERA (ERA Nutrients in Soil, Catalog #542, or equivalent). Refer to manufacturer's Certificate of Analysis for concentration and expiration.

8.3 Formulations

- 1000mg/L TOC stock standard – Dissolve 2.128g KHP in reagent water and dilute to 1L. Preserve to pH <2 with concentrated Sulfuric Acid. Store in an amber glass bottle at ≤6°C (not frozen). Expiration: six months. Commercially certified standard is acceptable.
- ICV – Weigh 1g of Sand, with a Class A glass pipet add 4mL of the 1000mg/L TOC Stock Standard to the sample before adding the 1N Potassium Dichromate and Concentrated Sulfuric Acid.
- MS/D -- Weigh 1g of selected field sample, with a Class A glass pipet add 4mL of the 1000mg/L TOC Stock Standard to the sample before adding the 1N Potassium Dichromate and Concentrated Sulfuric Acid.

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Support Equipment

Refer to laboratory SOP ENV-SOP-MTJL-0374, *Support Equipment*, or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

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9.1.2 Instrument Set Up

Read the sample and QC at 610nm.

9.2 Calibration

9.2.1 Calibration Frequency

The instrument must be calibrated at least every 6 months or sooner if instrument response changes or significant changes are made to the system.

9.2.2 Calibration Levels

Calibration standards are prepared from the Intermediate ICV Standard to create 6 working levels. Calibration standards are prepared in reagent water daily or as needed.

A blank is included as a point in the calibration curve. However, the regression equation for the calibration curve is not forced through zero.

Calibration Level	mL of TOC stock
1 µg/mL	0.1mL
4 µg/mL	0.4mL
10 µg/mL	1mL
20 µg/mL	2mL
50 µg/mL	5mL
100 µg/mL	10mL

9.2.3 Calibration Sequence

1) Select User Programs from the Main Menu
2) Select Program Options and then select New
3) Assign a program number from 950-999. The lowest available number automatically appears in the window.
4) When a program number has been assigned, push OK.
5) The program type window will appear next. Enter a name that includes the parameter, analyst initials, and the date. Push Next.
6) The program window will appear. Select single wavelength and push Next.
7) The units window will appear. Select mg/L and push Next.
8) The wavelength window will appear. Enter 610nm and push Next.
9) The concentration resolution window will appear. Select 0.001 and push Next.
10) The chemical form window will appear. Enter TOCWB and push Next.
11) The calibration window will appear. Select Read Standards and push Next.

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12) The calibration table will open. Press the + symbol, enter the concentration of the first standard and press OK.

13) Press the + symbol to enter the next standard concentration. Press OK when the concentration has been entered. Repeat the process until all of the calibrant concentrations have been entered.

14) Insert the blank vial into the instrument holder and press Zero.

15) Highlight the line in the table indicating the concentration of the first standard and press Read.

16) Continue the process until all the calibration standards have been read.

17) Press graph and review to make sure there are no outlying point, and that the correlation coefficient is 0.995 or greater.

18) Press Table.

19) Press Store.

20) Insert memory stick into the correct outlet.

21) Press the PC/Printer Icon. The data will be stored on the memory stick.

22) Insert the memory stick into a PC.

23) Graph the results into Excel using a scatter-plot graph and a trend line. The concentrations must be plotted on the x-axis and the absorbance must be plotted on the y-axis.

24) Create a sheet that includes the data points, graph, correlation coefficient, data, time, and analyst information.

25) Store the calibration sheet to be included with each set of TOCWB analytical data.

9.2.4 Calibration Evaluation

9.2.4.1 Curve Fit

The correlation coefficient, r, must be 0.995 or greater. R^2 greater than pr equal to 0.990. The graph must be visually inspected for outliers.

9.2.4.2 Relative Error

Calibration residuals are calculated by TREE by re-quantitating the expected value of each curve point against the curve that has been generated. All standards greater than the reporting limit must recover within ± 10% of the true value. The reporting limit and lower standards must recover within ± 50% of the true value.

9.2.4.3 Initial Calibration Verification

The ICV is required to be run immediately after a new calibration curve. This is the only time an ICV is required.

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9.2.4.4 Continuing Calibration Verification

The CCV is analyzed at the beginning of the sequence if a stored calibration is being used, after every 10 samples, and at the conclusion of each sequence.

9.3 Sample Preparation

1) Remove particles larger than 2mm. Weigh out a minimum of 1g of air or oven dried (103 ± 2°C) sample and place into a 125mL flask
2) Add 5mLof 1N Potassium Dichromate to each flask and swirl gently.
3) Make a Method Blank using 1 gram of sand.
4) In a well-ventilated area (i.e., in a hood), carefully add 10mL concentrated Sulfuric Acid to each flask. Swirl to mix.
5) If any sample turns dark green at this point, it is likely over the calibration range. Weigh out less sample and proceed to digest like the rest of the samples.
6) Cover each with aluminum foil. Make sure no sample is above the liquid layer.
7) Place flasks on a hot place that is set to 135 ± 5°C and digest for 30 ± 5 minutes.
8) Record start/stop time. It is important that the temperature is monitored closely because the dichromate will decompose at temperatures above 150°C.
9) Temperature is to be measured during digestion using a calibrated IR gun. The temperature will be measured at 15 minutes into the digestion and at the 30-minute time interval. This data is to be entered into the appropriate location in PrepData.
10) Remove flasks from heat and allow to cool. Quantitatively transfer to two centrifuge tubes or other suitable container. Bring volume to about 40mL with reagent water. Centrifuge at 2000rpm for roughly 5 minutes or until clear.
11) Transfer total supernatant to a 100mL volumetric flask or equivalent vessel. Dilute to final volume with reagent water.

9.4 Analysis

9.4.1 Preparation

1) Select User Programs from the Main Menu.
2) Use the cursor to select the correct program number.
3) Press Start
4) Press Options
5) Insert the instrument blank vial into the instrument holder and press Zero.
6) Insert the vial for the blank into the instrument holder and press Read.

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7) Continue inserting each vial for the sequence into the holder and pressing Read until the entire sequence has been read.

8) Press Options.

9) Press File Folder.

10) All the results for the sequence will appear in the window.

11) Select Options on the instrument screen.

12) Press the PC/Printer icon and the instrument data will transfer to the PC Screen.

13) Select All Data

14) The data on the PC screen can be used to generate an Excel document and to report in the automatic capture program (Tree).

9.4.2 Example Analytical Sequence

ICV (CCV if no ICAL)
ICB (CCB if no ICAL)
LLOQ
MB
LCS
SAMPLE 1
MS/MSD
SAMPLE 2 THRU 5
DUP
CCV
CCB

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Data Analysis

Quantitative analysis is performed using the most recent calibration curve. Results must be within the calibration range. Any sample exceeding the upper quantitation limit must be reanalyzed at a dilution.

10.2 Calculations

$$TOC\,\frac{\mu g}{g} = \frac{(\frac{\mu g}{mL}from\ instrument)(final\ volume\ mL)(d)}{sample\ weight, g}$$

Where:
d = dilution factor

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NOTE: No efficiency correction needed since reaction is heated.

NOTE: Samples are dried prior to analysis.

10.2.1 Manual Integration

Manual integration is sometimes necessary to correct inaccurate automated integrations but must never be used to meet QC criteria or to substitute for proper instrument maintenance and/or method set-up. To assure that all manual integrations are justified and proper all manual integrations must be performed, documented, reviewed, and approved in accordance with corporate SOP ENV-SOP-CORQ-0006, *Manual Integration.* Refer to this SOP for guidance on manual integration techniques and required procedures.

11.0 QUALITY CONTROL & METHOD PERFORMANCE

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples.
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples.
Sample Duplicate	SD	1 sample duplicate must be analyzed for every 20 samples
Matrix Spike/Matrix Spike Duplicate	MS/MSD	1 Matrix Spike/Matrix Spike Duplicate must be analyzed for every 20 samples

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix A for acceptance criteria and required corrective action.

11.3 Method Performance

Instrument Check	Acronym	Frequency
Initial Calibration Verification	ICV	After every calibration
Initial Calibration Blank	ICB	Immediately following each ICV
Continuing Calibration Verification	CCV	At the beginning of every batch, after every 10 samples, and after the last analytical sample
Continuing Calibration Blank	CCB	Immediately following each CCV

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011 for general requirements and procedures for method validation.

Establish detection limits (DL) and limits of quantitation (LOQ) at initial method set up and verify the DL and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for DL and LOQ requirements and procedures.

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12.0 DATA REVIEW & CORRECTIVE ACTION

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SOP ENV-SOP-MTJL-0014, Data Handling and Reporting andfor specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix A for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range.

Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

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13.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

The procedures in this SOP have been modified from the reference test method as follows:

Modification	Test Method Procedure	Justification for Modification
Samples are heated to drive reaction to completion. Samples quantitated spectrophotometrically instead of titration.	TOC by Walkley Black	Eliminate need to apply an efficiency correction factor.

When applicable, comparability and/or equivalency studies necessary to validate the modification as required per corporate SOP ENV-SOP-CORQ-0011 are retained by local quality personnel for historical reference.

15.0RESPONSIBILITIES

- PAS employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- PAS supervisors and managers however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP in the work area(s) they oversee.
- PAS employees are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local QM and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, Document Management and ENV-SOP-CORQ-0016, SOP for Creation of SOP and SWI.

16.0ATTACHMENTS

- Appendix A: QC Summary & Corrective Action Table

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17.0 REFERENCES

- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *SOP for SOP and SWI,* current version.
- ENV-TMP-MTJL-0001, *Quality Manual*, current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.
- Walkley, A.; Black, I. Armstrong; Walkley Black Method. Soil Science 37:29-37, 1934.
- Methods for the Determination of Total Organic Carbon (TOC) in Soils and Sediments, Brian A. Schumacher, USEPA, 04/02.
- Operation and Maintenance Manual for the HACH® DR6000 Spectrophotometer.
- Standard Test Methods for Organic Matter Content of Putting Green and Sports Turf Root Zone Mixes, ASTM F1647-02a Procedure B.

18.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
All	Updated to current corporate template.

Document Succession: This version replaces the following documents:

Document Number & Version	Document Title	Effective Date:
ENV-SOP-MTJL-0196 v03	Total Organic Cabron in Soil (Walkley Black)	03/31/2021

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Appendix A: QC Summary and Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
ICAL	At instrument set up, after CCV failure	The correlation coefficient (r) must be 0.995 or higher and there can be no outliers or if r2 greater than or 0.990.	Identify and correct source of problem, repeat If the calibration curve fails, check instrument and lamp performance. Rerun calibration curve. If it still fails, re-prep and re-analyze calibration standards.	None. Do not proceed with analysis
ICV	After Each ICAL	All analytes must be within ± 20% of the true value. (%R)	Identify source of problem, re-analyze. If repeat failure, repeat ICAL. Analysis may proceed if it can be demonstrated that the ICV exceedance has no impact on analytical measurements. For example, the ICV %R is high, CCV is within criteria, and the analyte is not detected in sample(s).	Qualify analytes with ICV out of criteria.
ICB	Immediately following each ICV	The concentration must be less than ½ RL.	Correct problem and repeat ICV/ICB analysis. If that fails, repeat ICAL. All samples following the last acceptable Calibration Blank must be reanalyzed.	Results may not be reported without valid Calibration Blanks.
CCV	Daily, before sample analysis, after every 10, and at end of analytical window.	Opening CCV: All analytes within ± 20 %D Ending CCV: All analytes within ± 20 %D	If the CCV fails and analysis of a second consecutive (immediate) calibration verification fails to produce results within acceptance criteria, corrective actions shall be performed. The laboratory shall demonstrate acceptable performance after corrective action with two consecutive calibration verifications, or a new initial instrument calibration shall be performed.	Qualify analytes with CCV out of of criteria.
CCB	After every CCV	The concentration must be less than ½ RL.	If the Method Blank or CCB fail, re-analyze once. If it fails again, the reason for the failure must be found and corrected. If the problem with the method blank was instrumental, the batch will not have to be re-prepped. If the problem with the method blank was with the digestion, the entire batch must be re-prepped. A passing method blank must be achieved before any samples can be analyzed. Passing CCBs are also necessary. If the failure of the CCB is not corrected with the	See General Guidelines below

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			re-analysis, then more extensive corrective action is necessary. This can include instrument maintenance, re-preparation and re-analysis of the calibration curve, etc. All samples between the first failing CCB and the last compliant CCB must be re-analyzed.	
Method Blank	1 per batch of 20 or fewer samples.	The concentration must be less than ½ RL.	If the Method Blank or CCB fail, re-analyze once. If it fails again, the reason for the failure must be found and corrected. If the problem with the method blank was instrumental, the batch will not have to be re-prepped. If the problem with the method blank was with the digestion, the entire batch must be re-prepped. A passing method blank must be achieved before any samples can be analyzed. Passing CCBs are also necessary. If the failure of the CCB is not corrected with the re-analysis, then more extensive corrective action is necessary. This can include instrument maintenance, re-preparation and re-analysis of the calibration curve, etc. All samples between the first failing CCB and the last compliant CCB must be re-analyzed.	See General Guidelines below
LCS/SRM	1 per batch of 20 or fewer samples.	The %R must be 75-144 or as specified. See LIMS for most up to date limits.	If the LCS/SRM fails, rerun each sample once. If the failure is repeated, identify and correct the reason for the failure. If the failure was unrelated to the digestion, the batch will not have to be re-prepped. If the problem was in the digestion procedure, the entire batch will have to be re-prepped.	N/A
Sample Duplicate	1 sample duplicate must be analyzed for every 20 samples	The RPD must be <20%.	If the RPD is >20%, the results may be reported with a J3 qualifier. If the RPD is beyond acceptance limits and the sample concentration is <5X the RL, then the value can be flagged with a “P1” qualifier indicating that the RPD calculation is not applicable at that concentration.	J3; P1
Matrix Spike/Matrix Spike Duplicate	1 Matrix Spike/Matrix Spike Duplicate must be analyzed for every 20 samples	RPD ≤ 20% (%D)	If the recovery of the MS falls outside of control limits, reanalyze parent sample and MS. If MS still fails, parent sample and MS/MSD must be prepared from new aliquots.	J3; P1

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Pace ANALYTICAL SERVICES	**ENV-SOP-MTJL-0163v13_pH & Corrosivity by EPA 150.1, SM 4500H+ B, SW-846 9040B, C, 9045C, D**
	Effective Date: 05/20/2025

Management Approval:
Jeremiah Gupton Approved on 5/5/2025 1:49:03 PM
Christopher Johnson Approved on 5/8/2025 6:58:35 AM
Blake Judge Approved on 5/20/2025 9:31:33 AM

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1.0 SCOPE & APPLICATION

This Standard Operating Procedure (SOP) describes the laboratory procedure used by PAS-Mt. Juliet for the determination of pH/Corrosivity by probe, following EPA method 150.1, SM 4500 H^+ B and SW-846 9040B/C, 9045C/D. This SOP is applicable to Drinking Waters (150.1 & SM), Non-Potable Water (SM & 9040B/C), and Solids (9045C/D).

1.1 Reference Methods & Documents

This SOP is based on reference method SM 4500 H^+, EPA 150.1, SW-846 9040B/C and 9045C/D. If the laboratory procedure is modified from the reference method, a list of modifications and rationale for the modification is provided in Section 14.0. Modifications are permitted when allowed by the regulatory program for which test results will be used and when the modification has been validated comparable and equivalent to the reference method.

1.2 Corrosivity by Langelier Saturation Index (LSI)

Calculated using the results from Total Dissolved Solids (TDS), Temperature, Calcium Hardness (calculated from total calcium), and Total Alkalinity.

1.3 Quantitation Range

This procedure has a quantitation range dependent of the pH of the sample. For samples a pH <2 or >12.5, they are reported as “Corrosive.” For samples with a pH>2 or <12.5, they are reported as “Not Corrosive.”

2.0 SUMMARY OF METHOD

A sample's pH is determined electrometrically using either a glass electrode with a reference potential or a combination electrode. Automatic temperature compensation is utilized to compensate for temperature variations during analysis. The measuring device is calibrated using a series of buffer solutions of known pH. Aqueous samples are measured directly. Non-Aqueous samples require extraction with reagent water prior to analysis. Corrosivity determination is made using the pH value obtained.

3.0 INTERFERENCES

Oily material or particulate matter may coat electrodes and impair responses. Remove these interferents by gently washing with detergent, rinsing with reagent water, and wiping with a soft cloth.

Electrode responses can differ at varying temperatures. Using a temperature-compensating electrode and a pH meter with temperature compensation capability controls fluctuations of this kind.

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In some samples, pH change is inherent at different temperatures. This error is sample dependent and cannot be controlled. Both pH and temperature should be recorded at the time of analysis and noted in the final report.

Acid rain samples must not be analyzed using a magnetic stirrer because pH values will change if the sample is not in equilibrium with the air. Instead, swirl the sample gently.

Sodium concentrations in samples at a pH value greater than 10 can cause a bias in pH measurements. “Low Sodium Error” Electrodes are used.

Scratches, deterioration, and accumulation of debris on the glass surface are the most common causes of electrode failure. Use, Store, and maintain electrodes according to manufacturer’s instructions.

Organic solvents are damaging the electrode. If a sample is an organic solvent, do not allow it to contact the electrode.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **PAS:** Acronym for Pace® Analytical Services, LLC
- **pH:** The inverse logarithm (base 10) of the Hydrogen Ion activity.
- **Corrosivity:** The ability of a substance to destroy and/or damage other substances with which it comes into contact. Routinely, common corrosives are either strong acids/bases or concentrated solutions of certain weak acids/bases.
- **Langelier Saturations Index (LSI):** An indicator that the water is corrosive or scale-forming.
- **Reference Electrode:** A Silver-Silver chloride or other reference electrode of constant potential.
- **Hygroscopic:** The ability of waste/solid material to readily absorb water.

5.0 HEALTH & SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

The following sections provide general health and safety information about chemicals and materials present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has 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.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001).

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- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

PAS does not offer sample collection services for this test method. PAS advises customers to collect samples in accordance with a sampling plan and collection procedures appropriate to meet regulatory requirements and data quality objectives for the project. The minimum sample amounts required for the test are provided in this section.

PAS provides containers for the collection of samples upon client request. The routine container type and size is provided in the following table along with requirements for sample size, preservation and holding time. Refer to SOP ENV-SOP-MTJL-0064, *Sample Shipping,* or however named, for procedures related to preparation of bottle kits.

Container Type, Minimum Sample Amount, Preservation, and Holding Time

Matrix	Container Size & Type[1]	Minimum Sample Amount[2]	Preservation	Holding Time
Water	125mL HDPE	25mL	Thermal: 0-6°C Chemical: NA	Collection to Analysis: 15 Minutes
Solids	4oz Glass Jar	20g	Thermal: 0-6°C Chemical: NA	Collection to Analysis: 15 minutes
SAR PASTE	NA	200 g	Thermal: 0-6°C Chemical: NA	Collection to Analysis: 15 minutes

[1] *Default container type provided in sample kit.*

[2] *Amount of sample required for each discrete test.*

Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP ENV-SOP-MTJL-0060, *Sample Receiving*, or however named. Chemical preservation is checked and recorded at the time of receipt or prior to sample preparation unless specifically stated in the reference method.

Due to hold times, all samples should receive a “T8” qualifier.

After receipt, samples are stored at 6°C until sample preparation.

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After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

Use of equivalent instrumentation, support equipment, and supplies from alternative vendors is acceptable so long as they meet the specifications as stated in the reference method(s).

7.1 Instrumentation

- Thermo Scientific™ Orion™ Versa Star pH meter, or equivalent.
- Orion™ ROSS Ultra™ Refillable pH/ATC Triode™ Combination Electrodes, Cat. #8157BNUMD or equivalent.
- Orion™ pH Electrode Filling Solution, Cat. #810007, or equivalent.
- Orion™ ROSS™ Probe Storage Solution, Thermo Scientific™, Cat. #810001TS, or equivalent.

7.2 Support Equipment

- Top loading analytical balance, Ohaus Scout Pro, capable of accurate weight measurements to the nearest 0.1 g.
- Magnetic stir plate, Thermo Scientific™ SP-131015Q
- Centrifuge, Thermo Fisher ST8.
- Shaker

7.3 Supplies

- Magnetic PTFE-coated Stir Bars, Fisher Scientific, Cat. #14-511-58 or equivalent.
- Centrifuge Tubes, Corning, Cat. #430829 or equivalent.
- Disposable Beakers, Fisher Scientific, Cat. #01-291-10 or equivalent.

8.0 REAGENTS & STANDARDS

Refer to laboratory Form ENV-FRM-MTJL-0490, *Standard Logger Instructions*, or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared when available. Expiration and storage requirements are defined per manufacturer.

8.1 Reagents

Use of equivalent reagents from alternative vendors is acceptable so long as the substitution meets the performance specifications required by the reference method(s).

- Reagent water: Analyte-free, deionized, bottled, or internally produced, that meets or exceeds ASTM Type II reagent grade.

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8.2 Standards

Use of equivalent standards from alternative vendors is acceptable so long as they are traceable to a national standard, when commercially available.

Primary Standards	Vendor	Catalog #	Concentration (pH)	Storage (°C)
Buffer, pH 1	Ricca	1489-32	1	Ambient
Buffer, pH 4	SPEX certiprep	VPACEMN-93-4L	4	
Buffer, pH 7	SPEX certiprep	VPACEMN-94-4L	7	
Buffer, pH 10	SPEX certiprep	VPACEMN-95-4L	10	
Buffer, pH 13	Ricca	1625-16	13	

- All titrants ISO 17034 if available.

Buffer solutions should be routinely checked for growth or contamination. Evidence of buffer degradation should result in the immediate replacement of the affected solutions.

Buffers can be used only once i.e., daily. Use the smallest possible aliquots of each buffer that provides sufficient probe immersion and discard remainders of the aliquots when completed. Opened stock buffers are valid for one (1) month but cannot exceed manufacturers' expiration date.

Secondary Standard	Vendor	Part #	Concentration (pH)	Storage (°C)
Buffer, pH 7	Inorganic Ventures	PHYELLOW-7-4L	7	Ambient

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Instrument Setup

9.1.1.1 Routine Instrument Operating Conditions

Refer to Appendix B for routine instrument operating conditions.

9.1.2 Support Equipment

Refer to laboratory SOP ENV-SOP-MTJL-0374, *Support Equipment*, or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

9.1.2.1 Automatic Temperature Compensation (ATC) Verification

Probes for pH analysis are often equipped with automatic temperature compensation. Some meters may also allow for external probes for this same purpose. For meters capable of ATC (internal or external), the temperature measuring device must be verified prior to being placed into service and on a

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quarterly basis thereafter. Refer to laboratory SOP ENV-SOP-MTJL-0040, Verification of Automatic Temperature Compensation Probes on Laboratory pH Meters, or however named, for additional information on ATC verification requirements.

9.1.2.2 Preparation of pH Electrode

1) Remove the storage bottle from the sensing bulb.
2) Clean any salt deposits from the exterior of the electrode by rinsing it with reagent water.
3) If a residue is visible on the sensing bulb that cannot be removed with reagent water, such as oils or grease, use the following cleaning agents:
   - Low residue detergent.
   - Dilute HCl, 0.1N
4) If a low residue detergent is used, rinse the probe with warm reagent water after washing.
5) If dilute HCl is used, allow the probe to sit overnight, if necessary, then rinse with reagent water.
6) Uncover the fill hole by removing the tape and add filling solution. To maintain an adequate flow rate, the level of fill solution must always be above the reference junction and at least one inch above the sample level.
7) The fill hole should remain open whenever the electrode is in use.
8) Wet the junction by pressing down on the electrode cap to let a few drops of the filling solution flow out of the electrode and then replenish any lost filling solution.
9) Shake the electrode downward (like a clinical thermometer) to remove any air bubbles.
10) Soak electrode in pH electrode storage solution for 30 to 60 minutes, then connect the electrode to the meter.

9.2 Calibration

Refer to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for general laboratory calibration policies and procedures.

9.2.1 Calibration Frequency

Calibration is performed daily prior to sample analysis.

9.2.2 Calibration Levels

If analyzing for SAR PASTE, pH buffer 1 and 13 may be dropped, depending on probe being used. Refer to probe or meter manual for clarification on number of buffers to use.

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Standard	pH Buffer
CAL 1	1
CAL 2	4
CAL 3	7
CAL 4	10
CAL 5	13

Note: Buffer solutions should be routinely checked for growth or contamination. Evidence of buffer degradation should result in the immediate replacement of the affected solutions.

9.2.3 Calibration Sequence

If analyzing for SAR PASTE, pH buffer 1 and 13 may be dropped, depending on probe being used. Refer to probe or meter manual for clarification on number of buffers to use.

Demonstration and documentation of acceptable initial calibration is required before any samples are analyzed. Subsequent calibration verification is required at regular intervals throughout the analytical sequence. Upon the successful completion of the ICAL, an initial calibration verification is performed, followed by continuing calibration checks after the analysis of a maximum of ten samples, and at the end of the analytical sequence.

For corrosivity characterization, the calibration of the pH meter should include a buffer of pH 2 for acidic wastes and a pH 12 buffer for caustic wastes.

The following instructions are used with the Thermo Scientific™ Orion™ Versa Star pH meter and are provided as general direction. Use of other pH meters with this procedure may cause slight variation from the process that follows.

1) Press Cal (F1).
2) Select desired channel (1 or 2)
3) Pour pH 1 buffer into a disposable beaker with a stir bar and place the beaker on a stir plate. Use sufficient volume of solution to cover the sensing unit on the probe and to allow for adequate clearance between the probe and the rotating stir bar. Rinse the electrodes and place them in the buffer solution. When the display prompts that the reading is stable, press [accept] (F2) once. Record the mV and temperature value that is then displayed in the pH calibration log and then proceed with other buffers by selecting [next].
4) Place pH 4 buffer on stir plate and repeat instructions in step 3.
5) Place pH 7 buffer on stir plate and repeat instructions in step 3.
6) Place the pH 10 buffer on the stir plate and repeat instructions step 3.
7) Place the pH 13 buffer on the stir plate and repeat instructions step 3.
8) When finished select [CAL DONE] button. Record the slope between buffers 4 and 7, 7 and 10, and the final slope in the pH calibration log. Refer to section 9.2.4.1 for calibration evaluation.

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9) The slope must be between 95-102% for analysis to proceed. If the slope is not within this range, repeat calibration with fresh buffers.

10) Buffers can be used only once. Use the smallest possible aliquots and then discard.

Note: Samples must be bracketed by buffers.

9.2.4 Calibration Evaluation

If analyzing for SAR PASTE, pH buffer 1 and 13 may be dropped, depending on probe being used. Refer to probe or meter manual for clarification on number of buffers to use.

9.2.4.1 Slope Determination

Calibration is performed by the analysis of certified pH buffer solutions (1, 4, 7, 10, and 13). The calibration slope is a conversion that the pH meter uses to convert the electrode signal in mV to pH. The meter determines the slope by measuring the difference in mV readings for each pH buffer. The output of a pH measuring electrode is equal to -59.16 mV per pH unit. Review the slopes between buffers 4 to 7 and 7 to 10. If the slopes differ more than 3%, recalibrate. Each buffer must be within 0.05 pH units. The final calculated slope must be 95-102%

9.2.4.2 Initial Calibration Verification (ICV)

Included in every workgroup batch. A Second source verification is ran prior to sample analysis. Acceptance criteria is within 0.05 pH units of the true value. The ICV and CCV are prepared from the same secondary source.

9.2.4.3 Continuing Calibration Verification (CCV)

A pH 7 buffer solution as a CCV is analyzed after every 10 samples, and at the end of the analytical sequence. The pH reading should meet the criteria as defined in Appendix A. If the CCV fails, perform corrective action(s), and repeat the analysis of the CCV using a fresh aliquot of pH 7 buffer. The CCV and ICV are prepared from the same secondary source.

9.3 Sample Preparation

9.3.1 Homogenization & Subsampling

Refer to laboratory SOP ENV-SOP-MTJL-0030, *Sample Homogenization and Sub-Sampling*, or however named, for information regarding the handling, homogenization, and splitting of samples to ensure that a representative aliquot is used for preparation.

9.3.2 Soil Preparation

1) Tare balance with an empty disposable centrifuge tube.

2) Weigh 20 ± 0.1g of soil into the disposable centrifuge tube. Record weight on bench sheet and transfer to LIMS.

3) Add 20 mL of reagent water. Record volume on bench sheet and transfer to LIMS.

4) continuously shake for 10-15 minutes on the shaker table.

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5) Additional water may be added when working with hygroscopic soils, salts, and other problematic matrices. Add additional water in 10 mL increments until there is enough free liquid to measure the pH. Record additional volume on bench sheet and transfer to LIMS.

6) Allow the sample to sit for about 1 hour to let the particulates settle. OR

7) centrifuge (3300 rpm or greater) for approximately 15 minutes. Record start and stop times on bench sheet and transfer to LIMS.

9.3.3 Water Preparation

1) Allow samples to warm up to room temperature.

2) Verify that the sample is water soluble by placing a few drops into a test tube containing water. Verify mixing. If two layers are visible, treat the sample as an oily waste. Proceed to Section 9.3.4.

3) Shake samples thoroughly; pour approximately 25 mL into a plastic beaker containing a magnetic stir bar. Sufficient samples must be available to cover the sensing element of the electrode and to give adequate clearance for the stir bar.

4) Prepare 1 DUP sample per 10 field samples. Proceed to Section 9.4

9.3.4 Saturated Soluble Paste (SAR PASTE)

1) Samples normally are received as SAR paste from the Metals department or dried and sieved from building 5. If samples are not dried and sieved, air dry samples. Once dried, pulverize and pass through a 10-mesh sieve.
2) If the lab has to dry and sieve, weigh between 50 and 200 ± 0.5 g into a plastic container. Record actual weight used.
3) Gradually add ASTM Type I water and mix uniformly until saturated paste is obtained (pancake batter). Ensure that the sample meets the criteria below

   a. Does not have free standing water on the surface of the paste

   b. Soil pastes slide freely and cleanly off a spatula (does not apply to high clay soils)

   c. Paste will flow slightly when the container is tipped to a 45-degree angle from horizontal.

   d. Soil surface glistens as it reflects light

   e. Consolidates easily by tapping after a trench is formed in the paste with the flat side of a spatula (may not apply to sandy soils).

4) Record total weight of soil and liquid and cover. Let stand for 4 hours. Check saturation characteristics again and add more soil or water as needed to obtain desired consistency (document amount extra used)

5) Proceed to SAR PASTE sample analysis below.

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6) Once 4 hours has passed, check the pH of the slurry mixture by submerging pH probe and slowly rotating to remove air bubbles.

7) Rinse off probe in between each sample reading

9.4 Sample Analysis

9.4.1 Sequence Preparation

1) Place a stir bar into a disposable beaker and add sufficient sample, buffer, or soil/waste extract to cover the sensing unit on the electrode and to allow for adequate clearance between the electrode and the stir bar.

2) For preparation of the LCS, use an aliquot of a second source pH 7 buffer or certified reference material.

3) Place the sample on the stir plate and stir gently to generate as little agitation as possible at the air/sample interface. Refer to Section 3.0 for special handling of acid rain samples.

4) Immerse the electrodes in the sample to be analyzed.

5) When the reading is stable (less than 0.1 pH unit drift), the “Stable” prompt will appear on the meter display, then record the result as it is displayed. repeat the analysis. All samples must be analyzed in replicate. Record results on bench sheet and transfer to LIMS.

   - Any sample pH measurement above 12.0 must be reanalyzed at a temperature of 25 ± 1.0°C. Document the exact temperature measurement for samples of this type.
   - For SW-846 9040C
     - Determine the aqueous portion of the sample to be analyzed prior to analysis. The aqueous phase must constitute greater than 20% of the sample matrix by volume.
     - Repeat measurement on successive replicates of sample until values differ by <0.1 pH units. Two or three volume changes are usually sufficient.

6) Rinse the electrodes with reagent grade water and shake electrodes gently to remove excess water droplets or touch the bulb briefly with a lint-free wiper (do not rub).

9.4.2 SAR PASTE

1) If pH probe is not equipped with ATC, bring calibration and samples to 25°C ± 2°C prior to analysis.

2) Once 4 hours has passed, check the pH of the slurry mixture by submerging pH probe and slowly rotating to remove air bubbles.

3) For preparation of the LCS, use an aliquot of a second source pH 7 buffer or certified reference material.

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4) For the preparation of a Sample Duplicate, pour off a second aliquot of a randomly selected sample and analyze accordingly.

5) When the reading is stable (less than 0.1 pH unit drift), the “Stable” prompt will appear on the meter display, then record the result as it is displayed. repeat the analysis. All samples must be analyzed in replicate. Record results on bench sheet and transfer to LIMS.

6) Rinse the electrodes with reagent grade water and shake electrodes gently to remove excess water droplets or touch the bulb briefly with a lint-free wiper (do not rub).

9.4.3 Routine Analytical Sequence

Calibrate
Prepare soil/water samples
Analyze ICV
Analyze LCS
Analyze samples and batch QC.
Analyze CCV (after 10 samples)
Analyze samples.
Analyze CCV (end of sequence)

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Calculations

Refer to the laboratory Quality Assurance Manual and to laboratory SOP ENV-MAN-MTJL-0001, *Quality Manual - Quality Control Calculations*, for equations used to perform common calculations. Calculations are predominantly done through our LIMS system. Select formulas are listed below as a reference.

10.1.1 Calculation of Slope

Calculation of the slope of the calibrated pH meter when pH readings can be provided in millivolts (mV) and slope is not automatically provided by the meter.

$$Slope\ (\%) = \frac{((mV\ at\ pH\ 7) - (mV\ at\ pH\ 4))\ \ x\ 100}{177}$$

This is not the same as used in linear regression. The slope is relative to theoretical using the Nernst equation.

10.1.2 Calculation of Langelier Saturation Index

$$Langlier\ Index = pH - pHs$$

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$$pHs = \big(9.3 + (A + B)\big) - (C + D)$$

Where:

A = (Log_{10} [TDS (Total Dissolved Solids)] - 1) / 10

B = -13.12 x Log_{10} (°C + 273) + 34.55

C = Log_{10} [Ca^{2+} as $CaCO_3$] - 0.4

D = Log_{10} [alkalinity as $CaCO_3$]

11.0 Quality Control & Method Performance

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix A for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples.
Sample Duplicate	DUP	1 per 10 or fewer samples, per matrix

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix A for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Initial Calibration Verification	ICV	At the beginning of every workgroup
Continuing Calibration Verification	CCV	After every 10 samples, and at end of the sequence

11.3 Method Performance

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, for general requirements and procedures for method validation.

12.0 Data Review & Corrective Action

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs (Standard Operating Procedure) were followed, the analytical record is complete, and properly documented, QC

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criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SOP ENV-SOP-MTJL-0038, *Data Handling*, for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix A for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

13.0 POLLUTION PREVENTION & WASTE MANAGEMENT

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

The procedures in this SOP have not been modified from the reference test method(s) cited.

15.0 RESPONSIBILITIES

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PAS employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.

- PAS supervisors and managers, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP in the work area(s) they oversee.
- PAS employees are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local QM and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Management* and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI.*

16.0 ATTACHMENTS

- Appendix A: QC Summary & Corrective Action Table
- Appendix B: Thermo Scientific Orion™ Versa Star pH Meter Operating Conditions

17.0 REFERENCES

- ENV-POL-CORQ-0005, Acceptable Calibration Practices, current version.
- ENV-SOP-CORQ-0011, Method Validation and Instrument Verification, current version.
- ENV-SOP-CORQ-0015, Document Management, current version.
- ENV-SOP-CORQ-0016, Standard Operating Procedures and Standard Work Instructions, current version.
- COR-POL-0004, Code of Ethics and Professional Conduct, current version.
- COR-MAN-001, Pace® Safety Manual, current version.
- ENV-MAN-MTJL-0001, Quality Manual, current version.
- TNI Standard, “Volume 1 Management and Technical Requirements for Laboratories Performing Environmental Analysis”, current version.
- ENV-SOP-MTJL-0041 Standards Logger (Tree), current version.
- ENV-SOP-MTJL-0374 Support Equipment, current version.
- ENV-SOP-MTJL-0030 Sample Homogenization and Sub-Sampling, current version.
- ENV-SOP-MTJL-0038 Data Review, current version.
- ENV-SOP-MTJL-0315 Sample & Waste Disposal, current version.
- Laboratory Quality Manual, ENV-MAN-MTJL-0001, current version.
- Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.4

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- Quality Systems Manual (QSM) for Environmental Laboratories, Version 6.0
- Manual for the Certification of Laboratories Analyzing Drinking Water, Fifth Edition.
- USEPA Manual for the Certification of Laboratories Analyzing Drinking Water, EPA 815-R-05-004, 5th Edition, January 2005.
- pH (Electrometric), EPA Method 150.1, Approved for NPDES, Editorial Revision 1978, 1982.
- Standard Methods for the Examination of Water and Wastewater, SM4500H+ B-2011.
- Standard Methods for the Examination of Water and Wastewater, SM4500H+ B-2021.
- USEPA SW-846 9040C: pH Electrometric Measurement, part of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, November 2004
- USEPA SW-846 9045C, Soil and Waste pH, part of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, January 1995.
- USEPA SW-846 9045D, Soil and Waste pH, part of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, November 2004.
- Calcium Carbonate Saturation, Standard Methods 2330 B-2011
- Soil, Plant, and Water Referencing Methods for the Western Region S-1.00, 2013 4th Edition
- Soil, Plant, and Water Referencing Methods for the Western Region S-1.10, 2013 4th Edition

18.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
6.0	Added section in sample collection for SAR PASTE
9.2.2	Added comment that SAR PASTE does not require pH buffer 1 and 13 and to refer to the probe or meter manual for additional information.
9.2.3	Added comment that SAR PASTE does not require pH buffer 1 and 13 and to refer to the probe or meter manual for additional information.
9.2.4	Added comment that SAR PASTE does not require pH buffer 1 and 13 and to refer to the probe or meter manual for additional information.
9.3.4	Created Section on the preparation for SAR PASTE
9.4.2	Created Section for SAR Paste analysis
17.0	Added method references for SAR PASTE

Document Succession: This version replaces the following document(s):

Document Number	Version	Document Title	Effective Date:
0163	12	pH & Corrosivity by EPA 150.1, SM4500H+, SW 9040B, C, 9045C, D	02/12/2025

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Appendix A: QC Summary & Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Initial Calibration (ICAL)	ICAL prior to sample analysis	Slope between pH buffers 4 to 7 and 7 to 10 must not differ greater than 3%. Final pH slope must be within 95-102%	Identify and correct source of the problem, repeat calibration.	None. Do not proceed with analysis
Calibration Standard Check	Immediately following ICAL	All buffers within ± 0.05 pH units of true value.	Identify and correct source of the problem, repeat calibration.	None. Do not proceed with analysis
Initial Calibration Verification (ICV)	At the beginning of every analytical sequence.	pH 7 buffer within ± 0.05 pH units of true value. (98.6-101%)	Identify and correct source of the problem, repeat calibration. ICV may be reanalyzed immediately after initial failure.	None. Do not proceed with analysis
Continuing Calibration Verification (CCV)	After every 10 samples, and at the end of analytical sequence.	pH 7 buffer within ± 0.05 pH units of true value. (98.6-101%)	Refer to Section 9.2.4.3 for required corrective actions based upon circumstance. CCV may be reanalyzed immediately after initial failure. Reanalyze CCV and all associated samples after the last acceptable CCV.	None. Do not proceed with analysis
Laboratory Control Sample (LCS)	1 per batch, per matrix, of twenty or fewer samples.	pH 10 buffer within ± 0.05 pH units of true value. (99-101%)	Identify and correct source of problem, reanalyze all associated samples and QC, repeat calibration. LCS may be reanalyzed immediately after initial failure.	None. Do not proceed with analysis
Sample Duplicate (DUP)	1 per 10 samples, per matrix.	Duplicate results within ± 0.1 pH units	Identify and correct source of problem, repeat replicate analysis.	Qualify sample with DUP out of criteria. Use “J3” qualifier Not applicable to DW (Drinking Water).

Appendix B: Thermo Scientific™ Orion™ Versa Star pH Meter Operating Conditions

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Orion VERSA STAR pH Module Specifications		
Catalog Number		VSTAR-PH
pH	**Range**	- 2.000 to 20.000
	Resolution	0.1, 0.01, 0.001
	Relative Accuracy	± 0.002
	Calibration Points	Up to 6
	Calibration Editing	Yes
	Adjustable ISO Point	Yes
	Input Impedance	> 10^12 ohms
mV / RmV	**Range**	± 2000.0 mV
	Resolution	0.1 mV
	Relative Accuracy	± 0.2 mV or ± 0.05 % of reading, whichever is greater
	Relative mV Mode	Yes
	E_H ORP Mode	Yes
Temperature	**Range**	-5 to 105 °C, 22 to 221 °F
	Resolution	0.1 °C, 0.1 °F
	Relative Accuracy	± 0.1 °C, ± 0.1 °F
	Offset Calibration	1 point
	Source Options	Manual or automatic with ATC probe
Inputs	**BNC**	pH or ORP electrode
	Pin Tip	Reference electrode
	8 pin MiniDIN	ATC temperature probe

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Schnabel ENGINEERING

Standard Operating Procedure

Grain Size Determined by Sedimentation Analysis (Hydrometer)

SCOPE AND APPLICATION

This method determines the particle size distribution in soil. Particles greater than 75-um (gravels to fine sands) are determined by sieving and particles less than 75-um (silts and clays) are determined by sedimentation using a hydrometer. This preparation is used for samples containing gravel, sand, silt, and clay.

References used: ASTM Standards D6913 and/or D7928

ASTM D6913 test method is typically used for determining the gradation of soil between the 3-in. (75-mm) and No. 200 (75-µm) sieves.

ASTM D7928 test method covers the quantitative determination of the distribution of particle sizes of the fine-grained portion of soils. The sedimentation or hydrometer method is used to determine the particle-size distribution (gradation) of the material that is finer than the No. 200 (75-µm) sieve and larger than about 0.2-µm. The test is performed on material passing the No. 10 (2.0-mm) or finer sieve.

EQUIPMENT AND SUPPLIES

Balance sensitive to 0.01 grams
Mixer and dispersion cup
1000 ml sedimentation cylinder
Sodium Hexametaphosphate (dispersion reagent)
Soil test hydrometer
Mortar and rubber tipped pestle for breaking up soil aggregates
Oven with temperature range of 60°C to 110°C
Thermometer accurate to 0.5°C
Timer
Mixing utensils, metal and bristle brushes for sample recovery
Rototap machine, if necessary.

Typical sieves sizes used, where appropriate:
Note: sieve sizes used may vary depending on sample material and project specification

Sieve Size (in.)(mm)		
3.0 in. (75.00mm)	1/2 in. (12.50mm)	No. 40 (425um)
2.0 in. (50.00mm)	3/8 in. (9.50mm)	No. 60 (250.0um)
1.5 in. (37.50mm)	No. 4 (475mm)	No. 100 (150.0um)
1.0 in. (25.00mm)	No. 10 (2.00mm)	No. 200 (75.0um)
3/4 in. (19.00mm)	No. 20 (850.0um)	

SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

Minimum quantity of sample depends on subsequent analyses to be performed. Typical sample of 150 to 350 grams is used for analysis. Larger amounts (from 500 to 5000 grams) are specified for particle size analysis of soils with appreciable gravel component. The sample container must remained sealed to maintain natural water content.

There are no holding time requirements.

QUALITY CONTROL

Check balance daily with Class S weight, yearly manufacturer calibration.
Oven temperature is checked daily prior to start of work.
Thermometer is checked against similar or more accurate temperature device.

CALIBRATION AND STANDARDIZATION

Sieves calibrated twice a year using the National Bureau of Standard, Certificate of Calibration, standard reference materials 1017a, 1018a and 1019a calibrated glass beads.

Hydrometers are calibrated twice a year, and checked prior to each use.

Thermometer calibrated against NIST certified thermometer.

PROCEDURE

An air-dried representative sample is weighed. This weight is recorded as the dry weight of the sample.

Sample is processed through a series of sieve sizes greater than and equal to the No. 10 sieve size. This separates the soil sample from the material greater than the No. 10 sieve and what material is finer than the No. 10 sieve.

Weigh and record the contents of each sieve greater than No. 10. Also, weigh and record the contents retained on the No. 10 sieve.

Hydrometer Test: The soil passing the No. 10 sieve is used in the following steps.

Hydroscopic Moisture: Take a representative sample and place in a small tin (record weight of tin). Record weight of sample and tin. Place in oven for at least 16hrs. Place the tin in the oven at 110°C for at least 16 hours. Remove the tin and record the weight after drying period.

Weigh and record an appropriate amount of soil depending on the soil type. Typically, sample size for fine grained soils (clay/silt) is approximately 50 grams, and coarse grained soils (sand) approximately 100 grams, when feasible.

Add 100 ml of dispersing agent to soil sample and enough distilled water to be sufficient enough to facilitate the process of breaking apart the soil aggregations. Sample is then placed in the dispersion cup and agitated/blended for one minute. Upon completion of the blending, the dispersed slurry is then transferred into the sedimentation cylinder making sure all the slurry is transferred to the cylinder. Use a rinse bottle if necessary. Distilled water is used to fill the cylinder to the 1000 ml +/- mark. Then using the tipping method, tip the cylinder upside down and back for a period of one minute to complete the agitation of the slurry. If soils are highly plastic, the use of an agitator may be used. Cover cylinder to prevent evaporation and allow the cylinder to sit overnight.

The next day, the mixture in the cylinder needs to be remixed by the tipping method. Upon completion of the last inversion, start taking hydrometer readings using the prescribed times. A reading consists of inserting the hydrometer gently into the cylinder, (after the cylinder has been shaken for 1 minute), about 20 seconds before the actual reading. Read the hydrometer at the top of the meniscus and the reading where the plane of the water surface intersects the stem. The difference of the two readings is the meniscus correction. Record this value. Remove the hydrometer and insert a temperature sensor into the cylinder to the depth to which the hydrometer reached. Read the temperature meter to the nearest 0.1°C and remove the temperature sensor. The hydrometers and temperature sensor are rinsed in a distilled water bath between each reading.

The hydrometer reading, temperature, and time (from table) is entered on the hydrometer data sheet at the corresponding cylinder (test) number and time portion on the data sheet; deviations from the table schedule are noted on the sheet. The readings are taken at 0.5, 1, 2, 4, 15, 30, 60, 120, 240 and 1440 minute intervals. Temperature is recorded at the beginning of the sedimentation test and then every 30 minute intervals.

Upon completion of the 1440 minute reading, the sediment is washed over a No. 200 sieve. The soil retained on the No. 200 sieve is placed in an oven and dried overnight. The next day, the sample is removed from the oven. Record the weight.

Information obtained during the set up and testing process is entered in our gINT program to generate the necessary information to generate a sieve curve and gravel, sand, silt and clay particle information.

Note: when a full sieve is required, the sample removed from the oven after the No. 200 wash would be placed in the appropriate sieve stack on a Rototap sieve shaking machine. Upon completion of shaking, the sieves would be weighed and recorded.

CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Pace Analytical – South Carolina

106 Vantage Point Drive
West Columbia, SC 29172

Fulfills the requirements of

ISO/IEC 17025:2017

and the

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V5.4)

In the field of

TESTING

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

Jason Stine, Vice President

Expiry Date: 18 November 2025

Certificate Number: L2224

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

and

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V5.4)

Pace Analytical – South Carolina

106 Vantage Point Drive
West Columbia, SC 29172
Erin Boyd
803-227-2702

TESTING

Valid to: **November 18, 2025** Certificate Number: **L2224**

Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8151A	2,4,5-T
GC	EPA 8151A	2,4D
GC	EPA 8151A	2,4DB
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	Dichloroprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP
GC	EPA 8151A	Silvex(2,4,5 TP)
GC/MS	EPA 8270E	0,0,0-Triethylphosphorothioate
GC/MS	EPA 8270E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270E	1,2,4-Trichlorobenzene
GC/MS	EPA 8270E	1,2-Dichlorobenzene
GC/MS	EPA 8270E	1,3-Dichlorobenzene
GC/MS	EPA 8270E	1,3,5-Trinitrobenzene
GC/MS	EPA 8270E	1,4-Benzoquinone
GC/MS	EPA 8270E	1,4-Dichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	1,4-Dinitrobenzene
GC/MS	EPA 8270E	1,4-Naphthoquinone
GC/MS	EPA 8270E	1-Chloronaphthalene
GC/MS	EPA 8270E	1-Methylnaphthalene
GC/MS	EPA 8270E	1-Naphthylamine
GC/MS	EPA 8270E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270E	2,3,5,6-Tetrachlorophenol
GC/MS	EPA 8270E	2,4,5-Trichlorophenol
GC/MS	EPA 8270E	2,4,6-Trichlorophenol
GC/MS	EPA 8270E	2,4-Dichlorophenol
GC/MS	EPA 8270E	2,4-Dimethylphenol
GC/MS	EPA 8270E	2,4-Dinitrophenol
GC/MS	EPA 8270E	2,4-Dinitrotoluene
GC/MS	EPA 8270E	2,6-Dichlorophenol
GC/MS	EPA 8270E	2,6-Dinitrotoluene
GC/MS	EPA 8270E	2-Acetylaminofluorene
GC/MS	EPA 8270E	2-Chloronaphthalene
GC/MS	EPA 8270E	2-Chlorophenol
GC/MS	EPA 8270E	2-Methylnaphthalene
GC/MS	EPA 8270E	2-Methylphenol
GC/MS	EPA 8270E	2-Naphthylamine
GC/MS	EPA 8270E	2-Nitroaniline
GC/MS	EPA 8270E	2-Nitrophenol
GC/MS	EPA 8270E	2-Picoline
GC/MS	EPA 8270E	3,3'-Dichlorobenzidine
GC/MS	EPA 8270E	3-Methylcholanthrene
GC/MS	EPA 8270E	3-Nitroaniline
GC/MS	EPA 8270E	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270E	4-Aminobiphenyl
GC/MS	EPA 8270E	4-Bromophenylphenylether
GC/MS	EPA 8270E	4-Chloro-3-methylphenol
GC/MS	EPA 8270E	4-Chloroaniline
GC/MS	EPA 8270E	4-Chlorophenylphenylether
GC/MS	EPA 8270E	4-Nitroaniline
GC/MS	EPA 8270E	4-Nitrophenol
GC/MS	EPA 8270E	5-Nitro-o-toluidine

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	7,12-Dimethylbenzo(a)anthracene
GC/MS	EPA 8270E	Acenaphthene
GC/MS	EPA 8270E	Acenaphthylene
GC/MS	EPA 8270E	Acetophenone
GC/MS	EPA 8270E	Anthracene
GC/MS	EPA 8270E	Atrazine
GC/MS	EPA 8270E	Benzaldhyde
GC/MS	EPA 8270E	Benzidine
GC/MS	EPA 8270E	Benzo(a)Anthracene
GC/MS	EPA 8270E	Benzo(a)pyrene
GC/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS	EPA 8270E	Benzoic acid
GC/MS	EPA 8270E	Benzyl alcohol
GC/MS	EPA 8270E	Biphenyl
GC/MS	EPA 8270E	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270E	bis(2-Chloroethyl)ether
GCMS	EPA 8270E	Bis (2-Chloro-1-methylethyl) ether
GC/MS	EPA 8270E	bis(2-Ethylhexyl)phthalate
GC/MS	EPA 8270E	Butylbenzylphthalate
GC/MS	EPA 8270E	Caprolactam
GC/MS	EPA 8270E	Carbazole
GC/MS	EPA 8270E	Chrysene
GC/MS	EPA 8270E	Chlorobenzilate
GC/MS	EPA 8270E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270E	Dibenzo(a,e)pyrene
GC/MS	EPA 8270E	Dibenzofuran
GC/MS	EPA 8270E	Diethylphthalate
GC/MS	EPA 8270E	Dimethoate
GC/MS	EPA 8270E	Dimethylphthalate
GC/MS	EPA 8270E	Di-n-butylphthalate
GC/MS	EPA 8270E	Di-n-octylphthalate
GC/MS	EPA 8270E	Disulfoton
GC/MS	EPA 8270E	Ethyl methanesulfonate
GC/MS	EPA 8270E	Fluoranthene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	Fluorene
GC/MS	EPA 8270E	Hexachlorobenzene
GC/MS	EPA 8270E	Hexachlorobutadiene
GC/MS	EPA 8270E	Hexachlorocyclopentadiene
GC/MS	EPA 8270E	Hexachloroethane
GC/MS	EPA 8270E	Hexachloropropene
GC/MS	EPA 8270E	Indene
GC/MS	EPA 8270E	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 8270E	Isodrin
GC/MS	EPA 8270E	Isophorone
GC/MS	EPA 8270E	Isosafrole
GC/MS	EPA 8270E	m+p-Cresol
GC/MS	EPA 8270E	m-Dinitrobenzene
GC/MS	EPA 8270E	Methyl methacrylate
GC/MS	EPA 8270E	Methyl methanesulfonate
GC/MS	EPA 8270E	Methyl parathion
GC/MS	EPA 8270E	Naphthalene
GC/MS	EPA 8270E	Nitrobenzene
GC/MS	EPA 8270E	N-Nitrosodiethylamine
GC/MS	EPA 8270E	N-Nitrosodimethylamine
GC/MS	EPA 8270E	N-Nitrosodi-n-butylamine
GC/MS	EPA 8270E	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270E	n-Nitrosodiphenylamine
GC/MS	EPA 8270E	N-Nitrosomethylethylamine
GC/MS	EPA 8270E	N-Nitrosomorpholine
GC/MS	EPA 8270E	N-Nitrosopiperidine
GC/MS	EPA 8270E	N-Nitrosopyrrolidine
GC/MS	EPA 8270E	o-Cresol
GC/MS	EPA 8270E	o-Toluidine
GC/MS	EPA 8270E	Parathion
GC/MS	EPA 8270E	Pentachlorobenzene
GC/MS	EPA 8270E	Pentachloroethane
GC/MS	EPA 8270E	Pentachloronitrobenzene
GC/MS	EPA 8270E	Pentachlorophenol
GC/MS	EPA 8270E	Phenacetin
GC/MS	EPA 8270E	Phenanthrene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	Phenol
GC/MS	EPA 8270E	Phorate
GC/MS	EPA 8270E	Pronamide
GC/MS	EPA 8270E	Pyrene
GC/MS	EPA 8270E	Pyridine
GC/MS	EPA 8270E	Safrole
GC/MS	EPA 8270E	Tetraethyl dithiopyrophosphate
GC/MS	EPA 8270E	Thionazine
GC/MS	EPA 8270E	Tributyl phosphate
GC/MS	EPA 8270E	p-Phenylenediamine
GC/MS	EPA 8270E SIM	Acenaphthene
GC/MS	EPA 8270E SIM	Acenaphthylene
GC/MS	EPA 8270E SIM	Anthracene
GC/MS	EPA 8270E SIM	Benzo(a)anthracene
GC/MS	EPA 8270E SIM	Benzo(a)pyrene
GC/MS	EPA 8270E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270E SIM	Chrysene
GC/MS	EPA 8270E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270E SIM	1,4-Dioxane
GC/MS	EPA 8270E SIM	Fluoranthene
GC/MS	EPA 8270E SIM	Fluorene
GC/MS	EPA 8270E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270E SIM	1-Methylnaphthalene
GC/MS	EPA 8270E SIM	2-Methylnaphthalene
GC/MS	EPA 8270E SIM	Naphthalene
GC/MS	EPA 8270E SIM	Pentachlorophenol
GC/MS	EPA 8270E SIM	Phenanthrene
GC/MS	EPA 8270E SIM	Pyrene
GC/MS	EPA 625.1	Acenaphthene
GC/MS	EPA 625.1	Acenaphthylene
GC/MS	EPA 625.1	Aniline
GC/MS	EPA 625.1	Anthracene
GC/MS	EPA 625.1	Benzidine
GC/MS	EPA 625.1	Benzo(a)anthracene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 625.1	Benzo(a)pyrene
GC/MS	EPA 625.1	Benzo(b)fluoranthene
GC/MS	EPA 625.1	Benzo(g,h,i)perylene
GC/MS	EPA 625.1	Benzo(k)fluoranthene
GC/MS	EPA 625.1	Benzoic acid
GC/MS	EPA 625.1	Benzyl alcohol
GC/MS	EPA 625.1	4-Bromophenyl phenyl ether
GC/MS	EPA 625.1	Butyl benzyl phthalate
GC/MS	EPA 625.1	Carbazole
GC/MS	EPA 625.1	bis (2-Chloro-1-methylethyl) ether
GC/MS	EPA 625.1	4-Chloro-3-methyl phenol
GC/MS	EPA 625.1	4-Chloroaniline
GC/MS	EPA 625.1	bis(2-Chloroethoxy)methane
GC/MS	EPA 625.1	bis(2-Chloroethyl)ether
GC/MS	EPA 625.1	2-Chloronaphthalene
GC/MS	EPA 625.1	2-Chlorophenol
GC/MS	EPA 625.1	4-Chlorophenyl phenyl ether
GC/MS	EPA 625.1	Chrysene
GC/MS	EPA 625.1	n-Decane
GC/MS	EPA 625.1	Dibenzo(a,h)anthracene
GC/MS	EPA 625.1	Dibenzofuran
GC/MS	EPA 625.1	2,3-Dichloroaniline
GC/MS	EPA 625.1	3,3'-Dichlorobenzidine
GC/MS	EPA 625.1	2,4-Dichlorophenol
GC/MS	EPA 625.1	2,6-Dichlorophenol
GC/MS	EPA 625.1	Diethylphthalate
GC/MS	EPA 625.1	Dimethyl phthalate
GC/MS	EPA 625.1	3,3'-Dimethylbenzidine
GC/MS	EPA 625.1	2,4-Dimethylphenol
GC/MS	EPA 625.1	Di-n-butyl phthalate
GC/MS	EPA 625.1	4,6-Dinitro-2-methylphenol
GC/MS	EPA 625.1	2,4-Dinitrophenol
GC/MS	EPA 625.1	2,4-Dinitrotoluene
GC/MS	EPA 625.1	2,6-Dinitrotoluene
GC/MS	EPA 625.1	Di-n-octylphthalate
GC/MS	EPA 625.1	1,2-Diphenylhydrazine(as azobenzene)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 625.1	bis(2-Ethylhexyl)phthalate
GC/MS	EPA 625.1	Fluoranthene
GC/MS	EPA 625.1	Fluorene
GC/MS	EPA 625.1	Hexachlorobenzene
GC/MS	EPA 625.1	Hexachlorobutadiene
GC/MS	EPA 625.1	Hexachlorocyclopentadiene
GC/MS	EPA 625.1	Hexachloroethane
GC/MS	EPA 625.1	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 625.1	Isophorone
GC/MS	EPA 625.1	1-Methylnaphthalene
GC/MS	EPA 625.1	2-Methylnaphthalene
GC/MS	EPA 625.1	2-Methylphenol
GC/MS	EPA 625.1	3+4-Methylphenol
GC/MS	EPA 625.1	N,N-Diethyl-m-toluamide (DEET)
GC/MS	EPA 625.1	Naphthalene
GC/MS	EPA 625.1	Nitrobenzene
GC/MS	EPA 625.1	2-Nitrophenol
GC/MS	EPA 625.1	4-Nitrophenol
GC/MS	EPA 625.1	N-Nitrosodimethylamine
GC/MS	EPA 625.1	N-Nitrosodi-n-propylamine
GC/MS	EPA 625.1	N-Nitrosodiphenylamine (Diphenylamine)
GC/MS	EPA 625.1	n-Octadecane
GC/MS	EPA 625.1	Pentachlorophenol
GC/MS	EPA 625.1	Phenanthrene
GC/MS	EPA 625.1	Phenol
GC/MS	EPA 625.1	Piperonyl butoxide (PIP)
GC/MS	EPA 625.1	Pyrene
GC/MS	EPA 625.1	alpha-Terpineol
GC/MS	EPA 625.1	1,2,4-Trichlorobenzene
GC/MS	EPA 625.1	2,4,6-Trichlorophenol
GC/MS	EPA 8260D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260D	1,1,1-Trichloroethane
GC/MS	EPA 8260D	1,1,2,2-Tetrachloroethene
GC/MS	EPA 8260D	1,1,2-Trichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	1,1-Dichloropropene
GC/MS	EPA 8260D	1,2,3-Trichlorobenzene
GC/MS	EPA 8260D	1,2,3-Trichloropropane
GC/MS	EPA 8260D	1,2,4-Trichlorobenzene
GC/MS	EPA 8260D	1,2,4-Trimethylbenzene
GC/MS	EPA 8260D	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260D	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260D	1,2-Dichlorobenzene
GC/MS	EPA 8260D	1,2-Dichloroethane
GC/MS	EPA 8260D	1,2-Dichloropropane
GC/MS	EPA 8260D	1,3,5-Trimethylbenzene
GC/MS	EPA 8260D	1,3-Dichlorobenzene
GC/MS	EPA 8260D	1,3-Dichloropropane
GC/MS	EPA 8260D	1,4-Dichlorobenzene
GC/MS	EPA 8260D	1,4-Dioxane
GC/MS	EPA 8260D	2,2-Dichloropropane
GC/MS	EPA 8260D	2-Butanone (MEK)
GC/MS	EPA 8260D	2-Chloroethylvinyl ether
GC/MS	EPA 8260D	2-Chlorotoluene
GC/MS	EPA 8260D	2-Hexanone
GC/MS	EPA 8260D	3,3-Dimethyl-1-butanol
GC/MS	EPA 8260D	4-Chlorotoluene
GC/MS	EPA 8260D	4-Methyl-2-pentanone
GC/MS	EPA 8260D	Acetone
GC/MS	EPA 8260D	Acetonitrile
GC/MS	EPA 8260D	Acrolein
GC/MS	EPA 8260D	Acrylonitrile
GC/MS	EPA 8260D	Allyl chloride
GC/MS	EPA 8260D	Benzene
GC/MS	EPA 8260D	Benzyl chloride
GC/MS	EPA 8260D	Bromobenzene
GC/MS	EPA 8260D	Bromochloromethane
GC/MS	EPA 8260D	Bromodichloromethane
GC/MS	EPA 8260D	Bromoform
GC/MS	EPA 8260D	Bromomethane
GC/MS	EPA 8260D	Carbon disulfide

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	Carbon tetrachloride
GC/MS	EPA 8260D	Chlorobenzene
GC/MS	EPA 8260D	Chloroethane
GC/MS	EPA 8260D	Chloroform
GC/MS	EPA 8260D	Chloromethane
GC/MS	EPA 8260D	Chloroprene
GC/MS	EPA 8260D	cis-1,2-Dichloroethene
GC/MS	EPA 8260D	cis-1,3-Dichloropropene
GC/MS	EPA 8260D	Cyclohexane
GC/MS	EPA 8260D	Cyclohexanone
GC/MS	EPA 8260D	Dibromochloromethane
GC/MS	EPA 8260D	Dibromomethane
GC/MS	EPA 8260D	Dichlorodifluoromethane
GC/MS	EPA 8260D	Diisopropyl ether (IPE)
GC/MS	EPA 8260D	Ethanol
GC/MS	EPA 8260D	Ethyl ether
GC/MS	EPA 8260D	Ethyl methacrylate
GC/MS	EPA 8260D	Ethylbenzene
GC/MS	EPA 8260D	Ethyl-Tert-Butyl Ether
GC/MS	EPA 8260D	Freon 113
GC/MS	EPA 8260D	Hexachlorobutadiene
GC/MS	EPA 8260D	Isobutyl alcohol
GC/MS	EPA 8260D	Isopropylbenzene
GC/MS	EPA 8260D	m+p-Xylenes
GC/MS	EPA 8260D	Methacrylonitrile
GC/MS	EPA 8260D	Methyl Acetate
GC/MS	EPA 8260D	Methyl iodide
GC/MS	EPA 8260D	Methyl methacrylate
GC/MS	EPA 8260D	Methyl tertiary butyl ether (MTBE)
GC/MS	EPA 8260D	Methylcyclohexane
GC/MS	EPA 8260D	Methylene chloride
GC/MS	EPA 8260D	Naphthalene
GC/MS	EPA 8260D	n-Butylbenzene
GC/MS	EPA 8260D	n-Propylbenzene
GC/MS	EPA 8260D	o-Xylene
GC/MS	EPA 8260D	p-Isopropyltoluene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	Propionitrile
GC/MS	EPA 8260D	sec-Butylbenzene
GC/MS	EPA 8260D	Styrene
GC/MS	EPA 8260D	Tert-Amyl Alcohol (TAA)
GC/MS	EPA 8260D	Tert-Amyl Methyl Ether (TAME)
GC/MS	EPA 8260D	Tert-Butyl Alcohol (TBA)
GC/MS	EPA 8260D	Tert-Butyl Formate (TBF)
GC/MS	EPA 8260D	tert-Butylbenzene
GC/MS	EPA 8260D	Tetrachloroethene
GC/MS	EPA 8260D	Tetrahydrofuran
GC/MS	EPA 8260D	Toluene
GC/MS	EPA 8260D	Total Xylenes
GC/MS	EPA 8260D	trans-1,2-Dichloroethene
GC/MS	EPA 8260D	trans-1,3-Dichloropropene
GC/MS	EPA 8260D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260D	Trichloroethene
GC/MS	EPA 8260D	Trichlorofluoromethane
GC/MS	EPA 8260D	Vinyl acetate
GC/MS	EPA 8260D	Vinyl chloride
GC/MS	EPA 8260D SIM	1,4-Dioxane
GC/MS	EPA 624.1	Acetone
GC/MS	EPA 624.1	Acetonitrile
GC/MS	EPA 624.1	Acrolein
GC/MS	EPA 624.1	Acrylonitrile
GC/MS	EPA 624.1	Benzene
GC/MS	EPA 624.1	Bromochloromethane
GC/MS	EPA 624.1	Bromodichloromethane
GC/MS	EPA 624.1	Bromoform
GC/MS	EPA 624.1	Bromomethane (Methyl bromide)
GC/MS	EPA 624.1	2-Butanone (MEK)
GC/MS	EPA 624.1	Carbon disulfide
GC/MS	EPA 624.1	Carbon tetrachloride
GC/MS	EPA 624.1	Chlorobenzene
GC/MS	EPA 624.1	Chloroethane
GC/MS	EPA 624.1	2-Chloroethylvinylether
GC/MS	EPA 624.1	Chloroform

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624.1	Chloromethane (Methyl chloride)
GC/MS	EPA 624.1	Dibromochloromethane
GC/MS	EPA 624.1	1,2-Dibromoethane (EDB)
GC/MS	EPA 624.1	1,2-Dichlorobenzene
GC/MS	EPA 624.1	1,3-Dichlorobenzene
GC/MS	EPA 624.1	1,4-Dichlorobenzene
GC/MS	EPA 624.1	Dichlorodifluoromethane
GC/MS	EPA 624.1	1,1-Dichloroethane
GC/MS	EPA 624.1	1,2-Dichloroethane
GC/MS	EPA 624.1	1,1-Dichloroethene
GC/MS	EPA 624.1	cis-1,2-Dichloroethene
GC/MS	EPA 624.1	trans-1,2-Dichloroethene
GC/MS	EPA 624.1	1,2-Dichloropropane
GC/MS	EPA 624.1	cis-1,3-Dichloropropene
GC/MS	EPA 624.1	trans-1,3-Dichloropropene
GC/MS	EPA 624.1	Diisopropyl ether (IPE)
GC/MS	EPA 624.1	1,4-Dioxane
GC/MS	EPA 624.1	Ethylbenzene
GC/MS	EPA 624.1	Methyl methacrylate
GC/MS	EPA 624.1	Methyl tertiary butyl ether (MTBE)
GC/MS	EPA 624.1	Methylene chloride
GC/MS	EPA 624.1	Naphthalene
GC/MS	EPA 624.1	Styrene
GC/MS	EPA 624.1	1,1,2,2-Tetrachloroethane
GC/MS	EPA 624.1	Tetrachloroethene
GC/MS	EPA 624.1	Toluene
GC/MS	EPA 624.1	1,2,4-Trichlorobenzene
GC/MS	EPA 624.1	1,1,1-Trichloroethane
GC/MS	EPA 624.1	1,1,2-Trichloroethane
GC/MS	EPA 624.1	Trichloroethene
GC/MS	EPA 624.1	Trichlorofluoromethane
GC/MS	EPA 624.1	1,2,4-Trimethylbenzene
GC/MS	EPA 624.1	1,3,5-Trimethylbenzene
GC/MS	EPA 624.1	Vinyl acetate
GC/MS	EPA 624.1	Vinyl chloride
GC/MS	EPA 624.1	Xylenes (total)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	SM 6200B-2011	Benzene
GC/MS	SM 6200B-2011	Bromobenzene
GC/MS	SM 6200B-2011	Bromochloromethane
GC/MS	SM 6200B-2011	Bromodichloromethane
GC/MS	SM 6200B-2011	Bromoform
GC/MS	SM 6200B-2011	Bromomethane (Methyl bromide)
GC/MS	SM 6200B-2011	n-Butylbenzene
GC/MS	SM 6200B-2011	sec-Butylbenzene
GC/MS	SM 6200B-2011	tert-Butylbenzene
GC/MS	SM 6200B-2011	Carbon tetrachloride
GC/MS	SM 6200B-2011	Chlorobenzene
GC/MS	SM 6200B-2011	Chloroethane
GC/MS	SM 6200B-2011	Chloroform
GC/MS	SM 6200B-2011	Chloromethane (Methyl chloride)
GC/MS	SM 6200B-2011	2-Chlorotoluene
GC/MS	SM 6200B-2011	4-Chlorotoluene
GC/MS	SM 6200B-2011	Dibromochloromethane
GC/MS	SM 6200B-2011	1,2-Dibromoethane (EDB)
GC/MS	SM 6200B-2011	Dibromomethane (Methylene bromide)
GC/MS	SM 6200B-2011	1,2-Dichlorobenzene
GC/MS	SM 6200B-2011	1,3-Dichlorobenzene
GC/MS	SM 6200B-2011	1,4-Dichlorobenzene
GC/MS	SM 6200B-2011	Dichlorodifluoromethane
GC/MS	SM 6200B-2011	1,1-Dichloroethane
GC/MS	SM 6200B-2011	1,2-Dichloroethane
GC/MS	SM 6200B-2011	1,1-Dichloroethene
GC/MS	SM 6200B-2011	cis-1,2-Dichloroethene
GC/MS	SM 6200B-2011	trans-1,2-Dichloroethene
GC/MS	SM 6200B-2011	1,2-Dichloropropane
GC/MS	SM 6200B-2011	1,3-Dichloropropane
GC/MS	SM 6200B-2011	2,2-Dichloropropane
GC/MS	SM 6200B-2011	1,1-Dichloropropene
GC/MS	SM 6200B-2011	cis-1,3-Dichloropropene
GC/MS	SM 6200B-2011	trans-1,3-Dichloropropene
GC/MS	SM 6200B-2011	Diisopropyl ether (IPE)
GC/MS	SM 6200B-2011	Ethylbenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	SM 6200B-2011	Hexachlorobutadiene
GC/MS	SM 6200B-2011	Isopropylbenzene (Cumene)
GC/MS	SM 6200B-2011	p-Isopropyltoluene (p-Cymene)
GC/MS	SM 6200B-2011	Methyl tertiary butyl ether (MTBE)
GC/MS	SM 6200B-2011	4-Methyl-2-pentanone
GC/MS	SM 6200B-2011	Methylene chloride
GC/MS	SM 6200B-2011	Naphthalene
GC/MS	SM 6200B-2011	n-Propylbenzene
GC/MS	SM 6200B-2011	Styrene
GC/MS	SM 6200B-2011	1,1,1,2-Tetrachloroethane
GC/MS	SM 6200B-2011	1,1,2,2-Tetrachloroethane
GC/MS	SM 6200B-2011	Tetrachloroethene
GC/MS	SM 6200B-2011	Toluene
GC/MS	SM 6200B-2011	1,1,2-Trichloro-1,2,2-Trifluoroethane
GC/MS	SM 6200B-2011	1,2,3-Trichlorobenzene
GC/MS	SM 6200B-2011	1,2,4-Trichlorobenzene
GC/MS	SM 6200B-2011	1,1,1-Trichloroethane
GC/MS	SM 6200B-2011	1,1,2-Trichloroethane
GC/MS	SM 6200B-2011	Trichloroethene
GC/MS	SM 6200B-2011	Trichlorofluoromethane
GC/MS	SM 6200B-2011	1,2,3-Trichloropropane
GC/MS	SM 6200B-2011	1,3,5-Trimethylbenzene (Mesitylene)
GC/MS	SM 6200B-2011	1,2,4-Trimethylbenzene
GC/MS	SM 6200B-2011	Vinyl chloride
GC/MS	SM 6200B-2011	m+p - Xylenes
GC/MS	SM 6200B-2011	o-Xylene
GC	EPA 8081B	4,4'-DDD
GC	EPA 8081B	4,4'-DDE
GC	EPA 8081B	4,4'-DDT
GC	EPA 8081B	Aldrin
GC	EPA 8081B	alpha-BHC
GC	EPA 8081B	alpha-Chlordane
GC	EPA 8081B	beta-BHC
GC	EPA 8081B	Chlordane
GC	EPA 8081B	delta-BHC
GC	EPA 8081B	Dieldrin

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8081B	Endosulfan I
GC	EPA 8081B	Endosulfan II
GC	EPA 8081B	Endosulfan sulfate
GC	EPA 8081B	Endrin
GC	EPA 8081B	Endrin Aldehyde
GC	EPA 8081B	Endrin Ketone
GC	EPA 8081B	gamma-BHC (Lindane)
GC	EPA 8081B	gamma-Chlordane
GC	EPA 8081B	Heptachlor
GC	EPA 8081B	Heptachlor Epoxide
GC	EPA 8081B	Methoxychlor
GC	EPA 8081B	Mirex
GC	EPA 8081B	Toxaphene
GC	EPA 8082A	Aroclor 1016
GC	EPA 8082A	Aroclor 1221
GC	EPA 8082A	Aroclor 1232
GC	EPA 8082A	Aroclor 1242
GC	EPA 8082A	Aroclor 1248
GC	EPA 8082A	Aroclor 1254
GC	EPA 8082A	Aroclor 1260
GC	EPA 8082A	Aroclor 1262
GC	EPA 8082A	Aroclor 1268
GC	EPA 608.3	Aldrin
GC	EPA 608.3	gamma-BHC (Lindane)
GC	EPA 608.3	alpha-BHC
GC	EPA 608.3	beta-BHC
GC	EPA 608.3	delta-BHC
GC	EPA 608.3	Chlordane
GC	EPA 608.3	cis-Chlordane
GC	EPA 608.3	trans-Chlordane
GC	EPA 608.3	4,4'-DDD
GC	EPA 608.3	4,4'-DDE
GC	EPA 608.3	4,4'-DDT
GC	EPA 608.3	Dieldrin
GC	EPA 608.3	Endosulfan I
GC	EPA 608.3	Endosulfan II
GC	EPA 608.3	Endosulfan sulfate

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 608.3	Endrin
GC	EPA 608.3	Endrin aldehyde
GC	EPA 608.3	Endrin ketone
GC	EPA 608.3	Heptachlor
GC	EPA 608.3	Heptachlor epoxide
GC	EPA 608.3	Methoxychlor
GC	EPA 608.3	Toxaphene
GC	EPA 608.3	Aroclor 1016
GC	EPA 608.3	Aroclor 1221
GC	EPA 608.3	Aroclor 1232
GC	EPA 608.3	Aroclor 1242
GC	EPA 608.3	Aroclor 1248
GC	EPA 608.3	Aroclor 1254
GC	EPA 608.3	Aroclor 1260
HPLC	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330A	1,3-Dinitrobenzene
HPLC	EPA 8330A	2,4-Dinitrotoluene
HPLC	EPA 8330A	2,6-Dinitrotoluene
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330B	Nitrocellulose
HPLC	EPA 8330B	Nitroguanidine
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	Tetryl
HPLC	EPA 8330A	1,3,5-Trinitrobenzene
HPLC	EPA 8330A	2,4,6-Trinitrotoluene
HPLC	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B	1,3-Dinitrobenzene
HPLC	EPA 8330B	2,4-Dinitrotoluene
HPLC	EPA 8330B	2,6-Dinitrotoluene
HPLC	EPA 8330B	HMX

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC	EPA 8330B	Nitrobenzene
HPLC	EPA 8330B	Nitroglycerin (NG)
HPLC	EPA 8330B	2-Nitrotoluene
HPLC	EPA 8330B	3-Nitrotoluene
HPLC	EPA 8330B	4-Nitrotoluene
HPLC	EPA 8330B	RDX
HPLC	EPA 8330B	Tetryl
HPLC	EPA 8330B	1,3,5-Trinitrobenzene
HPLC	EPA 8330B	2,4,6-Trinitrotoluene
HPLC	EPA 8330B	3,5-Dinitroaniline
HPLC	EPA 8330B	Pentaerythritol tetranitrate (PETN)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Fluorotelomer sulfonate 8:2 [1H,1H,2H,2H-perfluorodecane sulfonate] (8:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Fluorotelomer sulfonate 4:2 [1H,1H,2H,2H-perfluorohexane sulfonate] (4:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Fluorotelomer sulfonate 6:2 [1H,1H,2H,2H-perfluorooctane sulfonate] (6:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	GenX (HFPO-DA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-butanesulfonate (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-butanoic acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-decanesulfonate (PFDS)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-decanoic acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-dodecanoic acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-heptanesulfonate (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-heptanoic acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-hexanesulfonate (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-hexanoic acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-nonanesulfonate (PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-nonanoic acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanesulfonate (PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-octanesulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-octanoic acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-pentanoic acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-pentansulfonate (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-tetradecanoic acid (PFTeDA)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-tridecanoic acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-undecanoic acid (PFUDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-methylperfluoro-1-octanesulfonamide (MeFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-ethylperfluoro-1-octanesulfonamide (EtFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	1H,1H,2H,2H-perfluorododecane sulfonate (10:2FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl Perfluorooctane sulfonamido ethanol (EtFOSE)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl Perfluorooctane sulfonamido ethanol (MeFOSE)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Sodium dodecafluoro-3H-4, 8-dioxanonanoate (NaDONA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	9Cl-PF3ONS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	11Cl-PF3OUDS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanesulfonic acid (PFDOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctadecanoic acid (PFODA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorobutanoic acid (PFBA)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoropentanoic acid (PFPeA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorohexanoic acid (PFHxA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroheptanoic acid (PFHpA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanoic acid (PFOA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorononanoic acid (PFNA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorodecanoic acid (PFDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroundecanoic acid (PFUnA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorododecanoic acid (PFDoA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorotridecanoic acid (PFTrDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorotetradecanoic acid (PFTeDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorobutanesulfonic acid (PFBS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoropentanesulfonic acid (PFPeS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorohexanesulfonic acid (PFHxS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroheptanesulfonic acid (PFHpS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanesulfonic acid (PFOS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorononanesulfonic acid (PFNS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorodecanesulfonic acid (PFDS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorododecanesulfonic acid (PFDoS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2FTS)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Draft Method 1633 Version 2	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Draft Method 1633 Version 2	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Draft Method 1633 Version 2	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Draft Method 1633 Version 2	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)
LC/MS/MS	EPA Draft Method 1633 Version 2	3-Perfluoropropyl propanoic acid (3:3FTCA)
LC/MS/MS	EPA Draft Method 1633 Version 2	2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)
LC/MS/MS	EPA Draft Method 1633 Version 2	3-Perfluoroheptyl propanoic acid (7:3FTCA)
GC	EPA 8015C	Diesel Range Organics
GC	EPA 8015C	WI-Diesel Range Organics
GC	EPA 8015C	Gasoline Range Organics
GC	EPA 8015C	WI-Gasoline Range Organics
GC	RSK - 175	Methane, Ethane, Ethene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8011	1,2-Dibromoethane (EDB)
GC	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
GC	FL-PRO	FL-PRO
ICP	EPA 6010D	Aluminum
ICP	EPA 6010D	Antimony
ICP	EPA 6010D	Arsenic
ICP	EPA 6010D	Barium
ICP	EPA 6010D	Beryllium
ICP	EPA 6010D	Cadmium
ICP	EPA 6010D	Calcium
ICP	EPA 6010D	Chromium
ICP	EPA 6010D	Cobalt
ICP	EPA 6010D	Copper
ICP	EPA 6010D	Iron
ICP	EPA 6010D	Lead
ICP	EPA 6010D	Magnesium
ICP	EPA 6010D	Manganese
ICP	EPA 6010D	Molybdenum
ICP	EPA 6010D	Nickel
ICP	EPA 6010D	Potassium
ICP	EPA 6010D	Selenium
ICP	EPA 6010D	Silver
ICP	EPA 6010D	Sodium
ICP	EPA 6010D	Thallium
ICP	EPA 6010D	Tin
ICP	EPA 6010D	Vanadium
ICP	EPA 6010D	Zinc
ICP/MS	EPA 200.8	Aluminum
ICP/MS	EPA 200.8	Antimony
ICP/MS	EPA 200.8	Arsenic
ICP/MS	EPA 200.8	Barium
ICP/MS	EPA 200.8	Beryllium
ICP/MS	EPA 200.8	Boron
ICP/MS	EPA 200.8	Cadmium
ICP/MS	EPA 200.8	Calcium
ICP/MS	EPA 200.8	Chromium
ICP/MS	EPA 200.8	Cobalt

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/MS	EPA 200.8	Copper
ICP/MS	EPA 200.8	Iron
ICP/MS	EPA 200.8	Lead
ICP/MS	EPA 200.8	Magnesium
ICP/MS	EPA 200.8	Manganese
ICP/MS	EPA 200.8	Molybdenum
ICP/MS	EPA 200.8	Nickel
ICP/MS	EPA 200.8	Potassium
ICP/MS	EPA 200.8	Selenium
ICP/MS	EPA 200.8	Silicon
ICP/MS	EPA 200.8	Silver
ICP/MS	EPA 200.8	Sodium
ICP/MS	EPA 200.8	Thallium
ICP/MS	EPA 200.8	Tin
ICP/MS	EPA 200.8	Titanium
ICP/MS	EPA 200.8	Vanadium
ICP/MS	EPA 200.8	Zinc
ICP/MS	EPA 6020B	Aluminum
ICP/MS	EPA 6020B	Antimony
ICP/MS	EPA 6020B	Arsenic
ICP/MS	EPA 6020B	Barium
ICP/MS	EPA 6020B	Beryllium
ICP/MS	EPA 6020B	Cadmium
ICP/MS	EPA 6020B	Calcium
ICP/MS	EPA 6020B	Chromium
ICP/MS	EPA 6020B	Cobalt
ICP/MS	EPA 6020B	Copper
ICP/MS	EPA 6020B	Iron
ICP/MS	EPA 6020B	Lead
ICP/MS	EPA 6020B	Magnesium
ICP/MS	EPA 6020B	Manganese
ICP/MS	EPA 6020B	Nickel
ICP/MS	EPA 6020B	Potassium
ICP/MS	EPA 6020B	Selenium
ICP/MS	EPA 6020B	Silver
ICP/MS	EPA 6020B	Sodium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/MS	EPA 6020B	Thallium
ICP/MS	EPA 6020B	Tin
ICP/MS	EPA 6020B	Vanadium
ICP/MS	EPA 6020B	Zinc
CVAA	EPA 1631E	Low Level Mercury
CVAA	EPA 7470A / EPA 245.1	Mercury
Gravimetric	EPA 1664B	Oil & Grease
Titration	SM 2320B-2011	Alkalinity
Calculation	SM 2320B-2011	Bicarbonate Alkalinity
Calculation	SM 2320B-2011	Carbonate Alkalinity
Calculation	SM 2320B-2011	Hydroxide Alkalinity
Calculation	SM 4500-CO2 D	Carbon Dioxide (CO2)
Photometric	SM 2120F-2011	Color
Photometric	SM 2120B-2011	Platinum Cobalt Color
UV/VIS	SM 3500-Fe B-2011	Ferrous Iron
Titration	SM 4500-S2 F-2011	Sulfide
Wet Oxidation	EPA 9060A	TOC
Wet Oxidation	SM 5310C-2014	TOC
Titration	SM 2340C-2011	Total Hardness
Filtration	SM 2540C-2015	Total Dissolved Solids (TDS)
Filtration	SM 2540D-2015	Total Suspended Solids (TSS)
UV/VIS	SM 4500-CN E-2016	Total Cyanide
UV/VIS	EPA 9012B	Total Cyanide
UV/VIS	EPA 9065	Phenolics
UV/VIS	EPA 9066	Phenolics
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Chloride
IC	EPA 9056A	Sulfate
IC	EPA 9056A	Bromide
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Chloride
IC	EPA 300.0	Sulfate

Non-Potable Water		
Technology	**Method**	**Analyte**
IC	EPA 300.0	Bromide
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 218.6	Hexavalent chromium
IC	EPA 7199	Hexavalent chromium
UV/VIS	EPA 7196A	Hexavalent chromium
Discrete Analyzer	SM 3500-Cr B-2011	Hexavalent chromium
Pensky-Martens	EPA 1010A	Ignitability
Electrode	EPA 9040C	Corrosivity
Electrode	SM 4500-H B-2011	Corrosivity
Electrode	EPA 120.1	Specific Conductance
Electrode	EPA 180.1	Turbidity
Photometric	Sec. 7.3.3 SW-846	Reactive Cyanide
Titration	Sec. 7.3.4 SW-846	Reactive Sulfide
UV/VIS	EPA 353.2	Nitrate
UV/VIS	EPA 353.2	Nitrite
UV/VIS	EPA 353.2	Nitrate-Nitrite
UV/VIS	EPA 365.1	Phosphorus/ Orthophosphate
Gas Diffusion / UV/VIS	EPA 350.1	Ammonia - N
UV/VIS	EPA 351.2	TKN
UV/VIS	SM 5220D-2011	COD
GC	MADEP-EPH-MOD	Extractable Petroleum Hydrocarbons (EPH) Modified
GC	MADEP-VPH-MOD	Volatile Petroleum Hydrocarbons (VPH) Modified
Preparation	**Method**	**Type**
Organic Preparation	EPA 3520C	Organic Prep. of Water by Continuous Liquid-Liquid
Organic Preparation	EPA 3535A	Solid-Phase Extraction (SPE)
Organic Cleanup	EPA 3620B	Florisil Cleanup Procedure
Organic Cleanup	EPA 3660B	Sulfur Cleanup Procedure
Organic Cleanup	EPA 3665A	Sulfuric Acid Cleanup Procedure
Waste Dilution	EPA 3580A	Waste Dilution
Volatile Organic Preparation	EPA 5030B	Purge-and-Trap for Aqueous Samples
Volatile Organic Preparation	EPA 5035	Closed-System Purge-and-Trap and extraction for Volatile Organics in Soil and Waste Samples
Volatile Organic Preparation	EPA 3585	Waste Dilution for Volatile Organics

Non-Potable Water		
Technology	**Method**	**Analyte**
Inorganic Preparation	EPA 3005A	Preparation of Waters by Hotblock
Inorganic Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure (TCLP)
Inorganic Metals Preparation	EPA 3010A	Acid Digestion of Aqueous Samples and TCLP/SPLP Extracts for ICP analysis
Organic Cleanup	EPA 3640	GPC Cleanup Procedure

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	Dichloroprop
GC	EPA 8151A	MCPP
GC	EPA 8151A	MCPA
GC	EPA 8151A	2,4D
GC	EPA 8151A	Silvex(2,4,5 TP)
GC	EPA 8151A	2,4,5-T
GC	EPA 8151A	2,4DB
GC	EPA 8151A	Dinoseb
GC/MS	EPA 8270E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270E	1,2,4-Trichlorobenzene
GC/MS	EPA 8270E	1,2-Dichlorobenzene
GC/MS	EPA 8270E	1,3-Dichlorobenzene
GC/MS	EPA 8270E	1,4-Dichlorobenzene
GC/MS	EPA 8270E	1-Methylnaphthalene
GC/MS	EPA 8270E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270E	2,4,5-Trichlorophenol
GC/MS	EPA 8270E	2,4,6-Trichlorophenol
GC/MS	EPA 8270E	2,4-Dichlorophenol
GC/MS	EPA 8270E	2,4-Dimethylphenol
GC/MS	EPA 8270E	2,4-Dinitrophenol
GC/MS	EPA 8270E	2,4-Dinitrotoluene
GC/MS	EPA 8270E	2,6-Dichlorophenol

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	2,6-Dinitrotoluene
GC/MS	EPA 8270E	2-Chloronaphthalene
GC/MS	EPA 8270E	2-Chlorophenol
GC/MS	EPA 8270E	2-Methylnaphthalene
GC/MS	EPA 8270E	2-Methylphenol
GC/MS	EPA 8270E	2-Nitroaniline
GC/MS	EPA 8270E	2-Nitrophenol
GC/MS	EPA 8270E	3,3'-Dichlorobenzidine
GC/MS	EPA 8270E	3-Nitroaniline
GC/MS	EPA 8270E	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270E	4-Bromophenylphenylether
GC/MS	EPA 8270E	4-Chloro-3-methylphenol
GC/MS	EPA 8270E	4-Chloroaniline
GC/MS	EPA 8270E	4-Chlorophenylphenylether
GC/MS	EPA 8270E	4-Nitroaniline
GC/MS	EPA 8270E	4-Nitrophenol
GC/MS	EPA 8270E	Acenaphthene
GC/MS	EPA 8270E	Acenaphthylene
GC/MS	EPA 8270E	Acetophenone
GC/MS	EPA 8270E	Anthracene
GC/MS	EPA 8270E	Atrazine
GC/MS	EPA 8270E	Benzaldhyde
GC/MS	EPA 8270E	Benzidine
GC/MS	EPA 8270E	Benzo(a)Anthracene
GC/MS	EPA 8270E	Benzo(a)pyrene
GC/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS	EPA 8270E	Benzoic acid
GC/MS	EPA 8270E	Benzyl alcohol
GC/MS	EPA 8270E	Biphenyl
GC/MS	EPA 8270E	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270E	bis(2-Chloroethyl)ether
GCMS	EPA 8270E	Bis (2-Chloro-1-methylethyl) ether
GC/MS	EPA 8270E	bis(2-Ethylhexyl)phthalate
GC/MS	EPA 8270E	Butylbenzylphthalate

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	Caprolactam
GC/MS	EPA 8270E	Carbazole
GC/MS	EPA 8270E	Chrysene
GC/MS	EPA 8270E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270E	Dibenzofuran
GC/MS	EPA 8270E	Diethylphthalate
GC/MS	EPA 8270E	Dimethylphthalate
GC/MS	EPA 8270E	Di-n-butylphthalate
GC/MS	EPA 8270E	Di-n-octylphthalate
GC/MS	EPA 8270E	Fluoranthene
GC/MS	EPA 8270E	Fluorene
GC/MS	EPA 8270E	Hexachlorobenzene
GC/MS	EPA 8270E	Hexachlorobutadiene
GC/MS	EPA 8270E	Hexachlorocyclopentadiene
GC/MS	EPA 8270E	Hexachloroethane
GC/MS	EPA 8270E	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 8270E	Isophorone
GC/MS	EPA 8270E	m+p-Cresol
GC/MS	EPA 8270E	Naphthalene
GC/MS	EPA 8270E	Nitrobenzene
GC/MS	EPA 8270E	N-Nitrosodimethylamine
GC/MS	EPA 8270E	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270E	n-Nitrosodiphenylamine
GC/MS	EPA 8270E	N-Nitrosopyrrolidine
GC/MS	EPA 8270E	o-Cresol
GC/MS	EPA 8270E	Pentachlorophenol
GC/MS	EPA 8270E	Phenanthrene
GC/MS	EPA 8270E	Phenol
GC/MS	EPA 8270E	Pyrene
GC/MS	EPA 8270E	Pyridine
GC/MS	EPA 8270E	n-Nitrosopiperidine
GC/MS	EPA 8270E	n-Nitrosomethylethylamine
GC/MS	EPA 8270E	p-Phenylenediamine
GC/MS	EPA 8270E	2-Picoline
GC/MS	EPA 8270E	1-Naphthylamine
GC/MS	EPA 8270E	n-Nitrosodiethylamine

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	n-Nitrosomorpholine
GC/MS	EPA 8270E	Phenacetin
GC/MS	EPA 8270E	Pentachloronitrobenzene (Quintozene)
GC/MS	EPA 8270E	2-Naphthylamine
GC/MS	EPA 8270E	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270E	4-Aminobiphenyl
GC/MS	EPA 8270E	o-Toluidine
GC/MS	EPA 8270E	5-Nitro-o-toluidine
GC/MS	EPA 8270E SIM	Acenaphthene
GC/MS	EPA 8270E SIM	Acenaphthylene
GC/MS	EPA 8270E SIM	Anthracene
GC/MS	EPA 8270E SIM	Benzo(a)anthracene
GC/MS	EPA 8270E SIM	Benzo(a)pyrene
GC/MS	EPA 8270E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270E SIM	Chrysene
GC/MS	EPA 8270E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270E SIM	1,4-Dioxane
GC/MS	EPA 8270E SIM	Fluoranthene
GC/MS	EPA 8270E SIM	Fluorene
GC/MS	EPA 8270E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270E SIM	1-Methylnaphthalene
GC/MS	EPA 8270E SIM	2-Methylnaphthalene
GC/MS	EPA 8270E SIM	Naphthalene
GC/MS	EPA 8270E SIM	Pentachlorophenol
GC/MS	EPA 8270E SIM	Phenanthrene
GC/MS	EPA 8270E SIM	Pyrene
GC/MS	EPA 8260D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260D	1,1,1-Trichloroethane
GC/MS	EPA 8260D	1,1,2,2-Tetrachloroethene
GC/MS	EPA 8260D	1,1,2-Trichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethane
GC/MS	EPA 8260D	1,1-Dichloroethene
GC/MS	EPA 8260D	1,1-Dichloropropene
GC/MS	EPA 8260D	1,2,3-Trichlorobenzene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	1,2,3-Trichloropropane
GC/MS	EPA 8260D	1,2,4-Trichlorobenzene
GC/MS	EPA 8260D	1,2,4-Trimethylbenzene
GC/MS	EPA 8260D	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260D	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260D	1,2-Dichlorobenzene
GC/MS	EPA 8260D	1,2-Dichloroethane
GC/MS	EPA 8260D	1,2-Dichloropropane
GC/MS	EPA 8260D	1,3,5-Trimethylbenzene
GC/MS	EPA 8260D	1,3-Dichlorobenzene
GC/MS	EPA 8260D	1,3-Dichloropropane
GC/MS	EPA 8260D	1,4-Dichlorobenzene
GC/MS	EPA 8260D	1,4-Dioxane
GC/MS	EPA 8260D	2,2-Dichloropropane
GC/MS	EPA 8260D	2-Butanone (MEK)
GC/MS	EPA 8260D	2-Chloroethylvinyl ether
GC/MS	EPA 8260D	2-Chlorotoluene
GC/MS	EPA 8260D	2-Hexanone
GC/MS	EPA 8260D	4-Chlorotoluene
GC/MS	EPA 8260D	4-Methyl-2-pentanone
GC/MS	EPA 8260D	Acetone
GC/MS	EPA 8260D	Acetonitrile
GC/MS	EPA 8260D	Acrolein
GC/MS	EPA 8260D	Acrylonitrile
GC/MS	EPA 8260D	Allyl chloride
GC/MS	EPA 8260D	Benzene
GC/MS	EPA 8260D	Benzyl chloride
GC/MS	EPA 8260D	Bromobenzene
GC/MS	EPA 8260D	Bromochloromethane
GC/MS	EPA 8260D	Bromodichloromethane
GC/MS	EPA 8260D	Bromoform
GC/MS	EPA 8260D	Bromomethane
GC/MS	EPA 8260D	Carbon disulfide
GC/MS	EPA 8260D	Carbon tetrachloride
GC/MS	EPA 8260D	Chlorobenzene
GC/MS	EPA 8260D	Chloroethane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	Chloroform
GC/MS	EPA 8260D	Chloromethane
GC/MS	EPA 8260D	Chloroprene
GC/MS	EPA 8260D	cis-1,2-Dichloroethene
GC/MS	EPA 8260D	cis-1,3-Dichloropropene
GC/MS	EPA 8260D	Cyclohexane
GC/MS	EPA 8260D	Cyclohexanone
GC/MS	EPA 8260D	Dibromochloromethane
GC/MS	EPA 8260D	Dibromomethane
GC/MS	EPA 8260D	Dichlorodifluoromethane
GC/MS	EPA 8260D	Diisopropyl ether (IPE)
GC/MS	EPA 8260D	Ethyl ether
GC/MS	EPA 8260D	Ethyl methacrylate
GC/MS	EPA 8260D	Ethylbenzene
GC/MS	EPA 8260D	Freon 113
GC/MS	EPA 8260D	Hexachlorobutadiene
GC/MS	EPA 8260D	Isobutyl alcohol
GC/MS	EPA 8260D	Isopropylbenzene
GC/MS	EPA 8260D	m+p-Xylenes
GC/MS	EPA 8260D	Methacrylonitrile
GC/MS	EPA 8260D	Methyl Acetate
GC/MS	EPA 8260D	Methyl iodide
GC/MS	EPA 8260D	Methyl methacrylate
GC/MS	EPA 8260D	Methyl tertiary butyl ether (MTBE)
GC/MS	EPA 8260D	Methylcyclohexane
GC/MS	EPA 8260D	Methylene chloride
GC/MS	EPA 8260D	Naphthalene
GC/MS	EPA 8260D	n-Butylbenzene
GC/MS	EPA 8260D	n-Propylbenzene
GC/MS	EPA 8260D	o-Xylene
GC/MS	EPA 8260D	p-Isopropyltoluene
GC/MS	EPA 8260D	Propionitrile
GC/MS	EPA 8260D	sec-Butylbenzene
GC/MS	EPA 8260D	Styrene
GC/MS	EPA 8260D	tert-Butylbenzene
GC/MS	EPA 8260D	Tetrachloroethene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260D	Tetrahydrofuran
GC/MS	EPA 8260D	Toluene
GC/MS	EPA 8260D	Total Xylenes
GC/MS	EPA 8260D	trans-1,2-Dichloroethene
GC/MS	EPA 8260D	trans-1,3-Dichloropropene
GC/MS	EPA 8260D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260D	Trichloroethene
GC/MS	EPA 8260D	Trichlorofluoromethane
GC/MS	EPA 8260D	Vinyl acetate
GC/MS	EPA 8260D	Vinyl chloride
GC/MS	EPA 8260D SIM	1,4-Dioxane
GC	EPA 8081B	4,4'-DDD
GC	EPA 8081B	4,4'-DDE
GC	EPA 8081B	4,4'-DDT
GC	EPA 8081B	Aldrin
GC	EPA 8081B	alpha-BHC
GC	EPA 8081B	alpha-Chlordane
GC	EPA 8081B	beta-BHC
GC	EPA 8081B	Chlordane
GC	EPA 8081B	delta-BHC
GC	EPA 8081B	Dieldrin
GC	EPA 8081B	Endosulfan I
GC	EPA 8081B	Endosulfan II
GC	EPA 8081B	Endosulfan sulfate
GC	EPA 8081B	Endrin
GC	EPA 8081B	Endrin Aldehyde
GC	EPA 8081B	Endrin Ketone
GC	EPA 8081B	gamma-BHC (Lindane)
GC	EPA 8081B	gamma-Chlordane
GC	EPA 8081B	Heptachlor
GC	EPA 8081B	Heptachlor Epoxide
GC	EPA 8081B	Methoxychlor
GC	EPA 8081B	Mirex
GC	EPA 8081B	Toxaphene
GC	EPA 8082A	Aroclor 1016
GC	EPA 8082A	Aroclor 1221

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8082A	Aroclor 1232
GC	EPA 8082A	Aroclor 1242
GC	EPA 8082A	Aroclor 1248
GC	EPA 8082A	Aroclor 1254
GC	EPA 8082A	Aroclor 1260
GC	EPA 8082A	Aroclor 1262
GC	EPA 8082A	Aroclor 1268
HPLC	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330A	1,3-Dinitrobenzene
HPLC	EPA 8330A	2,4-Dinitrotoluene
HPLC	EPA 8330A	2,6-Dinitrotoluene
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	Tetryl
HPLC	EPA 8330A	1,3,5-Trinitrobenzene
HPLC	EPA 8330A	2,4,6-Trinitrotoluene
GC	EPA 8015C	Diesel Range Organics
GC	EPA 8015C	WI-Diesel Range Organics
GC	EPA 8015C	Gasoline Range Organics
GC	EPA 8015C	WI-Gasoline Range Organics
GC	FL-PRO	FL-PRO
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Fluorotelomer sulfonate 8:2 [1H,1H,2H,2H-perfluorodecane sulfonate] (8:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Fluorotelomer sulfonate 4:2 [1H,1H,2H,2H-perfluorohexane sulfonate] (4:2 FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Fluorotelomer sulfonate 6:2 [1H,1H,2H,2H-perfluorooctane sulfonate] (6:2 FTS)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	GenX (HFPO-DA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-butanesulfonate (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-butanoic acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-decanesulfonate (PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-decanoic acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-dodecanoic acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-heptanesulfonate (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-heptanoic acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-hexanesulfonate (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-hexanoic acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-nonanesulfonate (PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-nonanoic acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanesulfonate (PFOS)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-octanesulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-octanoic acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-pentanoic acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-1-pentansulfonate (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-tetradecanoic acid (PFTeDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-tridecanoic acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-n-undecanoic acid (PFUDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-methylperfluoro-1-octanesulfonamide (MeFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-ethylperfluoro-1-octanesulfonamide (EtFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	1H,1H,2H,2H-perfluorododecane sulfonate (10:2FTS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl Perfluorooctane sulfonamido ethanol (EtFOSE)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl Perfluorooctane sulfonamido ethanol (MeFOSE)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Sodium dodecafluoro-3H-4, 8-dioxanonanoate (NaDONA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	9Cl-PF3ONS

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	11Cl-PF3OUDS
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanesulfonic acid (PFDOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctadecanoic acid (PFODA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorobutanoic acid (PFBA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoropentanoic acid (PFPeA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorohexanoic acid (PFHxA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroheptanoic acid (PFHpA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanoic acid (PFOA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorononanoic acid (PFNA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorodecanoic acid (PFDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroundecanoic acid (PFUnA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorododecanoic acid (PFDoA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorotridecanoic acid (PFTrDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorotetradecanoic acid (PFTeDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorobutanesulfonic acid (PFBS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoropentanesulfonic acid (PFPeS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorohexanesulfonic acid (PFHxS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroheptanesulfonic acid (PFHpS)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanesulfonic acid (PFOS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorononanesulfonic acid (PFNS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorodecanesulfonic acid (PFDS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorododecanesulfonic acid (PFDoS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Draft Method 1633 Version 2	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Draft Method 1633 Version 2	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Draft Method 1633 Version 2	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Draft Method 1633 Version 2	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)
LC/MS/MS	EPA Draft Method 1633 Version 2	3-Perfluoropropyl propanoic acid (3:3FTCA)
LC/MS/MS	EPA Draft Method 1633 Version 2	2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)
LC/MS/MS	EPA Draft Method 1633 Version 2	3-Perfluoroheptyl propanoic acid (7:3FTCA)
HPLC	EPA 8330B MOD	2-Amino-4,6-dinitrotoluene
HPLC	EPA 8330B MOD	4-Amino-2,6-dinitrotoluene
HPLC	EPA 8330B MOD	1,3-Dinitrobenzene
HPLC	EPA 8330B MOD	2,4-Dinitrotoluene
HPLC	EPA 8330B MOD	2,6-Dinitrotoluene
HPLC	EPA 8330B MOD	HMX
HPLC	EPA 8330B MOD	Nitrobenzene
HPLC	EPA 8330B MOD	Nitrocellulose
HPLC	EPA 8330B MOD	Nitroguanidine
HPLC	EPA 8330B MOD	Nitroglycerin (NG)
HPLC	EPA 8330B MOD	2-Nitrotoluene
HPLC	EPA 8330B MOD	3-Nitrotoluene
HPLC	EPA 8330B MOD	4-Nitrotoluene
HPLC	EPA 8330B MOD	RDX
HPLC	EPA 8330B MOD	Tetryl
HPLC	EPA 8330B MOD	1,3,5-Trinitrobenzene
HPLC	EPA 8330B MOD	2,4,6-Trinitrotoluene
HPLC	EPA 8330B MOD	3,5-Dinitroaniline
HPLC	EPA 8330B MOD	Pentaerythritol tetranitrate (PETN)
ICP	EPA 6010D	Aluminum
ICP	EPA 6010D	Antimony
ICP	EPA 6010D	Arsenic
ICP	EPA 6010D	Barium
ICP	EPA 6010D	Beryllium
ICP	EPA 6010D	Cadmium
ICP	EPA 6010D	Calcium
ICP	EPA 6010D	Chromium
ICP	EPA 6010D	Cobalt
ICP	EPA 6010D	Copper

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	EPA 6010D	Iron
ICP	EPA 6010D	Lead
ICP	EPA 6010D	Magnesium
ICP	EPA 6010D	Manganese
ICP	EPA 6010D	Molybdenum
ICP	EPA 6010D	Nickel
ICP	EPA 6010D	Potassium
ICP	EPA 6010D	Selenium
ICP	EPA 6010D	Silver
ICP	EPA 6010D	Sodium
ICP	EPA 6010D	Thallium
ICP	EPA 6010D	Tin
ICP	EPA 6010D	Vanadium
ICP	EPA 6010D	Zinc
ICP/MS	EPA 6020B	Aluminum
ICP/MS	EPA 6020B	Antimony
ICP/MS	EPA 6020B	Arsenic
ICP/MS	EPA 6020B	Barium
ICP/MS	EPA 6020B	Beryllium
ICP/MS	EPA 6020B	Cadmium
ICP/MS	EPA 6020B	Calcium
ICP/MS	EPA 6020B	Chromium
ICP/MS	EPA 6020B	Cobalt
ICP/MS	EPA 6020B	Copper
ICP/MS	EPA 6020B	Iron
ICP/MS	EPA 6020B	Lead
ICP/MS	EPA 6020B	Magnesium
ICP/MS	EPA 6020B	Manganese
ICP/MS	EPA 6020B	Nickel
ICP/MS	EPA 6020B	Potassium
ICP/MS	EPA 6020B	Selenium
ICP/MS	EPA 6020B	Silver
ICP/MS	EPA 6020B	Sodium
ICP/MS	EPA 6020B	Thallium
ICP/MS	EPA 6020B	Vanadium
ICP/MS	EPA 6020B	Zinc

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
CVAA	EPA 7471B	Mercury
Titration	Walkley-Black	TOC
UV/VIS	EPA 9012B	Total Cyanide
IC	EPA 9056A	Bromide
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Sulfate
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Chloride
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Bromide
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 7199 / EPA 3060A	Hexavalent chromium
UV/VIS	EPA 7196A / EPA 3060A	Hexavalent chromium
Pensky-Martens	EPA 1010A	Ignitability
Electrode	EPA 9045D	Corrosivity
Photometric	Sec. 7.3.3 SW-846	Reactive Cyanide
Titration	Sec. 7.3.4 SW-846	Reactive Sulfide
Filtration	EPA 9095B	Paint Filter Test
UV/VIS	EPA 365.1 MOD	Phosphorus
UV/VIS	EPA 353.2 MOD	Nitrate
UV/VIS	EPA 353.2 MOD	Nitrite
UV/VIS	EPA 353.2 MOD	Nitrate-Nitrite
Gas Diffusion / UV/VIS	EPA 350.1	Ammonia - N
UV/VIS	EPA 351.2 MOD	TKN
GC	MADEP-EPH MOD	Extractable Petroleum Hydrocarbons (EPH) Modified
GC	MADEP-VPH-MOD	Volatile Petroleum Hydrocarbons (VPH) Modified
Preparation	**Method**	**Type**
Organic Preparation	EPA 3550C	Preparation of Soil by Sonication
Organic Preparation	EPA 3546	Microwave Extraction

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Organic Cleanup	EPA 3620B	Florisil Cleanup Procedure
Organic Cleanup	EPA 3660B	Sulfur Cleanup Procedure
Organic Cleanup	EPA 3665A	Sulfuric Acid Cleanup Procedure
Organic Cleanup	EPA 3640C	GPC Cleanup Procedure
Volatile Organic Preparation	EPA 5035	Closed-System Purge-and-Trap and extraction for Volatile Organics in Soil and Waste Samples
Volatile Organic Preparation	EPA 3585	Waste Dilution for Volatile Organics
Waste Dilution	EPA 3580A	Waste Dilution
Inorganic Preparation	EPA 3050B	Preparation of Soils by Hotblock
Inorganic/Organic Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure (TCLP)
Inorganic/Organic Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure (SPLP)
Inorganic Metals Preparation	EPA 3010A	Acid Digestion of Aqueous Samples and TCLP/SPLP Extracts

Biological Tissue		
Technology	**Method**	**Analyte**
GC	EPA 8081B	4,4'-DDE
GC	EPA 8081B	4,4'-DDT
GC	EPA 8081B	Aldrin
GC	EPA 8081B	alpha-BHC
GC	EPA 8081B	alpha-Chlordane
GC	EPA 8081B	beta-BHC
GC	EPA 8081B	Chlordane
GC	EPA 8081B	delta-BHC
GC	EPA 8081B	Dieldrin
GC	EPA 8081B	Endosulfan I
GC	EPA 8081B	Endosulfan II
GC	EPA 8081B	Endosulfan sulfate
GC	EPA 8081B	Endrin
GC	EPA 8081B	Endrin Aldehyde
GC	EPA 8081B	Endrin Ketone
GC	EPA 8081B	gamma-BHC (Lindane)
GC	EPA 8081B	gamma-Chlordane
GC	EPA 8081B	Heptachlor
GC	EPA 8081B	Heptachlor Epoxide
GC	EPA 8081B	Methoxychlor
GC	EPA 8081B	Toxaphene

Biological Tissue		
Technology	**Method**	**Analyte**
GC	EPA 8082A	Aroclor 1016
GC	EPA 8082A	Aroclor 1221
GC	EPA 8082A	Aroclor 1232
GC	EPA 8082A	Aroclor 1242
GC	EPA 8082A	Aroclor 1248
GC	EPA 8082A	Aroclor 1254
GC	EPA 8082A	Aroclor 1260
GC	EPA 8082A	Aroclor 1262
GC	EPA 8082A	Aroclor 1268
GC/MS	EPA 8270E	1,1'-Biphenyl
GC/MS	EPA 8270E	1-Methylnaphthalene
GC/MS	EPA 8270E	2-Methylnaphthalene
GC/MS	EPA 8270E	Acenaphthene
GC/MS	EPA 8270E	Acenaphthylene
GC/MS	EPA 8270E	Anthracene
GC/MS	EPA 8270E	Atrazine
GC/MS	EPA 8270E	Benzo(a)anthracene
GC/MS	EPA 8270E	Benzo(b)fluoranthene
GC/MS	EPA 8270E	Benzo(g,h,i)perylene
GC/MS	EPA 8270E	Benzo(k)fluoranthene
GC/MS	EPA 8270E	Chrysene
GC/MS	EPA 8270E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270E	Dibenzofuran
GC/MS	EPA 8270E	Dimethoate
GC/MS	EPA 8270E	Disulfoton
GC/MS	EPA 8270E	Fluoranthene
GC/MS	EPA 8270E	Fluorene
GC/MS	EPA 8270E	Hexachlorobenzene
GC/MS	EPA 8270E	Indeno(1,2,3-c,d)pyrene
GC/MS	EPA 8270E	Methyl parathion
GC/MS	EPA 8270E	Naphthalene
GC/MS	EPA 8270E	Phenanthrene
GC/MS	EPA 8270E	Phorate
GC/MS	EPA 8270E	Pronamide

Biological Tissue		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270E	Pyrene
Preparation	**Method**	**Type**
Organic Preparation	EPA 3540C	Soxhlet Extraction

AFFF (Aqueous Film Forming Foams) Products		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorobutanoic acid (PFBA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoropentanoic acid (PFPeA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorohexanoic acid (PFHxA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroheptanoic acid (PFHpA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanoic acid (PFOA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorononanoic acid (PFNA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorodecanoic acid (PFDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroundecanoic acid (PFUnA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorododecanoic acid (PFDoA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorotridecanoic acid (PFTrDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorotetradecanoic acid (PFTeDA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorobutanesulfonic acid (PFBS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoropentanesulfonic acid (PFPeS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorohexanesulfonic acid (PFHxS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoroheptanesulfonic acid (PFHpS)

AFFF (Aqueous Film Forming Foams) Products		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanesulfonic acid (PFOS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorononanesulfonic acid (PFNS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorodecanesulfonic acid (PFDS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorododecanesulfonic acid (PFDoS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2FTS)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-methyl perfluorooctanesulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Draft Method 1633 Version 2	N-ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Draft Method 1633 Version 2	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Draft Method 1633 Version 2	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Draft Method 1633 Version 2	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Draft Method 1633 Version 2	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Draft Method 1633 Version 2	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)

AFFF (Aqueous Film Forming Foams) Products		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Draft Method 1633 Version 2	Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)
LC/MS/MS	EPA Draft Method 1633 Version 2	3-Perfluoropropyl propanoic acid (3:3FTCA)
LC/MS/MS	EPA Draft Method 1633 Version 2	2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)
LC/MS/MS	EPA Draft Method 1633 Version 2	3-Perfluoroheptyl propanoic acid (7:3FTCA)

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2224.

Jason Stine, Vice President

Appendix B

Phase I Area 3 Preliminary Site Characterization Study

AREA 3 PRELIMINARY SITE CHARACTERIZATION SUMMARY
PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) REMEDIAL INVESTIGATION

FORMER FORT DEVENS ARMY INSTALLATION, DEVENS, MA

FEBRUARY 2021

Prepared for:
U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

Prepared by:
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Contract No.: W912WJ-18-C-0011

NOTICE

The United States Department of Defense, Department of Army, funded wholly or in part the preparation of this document and work described herein under Contract No. W912WJ-18-C-0011. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Area 3 Preliminary Site Characterization Summary

Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation

Former Fort Devens Army Installation

Devens, Massachusetts

February 2021

CERTIFICATION:

I hereby certify that the enclosed Report, shown and marked in this submittal, is that proposed to be incorporated with Contract Number W912WJ-18-C-0011. This document was prepared in accordance with the U.S. Army Corps of Engineers (USACE) Scope of Work and is hereby submitted for Government approval.

Reviewed By:

02/05/2021

KGS Project Manager **Date**

Received By:

Penelope Reddy Digitally signed by Penelope Reddy
Date: 2021.02.07 19:18:29 -05'00'

USACE Project Manager **Date**

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ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services Inc.
AFFF	aqueous film forming foam
ANL	Argonne National Laboratory
AOC	area of contamination
Army	U.S. Army
AST	above ground storage tank
BERS-Weston	BERS-Weston Services JVA, LLC
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeters
DPT	direct push technology
DRFTA	Devens Reserve Forces Training Area
DQO	data quality objectives
DRMO	Defense Reuse and Marketing Office
E&E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FSP	field sampling plan
ft	feet
MMCL/GW-1	Massachusetts Contingency Plan Method 1 Groundwater
HLA	Harding Lawson Associates
J	estimated result
KGS	KOMAN Government Solutions, LLC
k-spar	potassium-spar
LHA	lifetime health advisory
LTM	long-term monitoring
MassDEP	Massachusetts Department of Environmental Protection
MassDevelopment	Massachusetts Development and Finance Agency
MCP	Massachusetts Contingency Plan
MMCL	Massachusetts Maximum Contaminant Level
MNA	monitored natural attenuation
NAVD88	North America Vertical Datum 1988
NIA	North Impact Area
ng/L	nanograms per liter
PA	preliminary assessment
PFDA	perfluorodecanoic acid
PFAS	per- and polyfluoroalkyl substances
PFHpA	perfluoroheptanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
POL	petroleum, oil lubricants
PSCS	preliminary site characterization summary
RI	Remedial Investigation
RIBs	Rapid Infiltration Beds
ROD	Record of Decision

SA	study area
SHL	Shepley's Hill Landfill
SSSL	site-specific screening level
S&W	Stone and Webster Environmental Technology and Services
S-1	MCP Method 1 S-1 Soil Category
µg/kg	micrograms per kilogram
UST	underground storage tank

1.0 INTRODUCTION

KOMAN Government Solutions, LLC (KGS), on behalf of the U.S. Army Corps of Engineers (USACE) New England District, has prepared this Preliminary Site Characterization Summary (PSCS) for the Per- and Polyfluoroalkyl Substances (together, "PFAS") Remedial Investigation (RI) at the former Fort Devens Army Installation (Devens) located in Devens, Massachusetts.

The PSCS summarizes data that have been collected at numerous Areas of Contamination (AOC) identified in the *Draft Final Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS)* (KGS, 2020a) and as shown on Figure 1-1 and Figure 1-2.

The AOCs were grouped into three areas to expedite the field investigations and prioritize the investigations in areas where water supply wells were impacted. PSCSs for work performed at AOCs within Area 1 and Area 2 were previously submitted (KGS, 2020b and 2020c, respectively). This PSCS addresses Area 3, which includes the following sites:

- AOCs 20 and 21 Devens Wastewater Treatment Plant (WWTP)/Former Sludge Drying Beds, respectively;
- AOC 30 Former Drum Storage Areas;
- AOC 31 Former Fire Training Area (FTA);
- AOC 50 PCE Plume Area, Former Moore Army Airfield (MAAF), Former Devens Fire Station and Hangar Buildings; and
- Background Surface Water and Sediment.

The sampling locations were completed in accordance with the *Area 3 Field Sampling Plan (FSP) Addendum to Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances* (PFAS (KGS, 2019a). Please note that some locations agreed to in the draft final work plan were not completed prior to the demobilization from the field. These locations are shown on Figure 1-2 and on individual AOC figures, where applicable (refer to Sections 3.0 through 6.0) and the table presented below. The Army plans to incorporate these locations in the next Area 3 RI Work Plan Addendum.

Area 3 Location Not Completed Prior to Demobilization

Proposed Location	Rationale	Sampling intervals
Area of Concern 20		
20PZ-19-02	Determine if PFAS contamination is present in groundwater to the west of AOC 20 and upgradient (northwest) of PZ-5.	Water table to refusal
20VP-19-09/20PZ-19-01	Determine if PFAS contamination is present in groundwater to the west of AOC 20.	Water table to refusal
20VP-19-10	Determine if PFAS contamination is present in groundwater to the east of AOC 20.	Water table to refusal
20VP-19-11	Define extent of PFAS contamination in groundwater to the northeast of AOC 20.	Water table to refusal
Area of Concern 21		
21VP-19-03	Define extent of PFAS in groundwater to the east of AOCs 20 and 21	Water table to refusal
Area of Concern 30		
30PZ-19-06	Provide hydraulic measurement point northeast of eastern former drum storage area.	NA
30VP-19-07/30PZ-19-07	Determine if PFAS contamination is present in groundwater west of the former eastern drum storage area.	Water table to refusal
30PZ-19-08	Provide hydraulic measurement point southeast of eastern former drum storage area.	NA
Area of Concern 31		
31VP-19-02	Define extent of PFAS in groundwater within an area of known PFAS contamination downgradient of former fire training area.	Water table to refusal
31VP-19-03	Define extent of PFAS in groundwater within an area of known PFAS contamination downgradient of former fire training area.	Water table to refusal
31VP-19-09	Determine if PFAS contamination is present in groundwater to the west of former fire training area, on east side of the Nashua River.	Water table to refusal
31SB-19-08	Determine if PFAS contamination is present in soil downgradient of former fire training area.	0-0.5, 0.5-3, 3-7, and 7-15 ft bgs and two feet above the water table
Area of Concern 50		
50PZ-19-11	Define extent of PFAS within an area of known PFAS groundwater contamination at former airfield hanger.	Water table to refusal
50VP-19-14	Determine if PFAS are present in groundwater east of AOC 50 source area.	Water table to refusal
50VP-19-15	Determine if PFAS are below existing well G6M-04-14X.	90 ft bgs to refusal
50VP-19-16/50PZ-19-08	Determine if PFAS are present in groundwater and soil southwest of AOC50-17-08	Water table to refusal
50VP-19-17	Determine if PFAS are present in groundwater southwest of the former fire station	Water table to refusal
50VP-19-18/50PZ-19-09	Determine if PFAS are present in groundwater and soil southwest of the former fire station	Water table to refusal
50VP-19-19/50PZ-19-10/ 50SB-19-14	Determine if PFAS are present in groundwater and soil north of the former fire station	Water table to refusal/ 0-0.5, 0.5-3, 3-7, and 7-15 ft bgs and two feet above the water table
50VP-19-20	Determine if PFAS are present in groundwater east of Building 3813	Water table to refusal
50VP-19-21/50SB-19-15	Determine if PFAS are present in groundwater and soil east of Building 3818	Water table to refusal/ 0-0.5, 0.5-3, 3-7, and 7-15 ft bgs and two feet above the water table
50VP-19-22/50SB-19-16	Determine if PFAS are present in groundwater and soil west of Building 3818	Water table to refusal/ 0-0.5, 0.5-3, 3-7, and 7-15 ft bgs and at two feet above the water table
50VP-19-23/50SB-19-17	Determine if PFAS are present in groundwater and soil west of Building 3813	Water table to refusal/ 0-0.5, 0.5-3, 3-7, and 7-15 ft bgs
50VP-19-24/50SB-19-18	Determine if PFAS are present in groundwater and soil south of Building 3813	Water table to refusal/ 0-0.5, 0.5-3, 3-7, and 7-15 ft bgs and two feet above the water table
50VP-19-25/50PZ-19-12	Determine if PFAS are present in groundwater southwest of the former fire station	Water table to refusal
50SB-19-13	Determine if PFAS are present in soil east of the former fire station.	0-0.5, 0.5-3, 3-7, and 7-15 ft bgs and two feet above the water table

Notes:

AOC = Area of Contamination

ft bgs = feet below ground surface

Area 3 Co-Located Locations Not Completed Prior to Demobilization

Location	Location Identifier	Sample Location **
Nashua River	NR-19-15	Located along depositional area along the west bank adjacent to AOC 20/21
	NR-19-16	Located along depositional area along the east bank adjacent to AOC 50
	NR-19-17	Located along depositional area along the west bank across from AOC 31 and 50
	NR-19-18	Located along depositional area along the east bank adjacent to AOC 31
	NR-19-19	Located along depositional area along the west bank across from AOC 31 and 50
	NR-19-20	Located along depositional area along the east bank north of AOC 31
	NR-19-21	Located along depositional area along the west bank north of AOC 31
	NR-19-22	Located along depositional area along the west bank adjacent north of AOC 30

The PSCS is a summary of site data following completion of the initial field sampling and analysis (EPA, 1988). The PSCS data is being used by the Army to prepare the Area 3 RI Work Plan Addendum.

1.1 Investigation Approach

The initial field activities for the AOCs covered in this PSCS were detailed in the *Draft Final Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS)* (KGS, 2020a) and the *Area 3 Field Sampling Plan (FSP) Addendum to Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS)* (KGS, 2019a). The initial activities were planned based on results from the *Final Base-Wide Preliminary Assessment for Evaluation of Perfluoroalkyl Substances* (KGS, 2017), the *Site Inspection (SI) Addendum for Additional Per- and Polyfluoroalkyl Substances (PFAS) Sampling at Area of Contamination (AOC) 76-Devens Fire Department and Long Term Monitoring (LTM) Wells at AOCs 57, 43G, 43J, 32, 43A, 50 and Shepley's Hill Landfill (SHL) Former Fort Devens Army Installation Devens, Massachusetts* (BERS-Weston Services, JVA, LLC [BERS-Weston], 2018a), and the *Final Site Inspection Report for Per- and Polyfluoroalkyl Substances (PFAS) at Former Fort Devens Army Installation, Devens, MA* (BERS-Weston, 2018b). Knowledge of the sites through previous investigations, operation and maintenance activities, and long-term monitoring activities, which included various groundwater models were also used to plan field activities.

The field work was conducted in an iterative manner. The field work commenced with the work detailed in the *Area 3 Field Sampling Plan Addendum to Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS)* (KGS, 2019a). While executing the field work, analytical data from sampling of existing monitoring wells, groundwater vertical profiling, soil sampling, and surface water and sediment sampling was shared with U.S. Environmental Protection Agency (EPA) and Massachusetts Department of Environmental Protection (MassDEP) as it was received from the laboratory. The results were discussed with EPA and MassDEP and additional activities, not detailed in the field sampling plan (FSP), needed to achieve the study goals and DQOs were recommended. The recommendations were developed based on review of the analytical data and understanding of groundwater flow direction based on analysis of field data or review of information from previous field investigations or groundwater flow

models. Additional activities included moving vertical profiles, additional soil borings, sampling of additional existing monitoring wells, and synoptic water level surveys. The field work at each AOC is discussed in subsequent sections.

After existing monitoring wells were sampled in Area 3, additional sampling of existing monitoring wells was detailed in the *Work Plan for Additional Sampling of Existing Wells to Support the PFAS Remedial Investigation Former Fort Devens Army Installation, Devens, MA* (KGS, 2019b). This supplemental sampling of existing monitoring wells was intended to provide additional data regarding the nature and extent of PFAS at these sites for the RI and will be used to support evaluation of trends in PFAS concentrations in groundwater over time.

There were minor deviations to the FSP related to locations of drilling activities, additions and deletions of locations, or activities at specific locations. As is typical with field investigations, some locations were adjusted based on field conditions (e.g., steep terrain, proximity to wetlands, safety considerations). None of the adjustments to the locations negatively impacted meeting the DQOs. There were no major deviations to the methods detailed in the work plan and the FSP.

1.2 Report Organization

The site characteristics, general geology, and regional hydrogeology at former Fort Devens are described in Section 2.0. The results of synoptic water level events conducted in the areas addressed in this report are reported in Section 2.0 and site-specific groundwater flow conditions are described in the subsequent site-specific sections. Sections 3.0 through 6.0 each address a specific area of investigation listed above. The PFAS results related to each area of investigation are discussed in the applicable section. The PFAS results in various media are described in each applicable section with respect to the media-specific criteria (Table 1-1). Section 7.0 addresses background surface water and sediment samples collected in support of the PFAS RI. The field sheets, soil boring logs, piezometer construction logs, and results are presented in appendices.

2.0 FORMER FORT DEVENS SITE LOCATION AND DESCRIPTION

Devens is located in the towns of Ayer and Shirley in Middlesex County, and the towns of Harvard and Lancaster in Worcester County, Massachusetts, approximately 35 miles northwest of Boston, Massachusetts. The installation occupied approximately 9,260 acres. Fort Devens was divided into the North Post, Main Post, and South Post. Route 2 divides the South Post from the Main Post. The Nashua River runs through the North, Main, and South Posts. The area surrounding Devens is primarily rural residential properties. Portions of Devens have been redeveloped for commercial/industrial use.

Camp Devens was established in 1917 as a temporary training area for soldiers during World War I. In 1932, the site was named Fort Devens and made a permanent installation with the primary mission of commanding, training, and providing logistical support for non-divisional troop units. Fort Devens was used for a variety of training missions between 1917 and 1990. Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Fort Devens was placed on the National Priorities List on November 21, 1989, due to environmental contamination at several sites.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure (BRAC) Act of 1990, and officially closed in March 1996. As part of the Devens BRAC program, portions of the property formerly occupied by Devens were retained by the U.S. Army for reserve forces training and renamed the Devens Reserve Forces Training Area (DRFTA). Areas not retained as part of the DRFTA were transferred to new owners, the Massachusetts Development and Finance Agency (MassDevelopment), U.S. Department of Labor, U.S. Department of Justice, and the U.S. Fish and Wildlife Service, for reuse and redevelopment. In 2009, the DRFTA was renamed the U.S. Army Garrison Fort Devens.

2.1 Physical Characteristics

Devens lies within the Nashua River basin. The Nashua River flows north through the former North, Main, and South Posts (Figures 2-1 and 2-2). The Nashua River forms the western installation boundary on the former Main Post. Other notable surface water features include: Grove Pond located north of the Grove Pond wellfield, Plow Shop Pond located west of Grove Pond, Nonacoicus Brook flowing from Plow Shop Pond to the Nashua River, Cold Spring Brook located east of AOCs 57, 74, and 75, an unnamed stream located east of AOC 43G, Robbins Pond located east of AOC 43G, Willow Brook flowing north from Robbins Pond to Nonacoicus Brook, Cold Spring Brook Pond (AOC 40), and Mirror Lake and Little Mirror Lake located between Patton and Shabokin wells. The specific surface water bodies and their relations to specific areas of investigation are discussed in applicable sections.

The geography of Devens is characterized by undulating glacial terrain. The landforms are products of glacial erosion and deposition on a crystalline bedrock terrain. Terrain at Devens falls generally into three types. The least common is bedrock terrain, where rocks that have been resistant to both glacial and fluvial erosion remain as topographic highs, sometimes thinly veneered by glacial deposits. A more common terrain at Devens consists of tills deposited by glaciers. These landforms often conform to the shape of the underlying bedrock surface. They range from areas of comparatively low topographic relief to elongated hills (drumlins) [Harding Lawson Associates (HLA), 2000].

The most common terrain at Devens was formed by sediment accumulations in glacial-meltwater streams and lakes (glaciofluvial and glaciolacustrine deposits). Other prominent glacial meltwater features are kame and kettle topography present on the former Main Post near Mirror Lake and Little Mirror Lake located between the Patton and Shabokin wells.

2.2 Geology

The major glacial units consist of till, deltaic deposits from former glacial Lake Nashua, and deposits from glacial meltwater streams (Figure 2-3). Glacial till at Devens consists of unstratified gravel to silt and typically contains boulders. The till at the site is typically approximately 10 feet thick but is up to 60 feet

thick in the cores of drumlins. The glacial lake deposits consist chiefly of sand and gravelly sand. Lake bottom deposits consist of sand, silt, and clay. Post-glacial deposits consist of river terrace sands and gravels, fine alluvial sands and silts, as well as peat and silt and sands in swampy areas. Generalized surficial geology by AOC is described below and is based and is *2018 Surficial Materials Map of the Ayer Quadrangle, Massachusetts* (Stone and Stone, 2018) that in turn, was based on geologic units mapped by Richard Jahns in 1953 (Jahns, 1953).

- AOCs 20 and 21 – Mainly a mix of thick deposits of sand and gravel, sand and pebble to cobble gravel kame deposits, sand and pebble to cobble gravel terrace and delta-outwash plain deposits, and river terraces and floodplain silt and sand to the north. Some areas east of the WWTP Sludge Beds have been modified with artificial fill.
- Airfield (AOC 30, 31, and 50) – An extensive, relatively flat kame-plain remnant forms the majority of the airfield. The landform terminates on all sides in a bluff that slopes steeply downward 30 to 50 feet to grades established by Nashua River drainage to the west and south and Route 2A to the north and east. Soils are generally stratified sands and gravelly sand. Coarser materials are found in topset beds of deltas. These soils generally have significantly high hydraulic conductivities. Deeper soils beneath the northeastern end of the kame-plain are siltier and have lower conductivities. Several areas have been modified with artificial fill.

Bedrock beneath the portion of Devens covered under this PSCS has been mapped as part of the *Preliminary Bedrock Geologic Map of the Ayer Quadrangle, Massachusetts* (Kopera, 2006). Depth to bedrock beneath the former MAAF has been confirmed between 50 to 200 feet. Bedrock chiefly consists of low-grade metasedimentary rocks, gneisses, and granites. Due to limited bedrock exposures, contacts are considered approximate. The principal bedrock units underlining AOC 50 and the former MAAF are described below and illustrated on Figure 2-4.

- The Berwick Formation of Silurian age and described by Kopera as thinly to massively bedded, light green-grey, fine-grained metamorphosed calcareous siltstone, quartzite, and quartzo-feldspathic granofels. Also contains a fine-grained, massively bedded muscovite-quartz-biotite quartzite and schist containing distinctive 1-millimeter knots of biotite.

The bedrock elevation contours were mapped using data gathered as part of the PFAS RI, previous investigations at Devens, well drilling records available through the Massachusetts Energy & Environmental Affairs Data Portal (eeaonline.eea.state.ma.us), and Massachusetts Geological Survey (Figure 2-5, Table 2-1). There is significant relief in bedrock elevations across Devens and the surrounding area. Within the study area (i.e. Area 3), bedrock elevations range from 66.94 feet (ft) North America Vertical Datum 1988 (NAVD88) to 277.24 ft NAVD88.

2.3 Regional Hydrogeology

The Nashua River is the eventual discharge locus for surface water and groundwater flow at Devens. The tributaries of the Nashua River at Devens are Nonacoicus Brook and Walker Brook on the former North Post; Cold Spring Brook (which is a tributary of the Nonacoicus Brook through Grove Pond and Plow Shop Pond) on the former Main Post. There is also a lesser stream, Willow Brook that discharges to Nonacoicus Brook to the north. Willow Brook originates from Robbins Pond and is fed by Robbins Pond, surface water runoff, storm water discharge, and groundwater. On the west side of the Nashua River there are also a number of tributaries west of Devens, specifically Catacoonamug Brook, Trout Brook, Morse Brook, Walker Brook, and Mulpus Brook. The groundwater flow direction at each AOC is addressed in applicable sections.

Glacial meltwater deposits constitute the primary overburden aquifer at Devens. Groundwater also occurs in the underlying bedrock; however, flow is limited because regional bedrock lacks primary porosity and/or has been affected by metamorphism that limits transmissivity (an example would be the degree of

development of transmissive partings parallel to layering). The result is bedrock groundwater flow that is primarily via fractures and dissolution voids.

The zones of highest transmissivity within the overburden are found in areas of thick glacial meltwater (outwash) deposits on the former North Post at Devens, and these encompass deposits in which the MacPherson and Walker and Patterson (Town of Shirley) water supply well is screened (Figure 2-6). Due to the high transmissivity of these overburden deposits, these areas are preferential groundwater flow areas. The zones of lowest transmissivity are typically associated with exposed till and bedrock.

Groundwater recharge occurs in upland areas and groundwater flows generally from the topographic highs to topographic lows. Groundwater discharges in wetlands, ponds, streams, and directly into the Nashua River.

The Devens Groundwater Use and Value is categorized as "High" as determined by MassDEP (MassDEP, 2003) and the MassDEP groundwater classification of MMCL/GW-1 is applied throughout Devens. The MassDEP approved water supply Zone II's, as well as the potentially productive aquifer areas, and the Devens Aquifer Protection and Watershed Protection Districts are shown on Figure 2-6.

The synoptic water level measurements taken for the PFAS RI in the areas addressed in this report are presented in Tables 2-2, 2-3, and 2-4. The groundwater flow directions and gradients are discussed in the applicable sections and are shown on Figures 2-7, 2-8, and 2-9.

Hydraulic conductivities of overburden soil at AOC 50, and the former MAAF, ranged from 10^{-5} to 10^{-2} centimeters per second. The wide range of conductivities is related to the varying soil types encountered at AOC 50 and the former MAAF (e.g., sand, silty sand, and clayey silt) (Harding Lawson Associates [HLA], 2000).

3.0 AOCS 20 AND 21 PRELIMINARY SITE CHARACTERIZATION SUMMARY

3.1 Site Description

The Devens WWTP is active and is situated in the former North Post area southwest of the Nashua River and former MAAF (Figure 1-1). The site consists of structures to support wastewater treatment including 18 rapid infiltration beds (RIBs), three Imhoff tanks, a dosing tank, and a support building. The RIBs are located on a kame deposit that rises approximately 70 feet above the Nashua River floodplain. Municipal and industrial wastewater undergoes pretreatment in the WWTP before it is pumped to three Imhoff tanks, dosing tank, and then applied alternatively, to 18 RIBs.

Topography is generally flat across the beds, but slopes on each side in all directions. To the west of the RIBs, the topography is generally flat, however slopes steeply further west rising with the bedrock surface. To the north and south of the RIBs are low lying woods that gradually transition to wetland. To the east, four former sludge drying beds (AOC 21) are located. The sludge drying beds are below ground surface within secondary contaminant (raised platform, lined). These beds are no longer in use and are overgrown with brush and small diameter trees. East of the beds the land slopes gradually towards the Nashua River, transitioning from woods to wetlands before reaching the Nashua River.

The area is zoned for Environmental Business and Open Space/Recreation. There are no wells onsite that are used for drinking water supply, irrigation water supply, or any other water supply purposes. A bedrock well (total depth of 1,000 feet below ground surface [bgs]) that is used as a backup irrigation water supply is located approximately 1,200 feet hydraulically upgradient (west) of the site at Little Leaf Farms (Figure 3-2). This well was sampled in 2018 and the results for the Massachusetts Contingency Plan (MCP) Maximum Contaminant Level/Method 1 Groundwater (MMCL/GW-1) sum of the six compounds (PFOA, PFOS, perfluorodecanoic acid [PFDA], perfluorononanoic acid [PFNA], perfluoroheptanoic acid [PFHpA], and perfluorohexanesulfonic acid [PFHxS]) were non-detect. The MacPherson water supply well for Devens is located approximately 2,500 feet to the south of AOC 20, and the Walker and Patterson water supply wells for the Town of Shirley are located approximately 3,500 feet to the southwest of AOC 20 (Figure 2-6). A permit is required from Devens Enterprise Commission for installation of any water supply well.

3.2 Facility History and Utilities

The WWTP was constructed by the Army in 1942 and is still in operation by MassDevelopment. Three components of the WWTP were initially identified as Study Areas: Imhoff tanks (SA 19), rapid infiltration beds (SA 20), and sludge drying beds (SA 21) (ABB Environmental Services Inc. [ABB-ES], 1993). The WWTP has a design capacity of 3.0 million gallons per day (mgd). The average daily flow was about 1.3 mgd (KGS, 2017). Less than 1 percent of the flow was from industrial sources, including vehicle wash rack discharge, caustic radiator wash water, floor drains, heating plant boiler blowdown, and swimming pool filter backwash (Argonne National Laboratory [ANL], 1992) (KGS, 2017).

Wastewater is carried to the main pumping station via a gravity-flow sanitary sewer and several small pump stations (KGS, 2017). At the main pumping station, the wastewater is pretreated by passing through a bar screen, grit chamber, and comminutor. The wastewater is then pumped to three parallel Imhoff tanks (settling tanks and sludge digestors), a dosing tank, RIBs (originally 22 beds, 0.8 acre each), and four sludge drying beds. The primary effluent from the Imhoff tanks discharges into a dosing tank, which intermittently applies wastewater to the RIBs. The infiltration basins are used in rotation. The application cycle involves discharge to nine basins for nine days, to another seven basins for seven days, and to the remaining six basins for six days (KGS, 2017). The application rate for each RIB was calculated to be about 25-28 meters per year (ANL, 1992) (KGS, 2017). Sludge from the Imhoff tanks is drained to four uncovered sludge drying beds two to three times annually. The sludge drying beds were equipped with 4-, 8-, and 10-inch clay pipe underdrains to collect supernatant. Before 1982, the supernatant was discharged to an adjacent wetland area located on the east bank of the Nashua River. After 1985, supernatant was collected and

pumped back into an infiltration basin. In the past, dried sludge, typically about 70 percent solids, from the sludge drying beds was removed and applied to the land at the former MAAF per the requirements of a state Class EH Sludge application permit. Land application of dried sludge from the sludge drying beds at the former MAAF is no longer conducted (ANL, 1992, ABB-ES, 1993). The WWTP has been upgraded to provide advanced treatment (secondary treatment, nitrogen removal, and disinfection) through sequence batch reactors and ultraviolet disinfections (Nashua River Watershed Association, 2018). The WWTP is designed to treat 3 mgd of wastewater and is operated under a MassDEP groundwater discharge permit. The upgraded WWTP has been in operation since September 2001 and treats less than 1 mgd of wastewater from Devens and the Massachusetts Correctional Institution in Shirley. The treated effluent is discharged to the groundwater via 18 RIBs (Nashua River Watershed Association, 2018). Infiltration rate testing was performed at the WWTP beds and on average rates ranged from 1.46 centimeters per hour [cm/hr] to 173 cm/hr (Haley Aldrich, Inc., 2007). Infiltrated water likely creates a hydraulic mound, resulting in localized radial groundwater flow beneath the infiltration beds. However, infiltrated water ultimately migrates in the direction of regional groundwater flow, which is to the east/northeast, toward the Nashua River.

3.3 PFAS RI Field Investigation

The RI field investigation at AOCs 20 and 21 included sampling existing monitoring wells, collecting surface water and sediment samples from an unnamed pond north of AOC 20 and an unnamed stream east of AOC 21, groundwater vertical profiling using DPT, soil borings using DPT, and a synoptic water level event.

Sampling locations are presented on Figure 3-4 and summarized in Table 3-1. The results are discussed in Section 3.4.

3.3.1 Existing Wells

Groundwater samples were collected from 11 existing monitoring wells at AOC 20 from April to May 2020 (Table 3-1, Figure 3-4). The groundwater results are discussed in Section 3.4.1.

3.3.2 DPT Vertical Profiles

The DPT vertical profiles are described below, are shown on Figure 3-4 and are summarized in Table 3-1.

Eight vertical profiles were conducted at AOC 20 (20VP-19-01 through -08) from July to August 2019 within, cross-gradient, and upgradient of the RIBs (Table 3-1, Figure 3-4). All borings were completed down to refusal. At 20VP-19-08 there was no saturated overburden encountered and therefore no samples were collected.

Two vertical profiles were conducted at AOC 21 (21VP-19-01 and 21VP-19-02) in July 2019 (Table 3-1, Figure 3-4). Vertical profile location 21VP-19-01, was conducted adjacent to the former sludge drying beds, and 21VP-19-02 was conducted downgradient of the former sludge drying beds/RIBs, and adjacent to the west bank of the Nashua River. Both locations were completed down to refusal.

3.3.3 DPT Soil Borings

A total of eight soil borings (20SB-19-01 through -08) were conducted at AOC 20 in October 2019. All eight locations were located on-top of the RIBs. The results are summarized in Section 3.4.2.

Three soil borings (21SB-19-01 through -03) were conducted at AOC 21 in November 2019. All three locations were located within the former sludge drying beds. The results are summarized in Section 3.4.2.

3.3.4 Surface Water and Sediment

A surface water and sediment sample were collected from the unnamed pond north of AOC 20, and a sediment sample was collected from the unnamed stream east of AOC 21. A surface water sample was not collected at this location as the stream bed was dry during the sampling event. The results are discussed in

Section 3.4.3. Additional surface water and sediment samples were collected adjacent to AOC 20 and 21 within the Nashua River. These samples are discussed in detail in Sections 6.4.7 and 6.5.3.

3.3.5 Synoptic Water Level Survey

One synoptic water level monitoring event that encompassed AOC 20/21, AOC 30, AOC 31, AOC 50 was conducted on April 27, 2020 (Figure 2-9). A discussion on groundwater flow directions is presented in Section 3.4.1. Refer to Table 2-4.

3.4 PFAS Nature and Extent

Groundwater results are summarized on Figure 3-5 and in cross section (Figures 3-6 through Figure 3-8). The groundwater discussion evaluates PFAS concentrations with respect to; (1) the EPA Life-time Health Advisory (LHA) perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) concentrations individually or summed to 70 nanograms per liter (ng/L); and (2) the MMCL/GW-1 standard of the individual or summed concentration of six PFAS compounds (PFOA, PFOS, PFDA, PFNA, PFHpA, and PFHxS) of 20 ng/L. Soil sampling results are summarized on Figure 3-9 and are compared to MCP Method 1 S-1 Soil Category (S-1)/GW-1. Surface water and sediment sampling results are summarized on Figure 3-10 and are compared to EPA PFAS Site Specific Screening Levels for Former Fort Devens. All of the results are presented in tables in Appendix H. The media specific criteria are presented in Table 1-1.

3.4.1 Groundwater

As shown on Figure 2-9 and Figure 3-5, under ambient conditions, groundwater generally flows easterly across the RIBs and former sludge drying beds towards the Nashua River and southeasterly toward the Nashua River in the southern portion of the site. When wastewater is added to the RIBs, which occurs on a rotational basis, temporary mounding of groundwater beneath the beds that are being used likely occurs, resulting in local temporary radial flow in all directions.

AOC 20

Groundwater at AOC 20 was characterized through three groundwater samples collected during the SI (BERS-Weston, 2018a), and during the RI at 11 existing monitoring wells and seven vertical profiles. Samples were not collected from 20VP-19-08 since refusal was reached before encountering the water table.

Table 3-2 provides summary statistics of the results for the RI vertical profile samples. The summary statistics table provides statistics with respect to individual compounds (e.g., number of samples with PFOA that exceed the EPA LHA and the MMCL/GW-1 standard) and with respect to the sum of applicable compounds in the EPA LHA and the MMCL/MMCL/GW-1 standard (e.g., numbers of samples with the sum of PFOA+PFOS that exceed the EPA LHA, and number of samples with the sum PFOA+PFOS+PFHxS+PFNA+PFHpA+PFDA that exceed the MMCL/GW-1 standard]. Due to the summing of concentrations needed for comparison to the EPA LHA and the MMCL/GW-1 standard, the numbers of samples that exceed the EPA LHA or MMCL/GW-1 standard for individual compounds may not equal the numbers of samples that exceed the sum of the appropriate compounds for the EPA LHA or MMCL/GW-1 standard. One example is, if individual results of PFOA and PFOS were both below the EPA LHA, but the sum of the results exceeded the EPA LHA, then the sample would be counted as an exceedance of the EPA LHA even though the individual compounds would not be counted as exceedances.

A total of 35 vertical profile samples were collected. Of those samples, 25 samples (71%) of the samples had concentrations greater than the EPA LHA for PFOA+PFOS, and 35 samples (100%) had concentrations greater than the MMCL/GW-1 standard for the sum of the six compounds. Table 3-3 provides summary statistics of the results of the monitoring wells sampled as part of the RI for AOC 20. Of the 11 monitoring well samples collected, five samples (46%) had concentrations greater than the EPA LHA and eight samples (73%) had concentrations greater than the MMCL/GW-1. All of the wells at AOC 20 are screened in overburden, with the exception of MW-06, and MW-07 which are in shallow bedrock.

RIBS

Within the RIBs, the maximum PFOA+PFOS and sum of six compound concentrations (244 ng/L and 317 ng/L, respectively) detected were at existing monitoring well PZ-1 (screen 70-75 feet bgs). At vertical profile location 20VP-19-06, located in the middle section of the RIBs, PFAS concentrations were detected greater than the EPA LHA at the water table (63 feet bgs), and inconsistently down to refusal (156 feet bgs). However, compared to the MMCL/GW-1 standard, the sum of six compounds were detected from the water table down to refusal (156 feet bgs). The maximum concentrations greater the EPA LHA and sum of the six MMCL/GW-1 compounds (113 ng/L, and 154 ng/L, respectively) at 20VP-19-06 were detected at the 143-147 feet bgs interval. At vertical profile location 20VP-19-07, located in the northern portion of the RIBs, PFAS concentrations greater than the EPA LHA and the MMCL/GW-1 standard were detected from the water table (63 feet bgs) to refusal (157 feet bgs). The maximum concentrations for PFOA+PFOS and the sum of the six MMCL/GW-1 compounds (201 ng/L, and 259 ng/L, respectively), were detected at the 93-97 feet bgs interval. PFOS and PFOA were the two analytes consistently detected at higher concentrations compared to the other remaining MassDEP six compounds.

Downgradient

East (downgradient) of the RIBs (AOC 21 locations will be discussed separately), the maximum concentration was detected at existing monitoring well MW-02A. The sample was collected from the screen (18-33 feet bgs) and detected at a concentration of 250 ng/L for PFOA+PFOS and 649 ng/L for the sum of the six MMCL/GW-1 compounds. The top three analytes in order of decreasing concentration were PFHxS/PFOA/PFOS.

At MW-01A (screened 18-33 feet bgs), PFOA+PFOS was not detected above the EPA LHA but above the sum of six MMCL/GW-1 compounds at a concentration of 37.7 ng/L. The top three analytes in order of decreasing concentration were PFOA/PFHxS/PFHpA.

Cross-Gradient

In the immediate vicinity of the RIBs to the northeast (cross-gradient), the EPA LHA for PFOA+PFOS and the MMCL/GW-1 for the sum of the six compounds were exceeded with concentrations of 168 ng/L, and 218 ng/L, respectively at MW-04 (screen 7-22 feet bgs). The top three analytes in order of decreasing concentration were PFOS/PFOA/PFHpA, similar to what is observed within the RIBs.

Further north of the RIBs (20VP-19-02), the MMCL/GW-1 for the sum of six was exceeded down to refusal (33 feet bgs), but concentrations above the EPA LHA were only detected at the water table. The maximum concentrations greater than the EPA LHA and the sum of the six MMCL/GW-1 compounds (73 ng/L, and 95.3 ng/L, respectively) were detected at the water table (9 feet bgs) at this location. The top three analytes in order of decreasing concentration were PFOS, PFOA, and PFHpA.

Immediately south of the RIBs (cross-gradient) concentrations for PFOA+PFOS and the sum of the six MMCL/GW-1 compounds were detected above standards (decreasing with depth) from the water table (19 feet bgs) down to refusal (53 feet bgs) at 20VP-19-04. The maximum concentration of PFOA+PFOS (197 ng/L) and the sum of the six MMCL/GW-1 compounds (264 ng/L) were detected at the water table (19 feet bgs) at this location. Throughout the profile, the top three analytes in order of decreasing concentration were PFOS/PFOA/PFHxS.

Further south, concentrations of PFAS decrease as represented by locations 20VP-19-03 and WC-1A. The maximum PFOA+PFOS and sum of the six MMCL/GW-1 compounds (110 ng/L and 161 ng/L, respectively) were detected at 20VP-19-03 in the last interval sampled (54-58 feet bgs) just above refusal (58 feet bgs). At the water table, the top three analytes in order of decreasing concentration were PFOA/PFOS/PFHpA, followed mostly by PFOA/PFHpA/PFOS with depth. The last interval is PFOA/PFOS/PFHxS.

Upgradient

Immediately northwest of the RIBs (PZ-6), the concentration of PFOA+PFOS (38 ng/L) were below the EPA LHA, however the concentration (48.9 ng/L) for the sum of the six compounds did exceed the MMCL/GW-1. The top three analytes (PFOS/PFOA/PFHpA) displayed a similar ratio to the RIBs.

West (upgradient) of the RIBs, there was only one sample collected at vertical profile 20VP-19-05. The PFOA+PFOS concentration (19.3 ng/L) did not exceed the EPA LHA, however the concentration (28.5 ng/L) for the sum of the six compounds did exceed the MMCL/GW-1. The top three analytes detected at the water table in order of decreasing concentrations were PFOA/PFOS/PFHpA.

To the southwest (upgradient) of the RIBs, at MW-WC-2 (screened 5.4-19.9 feet bgs), PFOA+PFOS was not detected above the EPA LHA but the sum of the six compounds (51.7 ng/L) did exceed the MMCL/GW-1. The top three analytes in order of decreasing concentration were PFOA/PFHpA/PFHXs.

Samples were collected from shallow bedrock wells MW-06 and MW-07. MW-06 is located cross-gradient (north-northwest) of the RIBs, and MW-07 is located upgradient (west) of the RIBs. Samples were non-detect for PFOA+PFOS and the sum of the six MMCL/GW-1 compounds at both locations.

AOC 21

Groundwater at AOC 21 was characterized through two groundwater samples collected during the SI (BERS-Weston, 2018a) and during the RI via two vertical profiles (21VP-19-01 and 21VP-19-02). Table 3-4 provides summary statistics of the results of the RI vertical profile samples.

A total of 20 vertical profile samples were collected from AOC 21 during the RI. Of those samples, 19 samples (95%) had concentrations greater than the EPA LHA for PFOA+PFOS and 20 samples (100%) had concentrations greater than the MMCL/GW-1 standard for the sum of six compounds.

Sludge Drying Beds

At the sludge drying beds, the maximum PFAS concentrations were detected at the water table at SI location SA21-17-02. The concentration of PFOA+PFOS was 320 ng/L and the sum of five compound (PFOA, PFOS, PFHpA, PFHxS, PFNA) (the SI samples were not analyzed from PFDA) concentration was 404 ng/L. Vertically, PFAS was detected at concentrations greater than the EPA LHA and the sum of the six MMCL/GW-1 compounds from the water table (23 feet bgs) down to refusal (95 feet bgs) (72 feet thick) at 21VP-19-01. The maximum concentrations at 21VP-19-01 that were greater than the EPA LHA and sum of the six MMCL/GW-1 compounds (256 ng/L and 304 ng/L, respectively) were detected 10 feet below the water table at the 33-37 feet bgs interval. The top three analytes in order of frequency detected were PFOS/PFOA/PFHxS.

Downgradient

Downgradient of the sludge drying beds (21VP-19-02), PFOA+PFOS concentrations were detected greater than the EPA LHA beginning 10-feet below the water table (13 feet bgs), down to refusal (127 feet bgs). The sum of six compounds were greater than the MMCL/GW-1 standard from the water table down to refusal (114 ft thick). The maximum concentration (161 ng/L) of PFOA+PFOS was detected at the 23-27 feet bgs interval, while the maximum concentration (214 ng/L) for the sum of six compounds was detected at the deepest interval (123-127 feet bgs). The top three analytes in order of decreasing concentration were PFOS/PFOA/PFHxS throughout the profile.

3.4.2 Soil

AOC 20

At AOC 20, eight borings were conducted during the RI. The RI soil samples were collected from 0-0.5, 0.5-3, 3-7, 7-15 feet bgs, and from the 2-foot interval above the water table (at select locations). A total of 35 soil samples were collected for the RI (Figure 3-6 & 3-9, Appendix H). Table 3-5 provides summary statistics of the results of the RI samples. Of the 35 RI samples collected:

- 2 samples (6%) had PFDA concentrations greater than the S-1/GW-1,
- 0 samples (0%) had PFHpA concentrations greater than the S-1/GW-1,
- 2 samples (6%) had PFHxS concentrations greater than the S-1/GW-1,
- 0 samples (0%) had PFNA concentrations greater than the S-1/GW-1,
- 5 samples (14%) had PFOS concentrations greater than the S-1/GW-1, and
- 1 sample (3%) had PFOA concentrations greater than the S-1/GW-1.

The maximum concentrations of the six PFAS compounds in the S-1/GW-1 standards detected are:

- PFDA = 0.880 micrograms per kilograms (µg/kg) at 20SB-19-08 (0-0.5 feet bgs)
- PFHpA = 0.320 J µg/kg at 20SB-19-08 (3-7 feet bgs)
- PFHxS = 0.470 µg/kg at 20SB-19-01 (0-0.5 feet bgs)
- PFNA = 0.290 J µg/kg at 20SB-19-08 (0.5-3 feet bgs)
- PFOS = 13.0 µg/kg at 20SB-19-08 (0-0.5 feet bgs)
- PFOA = 1.80 µg/kg at 20SB-19-08 (3-7 feet bgs)

Three locations (20SB-19-01, 20SB-19-03, and 20SB-19-08) had one or more sample intervals with detections of PFAS compounds greater than the MCP Method 1 S-1/GW-1 standard (Figure 3-9, Appendix H). The results of the soil sampling suggest that there are impacts to the soil at the WWTP but the impacts vary across the site.

AOC 21

At AOC 21, three soil borings were conducted during the RI. The RI soil samples were collected from 0-0.5, 0.5-3, 3-7 feet bgs, and from the 2-foot interval above the water table (at 21SB-19-01). The 7-15 feet bgs interval was shortened at the soil locations at AOC 21 due to encountering the water table shallower than 15 feet bgs. A total of 13 soil samples were collected during the RI (Figure 3-9, Appendix H). Table 3-6 provides summary statistics of the results of the RI samples. Of the 13 RI samples:

- 2 samples (15%) had PFDA concentrations greater than the S-1/GW-1,
- 0 samples (0%) had PFHpA concentrations greater than the S-1/GW-1,
- 2 samples (15%) had PFHxS concentrations greater than the S-1/GW-1,
- 0 samples (0%) had PFNA concentrations greater than the S-1/GW-1,
- 7 samples (54%) had PFOS concentrations greater than the S-1/GW-1, and
- 3 sample (23%) had PFOA concentrations greater than the S-1/GW-1.

The maximum concentrations of the six PFAS compounds in the S-1/GW-1 standards detected are:

- PFDA = 0.460 µg/kg at 21SB-19-03 (3-7 feet bgs)
- PFHpA = 0.230 J µg/kg at 21SB-19-01 (0.5-3 feet bgs)
- PFHxS = 0.560 µg/kg at 21SB-19-01 (0-0.5 feet bgs)
- PFNA = 0.260 J µg/kg at 21SB-19-03 (3-7 feet bgs)
- PFOS = 19.0 J µg/kg at 21SB-19-01 (0.5-3 feet bgs)
- PFOA = 2.20 µg/kg at 21SB-19-01(3-7 feet bgs)

PFAS concentrations were greater than the S-1/GW-1 standards at both the SI soil borings (21SA-17-01 and -02) and at all three of the RI soil borings (21SB-19-01 through -03) (Figure 3-9, Appendix H). The results of the soil sampling suggest that historical sludge from WWTP operations have contributed to soil contamination above S-1/GW-1 standards.

3.4.3 Surface Water and Sediment

One co-located surface water and sediment sample were collected at AOC 20 (UP-19-01) and one sediment sample was collected at AOC 21 (US-19-01). A surface water sample was not collected at US-19-01 since it was dry during the sampling event.

The detections in surface water and sediment were below the EPA site-specific screening levels (SSSL) for PFAS at former Fort Devens (Table 1-1). The sampling location and data are summarized on Figure 3-10 and the data are presented in Appendix H. Of the three compounds (PFBS, PFOS, and PFOA) that have EPA SSSLs, PFBS was detected at a concentration of 8.40 ng/L, PFOS was detected at a concentration of 82.0 ng/L, and PFOA was detected at a concentration of 19.0 ng/L in the surface water sample from UP-19-01. These three compounds were non-detect in the co-located sediment sample for UP-19-01. For the sediment sample collected at location US-19-01, PFOS and PFOA were detected below EPA SSSLs at concentrations of 6.70 ng/L, and 0.460 J ng/L, respectively. PFBS was not-detected.

Additional surface water and sediment samples adjacent to AOCs 20 and 21 within the Nashua River were also collected and analyzed for PFAS. The results for these samples are also displayed on Figure 3-10. The data is discussed in Section 6.5.3.

4.0 AOC 30 PRELIMINARY SITE CHARACTERIZATION SUMMARY

4.1 Site Description

The former Drum Storage Area is located in the former North Post area at former MAAF (Figure 1-1). The former MAAF Drum Storage Area is comprised of two locations (labeled Area "A" and Area "B" for this report) north of the main airfield runway (Figure 4-1). These areas were used for drum storage, including 55-gallon drums of firefighting foam concentrate. The western most pad (Area A) is flat but the surface is slightly raised from the ground surface. The pad is asphalt and measures approximately 80 feet by 65 feet. The surrounding area slopes gently downward towards the north/northeast for approximately 90 feet, then becomes steeper as it approaches the Nashua River. To the west, and northwest of Area A, the surrounding area slopes gently for approximately 250 feet before becoming steeper as it approaches the Nashua River. The second former drum storage pad (Area B) is located approximately 440 feet east of Pad A, and approximately 445 feet northwest of the former fire station. A relatively flat grass field is located between the two Areas. The pad in Area B is concrete and flat and mostly even with surrounding grade. Currently, police vehicles are stored on the pad. A radio tower is located immediately to the west (Figure 4-4).

With the exception of the hangars, the former airfield including the former Drum Storage Area is currently leased by the Massachusetts State Police for training and vehicle storage. No drums are currently stored in the former Drum Storage Area. The former drum storage area is zoned for Special Use II and Innovation and Technology Business, which includes a broad range of industrial, light industrial, office, and research and development uses. There are currently no wells at the MAAF that are used for drinking water supply, irrigation water supply, or any other water supply purposes. A permit is required from Devens Enterprise Commission for installation of any water supply well within Devens.

4.2 Facility History and Utilities

The former Drum Storage Area at the former MAAF were initially identified as SA 30 based on historical uses and potential contamination (ANL, 1992).

The former Drum Storage Area was an outdoor satellite accumulation point for storage of containerized hazardous waste for 90 days or less. Pallets with space for ten to fifteen 55-gallon drums were positioned at the end of the aircraft defueling area (KGS, 2017). During 1990, Fort Devens constructed a prefabricated 90-day storage area at another location, and the area is no longer in use (KGS, 2017). This area was used to store materials such as alkaline cleaners (USEPA waste D002), methyl ethyl ketone (FO05), contaminated JP-4 jet fuel (DO01), and paint thinners (DO01, D008) (KGS, 2017). During the ANL site assessment in 1988, the following materials were being stored at this site: naphtha, dry cleaning solution (such as PD-680), JP-4, aircraft cleaning compounds, lube oil, and waste solvent (F-listed wastes). The JP-4 drum was resting on asphalt rather than on the pallet. In addition to these materials, five empty drums were present (out of a total of 21 drums). Several drums were damaged. The drums were all exposed to the natural elements, and ponding was evident on the drum tops (KGS, 2017).

Reviews conducted of available historical documents did not indicate the storage of AFFF or fire suppressant foams; however, interviews conducted with persons knowledgeable of previous site activities indicated foams were stored and used for firefighting training (KGS, 2017).

There are no current or historical subsurface features located within the vicinity of AOC 30 as shown on Figure 4-2 and Figure 4-3.

4.3 Remedial Status

Prior to the PFAS investigation, an SI on soil, groundwater, surface water and sediment was conducted at SA 30 in 1992 (ABB-ES, 1996) under CERCLA. The SI concluded organic compounds (toluene, xylene, and PAHs) were observed predominantly in surface soils in unpaved areas. Concentrations of these analytes decreased with or were absent at depth. The SI indicated that due to the poor correlation between

PAH and TPH distribution in surface soils, it was suggested that airborne combustion product deposition is a likely source for the PAHs. There were no chlorinated solvents in soils. No observable contamination of groundwater had occurred as a result of potential releases from SA 30. No further action was recommended.

4.4 PFAS RI Field Investigation

The RI field investigation at AOC 30 included groundwater vertical profiling using DPT, soil borings using DPT, installation of piezometers, and synoptic water level measurements. Surface water and sediment samples were also collected in the Nashua River, adjacent to AOC 30. The details regarding the surface water and sediment samples will be discussed further in Section 6.4.7.

Sampling locations are presented on Figures 4-4 and 4-5 and summarized in Table 4-1. The results are discussed in Section 4.5.

4.4.1 DPT Vertical Profiles

The DPT vertical profiles are described below, are shown on Figures 4-4 and 4-5 and are summarized in Table 4-1.

Six vertical profiles (30VP-19-01 through -06) were conducted in July 2019 (Table 4-1, Figure 4-4).

4.4.2 Soil Borings

The AOC 30 soil borings (30SB-19-01 through -06) were drilled in October 2019. The data are discussed in Section 4.5.2.

4.4.3 Piezometers

A series of overburden water table piezometers (30PZ-19-01 through -05) were installed in July 2019. Two of the piezometers (30PZ-19-02 and 30PZ-19-05) were added to the program prior to the finalization of the work plan.

4.4.4 Synoptic Water Level Event

A synoptic water level event encompassing the AOC 30 piezometers, one new piezometer installed as part of AOC 31 (Section 5.3.3), and existing wells associated with the Airfield (AOC 50) was conducted on August 14, 2019. Refer to Table 2-2.

A second synoptic water level event encompassing the AOC 30 piezometers, additional piezometers installed as part of AOC 31 (Section 5.4.3), new piezometers that were installed as part of AOC 50 (Section 6.4.4), and existing wells associated with the Airfield (AOC 50) was conducted on October 7, 2019. Refer to Table 2-3.

A third synoptic water level event encompassing the AOC 30 piezometers, additional piezometers installed as part of AOC 31 (Section 5.4.3), new piezometers that were installed as part of AOC 50 (Section 6.4.4), existing wells associated with the Airfield (AOC 50), a staff gauge installed in the Nashua River (Section 6.4.5), and existing wells associated with AOC 20, was conducted on April 27, 2020. Refer to Table 2-4.

4.5 PFAS Nature and Extent

Groundwater results are summarized on Figures 4-5 and in cross-section (Figures 4-6 through Figure 4-8). Soil sampling results are summarized on Figure 4-9. Site-specific groundwater contours are presented on Figures 2-7, 2-8, 2-9, and Figure 4-5. All of the results are presented in tables in Appendix H. The media specific criteria are presented in (Table 1-1).

4.5.1 Groundwater

As shown on Figures 2-7 through 2-9 and Figure 4-5, groundwater in the vicinity of Area A, was observed to flow in a southwesterly direction (summer 2019) and a westerly direction toward the Nashua River (fall

2019 and spring 2020). Groundwater within the vicinity of Area B flows in a southwesterly direction and then flows westerly as it approaches the Nashua River.

Groundwater at AOC 30 was characterized through six groundwater samples collected during the SI (BERS-Weston, 2018a) and during the RI via six DPT vertical profiles. During the RI two existing monitoring wells (G6P-97-05X and MW-7[IT]) were sampled as part of the AOC 50 existing well sampling program. A discussion on the concentrations of these wells is presented with AOC 30 where applicable, since these wells are located upgradient to AOC 30.

A total of 23 vertical profile samples were collected for AOC 30. Two locations, 30VP-19-03, and 30VP-19-06, were conducted in the immediate vicinity of drum storage "Area A", and drum storage "Area B", respectively. The remaining locations were conducted upgradient, cross-gradient, and downgradient of these areas. Of the 23 vertical profile samples, 11 samples (48%) had concentrations greater than the EPA LHA for PFOA+PFOS and 20 samples (87%) had concentrations greater than the MMCL/GW-1 standard for the sum of the six compounds. None of the concentrations were greater than the GW-3 standard (protective of surface water). Statistics for monitoring wells G6P-97-05X and MW-7 (IT) were included as part of the AOC 50 area (Section 6.5).

Area A

PFOA+PFOS was detected above the EPA LHA in all sampling intervals from the water table (73 feet bgs) down to refusal (117 feet bgs), with the exception of interval (83-87 feet bgs), and the MMCL/GW-1 standard was exceeded in all intervals from the water table to refusal at 30VP-19-03. Concentrations generally decreased with depth. The maximum PFOA+PFOS and sum of six MMCL/GW-1 compound concentrations (3,530 ng/L, and 6,330 ng/L, respectively) were detected at the water table (73 feet bgs) adjacent to the north end of Area A at vertical profile location 30VP-19-03. The presence of the highest concentration at the water table at 30VP-19-03 suggests former historical activities have contributed to point-source contamination at Area A. At the water table, the top three analytes in order of decreasing concentration were PFOA/PFHxS/PFHpA. With depth, PFOA concentrations decrease, while concentrations of PFOS increase. Based on groundwater flow, it is possible that contamination from Area B moves towards Area A resulting in a co-mingled PFOS plume at depth.

Area B

Within Area B, there were only two intervals sampled at 30VP-19-06. Both the water table (73 feet bgs) and deeper sample (83-87 feet bgs) were above the EPA LHA and MMCL/GW-1. Higher concentrations of PFOA+PFOS (1,930 ng/L) and the sum of the six MMCL/GW-1 compounds (2,420 ng/L) were detected at the deeper interval, just above refusal (87 feet bgs) compared to water table concentrations (980 ng/L, and 1,360 ng/L). The top three analytes detected at 30VP-19-06, in order of decreasing concentration, were PFOS/PFHxS/PFOA.

Upgradient/Cross-gradient

Upgradient of Area A, PFOA+PFOS concentrations (53.2 ng/L) did not exceed the EPA LHA at the water table (20 feet bgs) at 30VP-19-05. Concentrations exceeding the EPA LHA were detected from 40-44 feet bgs (84 ng/L) and 45-49 feet bgs (363 ng/L). The sum of six compounds, however, did exceed the MMCL/GW-1 in all intervals at 30VP-19-05, with a maximum concentration of 495 ng/L at the 45-49 feet bgs interval. With the exception of the water table, the top three analytes detected in order of decreasing concentration were PFOS/PFHxS/PFOA.

Immediately upgradient of Area B, concentrations of PFAS were detected above the EPA LHA and MMCL/GW-1 at monitoring wells MW-7 (IT) (screen 22-32 feet bgs) and G6P-97-05X (screen 33-43 feet bgs). During the same sampling event (October, 2019), higher PFOA+PFOS and sum of six compounds concentrations (1,350 ng/L, and 2,710 ng/L, respectively) were detected in the shallower well (MW-7 (IT)) compared to G6P-97-05X. Comparing spring and fall data from G6P-97-05X, higher concentrations were

detected during the spring event when groundwater elevations where higher. The top three analytes detected in order of decreasing concentration for MW-7[IT] were PFHxS/PFOS/PFOA, and for G6P-97-05X were PFOS/PFHxS/PFOA. These wells were installed to monitor a surficial gasoline spill in the area in 1994. Former personnel indicated that during the filling of emergency generators, gasoline overflowed (quantities unknown) over the ice and down the hill in the vicinity of where these wells were installed. It is not known whether AFFF was used as part of the cleanup.

Based on the samples collected at Area B, PFOS and PFHxS are dominant at the water table down to refusal. This signature is also the same at upgradient locations G6P-97-05X and 30VP-19-05. Within the shallower overburden in this area, PFHxS and PFOS are dominant at the water table from MW-7 (IT) to downgradient SI locations SA30-17-05, SA30-17-04, and SA30-17-06. These differences at the water table, suggest that Area A and Area B are two separate point-sources.

Cross-gradient to both areas, two samples were collected at 30VP-19-01. At the water table (18 feet bgs), the concentration of PFOA+PFOS (14.2 ng/L) was below the EPA LHA, however at the deeper sample (28-32 feet bgs) the concentration of PFOA+PFOS (127 ng/L) was detected above the EPA LHA. Both of these intervals exceeded the MMCL/GW-1 with concentrations of 29.4 and 215 ng/L, respectively. The top three analytes in order of decreasing concentration detected at the deeper sample were PFOS/PFHxS/PFOA. Downgradient to 30VP-19-01, concentrations of PFOA+PFOS and the sum of the six MMCL/GW-1 compounds decrease (30VP-19-02). The MMCL/GW-1 was only exceeded at the deepest interval (38-42 feet bgs). The top three analytes in order of decreasing concentrations detected at the interval above refusal were PFOS/PFHxS/PFOA.

Downgradient

Downgradient of Area B (30VP-19-06), PFAS groundwater results decrease dramatically at the water table as represented by PFOA+PFOS and the sum of 5 compounds at SI location SA30-17-04, where concentrations were 128 ng/L, and 429 ng/L, respectively. It should be noted that the SI samples consisted of a single sample at the water table only. Further downgradient, PFOA+PFOS concentrations are less than the EPA LHA for the shallowest four sample intervals at 30VP-19-04, and then increase to above the EPA LHA at the 123-127 feet bgs interval to refusal (135 feet bgs). These increases in the deeper overburden along with groundwater flow suggest that upgradient sources are moving deeper in the overburden as it approaches this location and towards the Nashua River. Similar observations were observed at these two locations when reviewing the sum of the six MMCL/GW-1 compounds.

4.5.2 Soil

Six soil borings were conducted during the RI. The RI soil samples were collected from 0-0.5, 0.5-3, 3-7, 7-15 feet bgs, and from the 2-foot interval above the water table (at select locations). A total of 26 soil samples were collected during the RI (Figure 4-9, Appendix H). Table 4-3 provides summary statistics of the results of the RI samples. Of the 26 RI samples collected:

- 0 samples (0%) had PFDA concentrations greater than the S-1/GW-1,
- 0 samples (0%) had PFHpA concentrations greater than the S-1/GW-1,
- 10 samples (38%) had PFHxS concentrations greater than the S-1/GW-1,
- 1 sample (4%) had PFNA concentrations greater than the S-1/GW-1,
- 7 samples (27%) had PFOS concentrations greater than the S-1/GW-1, and
- 8 samples (31%) had PFOA concentrations greater than the S-1/GW-1.

The maximum concentrations of the six PFAS compounds in the S-1/GW-1 standards detected in AOC 30 area are:

- PFDA = 0.230 J µg/kg at 30SB-19-01 (0.5-3 feet bgs)
- PFHpA = 0.110 J µg/kg at 30SB-19-01 (0-0.5 feet bgs)
- PFHxS = 7.20 µg/kg at 30SB-19-01 (0.5-3 feet bgs)

- PFNA = 0.330 µg/kg at 30SB-19-06 (3-7 feet bgs)
- PFOS = 100 µg/kg at 30SB-19-06 (3-7 feet bgs)
- PFOA = 5.70 µg/kg at 30SB-19-05 (7-15 feet bgs)

The results of the RI and SI soil sampling (Figure 4-9) suggest that historical storage activities conducted at the former drum storage areas have contributed to soil contamination surrounding the pads.

5.0 AOC 31 FIRE TRAINING AREA PRELIMINARY SITE CHARACTERIZATION SUMMARY

5.1 Site Description

The former FTA is located at the west end of the abandoned east/west trending runway in the former North Post area at former MAAF (Figure 1-1). The former FTA was a 50-ft by 50-ft asphalt-covered eight-inch thick concrete pad (Figure 5-1). The area now contains small brush and broken up concrete and asphalt. The immediate area surrounding the FTA is generally flat. West of the site, the ground surface slopes steeply to the west. At the base of the slope is the Nashua River floodplain and river.

Most of the former MAAF including the former FTA is currently leased by the Massachusetts State Police for training and vehicle storage. The former FTA is not currently used for fire training activities. The area is zoned for Special Use II and Innovation and Technology Business, which includes a broad range of industrial, light industrial, office, and research and development uses. There are currently no wells at the MAAF that are used for drinking water supply, irrigation water supply, or any other water supply purposes. A permit is required from Devens Enterprise Commission for installation of any water supply well within Devens.

5.2 Site History and Utilities

Approximately once a year between 1975 and 1986, as part of fire training exercises, an abandoned shell of a U-8 airplane was doused with fuel and paint thinner and was open-burned within the bermed area (ABB-ES, 1993). No discharge of fuel from the training pit was reported. Other disposal activities at SA 31 included burning of fuel samples from the laboratory about once per year (KGS, 2017). AFFF was historically used during the fire training exercises (KGS, 2017).

Interviews conducted with the Devens Fire Chief indicated that AFFF foam was historically used during firefighting training exercises. Based upon interviews with the Devens Fire Chief, fire suppression foams were mixed with water, placed in a pump tank, and then transported to the training area for use (KGS, 2017). Interviews with the Massachusetts State Police indicated firefighting foams are not used during their driver training activities.

The current and previous subsurface features are shown on Figures 4-2 and 4-3.

5.3 Remedial Status

Prior to the PFAS investigation, an SI on soil, and groundwater was conducted at SA 31 in 1992 (ABB-ES, 1996) under CERCLA. The SI concluded the petroleum-related organic compounds (TPHC and PAHs) were detected in soil samples located immediately below the concrete pad. These detected analytes were consistent with those presumed to have been used there. No observable contamination of groundwater had occurred as a result of potential releases associated with fire-fighting training activities at SA 31. No further action was recommended.

5.4 AOC 31 RI Field Investigation

The AOC 31 RI field investigation included the sampling of groundwater vertical profiling using DPT, soil borings using DPT, installation of piezometers, and synoptic water level measurements. Surface water and sediment samples were also collected in the Nashua River, adjacent to AOC 31. The details regarding the surface water and sediment samples will be discussed further in Sections 6.4.7 and 6.5.3.

Sampling locations are presented on Figures 5-1 and 5-2 and summarized in Table 5-1. The results are discussed in Section 5.5.

5.4.1 DPT Vertical Profiles

Two phases of DPT vertical profiles were conducted at AOC 31. As results from the first phase were received and reviewed, proposed vertical profiles were moved to better delineate the PFAS contamination. The DPT vertical profiles are described below, are shown on Figures 5-1 and 5-2 and are summarized in Table 5-1.

Three vertical profiles (31VP-19-01, -04 and -05) were conducted from August to September 2019 (Table 5-1, Figure 5-1). Based on the high concentrations observed at 31VP-19-01 and the results from the Area 1 PFAS vertical profile sampling which suggested PFAS was travelling significant distance from source area(s), it was likely that PFAS impacts from the former FTA had already traveled to the Nashua River. Therefore vertical profile locations 31VP-19-06, -07, and -08 were recommended to the BCT to extend further west towards the Nashua River in order to evaluate downgradient concentrations as they approach the river, rather than evaluating concentrations closer to the source area (i.e. former FTA). These points were drilled adjacent to the east bank of the Nashua River under a second phase from September to October 2019. The data are discussed in Section 5.5.1.

5.4.2 Soil Borings

The AOC 31 soil borings (31SB-19-01 through -07) and a concrete sample (associated with soil boring location 31SB-19-07) were drilled in October 2019. The data are discussed in Section 5.5.2.

5.4.3 Piezometers

A series of piezometers (31PZ-19-01 through -02S/D) were installed in August and October 2019, respectively. Piezometer 31PZ-19-01 and 31PZ-02S were installed at the water table. Piezometer 31PZ-19-02D was installed in the deep overburden at a depth of 65-70 feet bgs. The shallow (31PZ-19-02S) and deep (31PZ-19-02D) piezometers were installed as a co-located pair in order to assess the vertical hydraulic gradient of groundwater as it approaches the Nashua River.

5.4.4 Synoptic Water Level Event

A synoptic water level event encompassing the AOC 30 piezometers, one new piezometer installed as part of AOC 31, and existing wells associated with the Airfield (AOC 50) was conducted on August 14, 2019. Refer to Table 2-2.

A second synoptic water level event encompassing the AOC 30 piezometers, additional piezometers installed as part of AOC 31, new piezometers that were installed as part of AOC 50 (Section 6.4.4) and existing wells associated with AOC 50 was conducted on October 7, 2019. Refer to Table 2-3.

A third synoptic water level event encompassing the AOC 30 piezometers, additional piezometers installed as part of AOC 31, new piezometers that were installed as part of AOC 50 (Section 6.4.4), existing wells associated with AOC 50, a staff gauge installed in the Nashua River (Section 6.4.5), and existing wells associated with AOC 20, was conducted on April 27, 2020. Refer to Table 2-4.

Vertical gradients at well pair 31PZ-02S/D, were assessed using the fall 2019 and spring 2020 groundwater elevations in order to evaluate gradients as groundwater approaches the Nashua River. As shown in Table 2-5, groundwater gradients are minimal but upward in both the spring 2020 (-0.007 ft/ft) and fall 2019 (-0.004 ft/ft).

5.5 PFAS Nature and Extent

Groundwater results are summarized on Figure 5-2 and in the cross-sections (Figures 5-4 through 5-6). Soil sampling results are summarized on Figure 5-7. Site-specific groundwater contours are presented on Figures 2-7, 2-8, Figure 2-9, and Figure 5-2. All of the results are presented in the tables in Appendix H. The media specific criteria are presented in (Table 1-1).

5.5.1 Groundwater

As shown on Figures 2-7, 2-8, and 2-9 and Figure 5-2, groundwater generally flows across the airfield from the northeast to the southwest. From the former FTA, groundwater flows west towards the Nashua River.

Groundwater at AOC 31 was characterized through six groundwater samples collected during the SI (BERS-Weston, 2018a), and during the RI via six DPT vertical profiles. It should be noted that the SI samples consisted of a single sample at the water table only. A total of 50 vertical profile samples were collected during the RI. Table 5-2 provides summary statistics of the results of the vertical profile samples. Of those samples, 38 samples (76%) had concentrations greater than the EPA LHA and 43 samples (86%) had concentrations greater than the MMCL/GW-1 standard. None of the concentrations were greater than the GW-3 standard (protective of surface water).

Former FTA

The maximum PFOA+PFOS and sum of six compound concentrations (39,000 ng/L, and 42,900 ng/L, respectively) were detected at the water table (63 feet bgs) in the center of the former FTA at SI location SA31-17-01. The vertical profile (31VP-19-01) which was also taken within the former FTA, detected PFOA+PFOS above the EPA LHA in all sampling intervals from the water table (63 feet bgs) down to refusal (195.5 feet bgs), with the exception of intervals (73-77, 83-87, 153-157, and 183-187 feet bgs). The MMCL/GW-1 for the sum of the six compounds was exceeded in all intervals from the water table to refusal at this location, with the exception of the 183-187 ft sample interval. At the vertical profile location, the maximum PFOA+PFOS concentration (5,830 ng/L) was detected at the water table and the maximum sum of the six MMCL/GW-1 compounds (10,200 ng/L) were detected at interval 123-127 feet bgs. The difference is primarily due to increases in the PFHxS and PFOA concentrations.

Overall, high concentrations of PFAS (primarily PFOS and PFHxS) were detected at the water table (63 feet bgs). Comparatively, significant decreases in PFAS concentrations were observed below the water table (63 feet bgs) to a depth of 93 feet bgs. A significant increase of PFAS concentrations were then observed from 93 to 137 feet bgs (44-ft thick). These increases were primarily caused by an in flux of PFOA, PFHxS, and PFHpA. Concentrations then decrease from 143-157 feet bgs, with another flux of higher concentrations of mostly PFOA and PFHxS between 163 to 177 feet bgs. Concentrations from 183-187 feet bgs, decrease dramatically to below 15 ng/L for the sum of the six MMCL/GW-1 compounds. Concentrations then increase sharply in the last sample (192-195.5 feet bgs) at refusal (195.5 feet bgs). Variability in concentrations with depth across the entire vertical profile suggests additional upgradient source(s).

Upgradient

There are numerous vertical profile and monitoring wells located upgradient of AOC 31 which will be addressed as part of AOC 50 (Section 6.0).

Crossgradient

Crossgradient of the former FTA to the northwest, PFAS contamination was detected above the EPA LHA and MMCL/GW-1 at location 31VP-19-04. Overall, higher concentrations of PFAS (primarily PFHxS) were detected at the water table (69 feet bgs). Comparatively, significant decreases in PFAS concentrations were observed below the water table (69 feet bgs) to a depth of 93 feet bgs. A significant increase of PFAS concentrations were observed from 99 to 132 feet bgs (33-ft thick). These increases were primarily caused primarily by a flux of PFHxS, PFOA, and PFHpA. The maximum concentration of PFOA+PFOS (570 ng/L) was detected at the 99-103 feet bgs interval (~30 feet below the water table [69 feet bgs]) and the maximum concentration of sum of the six MMCL/GW-1 compounds (3,380 ng/L) was detected at the 109-113 feet bgs interval (~40 feet below the water table). The top three analytes detected throughout most of this vertical profile, in order of decreasing concentration, were PFHxS/PFOA/PFHpA. Concentrations of PFOS were either non-detect or lower than the three compounds listed above. Variability in concentrations

with depth across the entire vertical profile suggests additional upgradient source(s). Results from additional crossgradient locations to the north and south are discussed as part of AOC 50.

Downgradient

Downgradient of the FTA as groundwater approaches the Nashua River (31VP-19-06, 31VP-19-07, and 31VP-19-08), the higher concentrations were observed at and north of 31VP-19-07, compared to the south (31VP-19-08). The maximum PFOA+PFOS and sum of the six MMCL/GW-1 compounds (1,870 ng/L and 2,410 ng/L, respectively) were detected 20-feet below the water table (8 ft bgs) at 31VP-19-07. The top three analytes, in order of decreasing concentration, within this interval, were PFOS/PFHxS/PFOA. North of 31VP-19-07, at 31VP-19-06, the maximum PFOA+PFOS and sum of the six MMCL/GW-1 compounds (1,210 ng/L and 2,240 ng/L, respectively) were detected 10-feet below the water table (13 ft bgs) at 31VP-19-06. The top three analytes, in order of decreasing concentration, within this interval, were PFOA/PFHxS/PFOS.

To the south of 31VP-19-07, at 31VP-19-08, the maximum PFOA+PFOS and sum of the six MMCL/GW-1 compounds (349 ng/L and 649 ng/L, respectively) were observed at the water table (13 ft bgs). Concentrations were above the EPA LHA and MMCL/GW-1 for the sum of the six compounds down to refusal and were relatively stable. The top three analytes, in order of decreasing concentration, at the water table were PFHxS/PFOA/PFOS. At the interval 10-feet below the water table this ratio changed slightly to PFHxS/PFOS/PFOA. Below this interval (23-27 feet bgs), the ratio then switches to PFOS/PFOA/PFHxS down to refusal (87 feet bgs).

The upward vertical gradients observed at the edge of the Nashua River downgradient of AOC 31 suggest some portion of the PFAS impacted groundwater is discharging to the river.

West of the Nashua River

West of the Nashua River, west of AOC 31, the EPA LHA and MMCL/GW-1 was not exceeded at 31VP-19-05.

5.5.2 Soil

Seven borings were conducted during the RI. The RI soil samples were collected from 0-0.5, 0-0.5-3, 3-7, 7-15 feet bgs, and from the 2-foot interval above the water table. A total of 26 soil samples were collected during the RI (refer to Figure 5-7, Appendix H). Table 5-3 provides summary statistics of the results of the RI samples. Of the 25 RI samples collected:

- 7 samples (28%) had PFDA concentrations greater than the S-1/GW-1,
- 2 samples (8%) had PFHpA concentrations greater than the S-1/GW-1,
- 25 samples (100%) had PFHxS concentrations greater than the S-1/GW-1,
- 3 samples (12%) had PFNA concentrations greater than the S-1/GW-1,
- 25 samples (100%) had PFOS concentrations greater than the S-1/GW-1, and
- 18 samples (72%) had PFOA concentrations greater than the S-1/GW-1.

The maximum concentrations of the six PFAS compounds in the S-1/GW-1 standards detected in AOC 31 area are:

- PFDA = 0.960 µg/kg at 31SB-19-01 (0.5-3 feet bgs)
- PFHpA = 0.510 µg/kg at 31SB-19-01 (0.5-3 feet bgs)
- PFHxS = 67.0 µg/kg at 31SB-19-05 (3-7 feet bgs)
- PFNA = 0.450 µg/kg at 31SB-19-05 (0-0.5 feet bgs)
- PFOS = 530 µg/kg at 31SB-19-01 (3-7 feet bgs)
- PFOA = 53.0 µg/kg at 31SB-19-05 (3-7 feet bgs)

Locations with the maximum detected PFAS compounds are located within the former FTA footprint and are mostly PFOS and PFHxS dominant.

A sample from the concrete associated with the former FTA was also sampled at in the vicinity of location 31SB-19-07 and analyzed for PFAS. The concentrations are as follows:

- PFDA = not-detected
- PFHpA = 1.60 µg/kg
- PFHxS = 41.0 µg/kg
- PFNA = not-detected
- PFOS = 95.0 µg/kg
- PFOA = 4.90 µg/kg

The results from the concrete indicate that AFFF from former fire training has sorbed into the concrete surrounding the former FTA.

6.0 AOC 50 FORMER MOORE ARMY AIRFIELD PRELIMINARY SITE CHARACTERIZATION SUMMARY

6.1 Site Description

The former MAAF is located in the former North Post area at former Fort Devens, Massachusetts (Figure 1-1). Under the PFAS RI field program, AOC 50 is comprised of the entire former MAAF including the tetrachloroethylene (PCE) Source Area, the former Devens Fire Station, Hangar Buildings 3818 and 3813, and the airfield. The other AOCs with the former MAAF, specifically AOC 30 and AOC 31, are discussed previously.

All but approximately 14 acres of the former MAAF (approximately 246 acres total) were transferred to MassDevelopment for reuse in 1997. Currently, the airfield is closed to aircraft traffic and is used by the Massachusetts State Police for training purposes and vehicle storage. The former MAAF is zoned for Special Use II and Innovation and Technology Business by MassDevelopment. Under the Devens Reuse Plan dated 14 November 1994, Special Use II and Innovation and Technology Business includes a broad range of industrial, light industrial, office, and research and development use. MassDevelopment is considering repairs and upgrades for the Massachusetts State Police's use of the airfield, but the plans are still under development. The Devens Army Installation retained approximately nine acres of the former airfield for vehicle storage and maintenance around the Hangars, and approximately four acres in and around the AOC 50 Source Area for remediation activities. The Hangars are not occupied.

The USFWS owns undeveloped land south and west of the former airfield. The area is zoned Open Space/Recreation.

The Merrimack Warehouse Realty Co., Inc. owns the area north of Rt. 2A. The property is zoned commercial and is developed with a building used for the manufacture of windshield washer fluid and as a storage facility. A fire pond and detention basin is located on the property and would be used for fire suppression source water in the event of a fire.

The AOC 50 PCE Source Area is lower in elevation than the airfield. The ground then steeply slopes up to the west/southwest to the airfield which sits topographically higher. The airfield is generally flat. As the airfield approaches the Nashua River towards the southwest, west, and northwest the ground slopes steeply downwards towards the Nashua River.

6.2 Site History and Utilities

The main portion of the former MAAF consisted of two fixed wing runways, two rotary wing runways, a parking area for 15 rotary-wing aircraft, and aircraft hangars (Buildings 3813 and 3818) (Figure 6-1). The northern part of the former MAAF, south of Route 2A/Fitchburg Road, was used for the maintenance and storage of parachutes and former fueling systems were in this area.

The PCE Source Area, the former Devens Fire Station, Hangar Buildings 3818 and 3813, and historic airfield operations related to PFAS are described below.

- There was no documented usage or storage of AFFF at the AOC 50 PCE plume source area identified during the PA (KGS, 2017) or SI (BERS-Weston, 2018b).
- Due to the age of the fueling systems associated with AOC 50 (discontinued after the late 1940s), AFFF was not used for fire suppression (KGS, 2017).
- There is no documentation of AFFF being used in the fire suppression systems at the former hangar buildings (Buildings 3813 and 3818). However, AFFF may have been stored in the former hangar area during the operational period of the airfield (KGS, 2017).
- AFFF concentrate was also reportedly stored in 5-gallon pails and within firefighting equipment stored at the former MAAF Fire Station (KGS, 2019a).

- Both Devens Fire Chief LeBlanc and former Devens Fire Chief Broderick. Both Fire Chiefs could not specifically recall aircraft crashes or fires at the former MAAF. However, Chief LeBlanc acknowledged that when aircraft were reported to be using the airfield during an emergency, the fire trucks would respond and foam portions of the runway during aircraft landing. Historical review of aircraft landing and takeoff procedures indicated the use of fire apparatus being staged near the runway. Interviews conducted with Fire Chief LeBlanc confirmed this procedure; however, he could not specifically recall an incident when the runway was foamed. Both Fire Chiefs indicated the main airfield runway may have been foamed during firefighting and crash training. Both Fire Chief LeBlanc and former Fire Chief Broderick noted that "training foam" was primarily used, due to the expense of AFFF; however, neither could verify how often training foam was used compared to AFFF (KGS, 2017).
- Dried sludge from the Devens WWTP (AOC 21) was periodically spread on the ground surface at AOC 50. The area of historic sludge disposal to the ground surface at former MAAF was reportedly along the southwestern side of the main runway and in a triangular area of grass located in the center of the airfield (KGS, 2019a).

The current and previous subsurface features are shown on Figures 4-2 and 4-3.

6.3 Remedial Status

AOC 50 was originally identified for investigation due to the presence of two World War II vintage fueling systems (Fueling Systems A and B) (Figure 6-1). Environmental investigation commenced in 1992 with the completion of a SI (HLA, 2000). This was followed by removal of the fueling systems (including two USTs), a supplemental SI, and installation and operation of a soil vapor extraction (SVE) system to address PCE contamination discovered near the Former Fueling System B. Based on results of these investigations, a Phase III SI was conducted, and finally, after being renamed an AOC, a RI was initiated in 1996 and the final RI report was issued in 2000 (HLA, 2000). The primary contaminants addressed by the RI were PCE and related chlorinated compounds. However, during the course of the RI, low levels of fuel-related compounds (e.g., BTEX) were observed and evaluated in a separate report scheduled for simultaneous release (HLA, 2000).

The AOC 50 Source Area was used for the storage and maintenance of parachutes from the early 1970s to closure of the installation in 1996. The buildings in the AOC 50 Source Area include Buildings 3803 (the former parachute shop, used primarily as a storage and maintenance facility), 3840 (the former parachute shakeout tower), 3824 (a gazebo), and 3801 (the former 10th Special Forces airplane parachute simulation building) (Figure 6-1). A drywell associated with the floor and roof drains in Building 3840 and sinks located in Building 3803 was identified (Figure 6-1). PCE was used to spot-clean parachutes and may have entered sinks at Building 3803. Also, a PCE drum-storage area was located adjacent to Building 3801, later named the Former Drum Storage Area (FDSA) (Figure 6-1). The investigations indicated PCE was used in small amounts and that waste PCE evaporated or was disposed of at AOC 50 Source Area. Both the former dry well area and the former PCE drum storage area were subjects of removal actions; however, groundwater contamination with chlorinated compounds (primarily PCE) was identified. A groundwater plume was identified that extended southwest from the Source Area towards the Nashua River (Figure 6-1).

As documented in the ROD, the selected remedy for AOC 50 was SVE, enhanced reductive dechlorination (ERD) (with solubilized inorganic controls), In-Well Striping (IWS)/Aerobic Bioremediation, Monitoring, and Institutional Controls. In addition, Geochemical additives and In-situ Chemical Oxidation were included as contingencies to address inorganics and volatile organic compounds (VOCs), respectively, in the event that monitoring data indicate that implementation of these contingencies was warranted (ARCADIS, 2004).

In September 2004, a full-scale remedial action at AOC 50 was implemented that included SVE in the source area, ERD throughout the plume, and an IWS system at the western edge of the plume. The first ERD injection event was conducted in October 2004. The SVE system was discontinued in November 2005, as the monitoring program indicated that the recoverable mass of chlorinated VOCs (CVOCs) was removed from the vadose zone. The IWS was shut off in March 2013 once it was determined that it was not needed to treat dissolved arsenic or to "polish" the residual CVOC plume (Sovereign, 2013a). Semi-annual ERD injections continued through 2014. Annual ERD injections were completed in 2015, 2017, 2018, and 2019 (KGS, 2020d). Groundwater monitoring has been conducted since the start of the remedy. Through treatment in the source area and natural attenuation, CVOC concentrations in the North Plume have decreased below the cleanup criterion. As documented in the 2019 AOC 50 Annual Report (KGS, 2020d), since 2004, the PCE plume has decreased in size (15.5 acres in 2004 to 7.74 acres in 2019), and concentration (maximum concentration 14,000 micrograms per liter [µg/L] to 36 µg/L).

6.4 AOC 50 PFAS RI Field Investigation

The AOC 50 RI field investigation included the sampling of existing monitoring wells, groundwater vertical profiling using DPT, soil borings using DPT, surface water and sediment sampling, installation of piezometers, and synoptic water level measurements.

Sampling locations are presented on Figure 6-1 and summarized in Table 6-1. The results are discussed in Section 6.5.

6.4.1 Existing Monitoring Wells

Groundwater samples were collected from existing monitoring wells at AOC 50 from April 2019 to May 2019 in general accordance with the *Area 3 Field Sampling Plan Addendum to Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS)* (KGS, 2019a) (Table 6-1, Figure 6-1).

Groundwater samples were collected from an additional six existing monitoring wells (G6M-02-01X, G6M-13-05X, G6M-18-01, G6P-97-05X, XSA-12-96X, and XSA-12-98X) at AOC 50 in October 2019 and May 2020 in accordance with the *Work Plan for Additional Sampling of Existing Wells to Support the PFAS Remedial Investigation Former Fort Devens Army Installation, Devens, MA* (KGS, 2019b). The groundwater results are discussed in Section 6.5.

6.4.2 DPT Vertical Profiles

The DPT vertical profiles are described below, are shown on Figure 6-1 and are summarized in Table 6-1.

The AOC 50 vertical profiles were positioned in locations that were thought to be within the source area as well as cross-gradient, upgradient, and downgradient of the suspected source areas to assess the nature and extent of PFAS in groundwater in this area.

Two vertical profiles G6M-18-01 and G6M-18-02 were conducted in October 2018, and thirteen vertical profiles (50VP-19-01 through -13) were conducted from July to October 2019 (Table 6-1, Figure 6-1).

6.4.3 Soil Borings

The AOC 50 soil borings (50SB-19-01 through -12) were drilled between October and November 2019. The data are discussed in Section 5.4.2.

6.4.4 Piezometers

A series of overburden water table piezometers (50PZ-19-01 through -07) were installed between July and August 2019, respectively. These piezometers were surveyed in April 2020.

6.4.5 Staff Gauge

One staff-gauge (NRSG-01) was installed within the Nashua River on April 4, 2020. The staff-gauge is a 4-ft fiberglass gauge, mounted to a steel rod. The top reading (4-ft mark) was surveyed.

6.4.6 Synoptic Water Level Event

A synoptic water level event encompassing the AOC 30 piezometers, one new piezometer installed as part of AOC 31, and existing wells associated with the Airfield (AOC 50) was conducted on August 14, 2019.

A second synoptic water level event encompassing the AOC 30 piezometers, additional piezometers installed as part of AOC 31, and new piezometers that were installed as part of AOC 50, and existing wells associated with the Airfield (AOC 50) was conducted on October 7, 2019.

A third synoptic water level event encompassing the AOC 30 piezometers, additional piezometers installed as part of AOC 31, new piezometers that were installed as part of AOC 50, existing wells associated with the Airfield (AOC 50), the staff gauge installed in the Nashua River, and existing wells associated with AOC 20, was conducted on April 27, 2020.

Vertical gradients at well pair G6M-96-22A/B, were assessed using the fall 2019 and spring 2020 groundwater elevations in order to evaluate gradients north of Route 2A. As shown in Table 2-5, groundwater gradients are minimal but downward in both the fall (0.014 ft/ft) and spring (0.028 ft/ft).

Within the AOC 50 PCE Source Area, groundwater elevations at monitoring well pairs G6M-95-25A/B, and G6M-04-10A/X were used to evaluate vertical gradients within this area. As shown in Table 2-5, groundwater gradients are minimal and mostly downward in spring, summer, and fall ranging from 0.013 ft/ft to 0.064 ft/ft. Given the relatively flat horizontal gradient within the source area, the vertical gradient data provides evidence that this area is primarily a recharge zone (where groundwater moves vertically rather than spatially). It should be noted, a slight upward gradient was calculated at -0.022 ft/ft at well pair G6M-04-10A/X (summer 2019).

Downgradient of the airfield, groundwater elevations at monitoring well pair G6M-04-06X and G6M-04-07X were used to evaluate vertical gradients within this area. As shown in Table 2-5, groundwater gradients were minimal but upward in the fall 2019 (-0.004 ft/ft) and downward in the spring 2020 (0.006 ft/ft).

6.4.7 Surface Water/Sediment Sampling

Between October 14 to 18, 2019, thirteen surface water/sediment locations within the Nashua River, and two surface water/sediment locations located within an unnamed wetland west of the airfield (AFW-19-01 and -02). The last surface water/sediment sample (NR-19-14) was collected on December 18, 2019. Locations NR-19-02 thru NR-19-13 were located within the Nashua River in areas where there may be impacts from Area 3 AOCs. Location NR-19-01 was located upstream of Area 3, and NR-19-14 was located downstream of the former MAAF.

6.5 PFAS Nature and Extent

Groundwater results are summarized on Figure 6-2 and in cross-section (Figures 6-3 through 6-6). Soil sampling results are summarized on Figure 6-7 and surface and sediment sampling results are summarized on Figure 2-10. Site-specific groundwater contours are presented on Figures 2-7, 2-8, 2-9, and Figure 6-2. All of the results are presented in tables in Appendix H. The media specific criteria are presented in (Table 1-1).

6.5.1 Groundwater

As shown on Figures 2-7, 2-8, and 2-9 and Figure 6-2, in general, groundwater flows southwest toward the Nashua River. As the river curves to the north and northeast in the northern portion of the site, the groundwater flows more to the west.

Groundwater at AOC 50 was characterized through 20 groundwater samples collected during the SI (BERS-Weston, 2018a), and during the RI from 33 existing wells, and 15 vertical profile locations. It should be noted that the SI samples consisted of a single sample at the water table only. During the RI, a total of 45 samples were collected from existing monitoring wells, and 98 vertical profile samples were collected.

Table 6-2 provides summary statistics of the results of the vertical profile samples. Of the 98 vertical profile samples, 55 samples (56%) had concentrations greater than the EPA LHA and 77 samples (79%) had concentrations greater than the MMCL/GW-1 standard. Table 6-3 provides summary statistics of the results of the existing monitoring wells. Of the 45 samples collected from the monitoring wells, 29 samples (64%) had concentrations greater than the EPA LHA and 43 samples (86%) had concentrations greater than the MMCL/GW-1 standard. None of the concentrations were greater than the GW-3 standard (protective of surface water). A discussion of the results per area, beginning at the northeast portion of the site moving with groundwater flow to the southwest towards the Nashua River, is presented below.

North of Route 2A

Out of three vertical profiles that were conducted north of Route 2A, east of AOC 50 PCE Source Area, PFAS concentrations were highest at 50VP-19-01. The EPA LHA was exceeded in all intervals at 50VP-19-01 with the exception of the 39-43 ft bgs interval. The MMCL/GW-1 was exceeded in all intervals at this location. The maximum concentrations of PFOA+PFOS and the sum of the six MMCL/GW-1 compounds (411 ng/L and 753 ng/L, respectively) were detected in sample interval 59-63 ft bgs at 50VP-19-01. PFAS concentrations decrease to the southeast as represented by locations 50VP-19-02 and 50VP-19-03. The EPA LHA was not exceeded at 50VP-19-03.

AOC 50 PCE Source Area

Overall, within the AOC 50 PCE source area, concentrations above the EPA LHA were detected from 35 to 62 ft bgs. There were no LHA exceedances at the water table. Conversely, the MMCL/GW-1 was exceeded in all of the wells sampled from the water table (approximately 10 ft bgs) to 70 ft bgs, with the exception of G6M-04-13X and G6M-96-26B. The maximum PFOA+PFOS and sum of the six MMCL/GW-1 concentrations (580 ng/L, and 1,240 ng/L, respectively) detected within the AOC 50 PCE source area were at existing monitoring well G6M-13-05X (screen 45-55 feet bgs).

With the exception of G6M-04-10X and G6M-96-25B, all of the samples collected within the AOC 50 PCE Source Area contained higher concentrations of PFHxS compared to other PFAS compounds. At G6M-04-10X and G6M-96-25B, PFOS was detected at a higher concentration compared to PFHxS. The second highest PFAS compound detected at all locations was mostly PFOS, with the following exceptions; G6M-92-10X (PFOA), G6M-04-13X (PFOA), and G6M-96-26A (PFOA).

Former Hangars

With the exception of AOC50-17-06, all of the SI and RI locations surrounding the hangars, had at least one sample that exceeded the EPA LHA. The maximum PFOA+PFOS and sum of the six MMCL/GW-1 compound concentrations detected within the vicinity of the former airplane hangars was at the water table (63 feet bgs) at SI location AOC50-17-03. This location is immediately west of Hangar 3818 and the concentrations of PFOA+PFOS and sum of five compounds (PFOA, PFOS, PFHpA, PFHxS, PFNA) (the SI samples were not analyzed from PFDA) were 2,110 ng/L, and 3,850 ng/L, respectively. It should be noted that the SI samples consisted of a single sample at the water table only. A co-located RI vertical profile (50VP-19-05) was installed in the vicinity to evaluate vertical distribution. PFOA+PFOS and sum of the six MMCL/GW-1 compound concentrations (670 ng/L, and 1,700 ng/L, respectively) were detected at the water table at vertical profile location 50VP-19-05. Further at this location, with the exception of two sample intervals (83-87 feet bgs and 93-97 feet bgs), PFOA+PFOS was detected above the EPA LHA in all other intervals down to refusal (107 feet bgs). The MMCL/GW-1 was exceeded in all intervals at this location, with the exception of 83-87-feet bgs. The top three analytes detected at the water table, in order of decreasing concentration were PFHxS/PFOA/PFOS. Variability in concentrations with depth across the entire vertical profile suggests additional upgradient source(s).

Upgradient of Hangar 3818 (50VP-19-04), PFOA+PFOS was not-detected above the EPA LHA at the water table (49 feet bgs), however the MMCL/GW-1 was exceeded. The deeper sample intervals all had concentrations greater than the EPA LHA. The maximum concentrations of PFOA+PFOS (400 ng/L) and

the sum of the six MMCL/GW-1 compounds (807 ng/L) at this location were detected 20 feet below the water table (49 feet bgs) at sample interval 69-73 feet bgs. The top three analytes detected at the water table, in order of decreasing concentrations were PFHxS/PFOA/PFHpA. Below the water table, in order of decreasing concentrations, the top three analytes detected were PFHxS/PFOS/PFOA. This ratio is similar to the AOC 50 PCE Source Area.

At Hangar 3813, based on the SI data, the highest concentrations were PFHxS compared to other PFAS compounds at the water table, and show a similar ratio of PFAS to the AOC 50 PCE Source Area. It should be noted that the SI samples consisted of a single sample at the water table only.

Upgradient of Hangar 3813, both the EPA LHA and MMCL/GW-1 were exceeded at locations G6M-02-01X and G6M-04-03X. During the same sampling event (spring 2019), the maximum PFOA+PFOS and sum of the six MMCL/GW-1 compounds concentrations (427 ng/L and 841 ng/L, respectively) were detected at G6M-02-01X. G6M-02-01X was also sampled in the fall 2019 and spring 2020. During the fall 2019 event, concentrations of PFOA+PFOS and sum of the six compounds were 450 ng/L and 865 ng/L, respectively. Spring 2020 PFOA+PFOS and sum of the six compounds were 430 ng/L and 845 ng/L, respectively, and were similar to spring 2019 data. The increases in concentrations during the fall were primarily due to an increase in PFOA.

Crossgradient of the hangars to the east at G6M-97-09B, there was not an EPA LHA exceedance however the MMCL/GW-1 was exceeded at a concentration of 24.7 ng/L for the sum of six compounds.

Former Fire Station

Vertical profile location 50VP-19-06 was installed south of the garage located on the south side of the former fire station. At this location PFAS was detected above the EPA LHA and MMCL/GW-1 from the water table (63 feet bgs) down to refusal (96 feet bgs). The maximum PFOA+PFOS and sum of the six MMCL/GW-1 compound concentrations (1,750 ng/L, and 2,090 ng/L, respectively) were detected 10-feet below the water table (63 feet bgs). Concentrations decreased from 77 to 87 feet bgs, then increased from 92-96 feet bgs.

The top three analytes detected at the water table, in order of decreasing concentrations, were PFHxS/PFOA/PFHpA. Below the water table, increases of PFOS compared to PFHpA were observed.

Eastern Portion of the Airfield

Within the eastern portion of the Airfield (Figure 4-2 and Figure 6-2), potential sources included sludge application fields, stormwater discharge areas, and the runway itself. This portion of the airfield represents areas of lower PFAS concentrations compared to the western portion of the airfield. The maximum PFOA+PFOS and sum of the six MMCL/GW-1 compound concentrations detected within the eastern portion of the airfield was at the water table (approximately 51 feet bgs) at SI location AOC50-17-08. This location is within a paved area right off the runway. It should be noted that the SI samples consisted of a single sample at the water table only. The concentrations of PFOA+PFOS and sum of five compounds (PFOA, PFOS, PFHpA, PFHxS, PFNA) (the SI samples were not analyzed from PFDA) were 372 ng/L, and 397 ng/L, respectively.

There were only two other locations, AOC50-17-14 (SI location) and 50VP-19-09, within the eastern portion of the airfield that exceeded the EPA LHA. All of the locations, with the exception of 50VP-19-10 and 50VP-19-11 had at least one sample that exceeded the MMCL/GW-1 for the sum of six compounds.

Western Portion of the Airfield

Vertical profiles and SI locations within the western portion of the airfield were placed to investigate sludge application fields, potential PFAS from the runways, and evaluate downgradient migration from potential upgradient sources (e.g., Former Fire Station, AOC 50, hangars). Downgradient of the upgradient source areas within the western portion of the airfield, the maximum concentrations detected were at G6M-18-02.

This location is adjacent to the abandoned runway, crossgradient to the former FTA (AOC 31), and within an area where sludge from AOC 21 was reported to have been applied. PFAS concentrations at this location were detected above the EPA LHA and MMCL/GW-1 from the water table (64 feet bgs) down to refusal (128 feet bgs). Overall, the lowest concentrations of PFAS (albeit above the LHA and MMCL/GW-1) were detected at the water table (64 feet bgs). Below the water table, from 73 ft to refusal (128 feet bgs), significant increases in PFAS concentrations were observed. The maximum PFOA+PFOS and sum of the six MMCL/GW-1 compound concentrations (10,500 ng/L, and 17,800 ng/L, respectively) were detected 20-ft below the water table at sample interval 84-88 feet bgs. Variability in concentrations with depth across the entire vertical profile suggests additional upgradient source(s). Given the fact that shallower intervals contained lower concentrations of PFAS compared to the deeper intervals, the data also suggests that the sludge is not a significant contributor to groundwater contamination.

The second highest PFAS concentrations were detected at G6M-18-01. The maximum PFOA+PFOS and sum of six MMCL/GW-1 concentrations (5,200 ng/L, 10,900 ng/L, respectively) detected within this profile was at the deepest interval sampled (116-126 feet bgs). The LHA was not exceeded from the water table (60 feet bgs) down to 90 feet bgs. The MMCL/GW-1 was exceeded from the water table to the deepest sample (116-126 feet bgs). Given the fact that shallower intervals contained lower concentrations of PFAS compared to the deeper intervals, the data suggests that the sludge is not a significant contributor to groundwater contamination.

Overall, the EPA LHA was exceeded in at least one sample in every location within the western portion of the airfield with the exception of AOC50-17-11, AOC50-17-10, G6M-02-13X, G6M-01-01X, G6M-02-07X, G6M-03-11X, G6M-04-06X, and G6M-04-07X. The MMCL/GW-1 for the sum of six compounds was exceeded in at least one sample in every location with the exception of AOC50-17-11. The western portion contains higher concentrations and a thicker portion of the saturated overburden impacted with PFAS as a result of the co-mingling of multiple sources located upgradient compared to the eastern portion of the airfield.

West of the Nashua River

West of the Nashua River, concentrations of PFOA+PFOS and the sum of the six compounds were detected above the EPA LHA and MMCL/GW-1, respectively at locations G6M-04-08X, G6M-04-14X, and 50VP-19-08. The maximum PFOA+PFOS concentration (158 ng/L) were observed 10-ft below the water table (9 feet bgs) at 50VP-19-08 and the maximum sum of the six MMCL/GW-1 compound concentration (222 ng/L) were detected at G6M-04-14X (screen 80-90 ft bgs). At the vertical profile location 50VP-19-08, concentrations were not above the EPA LHA or MMCL/GW-1 at the water table but did exceed 10-feet below the water table down to the end of the boring (83 ft bgs).

The majority of samples collected west of the Nashua River were PFOS dominant and display an overall different ratio (PFOS/PFOA/PFHxS) compared to east of the River (PFHxS/PFOA/PFOS, and/or PFHxS/PFOS/PFOA).

6.5.2 Soil

Twelve borings were conducted during the RI. The RI soil samples were collected from 0-0.5, 0-0.5-3, 3-7, 7-15 feet bgs, and from the 2-foot interval above the water table (at select locations). A total of 51 soil samples were collected during the RI (Figure 6-7, Appendix H). Table 6-4 provides summary statistics of the results of the RI samples. Of the 51 RI samples collected:

- 1 sample (2%) had PFDA concentrations greater than the S-1/GW-1,
- 0 samples (0%) had PFHpA concentrations greater than the S-1/GW-1,
- 17 samples (33%) had PFHxS concentrations greater than the S-1/GW-1,
- 0 samples (0%) had PFNA concentrations greater than the S-1/GW-1,
- 12 samples (24%) had PFOS concentrations greater than the S-1/GW-1, and

- 10 samples (20%) had PFOA concentrations greater than the S-1/GW-1.

The maximum concentrations of the six PFAS compounds in the S-1/GW-1 standards detected in AOC 50 area are:

- PFDA = 0.410 µg/kg at 50SB-19-01 (0-0.5 feet bgs)
- PFHpA = 0.480 µg/kg at 50SB-19-03 (7-15 feet bgs)
- PFHxS = 19.0 µg/kg at 50SB-19-03 (0.5-3 feet bgs)
- PFNA = 0.210 J µg/kg at 50SB-19-08 (0-0.5 feet bgs)
- PFOS = 45.0 J µg/kg at 50SB-19-03 (0-0.5 feet bgs)
- PFOA = 26.0 µg/kg at 50SB-19-03 (0.5-3 feet bgs)

The majority of the exceedances in soil samples collected across the airfield were PFHxS dominant, followed by PFOS. The majority of the maximum PFAS concentrations were associated with the former fire station (50SB-19-03). North of Route 2A, the higher concentrations of PFAS were generally detected at 50SB-19-09, compared to 50SB-19-10, and were higher in PFOS compared to other PFAS compounds. The majority of the samples collected with former sludge application fields (50SB-19-06, -07, -08, -10, -11, and 12) were mostly non-detect or very low concentrations below standards. The only exception was the surface sample at 50SB-19-08 which had concentrations of PFOS and PFOA slightly above standards.

6.5.3 Surface Water and Sediment

All of the detections in surface water and sediment in the Nashua River were below the EPA SSSLs for PFAS at former Fort Devens (Table 1-1). The sampling locations and data are summarized on Figure 3-10 and the data are presented in Appendix H.

In the Nashua River, PFOA concentrations in the surface water, at locations NR-19-01 through -14, ranged from 10.0 ng/L to 28.0 ng/L (the maximum concentration was detected at NR-19-06), the PFOS concentrations ranged from 6.10 ng/L to 56.0 ng/L (the maximum concentration was detected at NR-19-06), and the PFBS concentrations ranged from 1.80 ng/L to 9.90 ng/L (the maximum concentration was detected at NR-19-02).

In the Nashua River, PFOA concentrations in sediment, at locations NR-19-01 through -14, ranged from non-detect to 0.590 J µg/kg (the maximum concentration was detected at NR-19-01), PFOS concentrations ranged from non-detect to 5.20 µg/kg (the maximum was detected at NR-19-12), and PFBS was not detected.

In the unnamed wetland west of the runway, PFOA concentrations in the surface water were 4.5 ng/L at AFW-19-01, and 9.30 ng/L at AFW-19-02, the PFOS concentrations were 6.70 ng/L at AFW-19-01 and 13.0 ng/L at AFW-19-02, and the PFBS concentrations were 0.510 J at AFW-19-01, and 1.50 J ng/L at AFW-19-02.

In the unnamed wetland west of the runway, PFOA concentrations in sediment were 0.770 J µg/kg at AFW-19-01, and 1.20 J µg/kg at AFW-19-02, the PFOS concentrations were 5.30 J µg/kg at AFW-19-01 and 16.0 µg/kg at AFW-19-02, and the PFBS was not detected.

7.0 BACKGROUND SURFACE WATER/SEDIMENT

As part of the RI, on December 18 and December 20, 2019, and March 20, 2020, seven surface water/sediment locations were sampled to evaluate background PFAS concentrations at locations not associated with the former Fort Devens. Not all locations proposed in the work plan were sampled due to access issues. Specifically, BB-19-02, BP-19-01, FP-19-03, and MB-19-01 have not been sampled. A summary of the data below will be presented and a decision will be made with the BCT to determine whether the additional locations presented in the work plan should be moved and/or are necessary.

A background sample was also collected within Balch Pond (BP-18-01) in 2018 during Area 1 PFAS RI activities. Those results are incorporated in the discussion below.

7.1.1 Results

All of the detections in surface water and sediment background locations were below the EPA SSSLs for PFAS at former Fort Devens (Table 1-1). The sampling locations and data are summarized on Figure 7-1 and the data are presented in Appendix H.

In summary, PFOA concentrations in the surface water ranged from 3.30 ng/L to 16.0 ng/L (the maximum concentration was detected at BP-18-01), the PFOS concentrations ranged from 1.50 J ng/L to 6.50 ng/L (the maximum concentration was detected at BP-18-01), and the PFBS concentrations ranged from 0.600 J ng/L to 7.80 ng/L (the maximum concentration was detected at WAB-19-01).

In sediment, PFOA concentrations ranged from non-detect to 2.80 µg/kg (the maximum concentration was detected at SR-19-01), the PFOS concentrations ranged from non-detect to 7.90 µg/kg (the maximum concentration was detected at SR-19-01), and the PFBS concentrations were non-detect. Specific results for each location are presented below:

- Squannacook River in the Town of Shirley - PFOA, PFOS, and PFBS were detected at concentrations of 7.80 ng/L, 2.80 J ng/L, and 0.600 J ng/L, respectively in surface water. PFOA, PFOS, and PFBS in sediment were detected at concentrations of 2.70 µg/kg, 7.90 µg/kg, and non-detect, respectively.
- Bowers Brook in the Town of Harvard - PFOA, PFOS, and PFBS were detected at concentrations of 3.30 ng/L, 2.40 J ng/L, and 1.10 J ng/L, respectively in surface water. PFOA, PFOS, and PFBS in sediment were not-detected.
- Balch Pond in the Town of Ayer - PFOA, PFOS, and PFBS were detected at concentrations of 16.0 ng/L, 6.50 ng/L, and 1.00 J ng/L, respectively in surface water. PFOS and PFBS in sediment were not-detected. PFOA in sediment was detected at a concentration of 0.160 J µg/kg.
- Flannigan's Pond in the Town of Ayer - PFOA concentrations in the surface water were 4.30 ng/L (FP-20-01) and 11.0 ng/L (FP-20-02), the PFOS concentrations were 3.20 J ng/L (FP-20-01) and 5.70 ng/L (FP-20-02), and the PFBS concentrations were 0.780 J ng/L (FP-20-01), and 0.830 J ng/L (FP-20-02). PFOA, PFOS, and PFBS in sediment were not-detected in sediment at both locations.
- Nashua River by Jackson Road (NRBK-19-01)- PFOA, PFOS, and PFBS were detected at concentrations of 10.0 ng/L, 4.00 ng/L, and 2.90 ng/L, respectively in surface water. PFOA, and PFBS in sediment were not-detected. PFOS in sediment was detected at a concentration of 0.420 J µg/kg.
- Nashua River in the Town of Lancaster (NRBK-19-02)- PFOA, PFOS, and PFBS were detected at concentrations of 10.0 ng/L, 4.20 ng/L, and 3.20 ng/L, respectively in surface water. PFOA and PFOS in sediment were detected at concentrations of 0.180 J µg/kg and 0.750 J µg/kg, respectively. PFBS was non-detect.

- Walker Brook in the Town of Shirley - PFOA, PFOS, and PFBS were detected at concentrations of 6.20 ng/L, 1.50 J ng/L, and 7.80 ng/L, respectively in surface water. PFOA, and PFBS in sediment were not-detected. PFOS in sediment was detected at a concentration of 0.720 J µg/kg.

8.0 REFERENCES

ABB Environmental Services, Inc. [ABB-ES], 1993. *Final Site Investigation Report, Fort Devens, Groups 3, 5, and 6*. April.

ABB-ES., 1996. *Revised Site Investigation Report Data Item A009, Fort Devens, Massachusetts.* Final. January.

Argonne National Laboratory (ANL), 1992. *Final Master Environmental Plan (MEP) for Fort Devens, Massachusetts*. April.

BERS-Weston Services, JVA, LLC (BERS-Weston), 2018a. *Site Inspection (SI) Addendum for Additional Per- and Polyfluoroalkyl Substances (PFAS) Sampling at Area of Contamination (AOC) 76-Devens Fire Department and Long Term Monitoring (LTM) Wells at AOCs 57, 43G, 43J, 32, 43A, 50 and Shepley's Hill Landfill (SHL) Former Fort Devens Army Installation Devens, Massachusetts.* Prepared by BERS-Weston Services, JVA, LLC. For U.S. Army Corps of Engineers, New England District, Concord, Massachusetts. August.

BERS-Weston Services, JVA, LLC (BERS-Weston), 2018b. *Final Site Inspection Report for Per- and Polyfluoroalkyl Substances (PFAS) at Former Fort Devens Army Installation, Devens, MA*. May.

Haley & Aldrich, Inc., (2007). *Report on Hydrogeologic Evaluation, Devens WasteWater Treatment Facility, Devens, Massachusetts*. April.

Harding Lawson Associates (HLA), 1999. *Final Record of Decision Landfill Remediation Study Areas 6, 12, and 13 and Areas of Contamination (AOC) 9, 11, 40, and 41*. U.S. Army Reserve Forces Training Area, Devens, MA. July.

HLA, 2000. *Final Remedial Investigation Report Area of Contamination (AOC) 50*. January.

Jahns, Richard H. 1953. Surficial Geology of the Ayer Quadrangle, Massachusetts

Kopera, Joseph P. 2006. Preliminary Bedrock Map of the Ayer Quadrangle, Massachusetts. Office of the Massachusetts State Geologist, Open File Report 06-02.

KOMAN Government Solutions, LLC (KGS), 2017. *Final Base-Wide Preliminary Assessment for Evaluation of Perfluoroalkyl Substances*, Former Fort Devens Army Installation BRAC Legacy Sites, Devens, Massachusetts. September.

KGS, 2018b. *Memorandum: Additional PFAS Sampling to Support the Development of the Remedial Investigation Work Plan, Former Fort Devens Army Installation, Devens, Massachusetts*. April.

KGS, 2019a. *Area 3 Field Sampling Plan (FSP) Addendum to Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS).* Former Fort Devens Army Installation, Devens, Massachusetts. Draft Final. October.

KGS, 2019b. *Work Plan for Additional Sampling of Existing Wells to Support the PFAS Remedial Investigation, Former Fort Devens Army Installation, Devens, MA* (October 9, 2019).

KGS, 2020a. *Draft Final Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances (PFAS),* Former Fort Devens Army Installation, Devens, MA. August.

KGS, 2020b. *Area 1 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation*. Former Fort Devens Army Installation, Devens, MA. June.

KGS, 2020c. *Area 2 Preliminary Site Characterization Summary Per- and Polyfluoroalkyl Substances (PFAS) Remedial Investigation*. Former Fort Devens Army Installation, Devens, MA. September.

KGS, 2020d. *Final 2019 Annual Operations, Maintenance, and Monitoring Report, Area of Contamination 50,* Former Fort Devens Army Installation, Devens, Massachusetts. August.

Stone, B. D., Stone, J. R., 2018. *Surficial Materials Map of the Ayer Quadrangle, Massachusetts*.

Stone&Webster Construction, Inc., 2003. *Remedial Action Closure Report, Remediation & Restoration Sites AOC 9, AOC 11, AOC 40, AOC 41, SA12, SA 13, Other Areas*. Landfill Remediation Project Devens Reserve Training Area, Devens, MA.

U.S. Environmental Protection Agency (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.* October.

TABLES

Table 1-1
Select PFAS Criteria
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

	EPA											Massachusetts			
	Lifetime Health Advisory Drinking Water		Site-Specific PFAS Screening Levels For the Former Fort Devens									Massachusetts Maximum Contaminant Levels for Drinking Water and GW-1 Standard		GW-3 Standard	S-1 SOIL & GW-1
	Summed Value	Individual Concentrations	Ingestion, Surface water	Ingestion, Groundwater		Dermal + Ingestion, Soil				Ingestion, Fish		Summed Value	Individual Concentrations	Individual Concentrations	Individual Concentrations
			Child Recreator	Child Resident	Adult Commercial Worker	Child Recreator	Child Resident	Adult Commercial Worker	Adult Construction Worker	Adult	Child				
	ng/L		ng/L	ng/L		µg/kg				mg/kg		ng/L		ng/L	µg/kg
PFBS			2,030,000	40,100	234,000	609,000	126,000	428,000	631,000	7.95	6.13				
PFOS	70	70	2,030	40.1	234	609	126	631	428	7.95X10-3	6.13X10-3	20	20	5.0E+05	2
PFOA		70	2,030	40.1	234	609	126	631	428	7.95X10-3	6.13X10-3		20	4.0E+07	0.72
PFDA													20	4.0E+07	0.3
PFHpA													20	4.0E+07	0.5
PFHxS													20	5.0E+05	0.3
PFNA													20	4.0E+07	0.32

Notes:
PFBS = Perfluorobutanesulfonic Acid
PFDA = Perfluorodecanoic Acid
PFHpA = Perfluoroheptanoic Acid
PFHxS = Perfluorohexanesulfonic Acid
PFNA = Perfluorononanoic Acid
PFOS = Perfluorooctanesulfonic Acid
PFOA = Perfluorooctanoic Acid
ng/L = nanograms per liter
µg/L = micrograms per liter
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram

Table 2-1
Bedrock Elevations
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location Name	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Bedrock Elevation (ft NAVD88)	Notes
20373	3032620.33	621929.81	275.58	Bedrock confirmed
20388	3028805.15	624936.08	158.81	Bedrock confirmed
20394	3035414.44	624799.81	202.36	Bedrock confirmed
20397	3028805.15	624936.08	155.81	Bedrock confirmed
20407	3034430.08	622483.34	248.05	Bedrock confirmed
20409	3031776.84	622046.01	249.37	Bedrock confirmed
20604	3028980.41	624996.59	96.05	Bedrock confirmed
20634	3029641.10	632392.17	256.11	Bedrock confirmed
132739	3036305.22	622730.82	256.13	Bedrock confirmed
258714	3036436.10	630314.01	150.65	Bedrock confirmed
258715	3036337.89	629777.30	161.78	Bedrock confirmed
258737	3036481.87	629619.12	168.02	Bedrock confirmed
274705	3035063.60	623410.29	234.00	Bedrock confirmed
310670	3031958.87	622171.27	258.82	Bedrock confirmed
612787	3037161.14	630443.47	210.68	Bedrock confirmed
663258	3034044.41	622542.30	245.12	Bedrock confirmed
20VP-19-01	3032600.39	624892.23	197.82	Refusal
20VP-19-02	3033357.35	625001.25	174.25	Refusal
20VP-19-03	3030129.29	625936.96	151.23	Refusal
20VP-19-04	3030532.95	625910.05	169.10	Refusal
20VP-19-05	3030678.03	624902.02	197.67	Refusal
20VP-19-06	3031415.26	625703.92	114.07	Refusal
20VP-19-07	3031901.54	625532.42	114.02	Refusal
20VP-19-08	3032067.88	624796.52	209.83	Refusal
21VP-19-01	3031387.24	626348.59	127.08	Refusal
21VP-19-02	3031603.90	627229.54	82.99	Refusal
30VP-19-01	3035432.10	626818.69	188.80	Refusal
30VP-19-02	3035422.41	626555.89	176.88	Refusal
30VP-19-03	3035147.30	626449.20	149.04	Refusal
30VP-19-04	3034928.90	626262.80	131.90	Refusal
30VP-19-05	3035471.80	627375.50	175.10	Refusal
30VP-19-06	3035031.44	627007.63	178.20	Refusal
31VP-19-01	3033967.58	626254.21	71.84	Refusal
31VP-19-04	3034167.00	626075.50	134.66	Refusal
31VP-19-05	3033990.08	624904.81	168.76	Refusal
31VP-19-06	3034307.57	625075.40	122.20	Refusal
31VP-19-07	3034028.75	625391.59	109.31	Refusal
31VP-19-08	3033810.30	625434.74	116.46	Refusal
50VP-19-01	3035340.65	628439.14	146.90	Refusal
50VP-19-02	3035185.21	628536.37	157.91	Refusal
50VP-19-03	3035071.22	628588.60	164.54	Refusal
50VP-19-04	3034979.40	627822.10	155.78	Refusal

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Location Name	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Bedrock Elevation (ft NAVD88)	Notes
50VP-19-05	3034810.35	627560.82	156.89	Refusal
50VP-19-06	3034649.60	627345.50	169.21	Refusal
50VP-19-07	3033667.76	626493.31	100.55	Refusal
50VP-19-08	3033351.49	625812.29	128.50	Refusal
50VP-19-09	3033897.90	628849.20	148.11	Refusal
50VP-19-10	3033509.90	628182.90	177.99	Refusal
50VP-19-11	3032501.90	629266.60	141.16	Refusal
50VP-19-12	3031601.90	628575.60	158.53	Refusal
50VP-19-13	3034626.90	625891.90	86.03	Refusal
Br. #A-19-7 - West Main St.	3028340.07	628919.41	183.44	Bedrock confirmed
BRIDGE # A-19-7	3028340.07	628919.41	155.28	Bedrock confirmed
EW-01	3027960.20	629942.81	130.95	Bedrock confirmed
EW-04	3027991.00	629895.33	120.40	Bedrock confirmed
G6M-97-05B	3033730.40	626265.10	66.94	Bedrock confirmed
G6M-97-09B	3034545.25	628271.92	174.80	Bedrock confirmed
G6M-97-28X	3034102.75	627185.77	126.63	Bedrock confirmed
G6M-97-29X	3033674.22	626736.78	74.00	Bedrock confirmed
G6P-97-05X	3035151.10	627296.40	190.49	Refusal
HA-1	3031667.55	625631.66	109.60	Bedrock confirmed
HA-3	3031436.86	624622.36	216.80	Bedrock confirmed
LIDAR13	3027686.65	628528.99	239.72	Bedrock confirmed
LIDAR17	3027822.07	628534.20	236.16	Bedrock confirmed
LIDAR37	3030483.53	630520.31	257.34	Bedrock confirmed
LIDAR7	3027767.38	629200.86	277.24	Bedrock confirmed
LIDAR8	3027814.26	629375.34	271.51	Bedrock confirmed
LLFARM-SHI	3030689.69	624154.01	226.00	Bedrock confirmed
MA-SMW_74	3028040.27	625163.67	89.23	Bedrock confirmed
MPVP-19-01	3028348.23	626014.80	113.43	Refusal
MPVP-19-02	3027861.05	626185.67	117.85	Refusal
MPVP-19-03	3027549.00	626769.00	132.86	Refusal
MPVP-19-04	3027636.00	627594.00	163.41	Refusal
MPVP-19-06	3028163.00	626523.00	121.34	Refusal
MPVP-19-07	3028478.01	626276.77	113.74	Refusal
MPVP-19-08	3029282.73	627333.91	146.50	Refusal
MW-06	3033479.80	624410.40	208.21	Bedrock confirmed
MW-07	3031439.80	624609.60	222.20	Bedrock confirmed
N1-P2	3027867.76	630723.38	156.28	Bedrock confirmed
Pt-A	3033601.22	626726.78	74.40	Bedrock confirmed
Pt-B	3033941.85	627669.65	141.60	Bedrock confirmed
Pt-C	3034541.36	628260.99	175.60	Bedrock confirmed
Pt-D	3034699.41	627904.01	155.50	Bedrock confirmed
Pt-E	3034887.44	628217.39	155.25	Bedrock confirmed

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Bedrock Elevations
Area 3 Preliminary Site Characterization Summary
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Location Name	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Bedrock Elevation (ft NAVD88)	Notes
Pt-F	3034966.47	628522.60	154.60	Bedrock confirmed
Pt-G	3035067.30	628081.14	152.90	Bedrock confirmed
Pt-H	3035020.97	628154.72	157.74	Bedrock confirmed
Pt-I	3035339.80	628429.95	145.80	Bedrock confirmed
Pt-J	3035318.00	628421.77	152.84	Bedrock confirmed
Pt-K	3035143.60	628536.22	151.52	Bedrock confirmed
Pt-L	3035187.20	628331.84	154.26	Bedrock confirmed
Pt-M	3035162.67	628389.07	137.31	Bedrock confirmed
Pt-N	3035162.67	627301.77	190.90	Bedrock confirmed
Pt-O	3034898.34	627064.69	172.90	Bedrock confirmed
SB-03	3028012.67	629815.70	127.30	Bedrock confirmed
SB-16-06	3027901.38	629772.99	147.89	Bedrock confirmed
SB-16-07	3027908.62	629816.11	126.04	Bedrock confirmed
SB-16-08	3027908.54	629880.77	136.54	Bedrock confirmed
SB-16-09	3027890.08	630093.61	162.42	Bedrock confirmed
SB-16-10	3027890.01	630150.19	156.30	Bedrock confirmed
SB-16-11	3027889.96	630195.99	145.61	Bedrock confirmed
SB-16-12	3027889.88	630268.74	138.46	Bedrock confirmed
SB-16-13	3028475.67	629515.00	182.61	Bedrock confirmed
SB-16-14	3028495.64	629576.99	188.77	Bedrock confirmed
SB-16-15	3028521.07	629647.07	185.02	Bedrock confirmed
SB-16-16	3028553.76	629742.76	155.88	Bedrock confirmed
SB-16-17	3028524.52	629819.51	149.03	Bedrock confirmed
SB-16-18	3028546.35	629854.56	110.37	Bedrock confirmed
SB-16-19	3028442.69	629652.41	176.84	Bedrock confirmed
SB-16-20	3028274.04	629628.56	195.83	Bedrock confirmed
SB-16-21	3028601.19	629488.72	184.90	Bedrock confirmed
SB-3	3028484.49	629522.42	183.00	Bedrock confirmed
SEA-8	3028127.50	630407.22	146.65	Bedrock confirmed
SHL-22	3028163.04	630056.40	104.06	Bedrock confirmed
SHL-5/WT-5	3028125.10	630192.21	138.81	Bedrock confirmed
SHL-8D	3028126.57	630407.10	146.95	Bedrock confirmed
SHM-05-39A	3028544.28	629761.38	152.79	Bedrock confirmed
SHM-05-39B	3028543.68	629765.33	152.78	Bedrock confirmed
SHM-05-40X	3028514.16	629636.83	185.55	Bedrock confirmed
SHM-07-03	3028444.63	629411.08	174.00	Bedrock confirmed
SHM-07-05	3028513.39	629631.98	177.62	Bedrock confirmed
SHM-10-01	3028617.32	628868.44	131.64	Bedrock confirmed
SHM-10-02	3028700.13	628381.41	118.12	Bedrock confirmed
SHM-10-03	3029000.27	628436.33	157.70	Bedrock confirmed
SHM-10-04	3029485.34	628959.21	114.73	Bedrock confirmed
SHM-10-05A	3028943.39	630441.84	125.24	Bedrock confirmed

Table 2-1
Bedrock Elevations
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location Name	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Bedrock Elevation (ft NAVD88)	Notes
SHM-10-06	3027882.54	630215.62	149.99	Bedrock confirmed
SHM-10-06A	3027895.73	630300.71	135.46	Bedrock confirmed
SHM-10-08	3028526.47	628351.74	149.18	Bedrock confirmed
SHM-10-09	3028460.97	628759.22	126.00	Bedrock confirmed
SHM-10-10	3028873.64	629105.25	143.43	Bedrock confirmed
SHM-10-16	3028355.25	629834.23	121.72	Bedrock confirmed
SHM-11-06	3027590.05	630411.30	181.27	Bedrock confirmed
SHM-13-01	3028294.76	628556.66	154.79	Bedrock confirmed
SHM-13-02	3028713.88	628980.64	145.88	Bedrock confirmed
SHM-13-03	3028990.91	629173.39	156.83	Bedrock confirmed
SHM-13-04	3028606.18	629479.56	182.34	Bedrock confirmed
SHM-13-05	3028776.73	629829.47	140.57	Bedrock confirmed
SHM-13-06	3028694.87	629245.10	167.23	Bedrock confirmed
SHM-13-08	3028837.54	629515.32	157.17	Bedrock confirmed
SHM-93-22C	3028158.60	630045.70	104.02	Bedrock confirmed
SHM-96-5B	3028112.94	630158.14	125.93	Bedrock confirmed
SHM-99-31X	3028561.83	629908.75	110.65	Bedrock confirmed
SHM-99-32X	3028574.65	630168.76	131.07	Bedrock confirmed
SHP-2016-06	3027906.15	629710.34	173.05	Bedrock confirmed
SHP-2016-1B	3027975.00	629925.01	122.69	Bedrock confirmed
SHP-2016-2B	3028205.00	629925.00	110.73	Bedrock confirmed
SHP-2016-3B	3028179.99	630000.01	108.13	Bedrock confirmed
SHP-2016-4B	3028150.00	629899.99	112.57	Bedrock confirmed
SHP-2016-5B	3028120.01	629960.01	102.38	Bedrock confirmed
SHP-99-31A	3028559.08	629895.03	110.76	Bedrock confirmed
SHW-07-05	3028455.38	628555.24	177.62	Bedrock confirmed

Notes:

ft NAVD88 = feet North America Vertical Datum 1988

Table 2-2
Synoptic Water Level Event Airfield, August 14, 2019
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	MPE (ft NAVD88)	Measurement Date	Depth to Water from MPE (ft)	Groundwater Elevation (ft NAVD88)
30PZ-19-01	224.63	08/14/2019	17.65	206.98
30PZ-19-02	267.12	08/14/2019	60.88	206.24
30PZ-19-03	267.90	08/14/2019	64.65	203.25
30PZ-19-04	266.80	08/14/2019	64.25	202.55
30PZ-19-05	223.77	08/14/2019	11.08	212.69
31PZ-19-01	269.38	08/14/2019	66.89	202.49
50PZ-19-01	252.02	08/14/2019	42.10	209.92
50PZ-19-02	264.94	08/14/2019	57.90	207.04
G6M-02-01X	262.44	08/14/2019	53.35	209.09
G6M-02-03X	263.03	08/14/2019	58.15	204.88
G6M-02-04X	264.92	08/14/2019	60.13	204.79
G6M-02-08X	224.23	08/14/2019	12.35	211.88
G6M-02-11X	263.93	08/14/2019	60.40	203.53
G6M-03-07X	262.66	08/14/2019	56.00	206.66
G6M-03-10X	265.81	08/14/2019	62.53	203.28
G6M-04-01X	261.15	08/14/2019	51.38	209.77
G6M-04-02X	266.55	08/14/2019	59.14	207.41
G6M-04-03X	264.29	08/14/2019	55.95	208.34
G6M-04-04X	262.66	08/14/2019	57.35	205.31
G6M-04-05X	258.13	08/14/2019	54.90	203.23
G6M-04-10A	224.02	08/14/2019	12.79	211.23
G6M-04-10X	224.22	08/14/2019	12.50	211.72
G6M-04-11X	229.47	08/14/2019	18.55	210.92
G6M-04-15X	253.23	08/14/2019	41.55	211.68
G6M-04-22X	255.89	08/14/2019	45.08	210.81
G6M-04-31X	255.91	08/14/2019	44.96	210.95
G6M-07-02X	225.10	08/14/2019	12.79	212.31
G6M-13-01X	266.82	08/14/2019	63.40	203.42
G6M-13-02X	263.82	08/14/2019	59.31	204.51
G6M-13-03X	264.37	08/14/2019	57.28	207.09
G6M-13-04X*	266.31	08/14/2019	63.65	202.66
G6M-13-05X	225.00	08/14/2019	13.41	211.59
G6M-18-01	264.24	08/14/2019	60.46	203.78
G6M-18-02	268.33	08/14/2019	65.80	202.53
G6M-95-19X	223.89	08/14/2019	11.65	212.24
G6M-95-20X	224.61	08/14/2019	12.19	212.42
G6M-96-22A	217.59	08/14/2019	4.74	212.85
G6M-96-22B	217.56	08/14/2019	5.10	212.46
G6M-96-25A*	225.52	08/14/2019	12.22	213.30
G6M-96-25B	225.64	08/14/2019	14.81	210.83
G6M-97-05B	268.12	08/14/2019	65.13	202.99

Table 2-2
Synoptic Water Level Event Airfield, August 14, 2019
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	MPE (ft NAVD88)	Measurement Date	Depth to Water from MPE (ft)	Groundwater Elevation (ft NAVD88)
G6M-97-28X	265.69	08/14/2019	60.96	204.73
G6P-97-05X	236.72	08/14/2019	26.00	210.72

Notes:
* = well not used in contouring due to different vertical head compared to surrounding wells with a similar screen interval.
MPE = Measuring Point Elevation
NAVD88 = North America Vertical Datum 1988

Table 2-3
Synoptic Water Level Event Airfield, October 7, 2019
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	MPE (ft NAVD88)	Measurement Date	Depth to Water from MPE (ft)	Groundwater Elevation (ft NAVD88)
30PZ-19-01	224.63	10/07/2019	21.16	203.47
30PZ-19-02	267.12	10/07/2019	62.02	205.10
30PZ-19-03	267.90	10/07/2019	65.68	202.22
30PZ-19-04	266.80	10/07/2019	65.14	201.66
30PZ-19-05	223.77	10/07/2019	12.30	211.47
31PZ-19-01	269.38	10/07/2019	68.70	200.68
31PZ-19-02D	209.48	10/07/2019	8.60	200.88
31PZ-19-02S	209.44	10/07/2019	8.81	200.63
50PZ-19-01	252.02	10/07/2019	42.98	209.04
50PZ-19-02	264.94	10/07/2019	59.03	205.91
50PZ-19-03	258.40	10/07/2019	45.10	213.30
50PZ-19-04	260.37	10/07/2019	52.20	208.17
50PZ-19-05	256.51	10/07/2019	44.40	212.11
50PZ-19-06	255.54	10/07/2019	51.05	204.49
50PZ-19-07	270.11	10/07/2019	69.15	200.96
G6M-02-01X	262.44	10/07/2019	54.37	208.07
G6M-02-03X	263.03	10/07/2019	59.97	203.06
G6M-02-04X*	264.92	10/07/2019	62.03	202.89
G6M-02-06X	209.73	10/07/2019	8.44	201.29
G6M-02-07X*	210.72	10/07/2019	9.65	201.07
G6M-02-08X*	224.23	10/07/2019	14.68	209.55
G6M-02-11X	263.93	10/07/2019	61.64	202.29
G6M-02-12X	262.46	10/07/2019	59.30	203.16
G6M-02-13X	263.61	10/07/2019	60.85	202.76
G6M-03-07X	262.66	10/07/2019	57.45	205.21
G6M-03-08X	258.60	10/07/2019	56.61	201.99
G6M-03-09X	258.89	10/07/2019	56.89	202.00
G6M-03-10X	265.81	10/07/2019	63.69	202.12
G6M-04-01X	261.15	10/07/2019	52.49	208.66
G6M-04-02X	266.55	10/07/2019	60.80	205.75
G6M-04-03X	264.29	10/07/2019	57.02	207.27
G6M-04-04X	262.66	10/07/2019	58.90	203.76
G6M-04-05X	258.13	10/07/2019	56.11	202.02
G6M-04-06X	263.97	10/07/2019	62.68	201.29
G6M-04-07X	263.82	10/07/2019	62.42	201.40
G6M-04-08X	209.55	10/07/2019	8.27	201.28
G6M-04-09X	242.66	10/07/2019	31.98	210.68
G6M-04-10A	224.02	10/07/2019	13.09	210.93
G6M-04-10X	224.22	10/07/2019	13.58	210.64
G6M-04-11X	229.47	10/07/2019	19.61	209.86
G6M-04-13X	225.88	10/07/2019	14.81	211.07
G6M-04-14X	210.61	10/07/2019	9.33	201.28

Table 2-3
Synoptic Water Level Event Airfield, October 7, 2019
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	MPE (ft NAVD88)	Measurement Date	Depth to Water from MPE (ft)	Groundwater Elevation (ft NAVD88)
G6M-04-15X	253.23	10/07/2019	42.65	210.58
G6M-04-22X	255.89	10/07/2019	46.13	209.76
G6M-04-31X	255.91	10/07/2019	46.02	209.89
G6M-07-02X	225.10	10/07/2019	14.54	210.56
G6M-13-01X*	266.82	10/07/2019	56.51	210.31
G6M-13-02X	263.82	10/07/2019	60.85	202.97
G6M-13-03X	264.37	10/07/2019	58.90	205.47
G6M-13-04X	266.31	10/07/2019	63.90	202.41
G6M-13-05X	225.00	10/07/2019	14.49	210.51
G6M-13-06X	224.37	10/07/2019	13.99	210.38
G6M-18-01	264.24	10/07/2019	61.95	202.29
G6M-18-02	268.33	10/07/2019	67.20	201.13
G6M-95-19X	223.89	10/07/2019	12.73	211.16
G6M-95-20X	224.61	10/07/2019	13.32	211.29
G6M-96-22A	217.59	10/07/2019	5.77	211.82
G6M-96-22B	217.56	10/07/2019	6.05	211.51
G6M-97-05B	268.12	10/07/2019	66.35	201.77
G6M-97-28X	265.69	10/07/2019	62.50	203.19
G6P-97-05X	236.72	10/07/2019	27.36	209.36
MW-3	265.75	10/07/2019	63.25	202.50
MW-7*	264.97	10/07/2019	63.20	201.77
MW-7 (IT)	234.00	10/07/2019	Dry	NA
XSA-12-95X	269.63	10/07/2019	70.40	199.23
XSA-12-96X	269.99	10/07/2019	69.00	200.99
XSA-12-97X	270.78	10/07/2019	71.23	199.55
XSA-12-98X	209.61	10/07/2019	8.94	200.67

Notes:
* = well not used in contouring due to different vertical head compared to surrounding wells with a similar screen interval.

NA = Not Applicable
MPE = Measuring Point Elevation
NAVD88 = North America Vertical Datum 1988

Table 2-4
Synoptic Water Level Event Area 3, April 27, 2020
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	MPE (ft NAVD88)	Measurement Date	Depth to Water from MPE (ft)	Groundwater Elevation (ft NAVD88)
30PZ-19-01	224.63	04/27/2020	15.55	209.08
30PZ-19-02	267.12	04/27/2020	60.12	207.00
30PZ-19-03	267.90	04/27/2020	62.8	205.10
30PZ-19-04	266.80	04/27/2020	62.01	204.79
30PZ-19-05	223.77	04/27/2020	9.81	213.96
31PZ-19-01	269.38	04/27/2020	64.68	204.70
31PZ-19-02D	209.48	04/27/2020	5.54	203.94
31PZ-19-02S	209.44	04/27/2020	5.9	203.54
50PZ-19-01	252.02	04/27/2020	41.8	210.22
50PZ-19-02	264.94	04/27/2020	57.23	207.71
50PZ-19-03	258.40	04/27/2020	43.58	214.82
50PZ-19-04	260.37	04/27/2020	51.03	209.34
50PZ-19-05	256.51	04/27/2020	43.64	212.87
50PZ-19-06	255.54	04/27/2020	47.9	207.64
50PZ-19-07	270.11	04/27/2020	67.52	202.59
G6M-02-01X	262.44	04/27/2020	53.15	209.29
G6M-02-03X	263.03	04/27/2020	56.68	206.35
G6M-02-04X	264.92	04/27/2020	58.62	206.30
G6M-02-06X	209.73	04/27/2020	5.3	204.43
G6M-02-07X	210.72	04/27/2020	6.48	204.24
G6M-02-08X*	224.23	04/27/2020	13.29	210.94
G6M-02-11X	263.93	04/27/2020	58.48	205.45
G6M-02-12X	262.46	04/27/2020	57.11	205.35
G6M-02-13X	263.61	04/27/2020	57.72	205.89
G6M-03-01X	225.09	04/27/2020	12.4	212.69
G6M-03-07X	262.66	04/27/2020	55.48	207.18
G6M-03-08X	258.60	04/27/2020	53.38	205.22
G6M-03-09X	258.89	04/27/2020	53.67	205.22
G6M-03-10X	265.81	04/27/2020	60.53	205.28
G6M-04-01X	261.15	04/27/2020	51.25	209.90
G6M-04-02X	266.55	04/27/2020	58.81	207.74
G6M-04-03X	264.29	04/27/2020	55.5	208.79
G6M-04-04X	262.66	04/27/2020	56.3	206.36
G6M-04-05X	258.13	04/27/2020	52.97	205.16
G6M-04-06X	263.97	04/27/2020	59.54	204.43
G6M-04-07X	263.82	04/27/2020	59.53	204.29
G6M-04-08X	209.55	04/27/2020	4.98	204.57
G6M-04-09X	242.66	04/27/2020	30.51	212.15
G6M-04-10A	224.02	04/27/2020	11.36	212.66
G6M-04-10X	224.22	04/27/2020	12.12	212.10
G6M-04-11X	229.47	04/27/2020	18.43	211.04

Table 2-4
Synoptic Water Level Event Area 3, April 27, 2020
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	MPE (ft NAVD88)	Measurement Date	Depth to Water from MPE (ft)	Groundwater Elevation (ft NAVD88)
G6M-04-13X	225.88	04/27/2020	13.14	212.74
G6M-04-14X*	210.61	04/27/2020	9.01	201.60
G6M-04-15X	253.23	04/27/2020	41.12	212.11
G6M-04-22X	255.89	04/27/2020	45.13	210.76
G6M-04-31X	255.91	04/27/2020	44.66	211.25
G6M-06-01X	264.54	04/27/2020	58.57	205.97
G6M-07-02X	225.10	04/27/2020	13.09	212.01
G6M-13-01X	266.82	04/27/2020	61.17	205.65
G6M-13-02X	263.82	04/27/2020	57.81	206.01
G6M-13-03X	264.37	04/27/2020	56.61	207.76
G6M-13-04X	266.31	04/27/2020	60.76	205.55
G6M-13-05X	225.00	04/27/2020	13.49	211.51
G6M-13-06X	224.37	04/27/2020	12.75	211.62
G6M-18-01	264.24	04/27/2020	58.64	205.60
G6M-18-02	268.33	04/27/2020	63.67	204.66
G6M-95-19X	223.89	04/27/2020	11.09	212.80
G6M-95-20X	224.61	04/27/2020	11.47	213.14
G6M-96-22A	217.59	04/27/2020	3.24	214.35
G6M-96-22B	217.56	04/27/2020	3.85	213.71
G6M-97-05B	268.12	04/27/2020	63.18	204.94
G6M-97-28X	265.69	04/27/2020	59.46	206.23
G6P-97-05X	236.72	04/27/2020	25.18	211.54
MW-01A	221.40	04/27/2020	14.63	206.77
MW-02A	225.30	04/27/2020	18.65	206.65
MW-04	217.30	04/27/2020	9.25	208.05
MW-06	233.90	04/27/2020	11.83	222.07
MW-07	242.50	04/27/2020	22.65	219.85
MW-3	265.75	04/27/2020	60.16	205.59
MW-7	264.97	04/27/2020	59.38	205.59
MW-7 (IT)*	234.00	04/27/2020	25.44	208.56
MW-WC1A	212.50	04/27/2020	5.35	207.15
MW-WC2	217.10	04/27/2020	7.56	209.54
NRSG-01	204.72	04/27/2020	1.98	202.74
PZ-1	274.60	04/27/2020	62.73	211.87
PZ-2	275.10	04/27/2020	Dry	NA
PZ-5	227.20	04/27/2020	19.23	207.97
PZ-6	221.80	04/27/2020	17.94	203.86
XSA-12-95X	269.63	04/27/2020	65.37	204.26
XSA-12-96X	269.99	04/27/2020	65.8	204.19
XSA-12-97X	270.78	04/27/2020	66.38	204.40
XSA-12-98X*	209.61	04/27/2020	2.88	206.73

Table 2-4
Synoptic Water Level Event Area 3, April 27, 2020
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	MPE (ft NAVD88)	Measurement Date	Depth to Water from MPE (ft)	Groundwater Elevation (ft NAVD88)

Notes:
* = well not used in contouring due to different vertical head compared to surrounding wells with a similar screen interval.

NA = Not Applicable
MPE = Measuring Point Elevation

NAVD88 = North America Vertical Datum 1988

Table 2-5
Vertical Groundwater Gradients
Water Level Gauging Events - 8/14/2019; 10/7/2019; and 4/27/2020
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Location ID	Location	Screen Interval	Bottom of Screen Interval	Top of Screen Interval	Mid-Point of Screen	Difference Between Mid-Screen	Groudwater Elevation	Difference GW Elevation	Downward Gradient (+)	Upward Gradient (-)
		(ft bgs)	(ft NAVD88)	(ft NAVD88)	(ft NAVD88)	(ft)	(ft NAVD88)	(ft)	(unitless)	(unitless)
AOC 31 - Area 3										
AOC 31 - Area 3 - Well Pair 1 (10/7/2019)										
31PZ-19-02S	Shallow Well	8-13	193.29	198.29	195.79	56.98	200.63	-0.25	--	-0.004
31PZ-19-02D	Deep Well	65-70	136.31	141.31	138.81		200.88			
AOC 31 - Area 3 - Well Pair 1 (4/27/2020)										
31PZ-19-02S	Shallow Well	8-13	193.29	198.29	195.79	56.98	203.54	-0.40	--	-0.007
31PZ-19-02D	Deep Well	65-70	136.31	141.31	138.81		203.94			
AOC 50 - North of Rte 2A										
AOC 50 - Area 3 - Well Pair 1 (10/7/2019)										
G6M-96-22A	Shallow Well	40-50	166.30	176.30	171.30	22.90	211.82	0.31	0.014	--
G6M-96-22B	Deep Well	65.5-70.5	150.90	145.90	148.40		211.51			
AOC 50 - Area 3 - Well Pair 1 (4/27/2020)										
G6M-96-22A	Shallow Well	40-50	166.30	176.30	171.30	22.90	214.35	0.64	0.028	--
G6M-96-22B	Deep Well	65.5-70.5	150.90	145.90	148.40		213.71			
AOC 50 - PCE Source Area										
AOC 50 - Area 3 - Well Pair 2 (8/14/2019)										
G6M-96-25A	Shallow Well	9-18.7	204.58	214.28	209.43	38.54	213.30	2.47	0.064	--
G6M-96-25B	Deep Well	48-58	165.89	175.89	170.89		210.83			
AOC 50 - Area 3 - Well Pair 3 (8/14/2019)										
G6M-04-10A	Shallow Well	30-40	182.37	192.37	187.37	21.91	211.23	-0.49	--	-0.022
G6M-04-10X	Deep Well	52-62	160.46	170.46	165.46		211.72			
AOC 50 - Area 3 - Well Pair 3 (10/7/2019)										
G6M-04-10A	Shallow Well	30-40	182.37	192.37	187.37	21.91	210.93	0.29	0.013	--
G6M-04-10X	Deep Well	52-62	160.46	170.46	165.46		210.64			
AOC 50 - Area 3 - Well Pair 3 (4/27/2020)										
G6M-04-10A	Shallow Well	30-40	182.37	192.37	187.37	21.91	212.66	0.56	0.026	--
G6M-04-10X	Deep Well	52-62	160.46	170.46	165.46		212.10			
AOC 50										
AOC 50 - Area 3 - Well Pair 3 (10/7/2019)										
G6M-04-06X	Shallow Well	95-105	157.20	167.20	162.20	25.40	201.29	-0.11	--	-0.004
G6M-04-07X	Deep Well	120-130	131.80	141.80	136.80		201.40			
AOC 50 - Area 3 - Well Pair 3 (4/27/2020)										
G6M-04-06X	Shallow Well	95-105	157.20	167.20	162.20	25.40	204.43	0.14	0.006	--
G6M-04-07X	Deep Well	120-130	131.80	141.80	136.80		204.29			

Notes:
bgs = below ground surface
MPE = Measuring Point Elevation
NAVD88 = North America Vertical Datum 1988

Table 3-1
AOCs 20 and 21 Field Activities
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

	Location	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Construction Method	Establishing Date	Surface Elevation (ft NAVD88)	Total Depth (ft BGS)	Description of Total Depth	Top of Casing Elevation (ft NAVD88)	Depth to Top of Screen (ft BGS)	Depth to Bottom of Screen (ft BGS)	Elevation of Top of Screen (ft NAVD88)	Elevation of Bottom of Screen (ft NAVD88)
Existing Monitoring Well Sampling													
Existing Monitoring Well Sampling	MW-01A	3030902.01	626348.76	UKN	10/19/2012	218.71	UKN	UKN	221.40	18	33	200.71	185.71
	MW-02A	3031750.73	626214.75	UKN	10/19/2012	223.65	UKN	UKN	225.30	18	33	205.65	190.65
	MW-04	3032569.67	625446.44	UKN	10/19/2012	214.72	UKN	UKN	217.30	7	22	207.72	192.72
	MW-06	3033479.80	624410.40	UKN	10/25/2012	231.71	29.50	UKN	233.90	14	29	217.71	202.71
	MW-07	3031439.80	624609.60	UKN	10/25/2012	241.20	35.50	UKN	242.50	20.5	35.5	220.70	205.70
	MW-WC1A	3030133.60	625913.90	UKN	12/4/1997	209.69	18.05	UKN	212.50	6.45	17.95	203.24	191.74
	MW-WC2	3029975.50	625338.20	UKN	12/9/1997	210.40	19.90	UKN	217.10	5.4	19.9	205.00	190.50
	PZ-1	3031669.86	625639.90	UKN	7/10/1995	272.10	75.00	UKN	274.60	70	75	202.10	197.10
	PZ-2	3031668.54	625635.77	UKN	7/10/1995	272.10	100.00	UKN	275.10	95	100	177.10	172.10
	PZ-5	3030540.09	625922.33	UKN	7/26/1995	224.30	34.00	UKN	227.20	25	30	199.30	194.30
	PZ-6	3032172.46	625046.89	UKN	7/20/1995	218.90	22.00	UKN	221.80	15	20	203.90	198.90
Vertical Profiles													
Vertical Profiles	20VP-19-01	3032600.39	624892.23	GP	7/30/2019	218.82	21	refusal	NA	NA	NA	NA	NA
	20VP-19-02	3033357.35	625001.25	GP	9/3/2019	208.25	34	refusal	NA	NA	NA	NA	NA
	20VP-19-03	3030129.29	625936.96	GP	7/31/2019	209.23	58	refusal	NA	NA	NA	NA	NA
	20VP-19-04	3030532.95	625910.05	GP	7/22/2019	225.10	56	refusal	NA	NA	NA	NA	NA
	20VP-19-05	3030678.03	624902.02	GP	7/22/2019	220.17	22.5	refusal	NA	NA	NA	NA	NA
	20VP-19-06	3031415.26	625703.92	GP	8/2/2019	270.07	156	refusal	NA	NA	NA	NA	NA
	20VP-19-07	3031901.54	625532.42	GP	7/25/2019	271.02	157	refusal	NA	NA	NA	NA	NA
	20VP-19-08	3032067.88	624796.52	GP	7/30/2019	239.83	30	refusal	NA	NA	NA	NA	NA
	21VP-19-01	3031387.24	626348.59	GP	7/23/2019	222.08	95	refusal	NA	NA	NA	NA	NA
	21VP-19-02	3031603.90	627229.54	GP	7/24/2019	211.99	129	refusal	NA	NA	NA	NA	NA
Soil Borings													
Soil Borings	20SB-19-01	3032163.77	625588.91	GP	10/18/2019	266.23	15	end of boring	NA	NA	NA	NA	NA
	20SB-19-02	3031936.29	625253.60	GP	10/22/2019	264.13	60	end of boring	NA	NA	NA	NA	NA
	20SB-19-03	3031890.78	625660.44	GP	10/18/2019	267.04	15	end of boring	NA	NA	NA	NA	NA
	20SB-19-04	3031591.67	625804.02	GP	10/18/2019	265.70	15	end of boring	NA	NA	NA	NA	NA
	20SB-19-05	3031455.97	625374.11	GP	10/18/2019	264.13	15	end of boring	NA	NA	NA	NA	NA
	20SB-19-06	3031067.83	625701.51	GP	10/21/2019	260.41	60	end of boring	NA	NA	NA	NA	NA
	20SB-19-07	3030876.63	625992.55	GP	10/22/2019	260.41	15	end of boring	NA	NA	NA	NA	NA
	20SB-19-08	3031425.26	625693.92	GP	10/21/2019	268.86	65	end of boring	NA	NA	NA	NA	NA
	21SB-19-01	3031394.58	626347.71	GP	11/14/2019	222.14	15	end of boring	NA	NA	NA	NA	NA
	21SB-19-02	3031474.38	626324.92	GP	11/14/2019	222.31	15	end of boring	NA	NA	NA	NA	NA
	21SB-19-03	3031566.97	626302.48	GP	11/14/2019	222.09	15	end of boring	NA	NA	NA	NA	NA

Table 3-1
AOCs 20 and 21 Field Activities
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

	Location	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Construction Method	Establishing Date	Surface Elevation (ft NAVD88)	Total Depth (ft BGS)	Description of Total Depth	Top of Casing Elevation (ft NAVD88)	Depth to Top of Screen (ft BGS)	Depth to Bottom of Screen (ft BGS)	Elevation of Top of Screen (ft NAVD88)	Elevation of Bottom of Screen (ft NAVD88)
Surface Water and Sediment Sampling													
Surface Water and Sediment Sampling	US-19-01	3031713.51	626984.25	NA	10/18/2019	210.03	NA	NA	NA	NA	NA	NA	NA
	UP-19-01	3032661.11	625448.97	NA	10/17/2019	205.81	NA	NA	NA	NA	NA	NA	NA

Notes:
BGS = below ground surface
ft = feet
GP = Geoprobe
NA = not applicable
NAD83 = North American Datum 1983
NAVD88 = North American Vertical Datum 1988
UKN = unknown
WWTP = waste water treatment plant

Table 3-2
AOC 20 Summary of PFAS Exceedances from Vertical Profile Samples
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Number of Samples Exceeding EPA LHA	Number of Samples Exceeding MassDEP GW-1	Maximum Detected Concentration (ng/L)	Minimum Detected Concentration (ng/L)	Sample Identifier of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	0/35	---	---	---	---	---
8:2 Fluorotelomer sulfonate (8:2 FTS)	0/35	---	---	---	---	---
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	3/35	---	---	3.70 J	2.80 J	20VP-19-06-113-117
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/35	---	---	---	---	---
Perfluorobutanesulfonic acid (PFBS)	34/35	---	---	10.0	---	20VP-19-07-93-97
Perfluorodecanoic acid (PFDA)	30/35	---	---	6.50	0.830 J	20VP-19-02-9-13
Perfluorododecanoic acid (PFDoA)	2/35	---	---	4.10	1.90	20VP-19-07-123-127
Perfluoroheptanoic acid (PFHpA)	35/35	---	9	30.0	2.00	20VP-19-07-93-97
Perfluorohexanesulfonic acid (PFHxS)	33/35	---	5	43.0	2.30	20VP-19-04-39-43
Perfluorohexanoic acid (PFHxA)	35/35	---	---	43.0	2.20	20VP-19-03-39-43
Perfluorononanoic acid (PFNA)	32/35	---	---	16.0	0.640 J	20VP-19-07-83-87
Perfluorooctanesulfonic acid (PFOS)	35/35	16	28	160	2.50 J	20VP-19-07-93-97
Perfluorooctanoic acid (PFOA)	35/35	1	29	70.0	4.50	20VP-19-04-29-33
Perfluorotetradecanoic acid (PFTA)	0/35	---	---	---	---	---
Perfluorotridecanoic acid (PFTrDA)	2/35	---	---	2.30 J	---	20VP-19-07-123-127
Perfluoroundecanoic acid (PFUnA)	6/35	---	---	1.60 J	0.690 J	20VP-19-06-83-87
EPA LHA	---	25	---	201	17.5	20VP-19-07-93-97
MassDEP GW-1	---	---	35	264	23.4	20VP-19-04-19-23

Notes:

J = estimated value.

ng/L = nanograms per liter.

EPA Life-time Health Advisory (LHA) is the individual or sum of PFOS and PFOA = 70 ng/L.

MassDEP GW-1 is the individual concentration or sum of PFOA, PFOS, PFHpA, PFHxS, PFNA, PFDA = 20 ng/L.

Table 3-3
AOC 20 Summary of PFAS Exceedances from Monitoring Wells
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Number of Samples Exceeding EPA LHA	Number of Samples Exceeding MassDEP GW-1	Maximum Detected Concentration (ng/L)	Minimum Detected Concentration (ng/L)	Sample Identifier of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	0/11	---	---	---	---	---
8:2 Fluorotelomer sulfonate (8:2 FTS)	0/11	---	---	---	---	---
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	0/11	---	---	---	---	---
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/11	---	---	---	---	---
Perfluorobutanesulfonic acid (PFBS)	7/11	---	---	48.0	0.500 J	MW-02A
Perfluorodecanoic acid (PFDA)	6/11	---	---	5.90	0.740 J	PZ-1
Perfluorododecanoic acid (PFDoA)	0/11	---	---	---	---	---
Perfluoroheptanoic acid (PFHpA)	9/11	---	4	30.0	1.70 J	MW-02A
Perfluorohexanesulfonic acid (PFHxS)	9/11	---	2	360	1.70 J	MW-02A
Perfluorohexanoic acid (PFHxA)	9/11	---	---	200	1.80 J	MW-02A
Perfluorononanoic acid (PFNA)	6/11	---	---	18.0	1.80	PZ-1
Perfluorooctanesulfonic acid (PFOS)	8/11	5	6	150	3.30 J	PZ-1
Perfluorooctanoic acid (PFOA)	9/11	2	6	140 J	6.60	MW-02A
Perfluorotetradecanoic acid (PFTA)	0/11	---	---	---	---	---
Perfluorotridecanoic acid (PFTrDA)	0/11	---	---	---	---	---
Perfluoroundecanoic acid (PFUnA)	0/11	---	---	---	---	---
EPA LHA	---	5	---	250	11.5	MW-02A
MassDEP GW-1	---	---	8	649	15.7	MW-02A

Notes:
J = estimated value
ng/L = nanograms per liter
EPA Life-time Health Advisory (LHA) is the individual or sum of PFOS and PFOA = 70 ng/L.
MassDEP GW-1 is the individual concentration or sum of PFOA, PFOS, PFHpA, PFHxS, PFNA, PFDA = 20 ng/L.
There were no AOC 21 monitoring wells.

Table 3-4
AOC 21 Summary of PFAS Exceedances from Vertical Profile Samples
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Number of Samples Exceeding EPA LHA	Number of Samples Exceeding MassDEP GW-1	Maximum Detected Concentration (ng/L)	Minimum Detected Concentration (ng/L)	Sample Identifier of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	0/20	---	---	---	---	---
8:2 Fluorotelomer sulfonate (8:2 FTS)	0/20	---	---	---	---	---
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	1/20	---	---	3.20 J	3.20 J	21VP-19-02-123-127
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/20	---	---	---	---	---
Perfluorobutanesulfonic acid (PFBS)	20/20	---	---	14.0	2.00	21VP-19-01-43-47
Perfluorodecanoic acid (PFDA)	19/20	---	---	4.90	1.70 J	21VP-19-01-43-47
Perfluorododecanoic acid (PFDoA)	0/20	---	---	---	---	---
Perfluoroheptanoic acid (PFHpA)	20/20	---	---	17.0	3.30	21VP-19-01-83-87
Perfluorohexanesulfonic acid (PFHxS)	20/20	---	7	27.0	4.10	21VP-19-02-123-127
Perfluorohexanoic acid (PFHxA)	20/20	---	---	31.0	2.20	21VP-19-01-53-57
Perfluorononanoic acid (PFNA)	19/20	---	---	11.0	3.00	21VP-19-01-33-37
Perfluorooctanesulfonic acid (PFOS)	20/20	16	20	190	38.0	21VP-19-01-43-47
Perfluorooctanoic acid (PFOA)	20/20	1	19	96.0	16.0	21VP-19-01-33-37
Perfluorotetradecanoic acid (PFTA)	0/20	---	---	---	---	---
Perfluorotridecanoic acid (PFTrDA)	0/20	---	---	---	---	---
Perfluoroundecanoic acid (PFUnA)	0/20	---	---	---	---	---
EPA LHA	---	19	---	256	54.0	21VP-19-01-33-37
MassDEP GW-1	---	---	20	304	61.4	21VP-19-01-33-37

Notes:

J = estimated value.

ng/L = nanograms per liter.

EPA Life-time Health Advisory (LHA) is the individual or sum of PFOS and PFOA = 70 ng/L.

MassDEP GW-1 is the individual concentration or sum of PFOA, PFOS, PFHpA, PFHxS, PFNA, PFDA = 20 ng/L.

Table 3-5
AOC 20 Summary of PFAS Exceedances from Soil Borings
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Samples Exceeding Regulatory Level	Maximum Detected Concentration (µg/kg)	Minimum Detected Concentration (µg/kg)	Project Action Limit Source	Project Action Limit (µg/kg)	Location of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	0/35	---	---		---	---	---
8:2 Fluorotelomer sulfonate (8:2 FTS)	0/35	---	---		---	---	---
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	13/35	---	4.50 J	0.330 J	---	---	20SB-19-01
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	22/35	---	8.90	0.300 J	---	---	20SB-19-01
Perfluorobutanesulfonic acid (PFBS)	0/35	---	---		---	---	---
Perfluorodecanoic acid (PFDA)	5/35	2	0.880	0.086 J	S-1/GW-1	0.30	20SB-19-08
Perfluorododecanoic acid (PFDoA)	12/35	---	1.30	0.110 J	---	---	20SB-19-01
Perfluoroheptanoic acid (PFHpA)	1/35	---	0.320 J	0.320 J	S-1/GW-1	0.50	20SB-19-08
Perfluorohexanesulfonic acid (PFHxS)	15/35	2	0.470	0.067 J	S-1/GW-1	0.30	20SB-19-01
Perfluorohexanoic acid (PFHxA)	2/35	---	0.210 J	0.170 J	---	---	20SB-19-08
Perfluorononanoic acid (PFNA)	4/35	---	0.290 J	0.110 J	S-1/GW-1	0.32	20SB-19-08
Perfluorooctane sulfonate (PFOS)	31/35	5	13.0	0.240 J	S-1/GW-1	2.0	20SB-19-08
Perfluorooctanoic acid (PFOA)	8/35	1	1.80	0.100 J	S-1/GW-1	0.72	20SB-19-08
Perfluorotetradecanoic acid (PFTA)	8/35	---	0.700	0.110 J	---	---	20SB-19-01
Perfluorotridecanoic acid (PFTrDA)	3/35	---	0.420	0.130 J	---	---	20SB-19-01
Perfluoroundecanoic acid (PFUnA)	4/35	---	0.420	0.130 J	---	---	20SB-19-01

Notes:
µg/kg denotes micrograms per kilogram
J denotes estimated result
S-1/GW-1 denotes Massachusetts Contigency Plan standards.

Table 3-6
AOC 21 Summary of PFAS Exceedances from Soil Borings
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Samples Exceeding Regulatory Level	Maximum Detected Concentration (µg/kg)	Minimum Detected Concentration (µg/kg)	Project Action Limit Source	Project Action Limit (µg/kg)	Location of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	0/13	---	---		---	---	---
8:2 Fluorotelomer sulfonate (8:2 FTS)	0/13	---	---		---	---	---
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	6/13	---	8.50	0.490 J	---	---	21SB-19-03
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	5/13	---	4.60	0.540 J	---	---	21SB-19-03
Perfluorobutanesulfonic acid (PFBS)	0/13	---	---		---	---	---
Perfluorodecanoic acid (PFDA)	9/13	2	0.460	0.120 J	S-1/GW-1	0.30	21SB-19-03
Perfluorododecanoic acid (PFDoA)	3/13	---	0.290 J	0.200 J	---	---	21SB-19-01
Perfluoroheptanoic acid (PFHpA)	2/13	---	0.230 J	0.150 J	S-1/GW-1	0.50	21SB-19-01
Perfluorohexanesulfonic acid (PFHxS)	9/13	2	0.560	0.084 J	S-1/GW-1	0.30	21SB-19-01
Perfluorohexanoic acid (PFHxA)	1/13	---	0.140 J	0.140 J	---	---	21SB-19-01
Perfluorononanoic acid (PFNA)	4/13	---	0.260 J	0.110 J	S-1/GW-1	0.32	21SB-19-03
Perfluorooctane sulfonate (PFOS)	13/13	7	19.0 J	0.350 J	S-1/GW-1	2.0	21SB-19-01
Perfluorooctanoic acid (PFOA)	9/13	3	2.20	0.130 J	S-1/GW-1	0.72	21SB-19-01
Perfluorotetradecanoic acid (PFTA)	0/13	---	---		---	---	---
Perfluorotridecanoic acid (PFTrDA)	0/13	---	---		---	---	---
Perfluoroundecanoic acid (PFUnA)	3/13	---	0.140 J	0.140 J	---	---	21SB-19-03

Notes:
µg/kg denotes micrograms per kilogram
J denotes estimated result
S-1/GW-1 denotes Massachusetts Contigency Plan standards.

Table 4-1
AOC 30 Field Activities
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

	Location	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Construction Method	Establishing Date	Surface Elevation (ft NAVD88)	Total Depth (ft BGS)	Description of Total Depth	Top of Casing Elevation (ft NAVD88)	Depth to Top of Screen (ft BGS)	Depth to Bottom of Screen (ft BGS)	Elevation of Top of Screen (ft NAVD88)	Elevation of Bottom of Screen (ft NAVD88)
Vertical Profiles													
Vertical Profiles	30VP-19-01	3035432.10	626818.69	GP	7/17/2019	221.30	32.5	refusal	NA	NA	NA	NA	NA
	30VP-19-02	3035422.41	626555.89	GP	7/18/2019	221.88	45	refusal	NA	NA	NA	NA	NA
	30VP-19-03	3035147.30	626449.20	GP	7/8/2019	268.04	119	refusal	NA	NA	NA	NA	NA
	30VP-19-04	3034928.90	626262.80	GP	7/9/2019	266.90	135	refusal	NA	NA	NA	NA	NA
	30VP-19-05	3035471.80	627375.50	GP	7/16/2019	224.10	49	refusal	NA	NA	NA	NA	NA
	30VP-19-06	3035031.44	627007.63	GP	7/12/2019	267.20	89	refusal	NA	NA	NA	NA	NA
Soil Borings													
Soil Borings	30SB-19-01	3034966.81	627049.26	GP	10/14/2019	266.44	65	end of boring	NA	NA	NA	NA	NA
	30SB-19-02	3034996.59	626968.47	GP	10/14/2019	268.04	15	end of boring	NA	NA	NA	NA	NA
	30SB-19-03	3034903.53	626941.19	GP	10/14/2019	267.77	15	end of boring	NA	NA	NA	NA	NA
	30SB-19-04	3035154.75	626456.78	GP	10/15/2019	268.03	70	end of boring	NA	NA	NA	NA	NA
	30SB-19-05	3035097.09	626453.98	GP	10/14/2019	268.46	15	end of boring	NA	NA	NA	NA	NA
	30SB-19-06	3035089.90	626406.54	GP	10/15/2019	268.11	15	end of boring	NA	NA	NA	NA	NA
Piezometer Installation													
Piezometers	30PZ-19-01	3035431.20	626817.10	GP	7/17/2019	221.30	28	end of boring	224.63	18	28	203.30	193.30
	30PZ-19-02	3034956.60	626870.20	GP	7/15/2019	267.45	80	end of boring	267.12	70	80	197.45	187.45
	30PZ-19-03	3035148.10	626448.80	GP	7/10/2019	268.04	80	end of boring	267.90	70	80	198.04	188.04
	30PZ-19-04	3034929.90	626262.80	GP	7/24/2019	266.90	77	end of boring	266.80	67	77	199.90	189.90
	30PZ-19-05	3035471.40	627375.50	GP	7/17/2019	224.10	30	end of boring	223.77	20	30	204.10	194.10

Notes:

BGS = below ground surface
ft = feet
GP = Geoprobe
NA = not applicable
NAD83 = North American Datum 1983
NAVD88 = North American Vertical Datum 1988
UKN = unknown

Table 4-2
AOC 30 Summary of PFAS Exceedances from Vertical Profile Samples
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Number of Samples Exceeding EPA LHA	Number of Samples Exceeding MassDEP GW-1	Maximum Detected Concentration (ng/L)	Minimum Detected Concentration (ng/L)	Sample Identifier of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	2/23	---	---	15.0 J	8.10 J	30VP-19-06-83-87
8:2 Fluorotelomer sulfonate (8:2 FTS)	3/23	---	---	59.0	29.0	30VP-19-06-83-87
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	0/23	---	---	---	---	---
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/23	---	---	---	---	---
Perfluorobutanesulfonic acid (PFBS)	22/23	---	---	49.0	0.450 J	30VP-19-03-73-77
Perfluorodecanoic acid (PFDA)	6/23	---	---	2.30 J	0.810 J	30VP-19-06-83-87
Perfluorododecanoic acid (PFDoA)	0/23	---	---	---	---	---
Perfluoroheptanoic acid (PFHpA)	21/23	---	7	300	0.580 J	30VP-19-03-73-77
Perfluorohexanesulfonic acid (PFHxS)	22/23	---	17	2,500	5.60	30VP-19-03-73-77
Perfluorohexanoic acid (PFHxA)	22/23	---	---	1,500	3.00	30VP-19-03-73-77
Perfluorononanoic acid (PFNA)	13/23	---	---	9.00	1.20 J	30VP-19-06-83-87
Perfluorooctanesulfonic acid (PFOS)	17/23	10	15	1,800	11.0	30VP-19-06-83-87
Perfluorooctanoic acid (PFOA)	20/23	6	10	3,500	0.730 J	30VP-19-03-73-77
Perfluorotetradecanoic acid (PFTA)	0/23	---	---	---	---	---
Perfluorotridecanoic acid (PFTrDA)	0/23	---	---	---	---	---
Perfluoroundecanoic acid (PFUnA)	0/23	---	---	---	---	---
EPA LHA		11		3,530	1.90	30VP-19-03-73-77
MassDEP GW-1			20	6,330	5.60	30VP-19-03-73-77

Notes:
J = estimated value.
ng/L = nanograms per liter.
EPA Life-time Health Advisory (LHA) is the individual or sum of PFOS and PFOA = 70 ng/L.
MassDEP GW-1 is the individual concentration or sum of PFOA, PFOS, PFHpA, PFHxS, PFNA, PFDA = 20 ng/L.

Table 4-3
AOC 30 Summary of PFAS Exceedances from Soil Borings
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Samples Exceeding Regulatory Level	Maximum Detected Concentration (µg/kg)	Minimum Detected Concentration (µg/kg)	Project Action Limit Source	Project Action Limit (µg/kg)	Location of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	0/26	---	---		---	---	---
8:2 Fluorotelomer sulfonate (8:2 FTS)	0/26	---	---		---	---	---
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	0/26	---	---		---	---	---
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/26	---	---		---	---	---
Perfluorobutanesulfonic acid (PFBS)	2/26	---	0.089 J	0.083 J	---	---	30SB-19-03
Perfluorodecanoic acid (PFDA)	2/26	---	0.230 J	0.140 J	S-1/GW-1	0.30	30SB-19-01
Perfluorododecanoic acid (PFDoA)	1/26	---	0.150 J	0.150 J	---	---	30SB-19-01
Perfluoroheptanoic acid (PFHpA)	1/26	---	0.110 J	0.110 J	S-1/GW-1	0.50	30SB-19-01
Perfluorohexanesulfonic acid (PFHxS)	18/26	10	7.20	0.067 J	S-1/GW-1	0.30	30SB-19-01
Perfluorohexanoic acid (PFHxA)	8/26	---	0.960	0.092 J	---	---	30SB-19-01
Perfluorononanoic acid (PFNA)	2/26	1	0.330	0.200 J	S-1/GW-1	0.32	30SB-19-06
Perfluorooctane sulfonate (PFOS)	11/26	7	100	0.580 J	S-1/GW-1	2.0	30SB-19-06
Perfluorooctanoic acid (PFOA)	16/26	8	5.70	0.100 J	S-1/GW-1	0.72	30SB-19-05
Perfluorotetradecanoic acid (PFTA)	0/26	---	---		---	---	---
Perfluorotridecanoic acid (PFTrDA)	0/26	---	---		---	---	---
Perfluoroundecanoic acid (PFUnA)	1/26	---	0.120 J	0.120 J	---	---	30SB-19-01

Notes:
µg/kg denotes micrograms per kilogram
J denotes estimated result
S-1/GW-1 denotes Massachusetts Contigency Plan standards.

Table 5-1
AOC 31 Field Activities
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

	Location*	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Construction Method	Establishing Date	Surface Elevation (ft NAVD88)	Total Depth (ft BGS)	Description of Total Depth	Top of Casing Elevation (ft NAVD88)	Depth to Top of Screen (ft BGS)	Depth to Bottom of Screen (ft BGS)	Elevation of Top of Screen (ft NAVD88)	Elevation of Bottom of Screen (ft NAVD88)
Vertical Profiles													
Initial Vertical Profiles	31VP-19-01	3033967.58	626254.21	GP	8/29/2019	267.34	195.5	refusal	NA	NA	NA	NA	NA
	31VP-19-04	3034167.00	626075.50	GP	8/5/2019	266.66	132	refusal	NA	NA	NA	NA	NA
	31VP-19-05	3033990.08	624904.81	GP	9/4/2019	206.26	37.5	refusal	NA	NA	NA	NA	NA
Second Set of Vertical Profiles	31VP-19-06	3034307.57	625075.40	GP	9/24/2019	209.20	87	refusal	NA	NA	NA	NA	NA
	31VP-19-07	3033989.86	625375.19	GP	9/26/2019	206.31	97	refusal	NA	NA	NA	NA	NA
	31VP-19-08	3033810.30	625434.74	GP	10/2/2019	206.96	90.5	refusal	NA	NA	NA	NA	NA
Soil Borings													
Soil Borings	31SB-19-01	3033974.05	626248.83	GP	10/16/2019	267.33	70	end of boring	NA	NA	NA	NA	NA
	31SB-19-02	3034008.58	626285.07	GP	10/17/2019	267.64	15	end of boring	NA	NA	NA	NA	NA
	31SB-19-03	3034009.09	626227.51	GP	10/17/2019	267.29	15	end of boring	NA	NA	NA	NA	NA
	31SB-19-04	3033943.09	626225.98	GP	10/16/2019	267.19	15	end of boring	NA	NA	NA	NA	NA
	31SB-19-05	3033925.37	626289.50	GP	10/17/2019	267.21	15	end of boring	NA	NA	NA	NA	NA
	31SB-19-06	3033881.15	626255.73	GP	10/16/2019	266.34	10	end of boring	NA	NA	NA	NA	NA
	31SB-19-07	3033980.73	626178.15	GP	10/16/2019	267.30	10	end of boring	NA	NA	NA	NA	NA
Concrete													
Concrete	31SB-19-07	3033980.73	626178.15	GP	10/16/2019	267.30	0.5	end of boring	NA	NA	NA	NA	NA
Piezometer Installation													
Piezometers	31PZ-19-01	3034166.00	626075.50	GP	8/7/2019	266.66	77	end of boring	269.38	67	77	199.66	189.66
	31PZ-19-02D	3033989.36	625372.87	GP	10/1/2019	206.31	70	end of boring	209.48	65	70	141.31	136.31
	31PZ-19-02S	3033989.86	625374.19	GP	10/1/2019	206.29	13	end of boring	209.44	8	13	198.29	193.29

Notes:
BGS = below ground surface
ft = feet
GP = Geoprobe
NA = not applicable
NAD83 = North American Datum 1983
NAVD88 = North American Vertical Datum 1988
*31VP-19-02/03 were not drilled.

Table 5-2
AOC 31 Summary of PFAS Exceedances from Vertical Profile Samples
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Number of Samples Exceeding EPA LHA	Number of Samples Exceeding MassDEP GW-1	Maximum Detected Concentration (ng/L)	Minimum Detected Concentration (ng/L)	Sample Identifier of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	17/50	---	---	780 J	10.0 J	31VP-19-01-63-67
8:2 Fluorotelomer sulfonate (8:2 FTS)	10/50	---	---	500 J	3.00 J	31VP-19-01-63-67
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	7/50	---	---	4.40 J	2.80 J	31VP-19-08-63-67
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	1/50	---	---	8.60 J	8.60 J	31VP-19-01-63-67
Perfluorobutanesulfonic acid (PFBS)	46/50	---	---	190	0.510 J	31VP-19-01-123-127
Perfluorodecanoic acid (PFDA)	15/50	---	---	6.90	0.550 J	31VP-19-07-88-92
Perfluorododecanoic acid (PFDoA)	0/50	---	---	---	---	---
Perfluoroheptanoic acid (PFHpA)	45/50	---	20	240	0.590 J	31VP-19-04-109-113
Perfluorohexanesulfonic acid (PFHxS)	47/50	---	42	4,800	3.70	31VP-19-01-123-127
Perfluorohexanoic acid (PFHxA)	48/50	---	---	2,400	0.500J	31VP-19-01-123-127
Perfluorononanoic acid (PFNA)	26/50	---	---	9.90	0.660 J	31VP-19-07-88-92
Perfluorooctanesulfonic acid (PFOS)	46/50	23	36	5,100	1.20 J	31VP-19-01-63-67
Perfluorooctanoic acid (PFOA)	48/50	26	40	4,100	1.20J	31VP-19-01-123-127
Perfluorotetradecanoic acid (PFTA)	0/50	---	---	---	---	---
Perfluorotridecanoic acid (PFTrDA)	0/50	---	---	---	---	---
Perfluoroundecanoic acid (PFUnA)	1/50	---	---	0.700 J	0.700 J	31VP-19-01-183-187
EPA LHA		38		5,830	2.70	31VP-19-01-63-67
MassDEP GW-1			43	10,200	2.70	31VP-19-01-123-127

Notes:
J = estimated value
ng/L = nanograms per liter
EPA Life-time Health Advisory (LHA) is the individual or sum of PFOS and PFOA = 70 ng/L.
MassDEP GW-1 is the individual concentration or sum of PFOA, PFOS, PFHpA, PFHxS, PFNA, PFDA = 20 ng/L.

Table 5-3
AOC 31 Summary of PFAS Exceedances from Soil Borings
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Samples Exceeding Regulatory Level	Maximum Detected Concentration (µg/kg)	Minimum Detected Concentration (µg/kg)	Project Action Limit Source	Project Action Limit (µg/kg)	Location of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	15/25	---	56.0	0.730 J	---	---	31SB-19-05
8:2 Fluorotelomer sulfonate (8:2 FTS)	22/25	---	84.0	0.320 J	---	---	31SB-19-04
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2/25	---	0.680 J	0.600 J	---	---	31SB-19-05
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	16/25	---	3.60	0.300 J	---	---	31SB-19-02
Perfluorobutanesulfonic acid (PFBS)	15/25	---	2.50	0.069 J	---	---	31SB-19-07
Perfluorodecanoic acid (PFDA)	16/25	7	0.960	0.120 J	Proposed S-1/GW-1	0.30	31SB-19-01
Perfluorododecanoic acid (PFDoA)	5/25	---	0.190 J	0.100 J	---	---	31SB-19-05
Perfluoroheptanoic acid (PFHpA)	23/25	2	0.510	0.094 J	Proposed S-1/GW-1	0.50	31SB-19-01
Perfluorohexanesulfonic acid (PFHxS)	25/25	25	67.0	0.330	Proposed S-1/GW-1	0.30	31SB-19-05
Perfluorohexanoic acid (PFHxA)	22/25	---	1.60	0.098 J	---	---	31SB-19-01
Perfluorononanoic acid (PFNA)	20/25	3	0.450	0.090 J	Proposed S-1/GW-1	0.32	31SB-19-05
Perfluorooctane sulfonate (PFOS)	25/25	25	530	7.10	Proposed S-1/GW-1	2.0	31SB-19-01
Perfluorooctanoic acid (PFOA)	25/25	18	53.0	0.110 J	Proposed S-1/GW-1	0.72	31SB-19-05
Perfluorotetradecanoic acid (PFTA)	0/25	---	---		---	---	---
Perfluorotridecanoic acid (PFTrDA)	0/25	---	---		---	---	---
Perfluoroundecanoic acid (PFUnA)	6/25	---	0.230 J	0.130 J	---	---	31SB-19-05

Notes:
µg/kg denotes micrograms per kilogram
J denotes estimated result
S-1/GW-1 denotes Massachusetts Contigency Plan standards.

Table 6-1
AOC 50 Field Activities
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

	Location	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Construction Method	Establishing Date	Surface Elevation (ft NAVD88)	Total Depth (ft BGS)	Description of Total Depth	Top of Casing Elevation (ft NAVD88)	Depth to Top of Screen (ft BGS)	Depth to Bottom of Screen (ft BGS)	Elevation of Top of Screen (ft NAVD88)	Elevation of Bottom of Screen (ft NAVD88)
Existing Monitoring Well Sampling													
Existing Monitoring Wells	G6M-18-01	3034124.29	626508.04	RD	1/10/2019	264.58	127	well depth	264.24	116	126	148.58	138.58
	G6M-18-02	3033809.06	626102.24	RD	1/9/2019	266.64	137	well depth	268.33	123.95	133.95	142.69	132.69
	G6M-01-01X	3033351.05	626357.87	UKN	UKN	263.62	152	well depth	265.67	130	150	133.62	113.62
	G6M-02-01X	3034746.23	627859.19	UKN	UKN	263.12	95	well depth	262.44	80	95	183.12	168.12
	G6M-02-02X	3034667.64	627949.01	UKN	UKN	263.25	97	well depth	262.98	80	95	183.25	168.25
	G6M-02-03X	3034149.41	627143.45	UKN	UKN	263.69	105	well depth	263.03	90	105	173.69	158.69
	G6M-02-04X	3034065.54	627229.70	UKN	UKN	262.99	105	well depth	264.92	90	105	172.99	157.99
	G6M-02-05X	3033741.43	626646.05	UKN	2/13/2002	264.33	135	well depth	266.50	120	135	144.33	129.33
	G6M-02-06X	3033118.06	626093.28	UKN	UKN	204.72	65	well depth	209.73	55	65	149.72	139.72
	G6M-02-07X	3033654.52	625702.35	UKN	UKN	207.74	40	well depth	210.72	30	40	177.74	167.74
	G6M-02-08X	3035050.83	628301.68	UKN	UKN	222.72	70	well depth	224.23	60	70	162.72	152.72
	G6M-02-09X	3033980.14	627285.59	UKN	UKN	262.66	105	well depth	264.10	90	105	172.66	157.66
	G6M-02-10X	3033677.48	626713.99	UKN	UKN	264.30	135	well depth	266.57	125	135	139.30	129.30
	G6M-02-11X	3033609.08	626634.25	UKN	UKN	261.89	135	well depth	263.93	125	135	136.89	126.89
	G6M-02-12X	3033555.91	626546.36	UKN	UKN	258.85	135	well depth	262.46	125	135	133.85	123.85
	G6M-02-13X	3033970.06	627017.90	UKN	UKN	263.81	120	well depth	263.61	110	120	153.81	143.81
	G6M-02-31BR	3034878.77	628213.01	UKN	UKN	254.29	95	well depth	255.71	85	95	169.29	159.29
	G6M-03-01X	3035060.06	628308.92	UKN	UKN	222.92	70	well depth	225.09	50	70	172.92	152.92
	G6M-03-02X	3035040.96	628302.67	UKN	UKN	222.72	43	well depth	224.31	28	43	194.72	179.72
	G6M-03-04X	3035001.44	628431.56	UKN	UKN	UKN	30	well depth	225.20	15	30	UKN	UKN
	G6M-03-07X	3034422.68	627560.62	UKN	UKN	262.84	90	well depth	262.66	80	90	182.84	172.84
	G6M-03-08X	3033490.46	626483.17	UKN	UKN	259.35	140	well depth	258.60	125	140	134.35	119.35
	G6M-03-09X	3033541.80	626480.17	UKN	UKN	257.85	140	well depth	258.89	125	140	132.85	117.85
	G6M-03-10X	3033630.78	626447.62	UKN	UKN	264.52	135	well depth	265.81	120	135	144.52	129.52
	G6M-03-11X	3033366.15	626365.16	UKN	UKN	260*	130	well depth	UKN	115	130	145*	130*
	G6M-04-01X	3034762.37	627999.88	UKN	UKN	261.69	92	well depth	261.15	82	92	179.69	169.69
	G6M-04-02X	3034493.28	627651.58	UKN	UKN	264.48	90	well depth	266.55	80	90	184.48	174.48
	G6M-04-03X	3034595.27	627791.55	UKN	UKN	264.78	95	well depth	264.29	85	95	179.78	169.78
	G6M-04-04X	3034333.77	627448.67	UKN	UKN	263.70	104	well depth	262.66	94	104	169.70	159.70
	G6M-04-05X	3033496.62	626482.47	UKN	UKN	258.60	110	well depth	258.13	100	110	158.60	148.60
	G6M-04-06X	3033359.03	626248.36	UKN	UKN	262.20	105	well depth	263.97	95	105	167.20	157.20
	G6M-04-07X	3033349.18	626248.44	UKN	UKN	261.80	130	well depth	263.82	120	130	141.80	131.80
	G6M-04-08X	3033449.92	625617.35	UKN	UKN	203.20	90	well depth	209.55	80	90	123.20	113.20
	G6M-04-09X	3034944.49	628303.76	UKN	UKN	242.38	65	well depth	242.66	55	65	187.38	177.38

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Existing Monitoring Wells	G6M-04-10A	3034996.14	628385.40	UKN	UKN	222.37	40	well depth	224.02	30	40	192.37	182.37
	G6M-04-10X	3034998.86	628380.01	UKN	UKN	222.46	62	well depth	224.22	52	62	170.46	160.46
	G6M-04-11X	3034988.58	628110.58	UKN	UKN	228.27	45	well depth	229.47	35	45	193.27	183.27
	G6M-04-12X	3035032.24	628232.51	UKN	UKN	UKN	64	well depth	225.61	54	64	UKN	UKN
	G6M-04-13X	3034974.08	628410.98	UKN	UKN	224.17	40	well depth	225.88	30	40	194.17	184.17
	G6M-04-14X	3033358.95	625817.67	UKN	UKN	208.51	90	well depth	210.61	80	90	128.51	118.51
	G6M-04-15X	3034916.27	628330.94	UKN	UKN	251.74	80	well depth	253.23	70	80	181.74	171.74
	G6M-04-22X	3034895.26	628167.87	UKN	UKN	254.20	84	well depth	255.89	74	84	180.20	170.20
	G6M-04-31X	3034869.22	628209.97	UKN	UKN	254.31	78	well depth	255.91	68	78	186.31	176.31
	G6M-06-01X	3034144.06	626954.60	UKN	3/22/2006	264.48	126	well depth	264.54	106	126	158.48	138.48
	G6M-07-01X	3034805.01	627885.20	UKN	UKN	262.18	89	well depth	262.10	78	89	184.18	173.18
	G6M-07-02X	3034987.40	628407.40	UKN	UKN	222.88	28	well depth	225.10	22.5	27.5	200.38	195.38
	G6M-13-01X	3033736.90	626402.10	UKN	UKN	265.20	135	well depth	266.82	125	135	140.20	130.20
	G6M-13-02X	3034076.71	626820.10	UKN	UKN	264.03	125	well depth	263.82	115	125	149.03	139.03
	G6M-13-03X	3034543.73	627535.38	UKN	UKN	264.78	90	well depth	264.37	80	90	184.78	174.78
	G6M-13-04X	3033706.70	626602.65	UKN	UKN	264.96	135	well depth	266.31	125	135	139.96	129.96
	G6M-13-05X	3035037.31	628219.4	UKN	UKN	223.86	55	well depth	225.00	45	55	178.86	168.86
	G6M-13-06X	3034982.10	628269.75	UKN	UKN	225.42	60	well depth	224.37	50	60	175.42	165.42
	G6M-92-10X	3035008.28	628503.4	UKN	UKN	222.40	19	well depth	225.08	9	19	213.40	203.40
	G6M-93-13X	3034988.40	628274.25	UKN	UKN	222.90	19	well depth	224.83	9	19	213.90	203.90
	G6M-94-15A	3034924.42	628328.64	UKN	UKN	250.70	43	well depth	252.88	33	43	217.70	207.70
	G6M-95-19X	3035057.71	628384.33	UKN	UKN	222.35	58	well depth	223.89	48	58	174.35	164.35
	G6M-95-20X	3035005.87	628485.81	UKN	UKN	222.51	23	well depth	224.61	18	23	204.51	199.51
	G6M-96-22A	3035142.80	628391.08	UKN	UKN	216.30	50	well depth	217.59	40	50	176.30	166.30
	G6M-96-22B	3035149.16	628384.37	UKN	UKN	216.40	70.5	well depth	217.56	65.5	70.5	150.90	145.90
	G6M-96-25A	3035060.98	628065.35	UKN	UKN	223.28	18.7	well depth	225.52	9	18.7	214.28	204.58
	G6M-96-25B	3035060.98	628065.35	UKN	UKN	223.89	58	well depth	225.64	48	58	175.89	165.89
	G6M-96-26A	3034950.67	628547.74	UKN	UKN	222.83	18	well depth	224.56	8	18	214.83	204.83
	G6M-96-26B	3034947.59	628554.41	UKN	UKN	222.89	78	well depth	224.40	68	78	154.89	144.89
	G6M-97-09B	3034545.25	628271.92	UKN	UKN	257.30	82.50	end of boring	260.05	71.5	81.5	185.80	175.80
	G6M-97-05B	3033730.40	626265.10	UKN	UKN	265.94	135	well depth	268.12	130	135	135.94	130.94
	G6M-97-09B	3034545.25	628271.92	UKN	UKN	257.30	82	well depth	260.05	71.5	81.5	185.80	175.80
	G6M-97-27X	3035019.74	628384.64	UKN	UKN	222.31	UNK	well depth	224.50	UNK	UNK	UNK	UNK
	G6M-97-28X	3034102.75	627185.77	UKN	UKN	263.13	105	well depth	265.69	100	105	163.13	158.13
	G6M-97-29X	3033672.09	626733.84	UKN	UKN	264.00	189	well depth	266.15	179	189	85.00	75.00

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Existing Monitoring Wells	G6M-98-32X	3033673.14	626756.31	UKN	UKN	264.17	135	well depth	266.41	130	135	134.17	129.17
	G6P-97-05X	3035151.10	627296.40	UKN	UKN	234.59	44.20	end of boring	236.72	33	43	201.59	191.59
	MW-3	3033717.29	626756.63	UKN	UKN	263.38	137	well depth	265.75	126	137	137.38	126.38
	MW-6	3033733.38	626818.97	UKN	UKN	263.59	135	well depth	265.20	125	135	138.59	128.59
	MW-7	3033767.80	626806.09	UKN	UKN	263.74	135	well depth	264.97	125	135	138.74	128.74
	MW-7 (IT)	3035121.81	627288.73	UKN	UKN	238.20	32.50	end of boring	234.00	22	32	216.20	206.20
	XSA-12-95X	3033422.57	626165.52	UKN	UKN	264.91	130	well depth	269.63	120	130	144.91	134.91
	XSA-12-96X	3033529.35	626043.13	UKN	UKN	266.56	130	well depth	269.99	120	130	146.56	136.56
	XSA-12-97X	3033633.51	625909.01	UKN	UKN	259.38	130	well depth	270.78	120	130	139.38	129.38
	XSA-12-98X	3033711.64	625683.75	UKN	UKN	204.14	70	well depth	209.61	60	70	144.14	134.14
Vertical Profiles													
Initial Vertical Profiles	50VP-19-01	3035340.65	628439.14	GP	8/28/2019	218.90	72	refusal	NA	NA	NA	NA	NA
	50VP-19-02	3035185.21	628536.37	GP	8/26/2019	215.91	58	refusal	NA	NA	NA	NA	NA
	50VP-19-03	3035071.22	628588.60	GP	8/23/2019	220.54	56	refusal	NA	NA	NA	NA	NA
	50VP-19-04	3034979.40	627822.10	GP	7/17/2019	249.78	94	refusal	NA	NA	NA	NA	NA
	50VP-19-05	3034810.35	627560.82	GP	10/18/2019	263.89	107	refusal	NA	NA	NA	NA	NA
	50VP-19-06	3034649.60	627345.50	GP	7/1/2019	265.21	96	refusal	NA	NA	NA	NA	NA
	50VP-19-07	3033667.76	626493.31	GP	10/7/2019	264.55	164	refusal	NA	NA	NA	NA	NA
	50VP-19-08	3033351.49	625812.29	GP	9/6/2019	208.50	80	refusal	NA	NA	NA	NA	NA
	50VP-19-09	3033897.90	628849.20	GP	8/16/2019	255.61	107.5	refusal	NA	NA	NA	NA	NA
	50VP-19-10	3033509.90	628182.90	GP	8/14/2019	256.99	79	refusal	NA	NA	NA	NA	NA
	50VP-19-11	3032501.90	629266.60	GP	8/23/2019	256.16	115	refusal	NA	NA	NA	NA	NA
	50VP-19-12	3031601.90	628575.60	GP	8/9/2019	256.03	97.5	refusal	NA	NA	NA	NA	NA
	50VP-19-13	3034626.90	625891.90	GP	8/12/2019	267.03	181	refusal	NA	NA	NA	NA	NA
	G6M-18-01	3034124.29	626508.04	GP	10/24/2018	264.58	104	end of boring	NA	NA	NA	NA	NA
	G6M-18-02	3033809.06	626102.24	GP	10/22/2018	266.64	128	end of boring	NA	NA	NA	NA	NA
Soil Borings													
Initial Soil Borings	50SB-19-01	3034928.63	627680.08	GP	10/24/2019	263.89	50	end of boring	NA	NA	NA	NA	NA
	50SB-19-02	3034742.78	627663.14	GP	10/24/2019	262.73	15	end of boring	NA	NA	NA	NA	NA
	50SB-19-03	3034690.07	627272.18	GP	10/23/2019	265.61	15	end of boring	NA	NA	NA	NA	NA
	50SB-19-04	3034556.61	627735.87	GP	10/23/2019	264.78	15	end of boring	NA	NA	NA	NA	NA
	50SB-19-05	3034805.91	627559.40	GP	10/23/2019	263.90	60	end of boring	NA	NA	NA	NA	NA

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Initial Soil Borings	50SB-19-06	3034340.37	626159.88	GP	10/28/2019	265.13	65	end of boring	NA	NA	NA	NA	NA
	50SB-19-07	3033706.65	627107.31	GP	10/25/2019	262.14	15	end of boring	NA	NA	NA	NA	NA
	50SB-19-08	3032857.70	628150.54	GP	10/25/2019	257.84	15	end of boring	NA	NA	NA	NA	NA
Second set of Soil Borings	50SB-19-09	3035336.91	628434.29	GP	10/31/2019	218.92	10	end of boring	NA	NA	NA	NA	NA
	50SB-19-10	3035370.51	628373.27	GP	10/31/2019	218.48	10	end of boring	NA	NA	NA	NA	NA
Initial Soil Borings**	50SB-19-11	3031916.34	628808.90	GP	11/25/2019	255.82	15	end of boring	NA	NA	NA	NA	NA
	50SB-19-12	3033511.41	628185.87	GP	11/18/2019	256.98	15	end of boring	NA	NA	NA	NA	NA
Surface Water and Sediment Sampling													
Surface Water and Sediment Sampling	AFW-19-01	3032884.81	627407.38	NA	10/18/2019	206.01	NA	NA	NA	NA	NA	NA	NA
	AFW-19-02	3033377.97	627071.04	NA	10/18/2019	206.66	NA	NA	NA	NA	NA	NA	NA
	NR-19-01	3026246.78	623892.16	NA	10/17/2019	217.44	NA	NA	NA	NA	NA	NA	NA
	NR-19-02	3030203.05	626397.04	NA	10/16/2019	207.78	NA	NA	NA	NA	NA	NA	NA
	NR-19-03	3030504.89	626714.00	NA	10/16/2019	208.25	NA	NA	NA	NA	NA	NA	NA
	NR-19-04	3031119.00	626885.39	NA	10/16/2019	210.44	NA	NA	NA	NA	NA	NA	NA
	NR-19-05	3031742.45	627055.80	NA	10/16/2019	203.83	NA	NA	NA	NA	NA	NA	NA
	NR-19-06	3032206.28	626137.19	NA	10/15/2019	202.45	NA	NA	NA	NA	NA	NA	NA
	NR-19-07	3032825.91	625987.27	NA	10/15/2019	209.89	NA	NA	NA	NA	NA	NA	NA
	NR-19-08	3033477.82	625860.28	NA	10/15/2019	206.96	NA	NA	NA	NA	NA	NA	NA
	NR-19-09	3033764.23	625317.90	NA	10/15/2019	208.87	NA	NA	NA	NA	NA	NA	NA
	NR-19-10	3034610.48	625453.41	NA	10/15/2019	206.09	NA	NA	NA	NA	NA	NA	NA
	NR-19-11	3035357.56	625890.56	NA	10/14/2019	203.93	NA	NA	NA	NA	NA	NA	NA
	NR-19-12	3035593.37	626568.36	NA	10/14/2019	203.84	NA	NA	NA	NA	NA	NA	NA
	NR-19-13	3035858.61	626698.30	NA	10/14/2019	203.27	NA	NA	NA	NA	NA	NA	NA
	NR-19-14	3037117.24	628697.12	NA	12/18/2019	200.24	NA	NA	NA	NA	NA	NA	NA
Piezometer Installation													
Initial Piezometers	50PZ-19-01	3034978.40	627821.10	GP	7/22/2019	249.78	53	end of boring	252.02	43	53	206.78	196.78
	50PZ-19-02	3034648.60	627345.50	GP	7/3/2019	265.21	67	end of boring	264.94	57	67	208.21	198.21
	50PZ-19-03	3033897.40	628849.20	GP	8/23/2019	255.61	50	end of boring	258.40	40	50	215.61	205.61
	50PZ-19-04	3033509.90	628182.70	GP	7/24/2019	256.99	55	end of boring	260.37	45	55	211.99	201.99
	50PZ-19-05	3032501.40	629266.50	GP	8/24/2019	256.16	49	end of boring	256.51	39	49	217.16	207.16
	50PZ-19-06	3031601.90	628574.60	GP	7/31/2019	256.03	63	end of boring	255.54	53	63	203.03	193.03
	50PZ-19-07	3034626.90	625891.40	GP	8/22/2019	267.03	74	end of boring	270.11	64	74	203.03	193.03

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Staff Gauge													
Staff Gauge	NRSG-01	3033874.98	625375.44	V	4/20/2020	NA	53	NA	204.72***	NA	NA	NA	NA

Notes:

Blue highlighlighting indicates the monitoring well was sampled for the PFAS RI.

* = Ground surface at G6M-03-11X is estimated based on Google Earth. Therefore well screen elevations are estimated.

** = Soil borings 50VP-19-11 and 50VP-19-12 were initially identified in WP as 50SB-19-09 and 50SB-19-10, respectively but were renumbered.

** = staff gauge elevation is at the 4-ft mark on the gauge.

BGS = below ground surface
ft = feet
GP = Geoprobe
RD = Rotosonic
V = hand driven
NA = not applicable
UKN = unknown
NAD83 = North American Datum 1983
NAVD88 = North American Vertical Datum 1988

Table 6-2
AOC 50 Summary of PFAS Exceedances from Vertical Profile Samples
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Number of Samples Exceeding EPA LHA	Number of Samples Exceeding MassDEP GW-1	Maximum Detected Concentration (ng/L)	Minimum Detected Concentration (ng/L)	Sample Identifier of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	16/98	---	---	1,720 J	7.30 J	G6M-18-02-84-88
8:2 Fluorotelomer sulfonate (8:2 FTS)	2/98	---	---	3.93 J	3.70 J	G6M-18-02-114-118
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	3/98	---	---	3.70 J	2.70 J	50VP-19-08-49-53
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/98	---	---	---	---	---
Perfluorobutanesulfonic acid (PFBS)	82/98	---	---	244	0.460 J	G6M-18-02-84-88
Perfluorodecanoic acid (PFDA)	16/98	---	---	3.50	0.490 J	50VP-19-08-19-23
Perfluorododecanoic acid (PFDoA)	1/98	---	---	1.30 J	1.30 J	50VP-19-03-24-28
Perfluoroheptanoic acid (PFHpA)	80/98	---	19	579	0.730 J	G6M-18-02-84-88
Perfluorohexanesulfonic acid (PFHxS)	91/98	---	64	6,690	1.60 J	G6M-18-02-84-88
Perfluorohexanoic acid (PFHxA)	84/98	---	---	4,010	0.620 J	G6M-18-02-84-88
Perfluorononanoic acid (PFNA)	42/98	---	---	9.50	0.450 J	50VP-19-08-79-83
Perfluorooctanesulfonic acid (PFOS)	80/98	39	50	1,600	1.00 J	50VP-19-06-73-77
Perfluorooctanoic acid (PFOA)	93/98	33	55	9,310	0.550 J	G6M-18-02-84-88
Perfluorotetradecanoic acid (PFTA)	1/98	---	---	0.890 J	0.890 J	50VP-19-12-53-57
Perfluorotridecanoic acid (PFTrDA)	1/98	---	---	1.10 J	1.10 J	50VP-19-03-24-28
Perfluoroundecanoic acid (PFUnA)	2/98	---	---	1.50 J	0.930 J	50VP-19-13-109-113
EPA LHA		55		10,500	1.76	G6M-18-02-84-88
MassDEP GW-1			77	17,800	3.6	G6M-18-02-84-88

Notes:
J = estimated value
ng/L = nanograms per liter
EPA Life-time Health Advisory (LHA) is the individual or sum of PFOS and PFOA = 70 ng/L.
MassDEP GW-1 is the individual concentration or sum of PFOA, PFOS, PFHpA, PFHxS, PFNA, PFDA = 20 ng/L.

Table 6-3
AOC 50 Summary of PFAS Exceedances from Monitoring Wells
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Number of Samples Exceeding EPA LHA	Number of Samples Exceeding MassDEP GW-1	Maximum Detected Concentration (ng/L)	Minimum Detected Concentration (ng/L)	Sample Identifier of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	4/45	---	---	18.0 J	7.70 J	G6M-18-01
8:2 Fluorotelomer sulfonate (8:2 FTS)	2/45	---	---	8.20 J	7.10 J	G6M-18-01
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2/45	---	---	3.00 J	2.60 J	G6P-97-05X
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/45	---	---	---	---	---
Perfluorobutanesulfonic acid (PFBS)	40/45	---	---	160	1.30 J	G6M-18-01
Perfluorodecanoic acid (PFDA)	11/45	---	---	3.20	0.450 J	G6M-04-08X
Perfluorododecanoic acid (PFDoA)	3/45	---	---	11.0	0.600 J	G6M-04-14X
Perfluoroheptanoic acid (PFHpA)	42/45	---	9	170	2.00	G6M-18-01
Perfluorohexanesulfonic acid (PFHxS)	45/45	---	38	5,600	2.70	G6M-18-01
Perfluorohexanoic acid (PFHxA)	42/45	---	---	2,700	3.50	G6M-18-01
Perfluorononanoic acid (PFNA)	35/45	---	---	8.70	0.510 J	G6M-18-01
Perfluorooctanesulfonic acid (PFOS)	42/45	24	35	1,500	0.970 J	G6M-18-01
Perfluorooctanoic acid (PFOA)	44/45	16	30	4,000	1.00 J	G6M-18-01
Perfluorotetradecanoic acid (PFTA)	1/45	---	---	1.30 J	1.30 J	G6M-04-14X
Perfluorotridecanoic acid (PFTrDA)	3/45	---	---	4.90	0.8 J	G6M-04-14X
Perfluoroundecanoic acid (PFUnA)	4/45	---	---	1.60 J	0.660 J	G6M-04-14X
EPA LHA		29		5,200	3.90	G6M-18-01
MassDEP GW-1			43	10,900	2.70	G6M-18-01

Notes:
J = estimated value
ng/L = nanograms per liter
EPA Life-time Health Advisory (LHA) is the individual or sum of PFOS and PFOA = 70 ng/L.
MassDEP GW-1 is the individual concentration or sum of PFOA, PFOS, PFHpA, PFHxS, PFNA, PFDA = 20 ng/L.

Table 6-4
AOC 50 Summary of PFAS Exceedances from Soil Borings
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

Parameter	Sample Count with Detected Concentrations	Samples Exceeding Regulatory Level	Maximum Detected Concentration (µg/kg)	Minimum Detected Concentration (µg/kg)	Project Action Limit Source	Project Action Limit (µg/kg)	Location of Maximum Detected Concentration
6:2 Fluorotelomer sulfonate (6:2 FTS)	1/51	---	2.80 J	2.80 J	---	---	50SB-19-05
8:2 Fluorotelomer sulfonate (8:2 FTS)	0/51	---	---	---	---	---	---
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	1/51	---	1.20 J	1.20 J	---	---	50SB-19-01
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0/51	---	---	---	---	---	---
Perfluorobutanesulfonic acid (PFBS)	1/51	---	0.076 J	0.076 J	---	---	50SB-19-09
Perfluorodecanoic acid (PFDA)	8/51	1	0.410	0.110 J	S-1/GW-1	0.30	50SB-19-01
Perfluorododecanoic acid (PFDoA)	1/51	---	0.690	0.690	---	---	50SB-19-01
Perfluoroheptanoic acid (PFHpA)	9/51	---	0.480	0.100 J	S-1/GW-1	0.50	50SB-19-03
Perfluorohexanesulfonic acid (PFHxS)	25/51	17	19.0	0.080 J	S-1/GW-1	0.30	50SB-19-03
Perfluorohexanoic acid (PFHxA)	17/51	---	0.610	0.079 J	---	---	50SB-19-10
Perfluorononanoic acid (PFNA)	8/51	---	0.210 J	0.091 J	S-1/GW-1	0.32	50SB-19-08
Perfluorooctane sulfonate (PFOS)	29/51	12	45.0 J	0.260 J	S-1/GW-1	2.0	50SB-19-03
Perfluorooctanoic acid (PFOA)	25/51	10	26.0	0.110 J	S-1/GW-1	0.72	50SB-19-03
Perfluorotetradecanoic acid (PFTA)	1/51	---	0.270 J	0.270 J	---	---	50SB-19-01
Perfluorotridecanoic acid (PFTrDA)	1/51	---	0.220 J	0.220 J	---	---	50SB-19-01
Perfluoroundecanoic acid (PFUnA)	2/51	---	0.610	0.160 J	---	---	50SB-19-01

Notes:
µg/kg denotes micrograms per kilogram
J denotes estimated result
S-1/GW-1 denotes Massachusetts Contigency Plan standards.

Table 7-1
Background Surface Water and Sediment Field Activities
Area 3 Preliminary Site Characterization Summary
Devens PFAS Remedial Investigation

	Location	North Coordinate (ft NAD83)	East Coordinate (ft NAD83)	Construction Method	Establishing Date	Surface Elevation (ft NAVD88)	Total Depth (ft BGS)	Description of Total Depth	Top of Casing Elevation (ft NAVD88)	Depth to Top of Screen (ft BGS)	Depth to Bottom of Screen (ft BGS)	Elevation of Top of Screen (ft NAVD88)	Elevation of Bottom of Screen (ft NAVD88)
Surface Water and Sediment Sampling													
Surface Water and Sediment Sampling	BB-20-01	3012180.35	637337.39	NA	5/20/2020	249.73	NA	NA	NA	NA	NA	NA	NA
	FP-20-01	3029865.61	638676.29	NA	5/20/2020	226.29	NA	NA	NA	NA	NA	NA	NA
	FP-20-02	3027996.68	637631.46	NA	5/20/2020	225.75	NA	NA	NA	NA	NA	NA	NA
	NRBK-19-01	3015566.95	620344.49	NA	12/20/2019	216.93	NA	NA	NA	NA	NA	NA	NA
	NRBK-19-02	2993222.69	613953.86	NA	12/20/2019	226.13	NA	NA	NA	NA	NA	NA	NA
	SR-19-01	3036780.59	626283.93	NA	12/18/2019	202.65	NA	NA	NA	NA	NA	NA	NA
	WAB-19-01	3029217.48	624842.12	NA	12/18/2019	212.87	NA	NA	NA	NA	NA	NA	NA

Notes:

BGS = below ground surface

ft = feet

GP = Geoprobe

NA = not applicable

NAD83 = North American Datum 1983

NAVD88 = North American Vertical Datum 1988

RD = Rotosonic

UKN = unknown

V = hand driven

FIGURES

SHIRLEY
GROTON
GROTON
AYER
AOC 30 - Drum Storage Area
AOC 31 - Firefighting Training Area
AOC 50 - Former Moore Army Airfield
Former
North Post
AOC 20 - WWTP Sand Infiltration Beds
AOC 21 - WWTP Sludge Beds
SHIRLEY
AYER
MacPherson Well
AOC 5 - Shepleys Hill Landfill
Grove Pond Supply Wells
Former
Main Post
AOC 32/43A - Former DRMO Yard/POL Storage Area
AYER
HARVARD
AOC 74 - Barnum Road Firefighting Exercise Site
Former
Main Post
AOC 76 - Devens Fire Station
AOC 57 - Building
3713 Fuel Oil Spill
AOC 75 - Building
T-1445 Warehouse Fire
SHIRLEY
HARVARD
AOC 43G - Former AAFES Gas Station
Former
Main Post
AOC 40 - Cold Spring Brook Landfill
AOC 43J - Former Gas Station
Patton Well
SHIRLEY
LANCASTER
Shabokin Well
South Post
N
W
E
S

Legend

- Area 1 - Grove Pond, Patton and Shabokin Supply Wells, AOCs 40, 43G, 43J, 57, 74, and 75
- Area 2 - MacPherson Water Supply Wells, SHL, AOCs 32/43A, and 76
- Area 3 - AOCs 20, 21, 30, 31, and 50
- Devens Regional Enterprise Zone
- City/Town Boundary
- Former Fort Devens Boundary

Devens PFAS Remedial Investigation Areas
Devens PFAS RI - Area 3 PSCS

Former Army Installation Devens
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 1,500 3,000
Feet

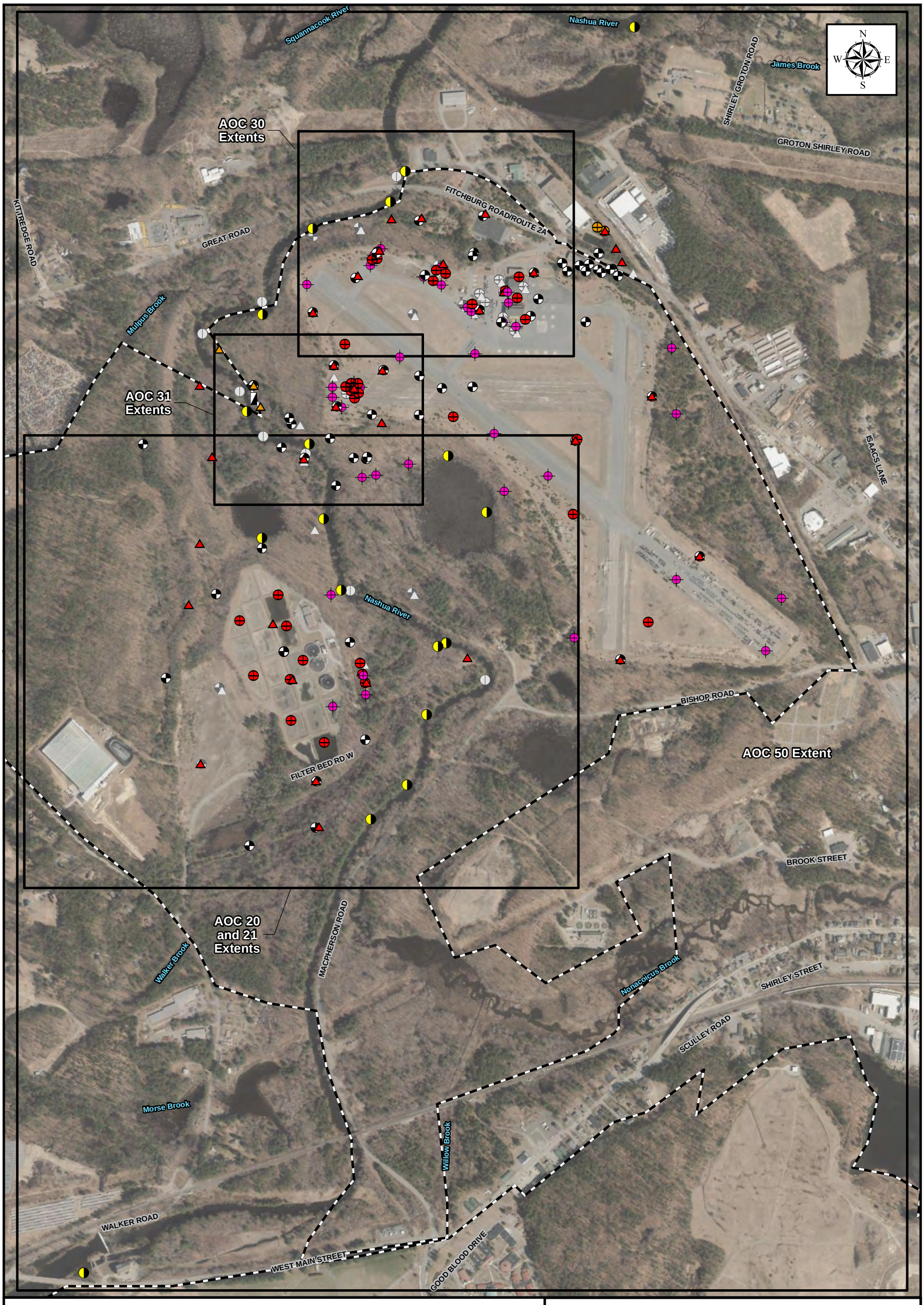
Date:
11/18/2020

Figure
1-1

KGS

File: PFAS2020_RI_WP_F1-2_Areas_v2.mxd

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Vertical Profiling Location Installation Phase 2
- Surface Water and Sediment Sampling Location
- Staff Gauge
- Temporary Well Location from SI
- Monitoring Well/Piezometer Not Completed
- Soil Boring Location Not Completed
- Vertical Profiling Location Not Completed
- Surface Water and Sediment Sampling Location Not Completed
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

Area 3 Field Activities
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
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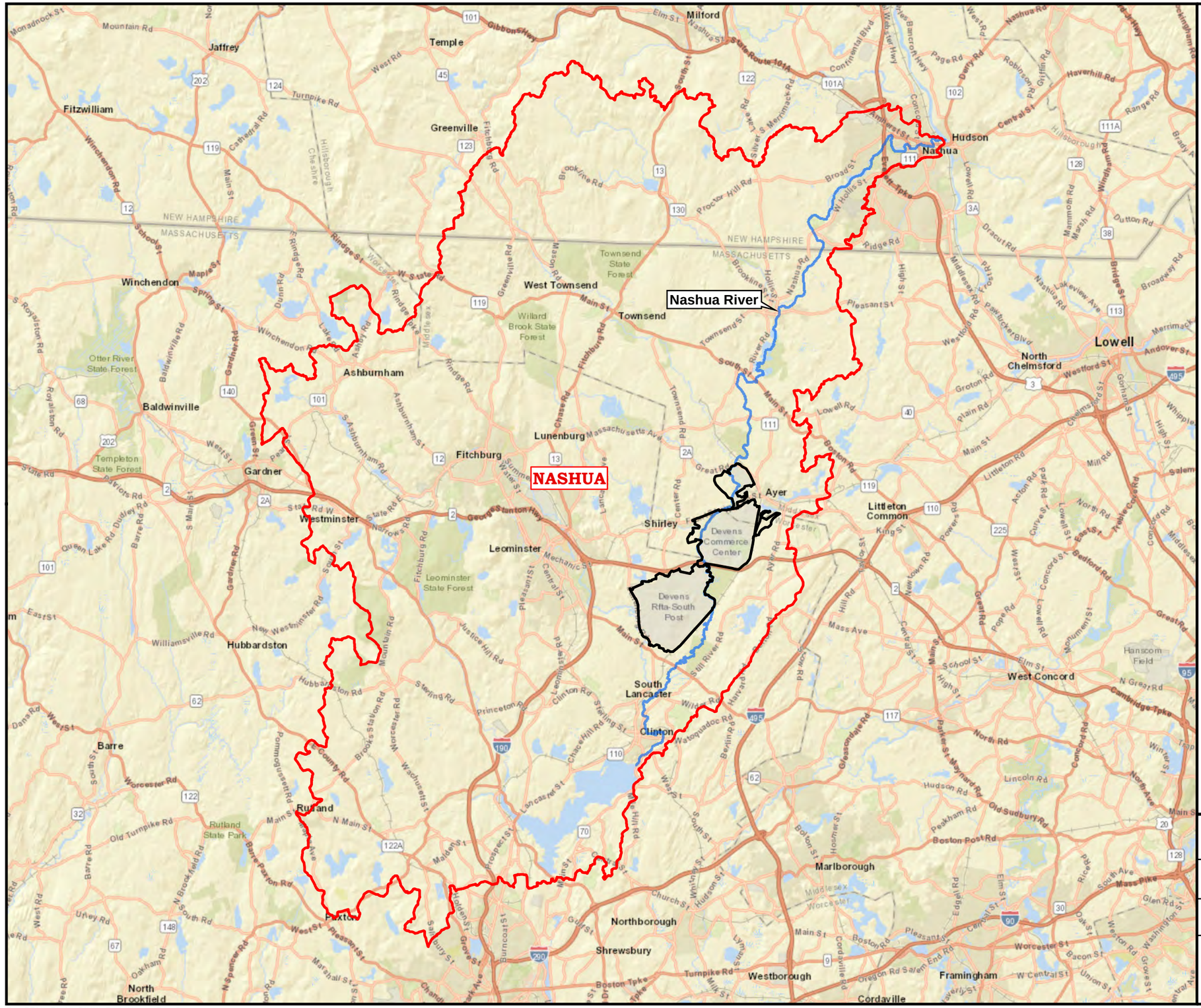
0 400 800
Feet

Date: 01/11/2021

Figure 1-2

File: PFAS_RI_A3_PSCS_F1-2_Area3_FieldActivities.mxd



Legend

- River
- Watershed Boundary
- Former Fort Devens Boundary

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Nashua River Basin
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
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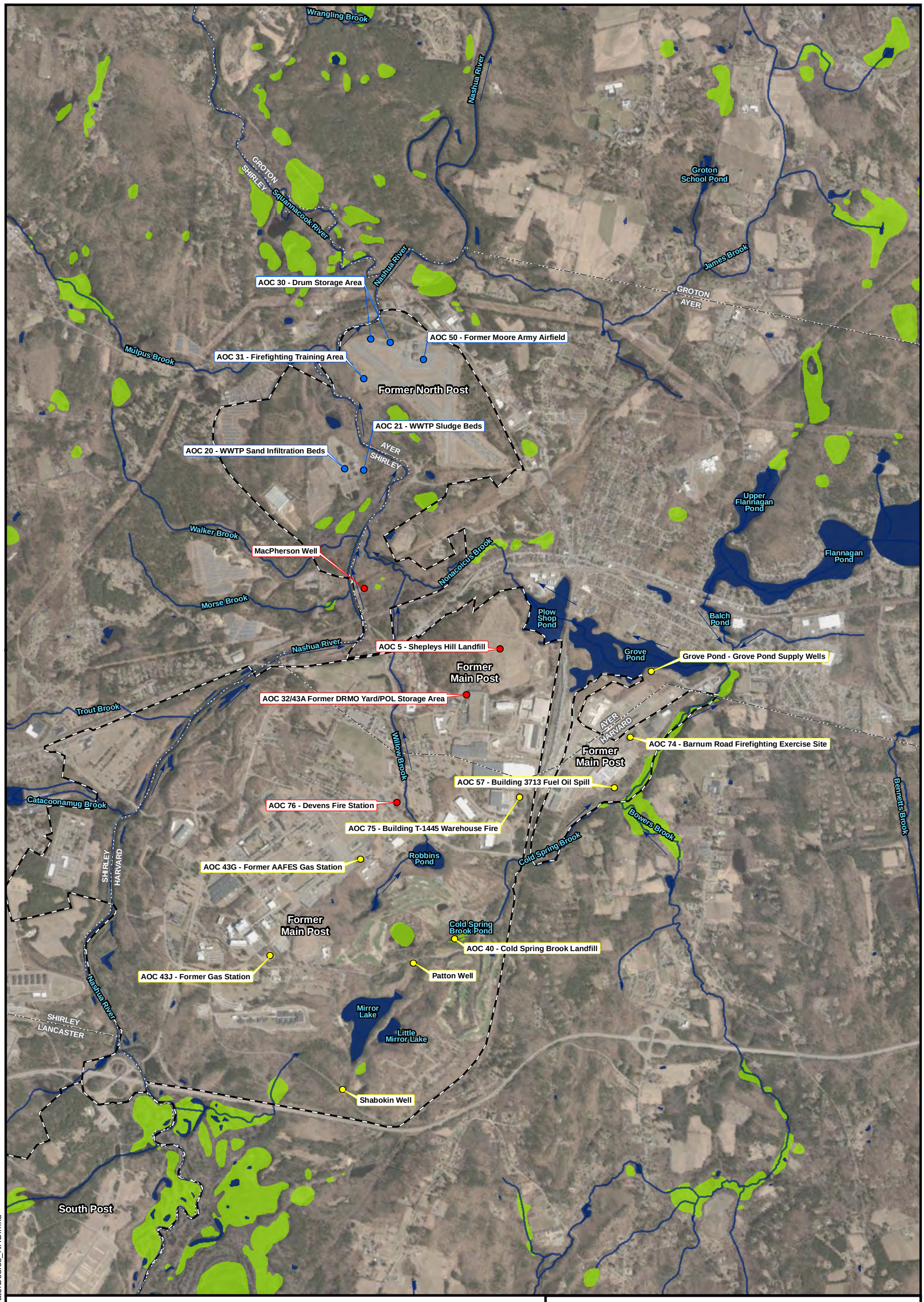
0 2 4
Miles

Date: 07/30/2020

Figure 2-1

File: PFAS_RI_A2_PSCS_F2-1_NashuaRiverBasin.mxd



Legend

- Area 1 - Grove Pond, Patton and Shabokin Supply Wells, AOCs 40, 43G, 43J, 57, 74, and 75
- Area 2 - MacPherson Water Supply Wells, SHL, AOCs 32/43A, and 76
- Area 3 - AOCs 20, 21, 30, 31, and 50
- Surface Water Flow Direction
- City/Town Boundary
- Former Fort Devens Boundary

National Hydrography Dataset

- Stream/River
- Lake/Pond
- Swamp/Marsh

N W E S

Surface Water Bodies
Devens PFAS RI - Area 3 PSCS

Former Army Installation Devens
Devens, Massachusetts

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0 1,250 2,500
Feet

Date: 02/03/2021

Figure 2-2

KGS

File: PFAS_RI_A3_PSCS_F2-2_SurfaceWaterBodies_NHD.mxd

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOC 30 - Drum Storage Area
AOC 50 - Former Moore Army Airfield
AOC 31 - Firefighting Training Area
AOC 21 - WWTP Sludge Beds
AOC 20 - WWTP Sand Infiltration Beds
MacPherson Well
AOC 5 - Shepleys Hill Landfill
Grove Pond Supply Wells
AOC 69W
AOC 32/43A - Former DRMO Yard/POL Storage Area
AOC 74 - Barnum Road Firefighting Exercise Site
AOC 75 - Building T-1445 Warehouse Fire
AOC 76 - Devens Fire Station
AOC 57 - Building 3713 Fuel Oil Spill
AOC 43G - Former AAFES Gas Station
AOC 40 - Cold Spring Brook Landfill
AOC 43J - Former Gas Station
Patton Well
Shabokin Well

Legend

AOC Location

Former Fort Devens Boundary

Surficial Geology (1:24,000)

- Abundant Outcrop and Shallow Bedrock
- Artificial Fill
- Swamp and Marsh Deposits
- Alluvium
- Inland Dune
- Coarse
- Glaciolacustrine Fine
- Thick Till
- Bedrock Outcrop
- Thin Till

USGS Overburden Geology
Devens PFAS RI Area 3 PSCS

Former Army Installation Devens
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

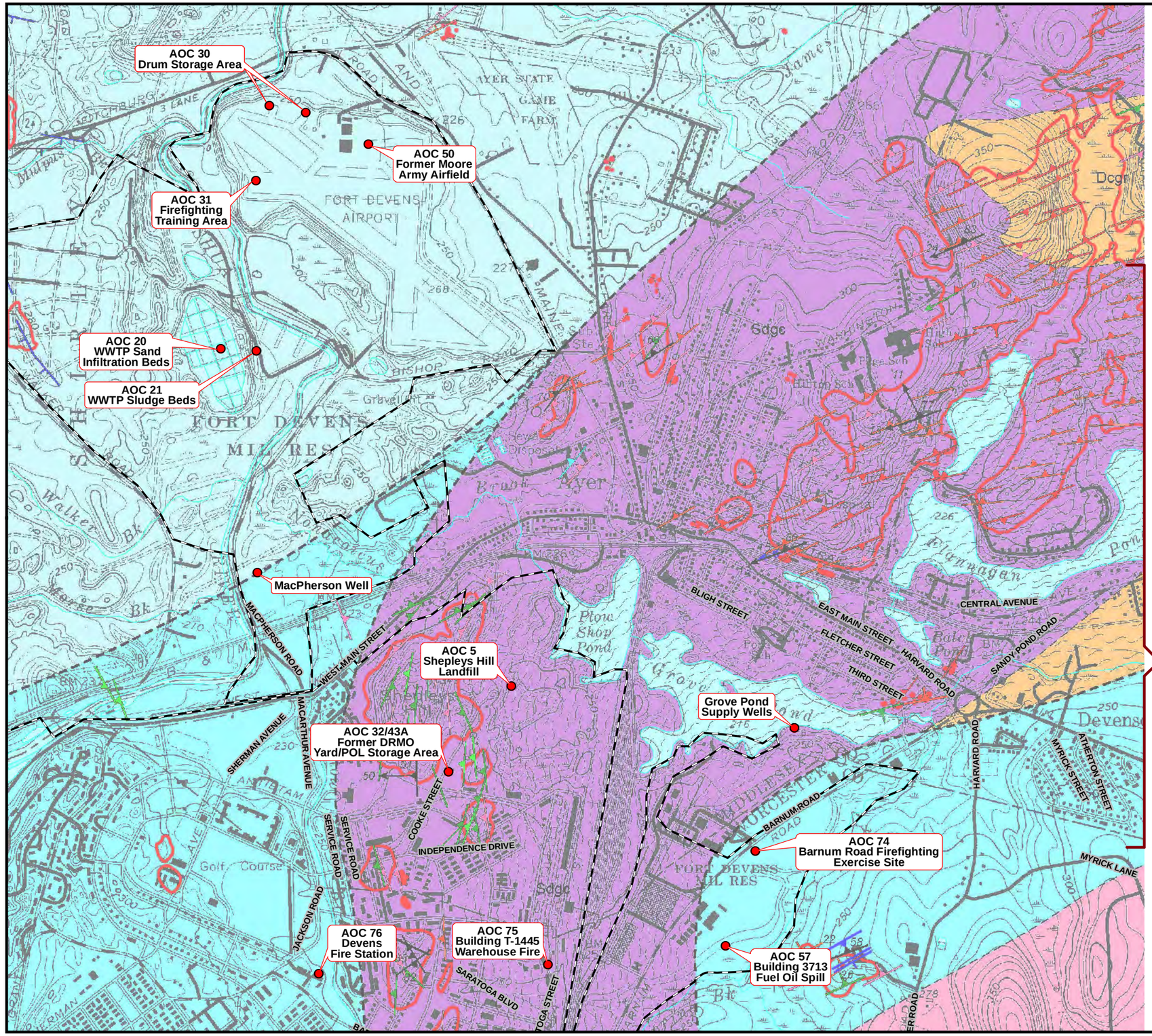
0 1,000 2,000
Feet

Date: 10/06/2020

Figure 2-3

File: PFAS_RI_A3_PSCS_F2-3_USGS_OverburdenGeol.mxd

Aerial Source: 2019, USGS, MassGIS



N
W E
S

Legend

- AOC Location
- Former Fort Devens Boundary

Lithologic Units

- Sb / Sbbks — Berwick Formation (Silurian)
- So — Oakdale Formation (Silurian)
- Dcgrm / Dcgr / Dcgm — Chelmsford Granite (Devonian)
- Saygr / Saygn — Ayer Granite (Silurian)
- Sdgc — Devens gneiss complex (Silurian(?))
- Bedrock outcrop
- Area where bedrock is shallow (<3 meters below surface) and/or outcrop is extensive
- Fault, approximately located (within approximately 50 meters)
- Fault, inferred
- Contact, approximately located (within approximately 50 meters)
- Contact, location inferred
- Gradational contact in Ayer granite

Map Reference: Preliminary Fracture Characterization Map of the Ayer Quadrangle Massachusetts Hydrostructural Domain Map Sheet 1

Bedrock Geology
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

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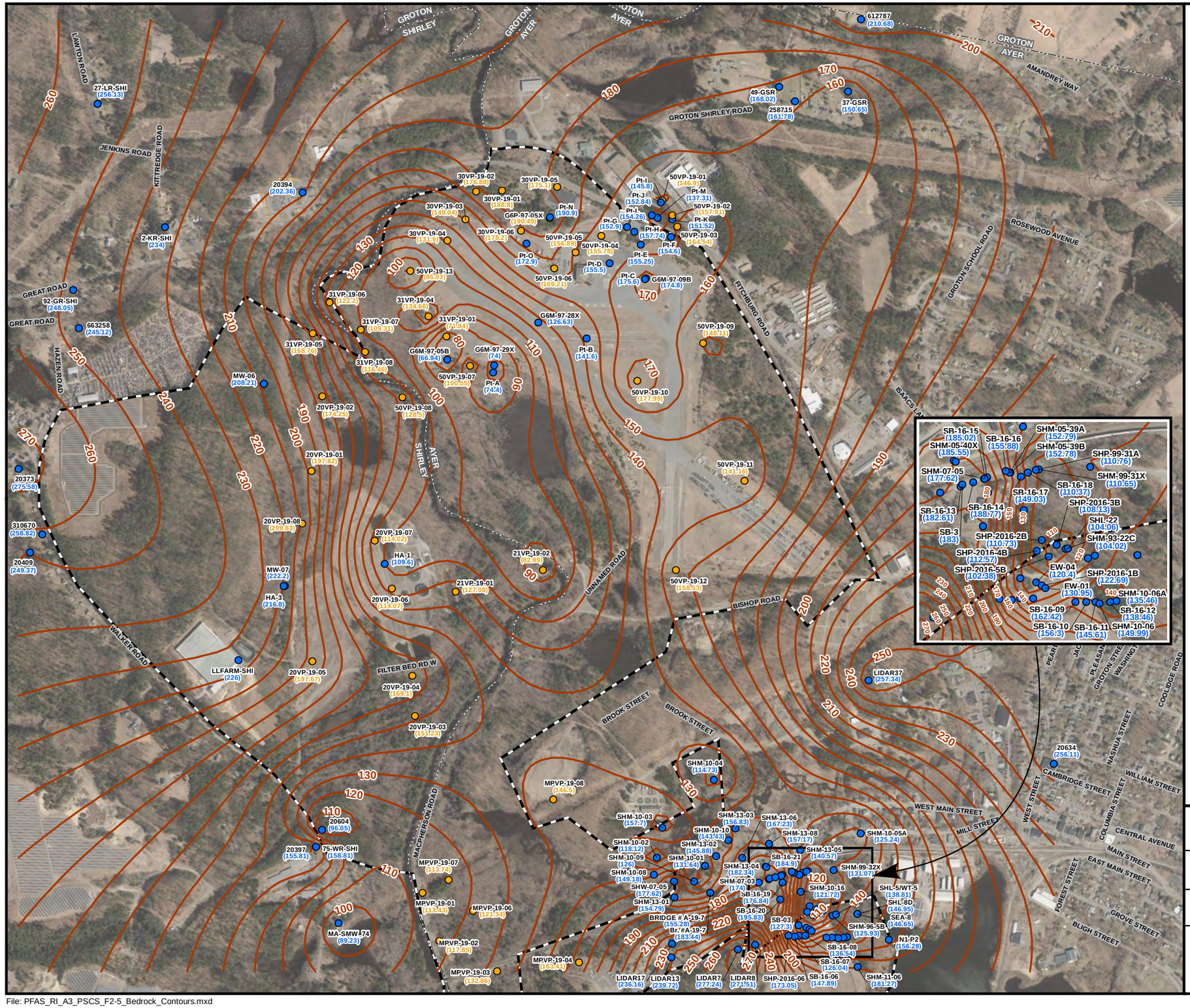
0 750 1,500
Feet

Date: 09/14/2020

Figure 2-4

KGS

File: PFAS_RI_A3_PSCS_F2-4_BedGeology_JPG.mxd



Bedrock Contours
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

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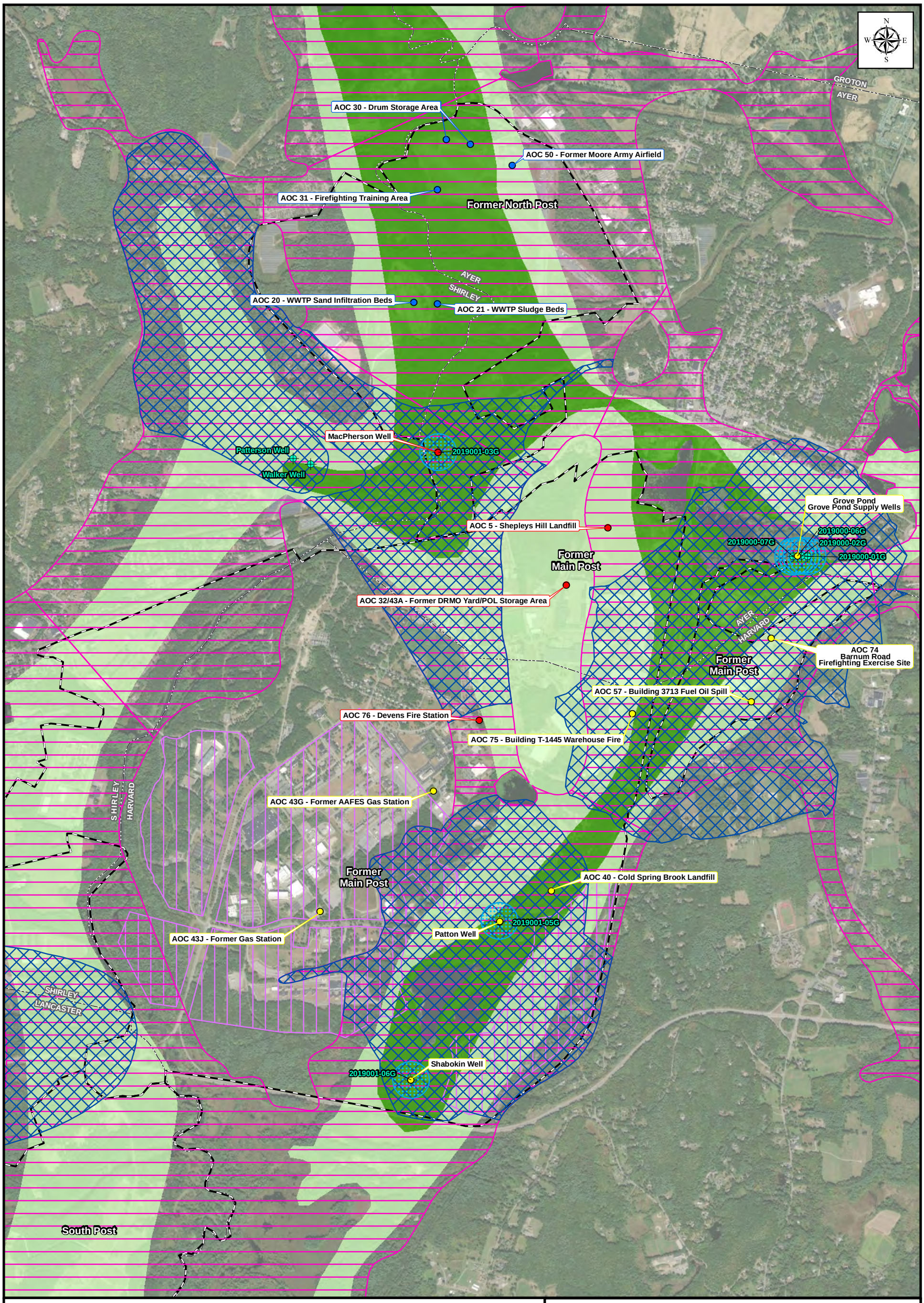
0 500 1,000
Feet

Date: 01/13/2021

Figure 2-5

KGS

File: PFAS_RI_A3_PSCS_F2-5_Bedrock_Contours.mxd



Legend

- Public Water Supply Well
- Area 1 - Grove Pond, Patton and Shabokin Supply Wells, AOCs 40, 43G, 43J, 57, 74, and 75
- Area 2 - MacPherson Water Supply Wells, SHL, AOCs 32/43A, and 76
- Area 3 - AOCs 20, 21, 30, 31, and 50
- City/Town Boundary
- Former Fort Devens Boundary
- MassDEP Approved Zone I
- MassDEP Approved Zone II
- Devens Watershed Protection District
- Devens Aquifer Protection District

Potentially Productive Aquifers

- High Yield
- Medium Yield

Devens Groundwater
Devens PFAS RI - Area 3 PSCS

Former Army Installation Devens
Devens, Massachusetts

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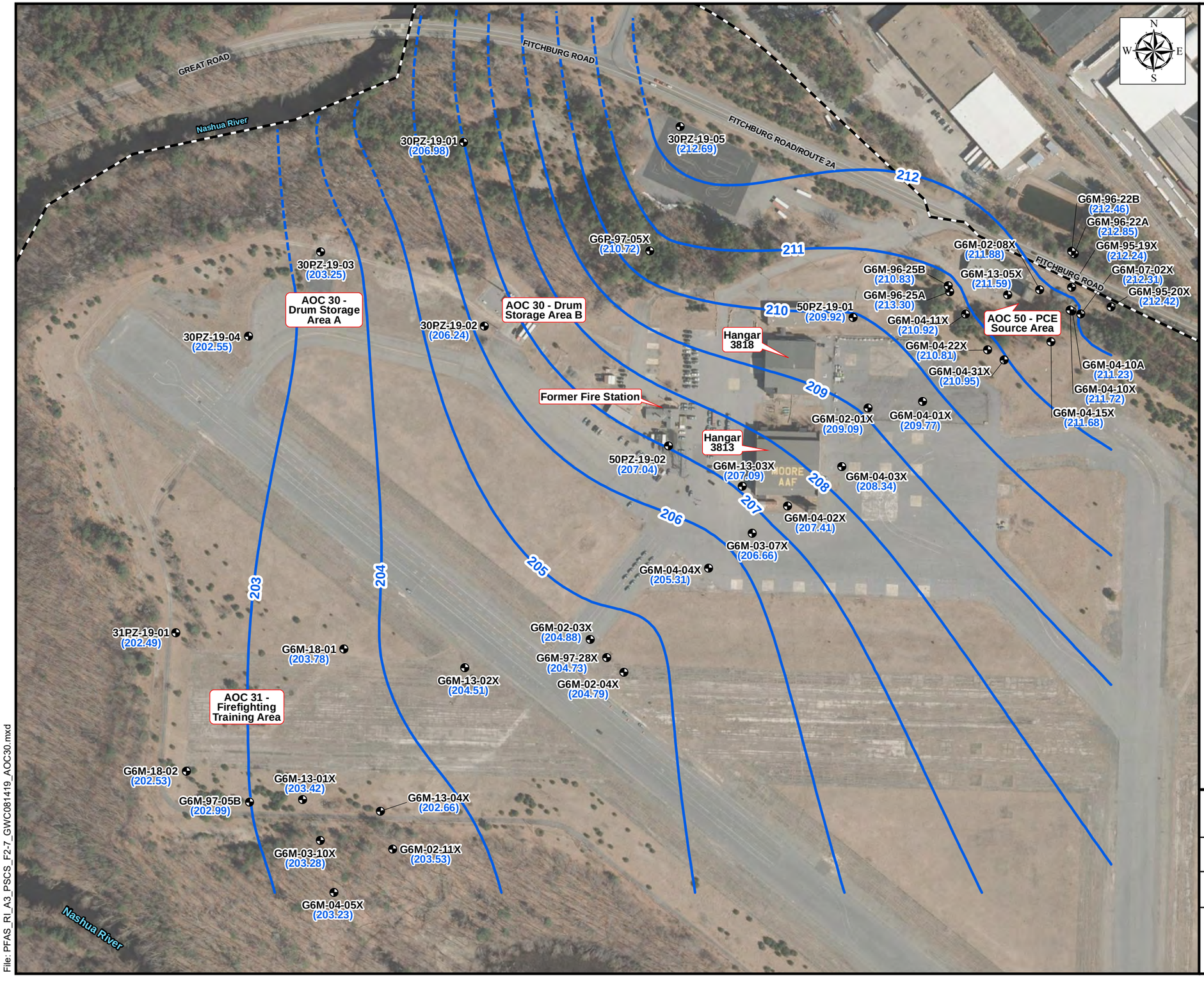
0 1,000 2,000
Feet

Date: 02/03/2021

Figure 2-6

File: PFAS_RI_A3_PSCS_F2-6_Aquifer.mxd

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend

- Monitoring Well/Piezometer
- (207.04) Groundwater Elevation (ft NAVD 88)
- Groundwater Contour (Contour Interval = 1 Foot) (ft NAVD88)
- Inferred Groundwater Contour (Contour Interval = 1 Foot) (ft NAVD88)
- Former Fort Devens Boundary

Note:

G6M-96-25A and G6M-13-04X were not used in generating the ground water contours.

Aerial Source: USGS, MassGIS Orthoimagery 2019

Groundwater Elevation Contours
Airfield Overburden, August 14, 2019
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

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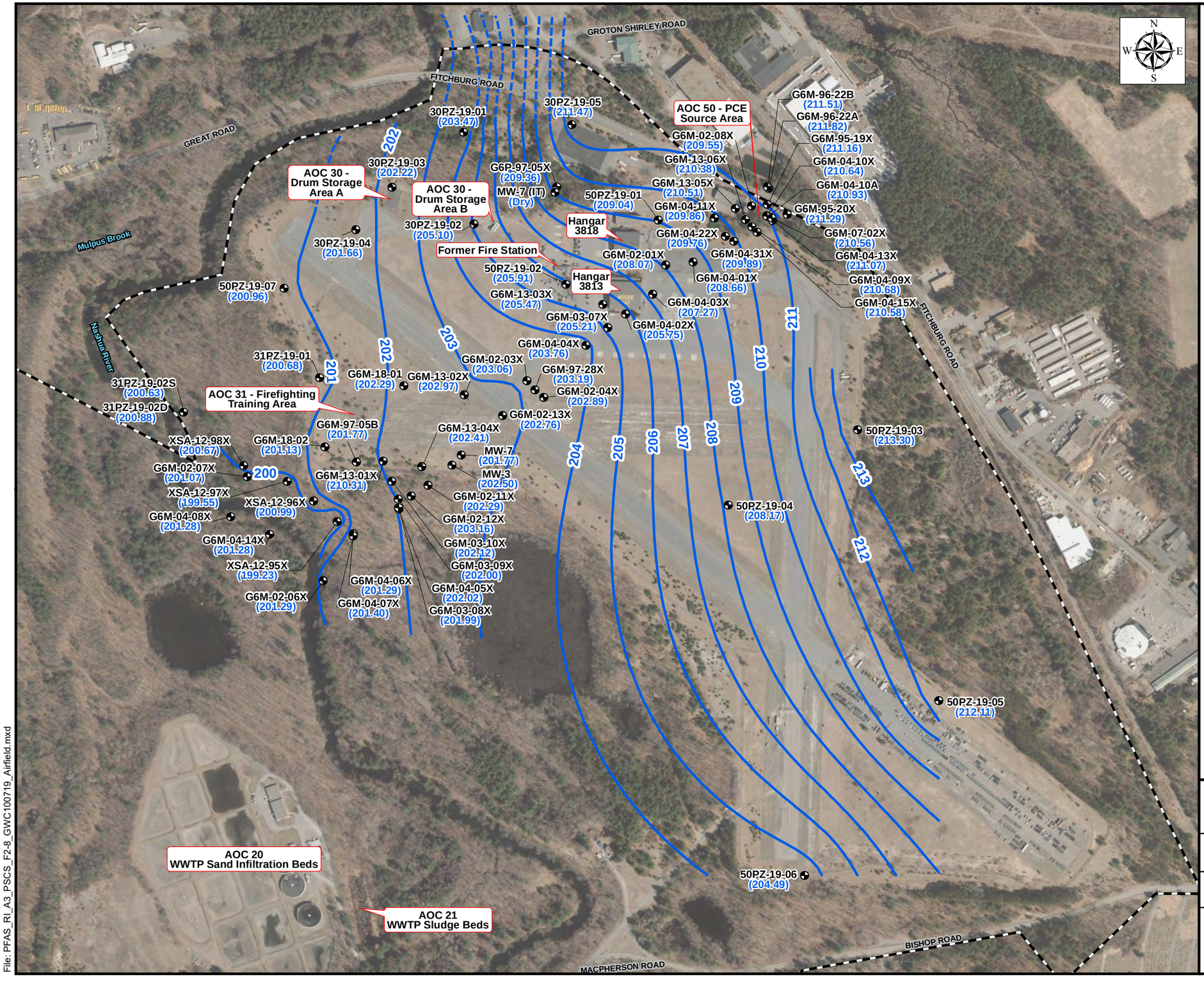
0 125 250
Feet

Date: 01/15/2021

Figure 2-7

File: PFAS_RI_A3_PSCS_F2-7_GWC081419_AOC30.mxd



Legend

- Monitoring Well/Piezometer
- (205.10) Groundwater Elevation (ft NAVD 88)
- Groundwater Contour (Contour Interval = 1 Foot) (ft NAVD88)
- Inferred Groundwater Contour (Contour Interval = 1 Foot) (ft NAVD88)
- Former Fort Devens Boundary

Notes:

MW-7, G6M-02-04X, G6M-02-07X, G6M-02-08X, and G6M-13-01X were not used in generating the ground water contours.

MW-7(IT) was Dry during the synoptic event and was not used in generating the ground water contours.

Aerial Source: USGS, MassGIS Orthoimagery 2019

Groundwater Elevation Contours
Airfield Overburden, October 7, 2019
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

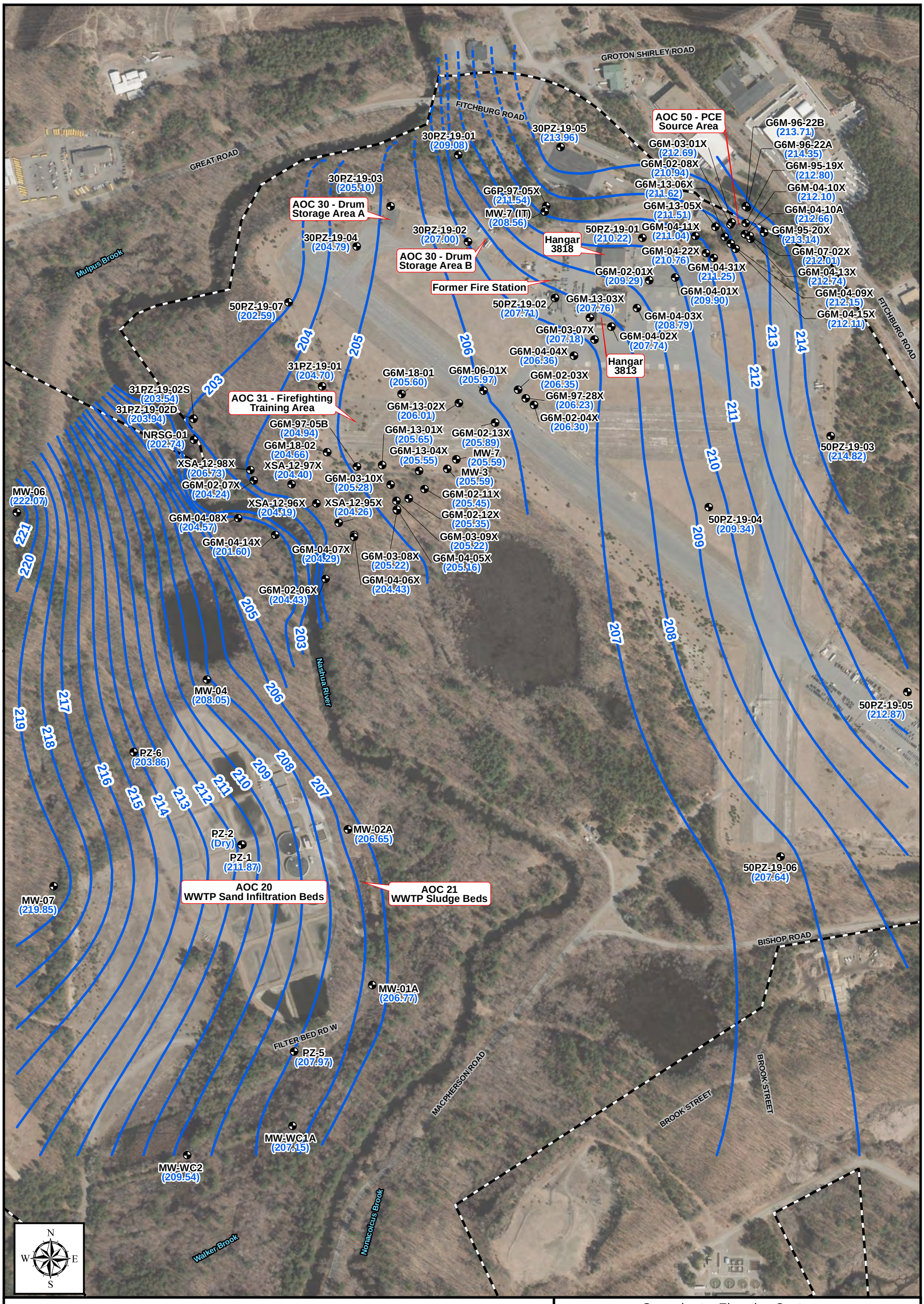
0 250 500
Feet

Date: 01/15/2021

Figure 2-8

KGS

File: PFAS_RI_A3_PSCS_F2-8_GWC100719_Airfield.mxd



Legend

- Monitoring Well/Piezometer
- (205.22) Groundwater Elevation (ft NAVD 88)
- Groundwater Contour (Contour Interval = 1 Foot) (ft NAVD88)
- Inferred Groundwater Contour (Contour Interval = 1 Foot) (ft NAVD88)
- Former Fort Devens Boundary

Notes:

G6M-02-08X, G6M-04-14X, MW-7(IT), PZ-6 and XSA-12-98X wer not used in generating the ground water contours.

PZ-2 was dry during the synoptic event and was not used in generating the ground water contours.

Aerial Source: USGS, MassGIS Orthoimagery 2019

Groundwater Elevation Contours
Area 3, April 27, 2020
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 250 500 Feet

Date: 01/15/2021

Figure 2-9

File: PFAS_RI_A3_PSCS_F2-9_GWC042720_Area3.mxd

Legend

- Current Road
- Former Fort Devens Boundary

Aerial Source: MassGIS - 1:5,000 Black and White Digital Orthophoto Images - 1992

AOCs 20 and 21 1992 Aerial Imagery
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
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0 200 400
Feet

Date: 01/11/2021

Figure 3-1

KGS

File: PFAS_RI_A3_PSCS_F3-1_AOC20_21_1992_Imagery.mxd

Legend

Historic Subsurface Features

- Communication
- Communication Line
- Electric
- Electric Line
- Storm
- Storm Line
- Storm Feature
- Sanitary
- Sanitary Line
- Sanitary Feature
- Water
- Water Line
- Water Feature
- Abandoned Feature
- Abandoned Line
- Gas
- Gas Line
- Irrigation Well
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOCs 20 and AOC 21 Historic Subsurface Features
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400
Feet

Date: 01/11/2021

Figure 3-2

KGS

File: PFAS_RI_A3_PSCS_F3-2_AOC20_21_HistoricUtilities.mxd

Legend

Water 01/06/2020
- Hydrant
- Main Fitting
- Service Fitting
- Main Valve
- Service Valve
- Wellhead
- Main Line
- Service Line
- Tie

Sewer 01/06/2020
- Force Fitting, Main Fitting, Service Fitting, Manhole
- Force Main, Gravity Main, Service Line, Tie
- DBox, Grease Trap, Lift Station, Oil/Water

Electric 01/07/2020
- Connection Box, Handhole, Junction Box, Manhole, Meter, Switch, or Transformer
- Inservice/Abandoned
- Vault

Gas 01/06/2020
- Main Fitting, Main Valve, Meter, Rectifier, Service Fitting, Service Regulator, Service Valve, Test Station, Anode
- Main, Service, Tie, Cathodic Loop

Stormwater 12/11/2019
- Catch Basin
- Outfall
- Manhole
- Pipe, Culvert
- Irrigation Well
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOCs 20 and 21 Current Subsurface Features
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

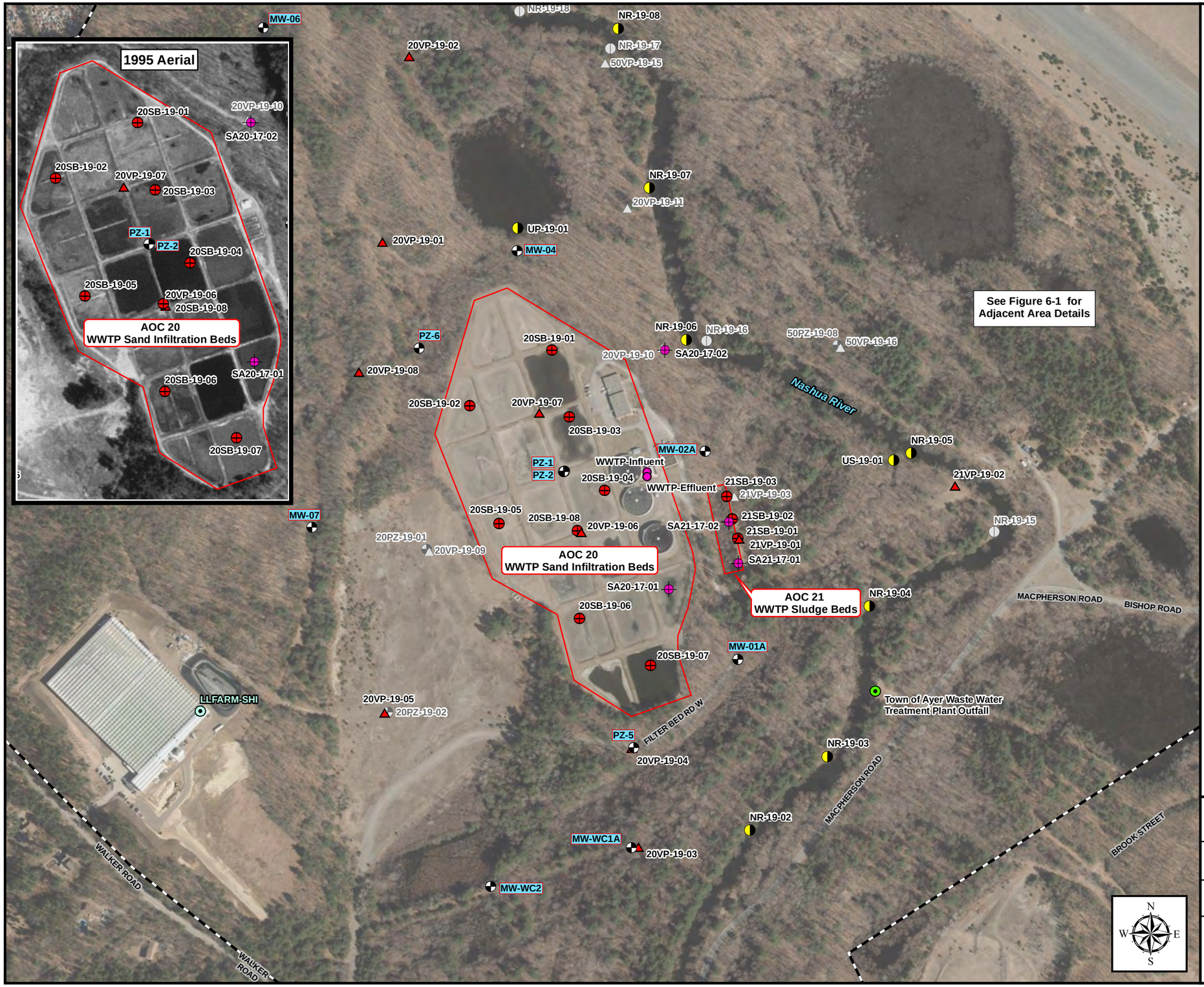
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400
Feet

Date: 01/11/2021

Figure 3-3

File: PFAS_RI_A3_PSCS_F3-3_AOC20_21_SubsurfaceUtilities.mxd



Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Soil Boring Location Installation Phase 1
- Surface Water and Sediment Sampling Location
- Temporary Well Location from SI
- Monitoring Well/Piezometer Not Completed
- Soil Boring Location Not Completed
- Vertical Profiling Location Not Completed
- Surface Water and Sediment Sampling Location Not Completed
- Irrigation Well
- MW-04 Wells Sampled as Part of PFAS RI
- Area of Contamination
- Former Fort Devens Boundary

Notes:

Locations shown on current and 1995 Aerial Imagery.

Nashua River Sample (NR-XX) addressed as part of AOC 50.

Aerial Source: USGS, MassGIS Orthoimagery 1995 and 2019

AOCs 20 and 21 Field Activities
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

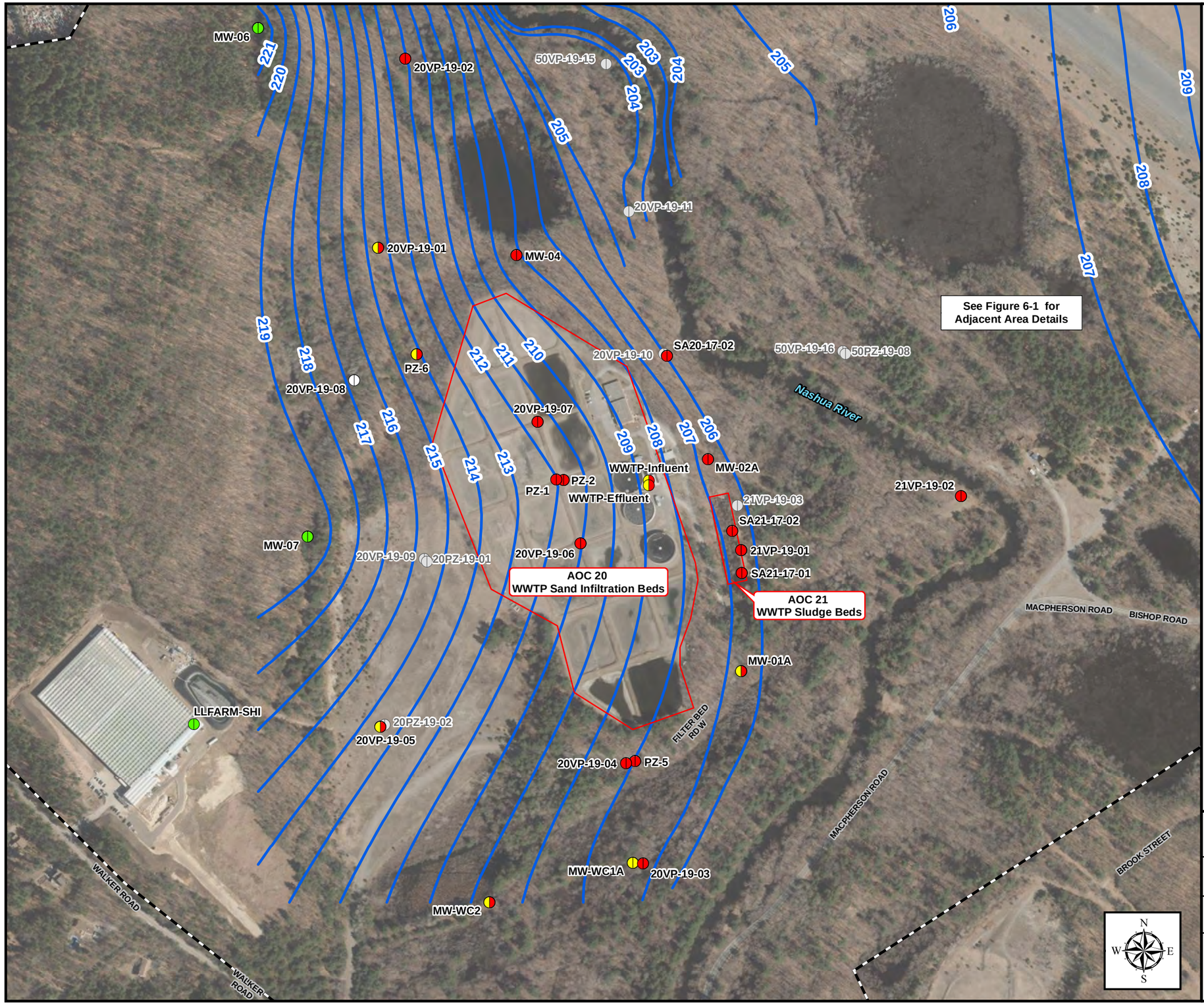
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400
Feet

Date: 02/03/2021

Figure 3-4

File: PFAS_RI_A3_PSCS_F3-4_AOC20_21_FieldActivities.mxd



Legend

- Monitoring Well/Vertical Profiling Location
- Piezometer/Vertical Profiling Locations Not Completed

EPA LHA
(sum of PFOA and PFOS) (ng/L)

- EPA LHA ≥ 70 ng/L
- EPA LHA < 70 ng/L
- EPA LHA No detection

MassDEP
(sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA) (ng/L)

- MassDEP ≥ 20 ng/L
- MassDEP < 20ng/L
- MassDEP no detection
- Groundwater Contour (April 27, 2020) (Contour Interval = 1 Foot) (ft NAVD88)
- Area of Contamination
- Former Fort Devens Boundary

Notes:

Vertical Profile 20VP-19-08 was attempted but no saturated overburden was encountered.

MassDEP GW-1 = sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA
MassDEP Exceedance Criteria is defined as equal to or greater than 20 ng/L

EPA LHA (Lifetime Health Advisory) = sum of PFOA and PFOS
EPA LHA Exceedance Criteria is defined as equal to or greater than 70 ng/L

SI GW results were not analyzed for PFDA.

Refer to Figure 2-9 for Groundwater Elevation Data

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOCs 20 and 21 Groundwater Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400
Feet

Date: 01/14/2021

Figure 3-5

File: PFAS_RI_A3_PSCS_F3-5_AOC20_21_GWResults.mxd

Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Soil Boring Location Installation Phase 1
- Surface Water and Sediment Sampling Location
- Temporary Well Location from SI
- Irrigation Well
- Cross Section Location
- Area of Contamination
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOCs 20 and 21 Cross Section Locations
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

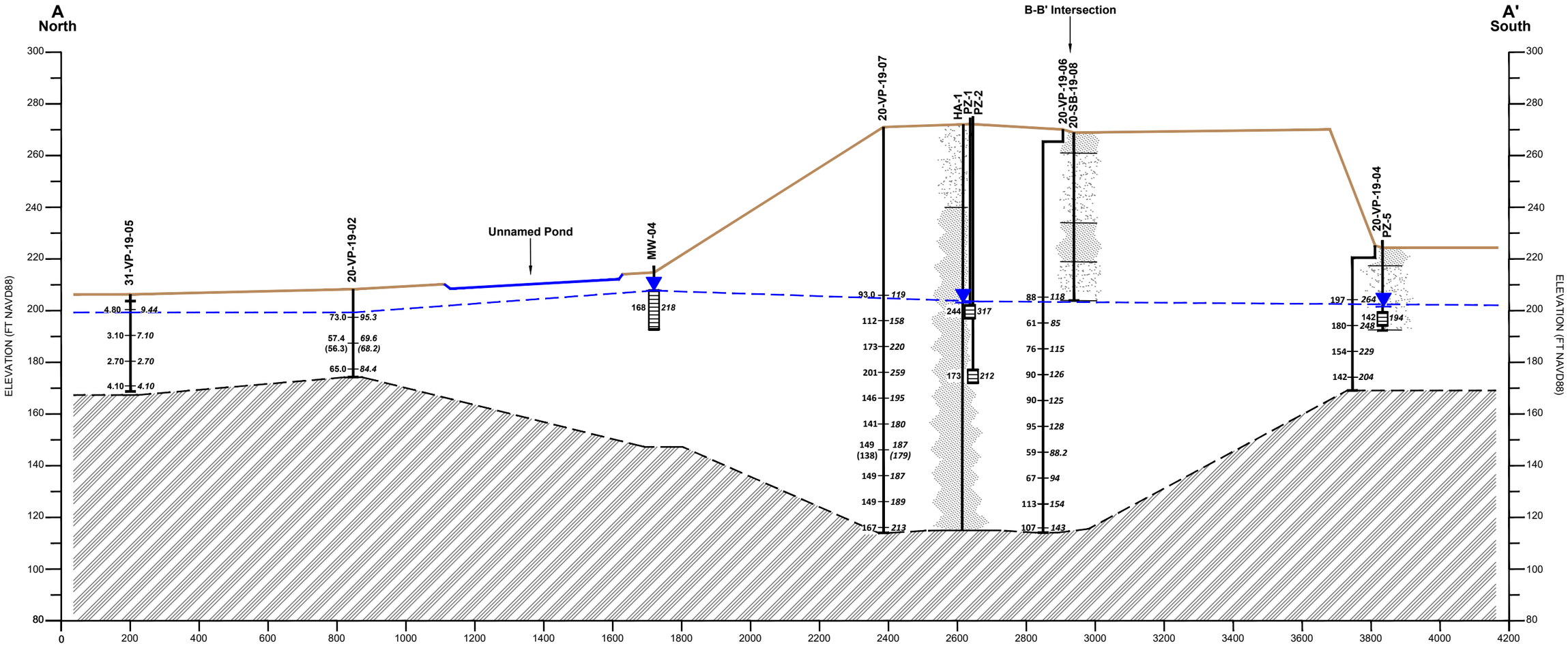
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 250 500
Feet

Date: 01/11/2021

Figure 3-6

File: PFAS_RI_A3_PSCS_F3-6_AOC20_21_XSLoc.mxd



Legend

Vertical Profile

1.39 U
EPA LHA Concentration (sum of PFOA and PFOS)

2.59 U
MassDEP Concentration (sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA)

Monitoring Well

Screened Interval

Medium to Coarse Sand

Fine Sand

Bedrock

Unknown

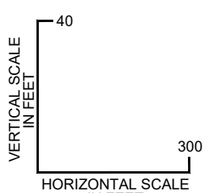
Water Table

Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
NS = no sample
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

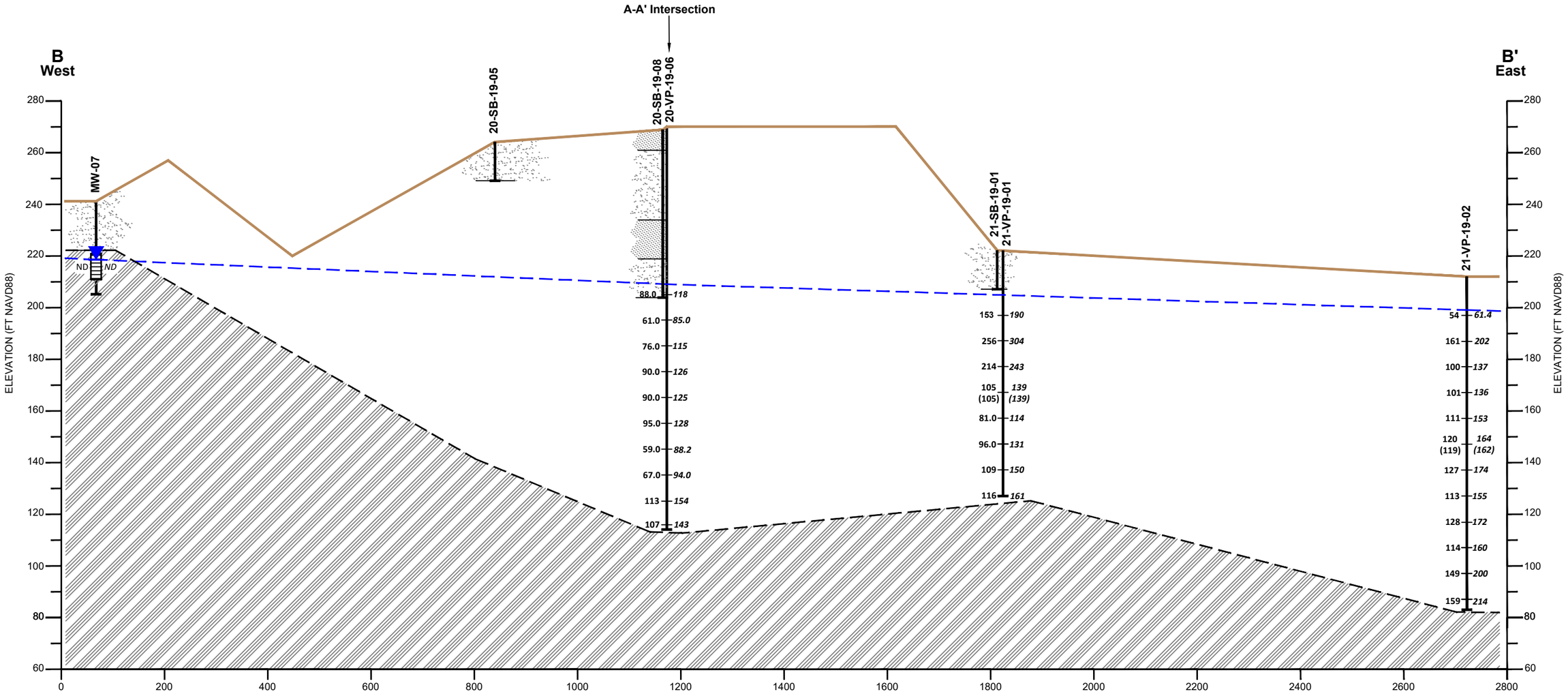


AOCs 20 and 21 Cross Section A-A'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/09/2020	Figure 3-7	KGS



Legend

Vertical Profile

1.39 U
EPA LHA
Concentration
(sum of PFOA
and PFOS)

2.59 U
MassDEP
Concentration
(sum of PFOS + PFOA
+ PFDA + PFHpA +
PFHxS + PFNA)

Monitoring Well

Screened
Interval

Medium - Coarse Sand

Silt

Bedrock

Unknown

Water Table

Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

VERTICAL SCALE IN FEET: 40

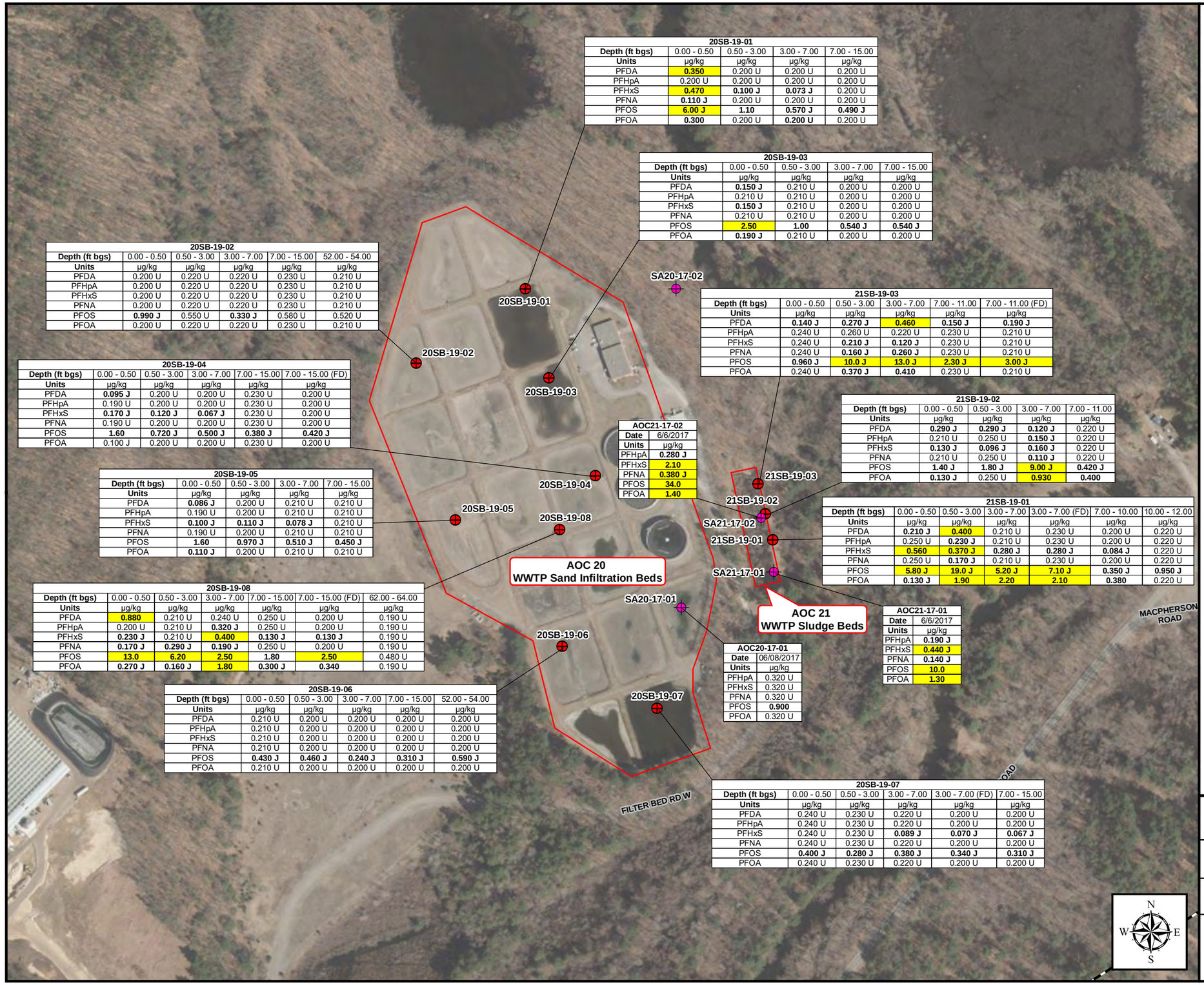
HORIZONTAL SCALE IN FEET: 200

AOCs 20 and 21 Cross Section B-B'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/09/2020	Figure 3-8	KGS



20SB-19-01

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.350**	0.200 U	0.200 U	0.200 U
PFHpA	0.200 U	0.200 U	0.200 U	0.200 U
PFHxS	**0.470**	**0.100 J**	**0.073 J**	0.200 U
PFNA	**0.110 J**	0.200 U	0.200 U	0.200 U
PFOS	**6.00 J**	**1.10**	**0.570 J**	**0.490 J**
PFOA	**0.300**	0.200 U	**0.200 U**	0.200 U

20SB-19-03

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.150 J**	0.210 U	0.200 U	0.200 U
PFHpA	0.210 U	0.210 U	0.200 U	0.200 U
PFHxS	**0.150 J**	0.210 U	0.200 U	0.200 U
PFNA	0.210 U	0.210 U	0.200 U	0.200 U
PFOS	**2.50**	**1.00**	**0.540 J**	**0.540 J**
PFOA	**0.190 J**	0.210 U	0.200 U	0.200 U

20SB-19-02

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	52.00 - 54.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
PFHpA	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
PFHxS	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
PFNA	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
PFOS	**0.990 J**	0.550 U	**0.330 J**	0.580 U	0.520 U
PFOA	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U

21SB-19-03

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 11.00	7.00 - 11.00 (FD)
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.140 J**	**0.270 J**	**0.460**	**0.150 J**	**0.190 J**
PFHpA	0.240 U	0.260 U	0.220 U	0.230 U	0.210 U
PFHxS	0.240 U	**0.210 J**	**0.120 J**	0.230 U	0.210 U
PFNA	0.240 U	**0.160 J**	**0.260 J**	0.230 U	0.210 U
PFOS	**0.960 J**	**10.0 J**	**13.0 J**	**2.30 J**	**3.00 J**
PFOA	0.240 U	**0.370 J**	**0.410**	0.230 U	0.210 U

20SB-19-04

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00 (FD)
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.095 J**	0.200 U	0.200 U	0.230 U	0.200 U
PFHpA	0.190 U	0.200 U	0.200 U	0.230 U	0.200 U
PFHxS	**0.170 J**	**0.120 J**	**0.067 J**	0.230 U	0.200 U
PFNA	0.190 U	0.200 U	0.200 U	0.230 U	0.200 U
PFOS	**1.60**	**0.720 J**	**0.500 J**	**0.380 J**	**0.420 J**
PFOA	0.100 J	0.200 U	0.200 U	0.230 U	0.200 U

AOC21-17-02

Date	6/6/2017
Units	µg/kg
PFHpA	**0.280 J**
PFHxS	**2.10**
PFNA	**0.380 J**
PFOS	**34.0**
PFOA	**1.40**

21SB-19-02

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 11.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.290 J**	**0.290 J**	**0.120 J**	0.220 U
PFHpA	0.210 U	0.250 U	**0.150 J**	0.220 U
PFHxS	**0.130 J**	**0.096 J**	**0.160 J**	0.220 U
PFNA	0.210 U	0.250 U	**0.110 J**	0.220 U
PFOS	**1.40 J**	**1.80 J**	**9.00 J**	**0.420 J**
PFOA	**0.130 J**	0.250 U	**0.930**	**0.400**

20SB-19-05

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.086 J**	0.200 U	0.210 U	0.210 U
PFHpA	0.190 U	0.200 U	0.210 U	0.210 U
PFHxS	**0.100 J**	**0.110 J**	**0.078 J**	0.210 U
PFNA	0.190 U	0.200 U	0.210 U	0.210 U
PFOS	**1.60**	**0.970 J**	**0.510 J**	**0.450 J**
PFOA	**0.110 J**	0.200 U	0.210 U	0.210 U

21SB-19-01

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	3.00 - 7.00 (FD)	7.00 - 10.00	10.00 - 12.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.210 J**	**0.400**	0.210 U	0.230 U	0.200 U	0.220 U
PFHpA	0.250 U	**0.230 J**	0.210 U	0.230 U	0.200 U	0.220 U
PFHxS	**0.560**	**0.370 J**	**0.280 J**	**0.280 J**	**0.084 J**	0.220 U
PFNA	0.250 U	**0.170 J**	0.210 U	0.230 U	0.200 U	0.220 U
PFOS	**5.80 J**	**19.0 J**	**5.20 J**	**7.10 J**	**0.350 J**	**0.950 J**
PFOA	**0.130 J**	**1.90**	**2.20**	**2.10**	**0.380**	0.220 U

20SB-19-08

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00 (FD)	62.00 - 64.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.880**	0.210 U	0.240 U	0.250 U	0.200 U	0.190 U
PFHpA	0.200 U	0.210 U	**0.320 J**	0.250 U	0.200 U	0.190 U
PFHxS	**0.230 J**	0.210 U	**0.400**	**0.130 J**	**0.130 J**	0.190 U
PFNA	**0.170 J**	**0.290 J**	**0.190 J**	0.250 U	0.200 U	0.190 U
PFOS	**13.0**	**6.20**	**2.50**	**1.80**	**2.50**	0.480 U
PFOA	**0.270 J**	**0.160 J**	**1.80**	**0.300 J**	**0.340**	0.190 U

AOC21-17-01

Date	6/6/2017
Units	µg/kg
PFHpA	**0.190 J**
PFHxS	**0.440 J**
PFNA	**0.140 J**
PFOS	**10.0**
PFOA	**1.30**

AOC20-17-01

Date	06/08/2017
Units	µg/kg
PFHpA	0.320 U
PFHxS	0.320 U
PFNA	0.320 U
PFOS	**0.900**
PFOA	0.320 U

20SB-19-06

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	52.00 - 54.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
PFHpA	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
PFHxS	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
PFNA	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
PFOS	**0.430 J**	**0.460 J**	**0.240 J**	**0.310 J**	**0.590 J**
PFOA	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U

20SB-19-07

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	3.00 - 7.00 (FD)	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
PFHpA	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
PFHxS	0.240 U	0.230 U	**0.089 J**	**0.070 J**	**0.067 J**
PFNA	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
PFOS	**0.400 J**	**0.280 J**	**0.380 J**	**0.340 J**	**0.310 J**
PFOA	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U

Legend

- Soil Boring Location Installation Phase 1
- Temporary Well Location from SI
- Area of Contamination
- Former Fort Devens Boundary

Notes:

Criteria = S-1/GW-1,Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

PFAS	Limits (µg/kg)
Perfluorodecanoic acid (PFDA)	0.300
Perfluoroheptanoic acid (PFHpA)	0.500
Perfluorohexanesulfonic acid (PFHxS)	0.300
Perfluorononanoic acid (PFNA)	0.320
Perfluorooctanesulfonic acid (PFOS)	2.00
Perfluorooctanoic acid (PFOA)	0.720

2.00 = detection of PFAS

2.00 = detection of PFAS above criteria

Data reported to three significant figures

µg/kg = micrograms per kilogram
U = non-detect
J = estimated result

AST = Above ground storage tank
UST = Underground storage Tank
DRMO = Defense Reutilization and Marketing Office
TPHC = Total petroleum hydrocarbons

SI Sample locations were not analyzed for PFDA

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOCs 20 and 21 Soil Sampling Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 150 300
Feet

Date: 10/12/2020

Figure 3-9

File: PFAS_RI_A3_PSCS_F3-9_AOC20_21_SoilResults.mxd

NR-19-14		
Sample	10/18/2019	
Units	ng/L	µg/kg
PFBS	**1.80**	0.300 U
PFOS	**6.10**	**1.60 J**
PFOA	**10.0**	**0.170 J**

NR-19-11				
Sample	10/14/2019			
Units	ng/L	ng/L (FD)	µg/kg	µg/kg (FD)
PFBS	**7.40**	**7.20**	0.280 U	0.290 U
PFOS	**8.20**	**7.90**	**1.20 J**	**1.20 J**
PFOA	**13.0**	**14.0**	0.310 U	0.330 U

NR-19-12		
Sample	10/14/2019	
Units	ng/L	µg/kg
PFBS	**6.80**	0.400 U
PFOS	**8.20**	**5.20**
PFOA	**14.0**	**0.340 J**

NR-19-13		
Sample	10/14/2019	
Units	ng/L	µg/kg
PFBS	**6.60**	0.210 U
PFOS	**10.0**	1.20 U
PFOA	**15.0**	0.240 U

NR-19-10		
Sample	10/15/2019	
Units	ng/L	µg/kg
PFBS	**7.30**	0.260 U
PFOS	**8.10**	**0.720 J**
PFOA	**15.0**	**0.140 J**

NR-19-09		
Sample	10/15/2019	
Units	ng/L	µg/kg
PFBS	**8.10**	0.240 U
PFOS	**9.00**	**0.700 J**
PFOA	**17.0**	0.270 U

NR-19-08		
Sample	10/15/2019	
Units	ng/L	µg/kg
PFBS	**7.90**	0.310 U
PFOS	**8.10**	**2.10**
PFOA	**17.0**	**0.570**

NR-19-07		
Sample	10/15/2019	
Units	ng/L	µg/kg
PFBS	**7.70**	0.290 U
PFOS	**10.0**	**2.10**
PFOA	**15.0**	0.320 U

AFW-19-02		
Sample	10/18/2019	
Units	ng/L	µg/kg
PFBS	**1.50 J**	1.10 U
PFOS	**13.0**	**16.0**
PFOA	**9.30**	**1.20 J**

UP-19-01		
Sample	10/17/2019	
Units	ng/L	µg/kg
PFBS	**3.10**	0.230 U
PFOS	**82.0**	1.30 U
PFOA	**19.0**	0.260 U

AFW-19-01		
Sample	10/18/2019	
Units	ng/L	µg/kg
PFBS	**0.510 J**	0.980 U
PFOS	**6.70**	**5.30 J**
PFOA	**4.50**	**0.770 J**

NR-19-06		
Sample	10/15/2019	
Units	ng/L	µg/kg
PFBS	**8.40**	0.220 U
PFOS	**56.0**	**0.930 J**
PFOA	**28.0**	0.240 U

NR-19-05		
Sample	10/16/2019	
Units	ng/L	µg/kg
PFBS	**9.20**	0.400 U
PFOS	**7.20**	**1.80 J**
PFOA	**15.0**	0.440 U

NR-19-04		
Sample	10/16/2019	
Units	ng/L	µg/kg
PFBS	**9.70**	0.300 U
PFOS	**6.40**	**2.90**
PFOA	**16.0**	**0.360 J**

US-19-01	
Sample	10/18/2019
Units	µg/kg
PFBS	0.480 U
PFOS	**6.70**
PFOA	**0.460 J**

NR-19-03		
Sample	10/16/2019	
Units	ng/L	µg/kg
PFBS	**9.70**	0.460 U
PFOS	**6.10**	**1.30 J**
PFOA	**16.0**	**0.360 J**

NR-19-02				
Sample	10/16/2019			
Units	ng/L	ng/L (FD)	µg/kg	µg/kg (FD)
PFBS	**9.90**	**11.0**	0.290 U	0.300 U
PFOS	**6.40**	**6.80**	**1.80**	**2.10**
PFOA	**16.0**	**13.0**	**0.330 J**	**0.400 J**

NR-19-01		
Sample	10/17/2019	
Units	ng/L	µg/kg
PFBS	**7.10**	0.590 U
PFOS	**7.90**	**4.20**
PFOA	**13.0**	**0.590 J**

NR-19-14 NR-19-13 NR-19-22 NR-19-11 NR-19-12 NR-19-21 NR-19-20 NR-19-10 NR-19-19 NR-19-09 NR-19-18 NR-19-08 NR-19-17 NR-19-07 UP-19-01 NR-19-06 NR-19-16 NR-19-05 US-19-01 NR-19-15 NR-19-04 NR-19-03 NR-19-02 NR-19-01 AFW-19-02 AFW-19-01

GROTON SHIRLEY Brook Walker Brook Morse Brook Nashua River Nonacoicus Brook Willow Brook Cold Spring Brook Bowers Brook SHIRLEY AYER AYER HARVARD

Former North Post Former Main Post Former Main Post

Plow Shop Pond School House Pond Grove Pond Robbins Pond

N W E S

Legend

- Surface Water and Sediment Sampling Location
- Surface Water and Sediment Sampling Location Not Completed
- Surface Water Flow Direction
- City/Town Boundary
- Former Fort Devens Boundary

National Hydrography Dataset

- Stream/River
- Lake/Pond
- Swamp/Marsh

Aerial Source:
USGS, MassGIS Orthoimagery 2019

EPA PFAS Site Specific Screening Levels for Former Fort Devens			
Surface Water		Sediment	
Units:	ng/L	Units:	µg/kg
PFOA	2,030	PFOA	609
PFOS	2,030	PFOS	609
PFBS	2,030,000	PFBS	609,000

Notes:
Perfluorooctane Sulfonic Acid (PFOS)
Perfluorooctanoic Acid (PFOA)
ng/L = nanograms per liter
(Surface Water Result Value)
µg/kg = microgram per kilogram
(Sediment Result Value)

J = estimated result
U= not detected above the reported sample quantitation limit
Bold = detection

Area 3 Surface Water and Sediment Sampling Results
Devens PFAS RI - Area 3 PSCS

Former Army Installation Devens
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 750 1,500
Feet

Date: 02/03/2021

Figure 3-10

File: PFAS_RI_A3_PSCS_F3-10_SWSDResults-NR_AFW.mxd

Legend

- Current Road
- Approximate Areas of Sludge Application
- Former Fort Devens Boundary

Aerial Source: MassGIS - 1:5,000 Black and White Digital Orthophoto Images - 1992

Airfield 1992 Aerial Imagery
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

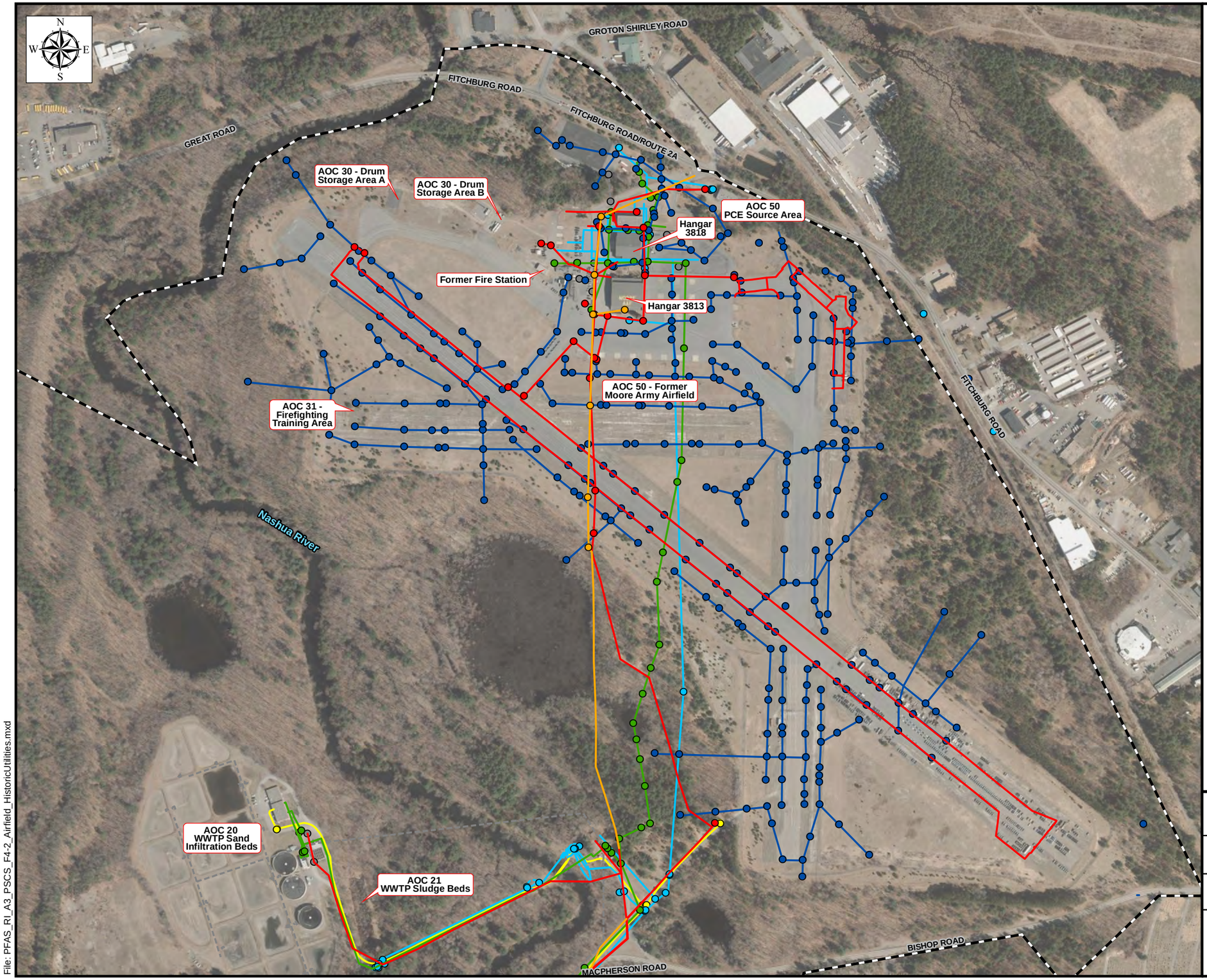
0 250 500
Feet

Date: 10/12/2020

Figure 4-1

KGS

File: PFAS_RI_A3_PSCS_F4-1_AIRFIELD_1992_Imagery.mxd



Legend

Historic Subsurface Features

- Communication
- Communication Line
- Electric
- Electric Line
- Storm
- Storm Line
- Storm Feature
- Sanitary
- Sanitary Line
- Sanitary Feature
- Water
- Water Line
- Water Feature
- Abandoned Feature
- Abandoned Line
- Gas
- Gas Line
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

Airfield Historic Subsurface Features
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

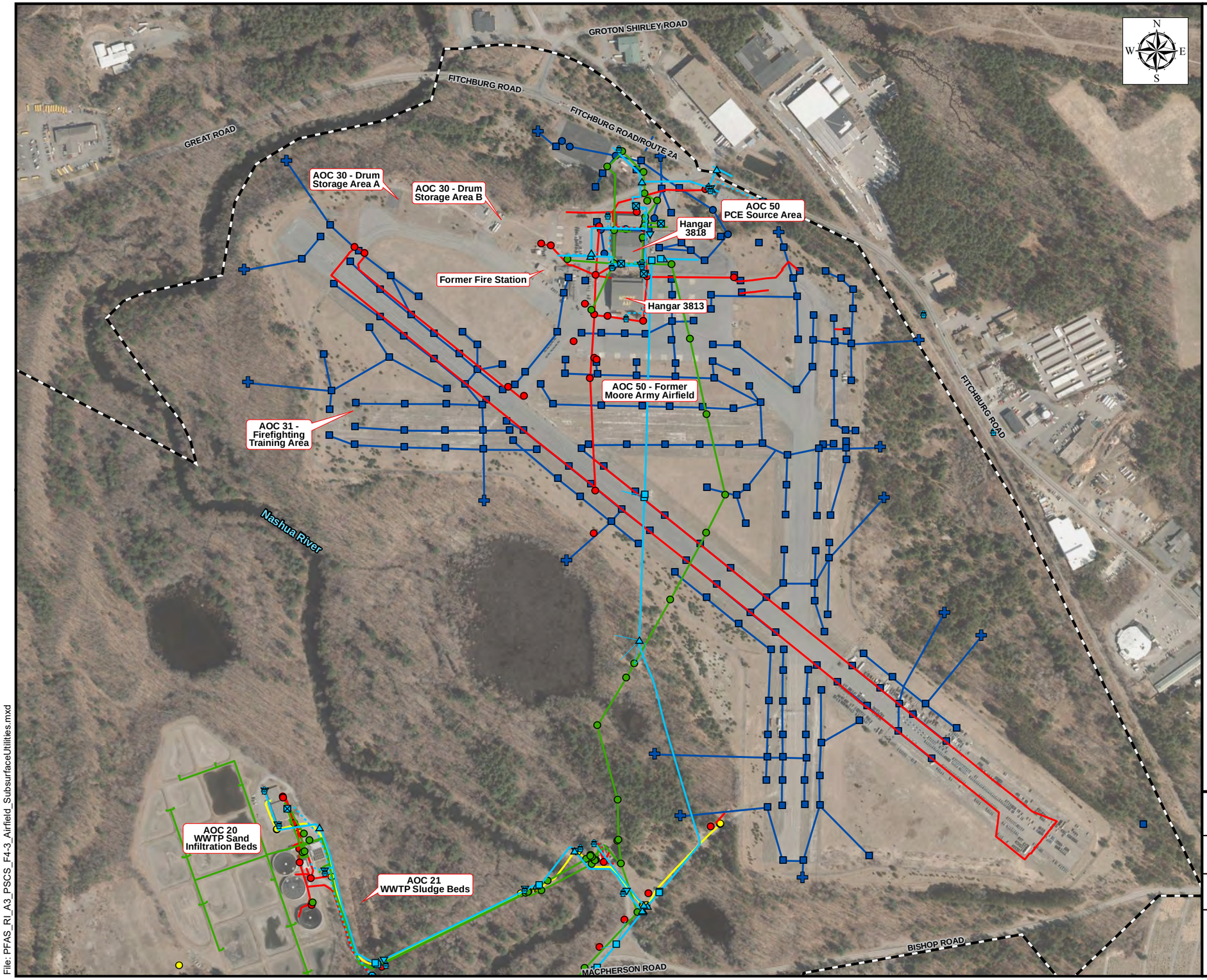
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 250 500
Feet

Date: 02/03/2021

Figure 4-2

File: PFAS_RI_A3_PSCS_F4-2_Airfield_HistoricUtilities.mxd



Legend

Water 01/06/2020
- Hydrant
- Main Fitting
- Service Fitting
- Main Valve
- Service Valve
- Wellhead
- Main Line
- Service Line
- Tie

Sewer 01/06/2020
- Force Fitting, Main Fitting, Service Fitting, Manhole
- Force Main, Gravity Main, Service Line, Tie
- DBox, Grease Trap, Lift Station, Oil/Water

Electric 01/07/2020
- Connection Box, Handhole, Junction Box, Manhole, Meter, Switch, or Transformer
- Inservice/Abandoned
- Vault

Gas 01/06/2020
- Main Fitting, Main Valve, Meter, Rectifier, Service Fitting, Service Regulator, Service Valve, Test Station, Anode
- Main, Service, Tie, Cathodic Loop

Stormwater 12/11/2019
- Catch Basin
- Outfall
- Manhole
- Pipe, Culvert
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

Airfield Current Subsurface Features
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

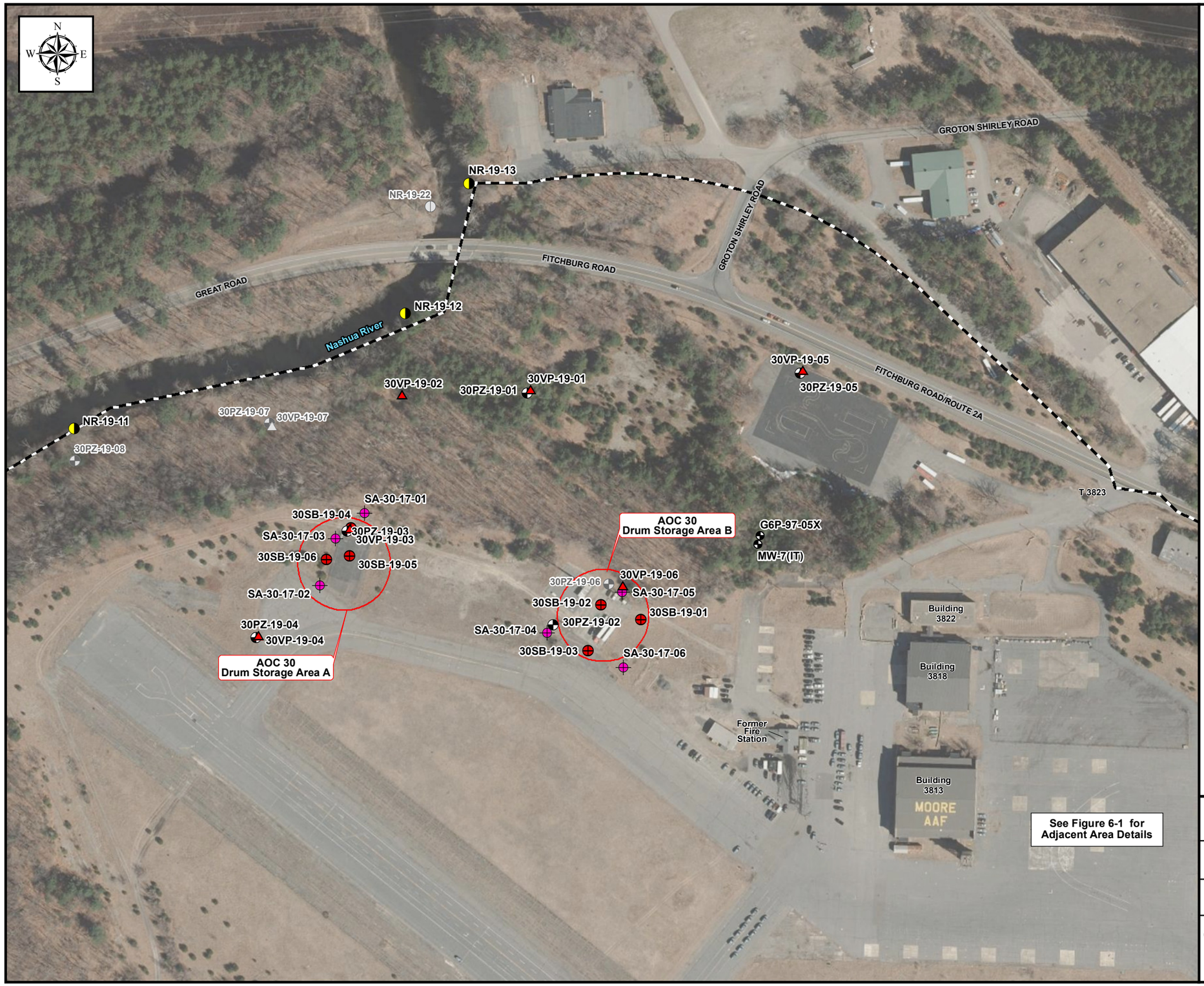
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 250 500
Feet

Date: 02/04/2021

Figure 4-3

File: PFAS_RI_A3_PSCS_F4-3_Airfield_SubsurfaceUtilities.mxd



Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Soil Boring Location Installation Phase 1
- Surface Water and Sediment Sampling
- Temporary Well Location from SI
- Monitoring Well/Piezometer Not Completed
- Soil Boring Location Not Completed
- Vertical Profiling Location Not Completed
- Surface Water and Sediment Sampling Location Not Completed
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOC30 Field Activities
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

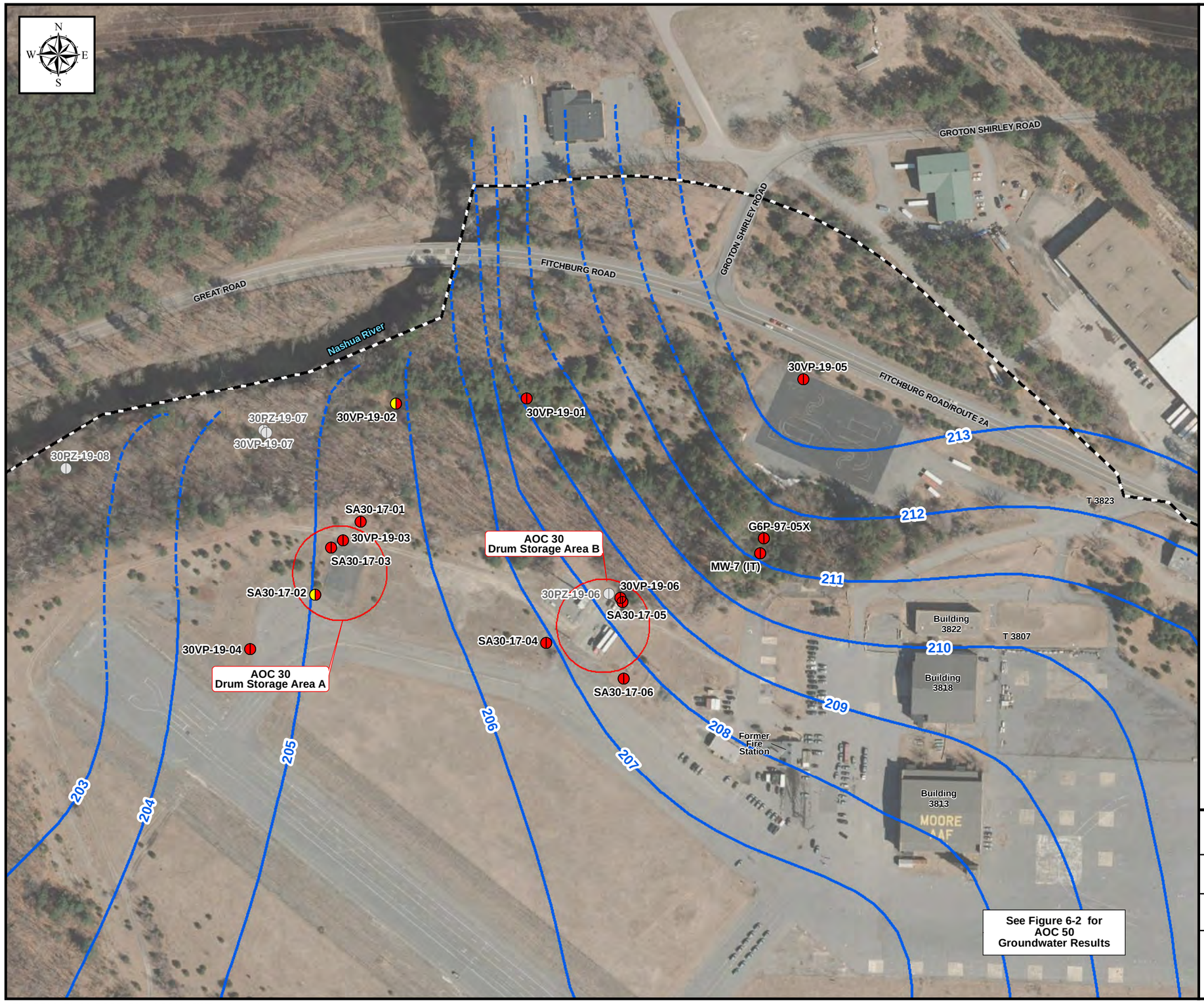
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 100 200
Feet

Date: 01/12/2021

Figure 4-4

File: PFAS_RI_A3_PSCS_F4-4_AOC30_FieldActivities.mxd



Legend

- Monitoring Well/Vertical Profiling Location
- Piezometer/Vertical Profiling Locations Not Completed

EPA LHA
(sum of PFOA and PFOS) (ng/L)

- EPA LHA ≥ 70 ng/L
- EPA LHA < 70 ng/L
- EPA LHA No detection

MassDEP
(sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA) (ng/L)

- MassDEP ≥ 20 ng/L
- MassDEP < 20ng/L
- MassDEP no detection
- Groundwater Contour (April 27, 2020) (Contour Interval = 1 Foot) (ft NAVD88)
- Inferred Groundwater Contour (April 27, 2020) (Contour Interval = 1 Foot) (ft NAVD88)
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Notes:

MassDEP GW-1 = sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA
MassDEP Exceedance Criteria is defined as equal to or greater than 20 ng/L

EPA LHA (Lifetime Health Advisory) = sum of PFOA and PFOS
EPA LHA Exceedance Criteria is defined as equal to or greater than 70 ng/L

SI GW results were not analyzed for PFDA.

Refer to Figure 2-9 for Groundwater Elevation Data

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOC30 Groundwater Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

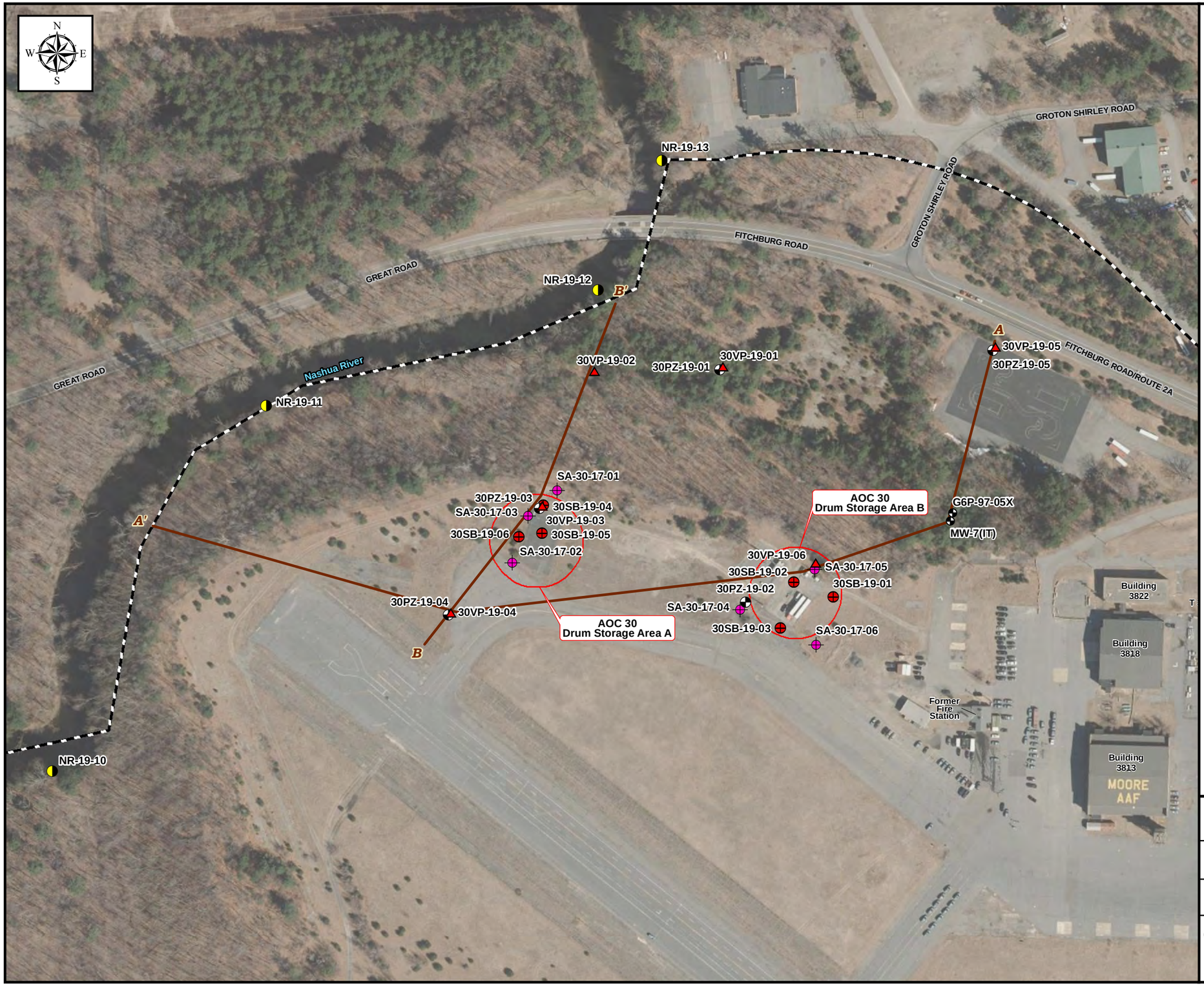
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 100 200
Feet

Date: 01/14/2021

Figure 4-5

File: PFAS_RI_A3_PSCS_F4-5_AOC30_GWResults.mxd



Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Soil Boring Location Installation Phase 1
- Surface Water and Sediment Sampling
- Temporary Well Location from SI
- Cross Section Location
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOC30 Cross Section Locations
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

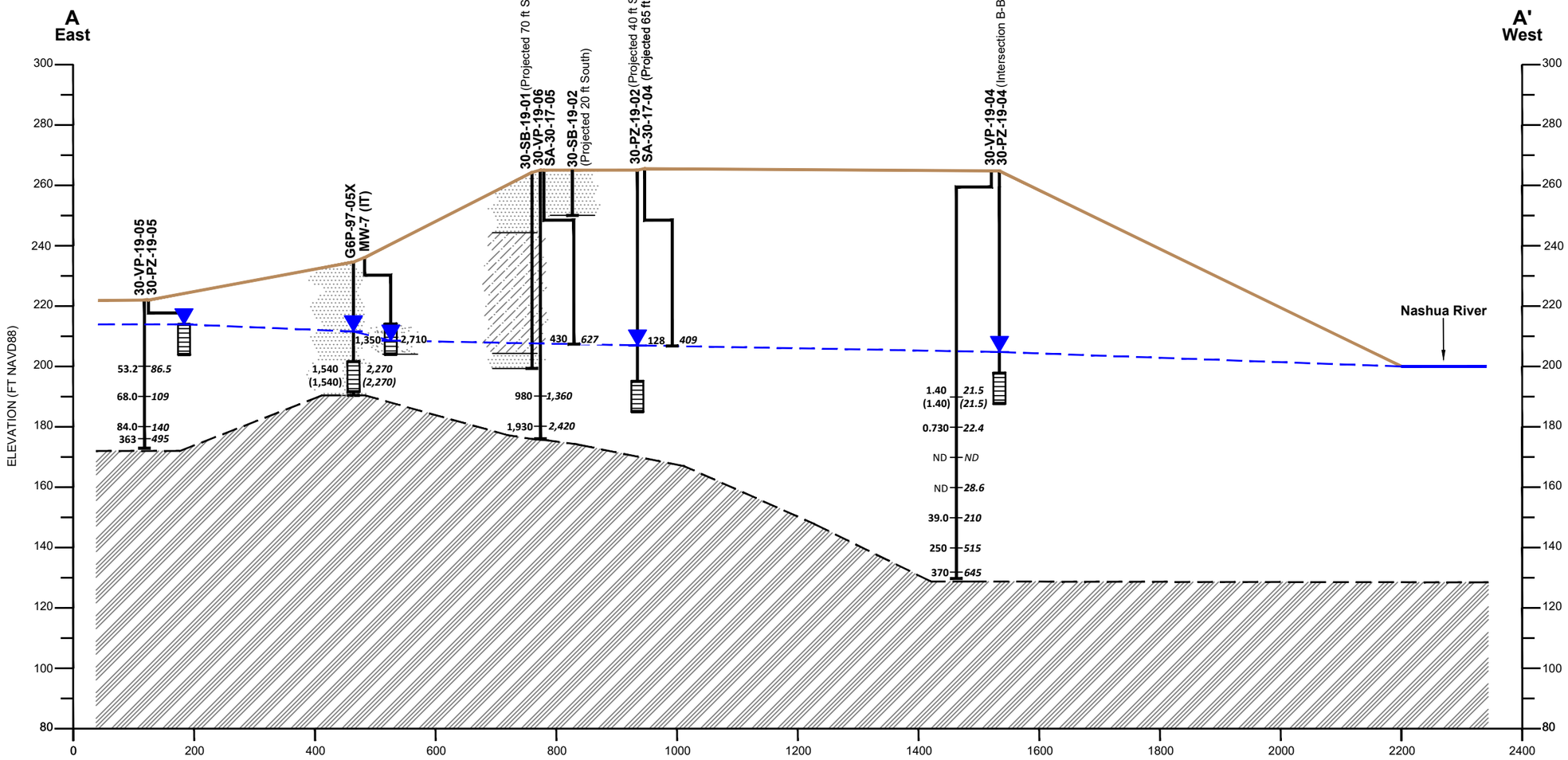
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 100 200
Feet

Date: 08/28/2020

Figure 4-6

File: PFAS_RI_A3_PSCS_F4-6_AOC30_XSLoc.mxd



Legend

Vertical Profile

1.39 U — EPA LHA Concentration (sum of PFOA and PFOS)

2.59 U — MassDEP Concentration (sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA)

Monitoring Well

Screened Interval

- Medium - Coarse Sand
- Silty Sand
- Fine Sand
- Bedrock
- Unknown
- Water Table
- Inferred Top of Bedrock

Notes:

SI results were not analyzed for PFDA

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
NS = no sample
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

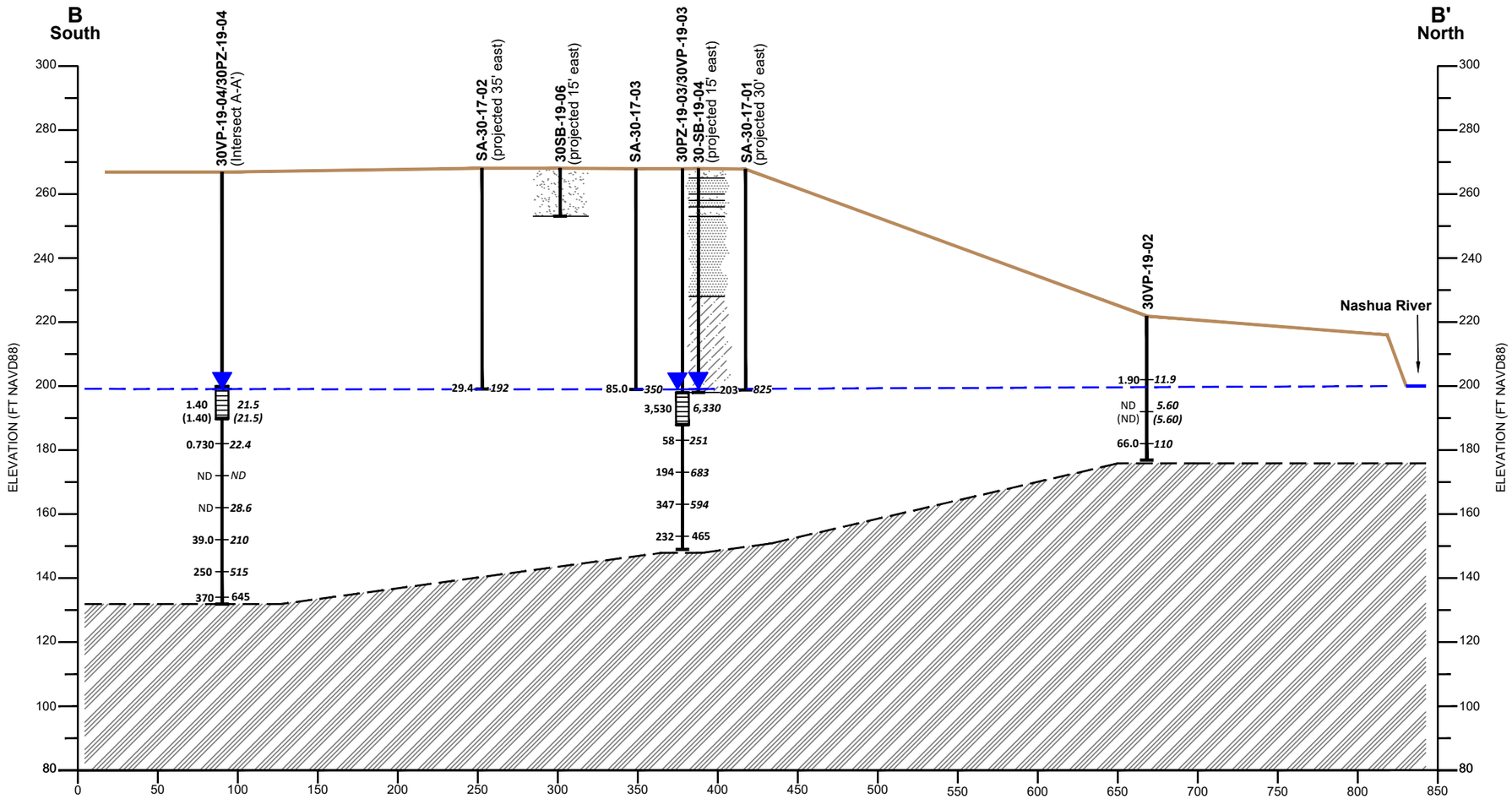
VERTICAL SCALE IN FEET: 40
HORIZONTAL SCALE IN FEET: 200

AOC 30 Cross Section A-A'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/09/2020	Figure 4-7	KGS



Legend

Vertical Profile

1.39 U
EPA LHA
Concentration
(sum of PFOA
and PFOS)

2.59 U
MassDEP
Concentration
(sum of PFOS + PFOA
+ PFDA + PFHpA +
PFHxS + PFNA)

Monitoring Well

Screened
Interval

Fine Sand

Medium - Coarse Sand

Sand with Silt/Silty Sand

Bedrock

Unknown

Water Table

Inferred Top of Bedrock

Notes:

SI results were not analyzed for PFDA

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
NS = no sample
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

VERTICAL SCALE IN FEET: 40

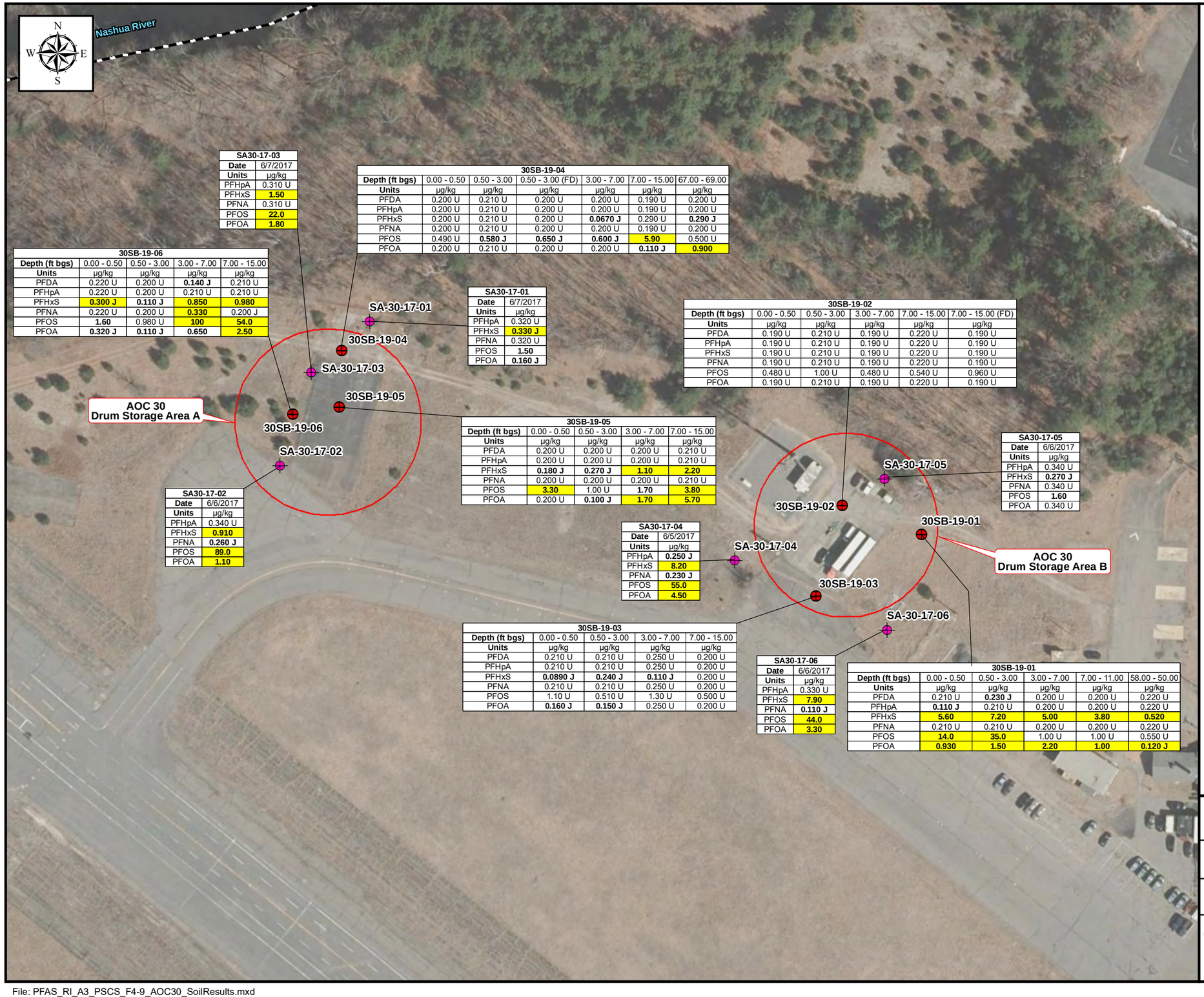
HORIZONTAL SCALE IN FEET: 80

AOC 30 Cross Section B-B'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/15/2020	Figure 4-8	KGS



SA30-17-03	
Date	6/7/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	**1.50**
PFNA	0.310 U
PFOS	**22.0**
PFOA	**1.80**

30SB-19-04						
Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	0.50 - 3.00 (FD)	3.00 - 7.00	7.00 - 15.00	67.00 - 69.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
PFHpA	0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
PFHxS	0.200 U	0.210 U	0.200 U	**0.0670 J**	0.290 U	**0.290 J**
PFNA	0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
PFOS	0.490 U	**0.580 J**	**0.650 J**	**0.600 J**	**5.90**	0.500 U
PFOA	0.200 U	0.210 U	0.200 U	0.200 U	**0.110 J**	**0.900**

30SB-19-06				
Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.220 U	0.200 U	**0.140 J**	0.210 U
PFHpA	0.220 U	0.200 U	0.210 U	0.210 U
PFHxS	**0.300 J**	**0.110 J**	**0.850**	**0.980**
PFNA	0.220 U	0.200 U	**0.330**	0.200 J
PFOS	0.980 U	**100**	**100**	**54.0**
PFOA	**0.320 J**	**0.110 J**	**0.650**	**2.50**

SA30-17-01	
Date	6/7/2017
Units	µg/kg
PFHpA	0.320 U
PFHxS	**0.330 J**
PFNA	0.320 U
PFOS	**1.50**
PFOA	**0.160 J**

30SB-19-02					
Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00 (FD)
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
PFHpA	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
PFHxS	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
PFNA	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
PFOS	0.480 U	1.00 U	0.480 U	0.540 U	0.960 U
PFOA	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U

30SB-19-05				
Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.200 U	0.200 U	0.200 U	0.210 U
PFHpA	0.200 U	0.200 U	0.200 U	0.210 U
PFHxS	**0.180 J**	**0.270 J**	**1.10**	**2.20**
PFNA	0.200 U	0.200 U	0.200 U	0.210 U
PFOS	**3.30**	1.00 U	**1.70**	**3.80**
PFOA	0.200 U	**0.100 J**	**1.70**	**5.70**

SA30-17-05	
Date	6/6/2017
Units	µg/kg
PFHpA	0.340 U
PFHxS	**0.270 J**
PFNA	0.340 U
PFOS	**1.60**
PFOA	0.340 U

SA30-17-02	
Date	6/6/2017
Units	µg/kg
PFHpA	0.340 U
PFHxS	**0.910**
PFNA	**0.260 J**
PFOS	**89.0**
PFOA	**1.10**

SA30-17-04	
Date	6/5/2017
Units	µg/kg
PFHpA	**0.250 J**
PFHxS	**8.20**
PFNA	**0.230 J**
PFOS	**55.0**
PFOA	**4.50**

30SB-19-03				
Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.210 U	0.210 U	0.250 U	0.200 U
PFHpA	0.210 U	0.210 U	0.250 U	0.200 U
PFHxS	**0.0890 J**	**0.240 J**	**0.110 J**	0.200 U
PFNA	0.210 U	0.210 U	0.250 U	0.200 U
PFOS	1.10 U	0.510 U	1.30 U	0.500 U
PFOA	**0.160 J**	**0.150 J**	0.250 U	0.200 U

SA30-17-06	
Date	6/6/2017
Units	µg/kg
PFHpA	0.330 U
PFHxS	**7.90**
PFNA	**0.110 J**
PFOS	**44.0**
PFOA	**3.30**

30SB-19-01					
Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 11.00	58.00 - 50.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.210 U	**0.230 J**	0.200 U	0.200 U	0.220 U
PFHpA	**0.110 J**	0.210 U	0.200 U	0.200 U	0.220 U
PFHxS	**5.60**	**7.20**	**5.00**	**3.80**	**0.520**
PFNA	0.210 U	0.210 U	0.200 U	0.200 U	0.220 U
PFOS	**14.0**	**35.0**	1.00 U	1.00 U	0.550 U
PFOA	**0.930**	**1.50**	**2.20**	**1.00**	**0.120 J**

Legend

- Soil Boring Location Installation Phase 1
- Temporary Well Location from SI
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Notes:

Criteria = S-1/GW-1,Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

PFAS	Limits (µg/kg)
Perfluorodecanoic acid (PFDA)	0.300
Perfluoroheptanoic acid (PFHpA)	0.500
Perfluorohexanesulfonic acid (PFHxS)	0.300
Perfluorononanoic acid (PFNA)	0.320
Perfluorooctanesulfonic acid (PFOS)	2.00
Perfluorooctanoic acid (PFOA)	0.720

2.00 = detection of PFAS

2.00 = detection of PFAS above criteria

Data reported to three significant figures

µg/kg = micrograms per kilogram
U = non-detect
J = estimated result

AST = Above ground storage tank
UST = Underground storage Tank
DRMO = Defense Reutilization and Marketing Office
TPHC = Total petroleum hydrocarbons

SI Sample locations were not analyzed for PFDA

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOC30 Soil Sampling Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 50 100
Feet

Date: 09/02/2020

Figure 4-9

File: PFAS_RI_A3_PSCS_F4-9_AOC30_SoilResults.mxd

Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Vertical Profiling Location Installation Phase 2
- Soil Boring Location Installation Phase 1
- Surface Water and Sediment Sampling
- Monitoring Well
- Temporary Well Location from SI
- Monitoring Well/Piezometer Not Completed
- Soil Boring Location Not Completed
- Vertical Profiling Location Not Completed
- Surface Water and Sediment Sampling Location Not Completed
- MW-6 Wells Sampled as Part of PFAS RI
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOC 31 Field Activities
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

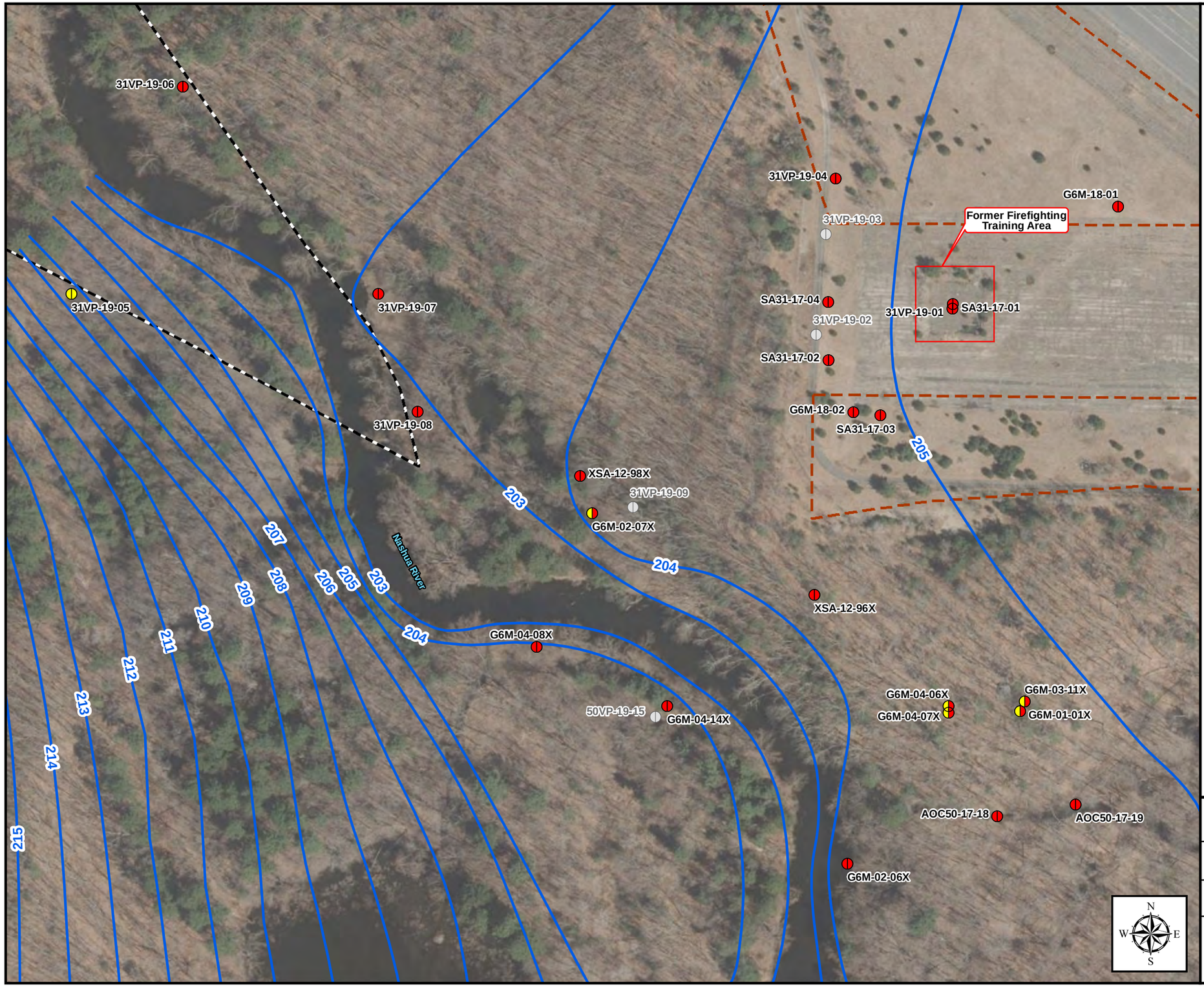
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 75 150
Feet

Date: 01/12/2021

Figure 5-1

File: PFAS_RI_A3_PSCS_F5-1_AOC31_FieldActivities.mxd



Legend

- Monitoring Well/Vertical Profiling Location
- Monitoring Well/Vertical Profiling Locations Not Completed

EPA LHA
(sum of PFOA and PFOS) (ng/L)

- EPA LHA ≥ 70 ng/L
- EPA LHA < 70ng/L
- EPA LHA no detection

MassDEP
(sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA) (ng/L)

- MassDEP ≥ 20 ng/L
- MassDEP < 20ng/L
- MassDEP no detection
- Groundwater Contour (April 27, 2020) (Contour Interval = 1 Foot) (ft NAVD88)
- Inferred Groundwater Contour (April 27, 2020) (Contour Interval = 1 Foot) (ft NAVD88)
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Notes:

MassDEP GW-1 = sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA
MassDEP Exceedance Criteria is defined as equal to or greater than 20 ng/L

EPA LHA (Lifetime Health Advisory) = sum of PFOA and PFOS
EPA LHA Exceedance Criteria is defined as equal to or greater than 70 ng/L

SI GW results were not analyzed for PFDA.

Refer to Figure 2-9 for Groundwater Elevation Data

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOC 31 Groundwater Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

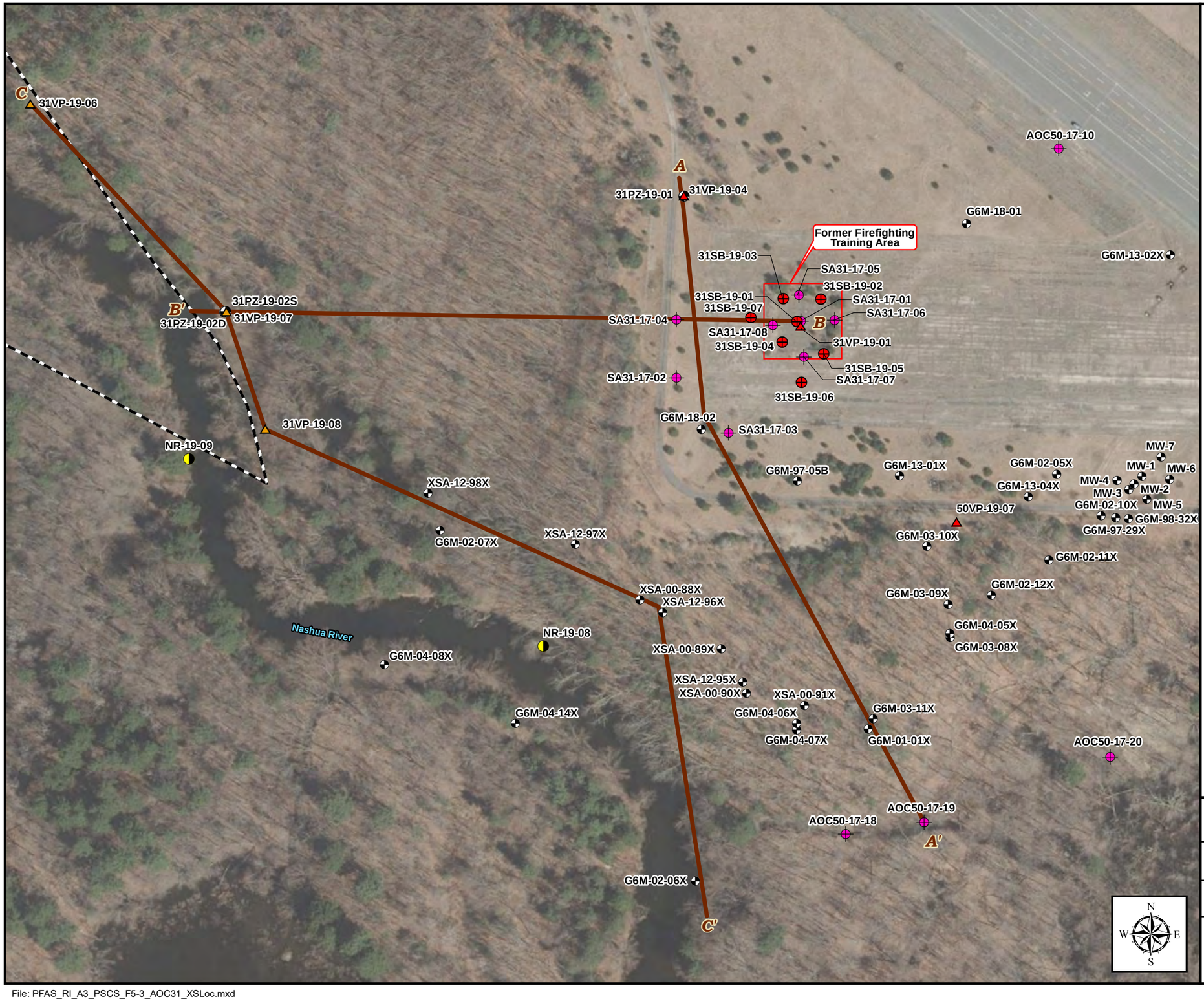
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 75 150
Feet

Date: 01/14/2021

Figure 5-2

File: PFAS_RI_A3_PSCS_F5-2_AOC31_GWResults.mxd



Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Vertical Profiling Location Installation Phase 2
- Soil Boring Location Installation Phase 1
- Surface Water and Sediment Sampling
- Temporary Well Location from SI
- Cross Section Location
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOC 31 Cross Section Locations
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

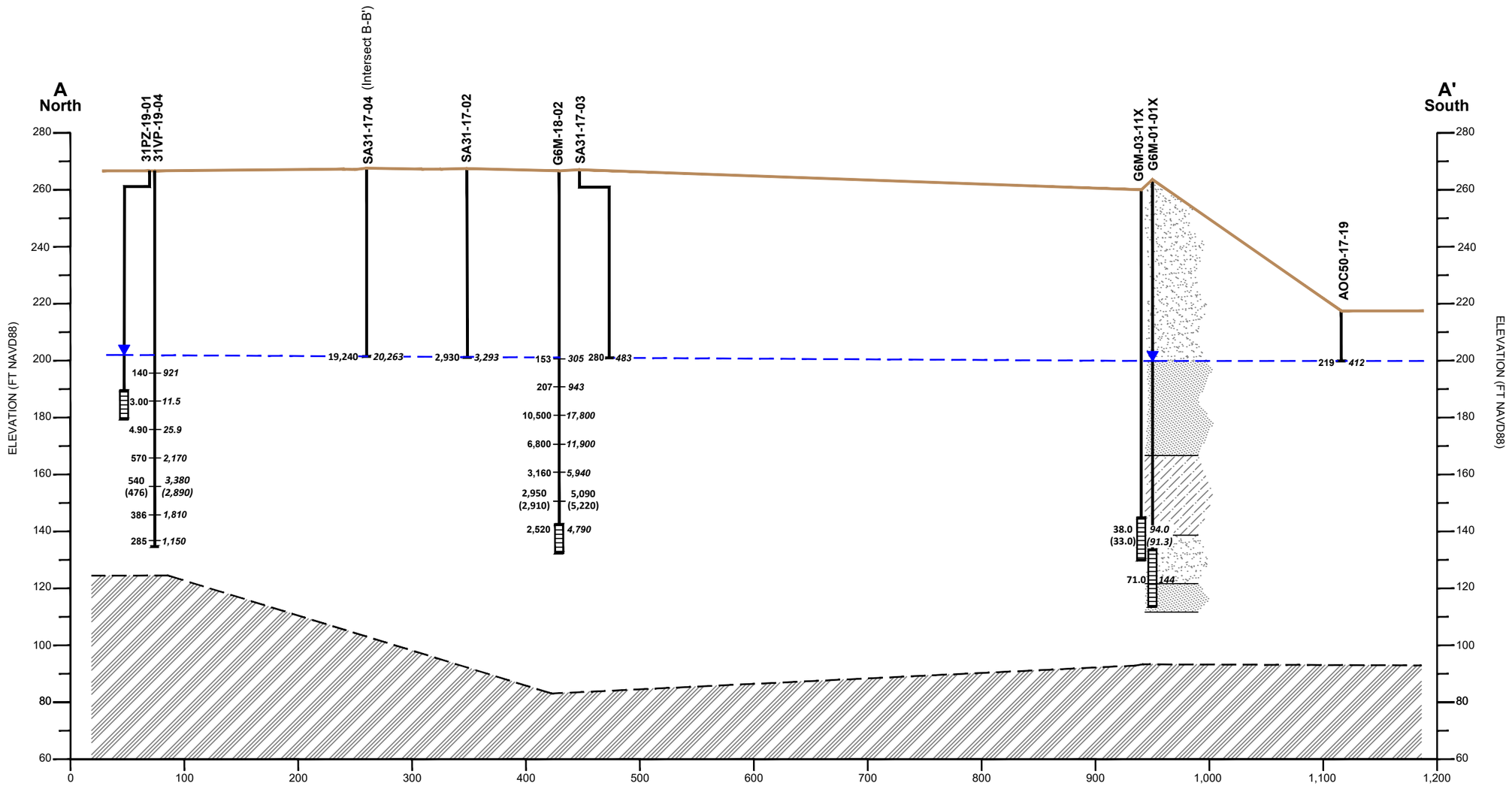
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 75 150
Feet

Date: 10/15/2020

Figure 5-3

File: PFAS_RI_A3_PSCS_F5-3_AOC31_XSLoc.mxd



Legend

Vertical Profile

1.39 U
EPA LHA
Concentration
(sum of PFOA
and PFOS)

2.59 U
MassDEP
Concentration
(sum of PFOS + PFOA
+ PFDA + PFHpA +
PFHxS + PFNA)

Monitoring Well

Screened
Interval

- Medium to Coarse Sand
- Fine Sand
- Sand with Silt/Silty Sand
- Till
- Bedrock
- Unknown
- Water Table
- Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
NS = no sample
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

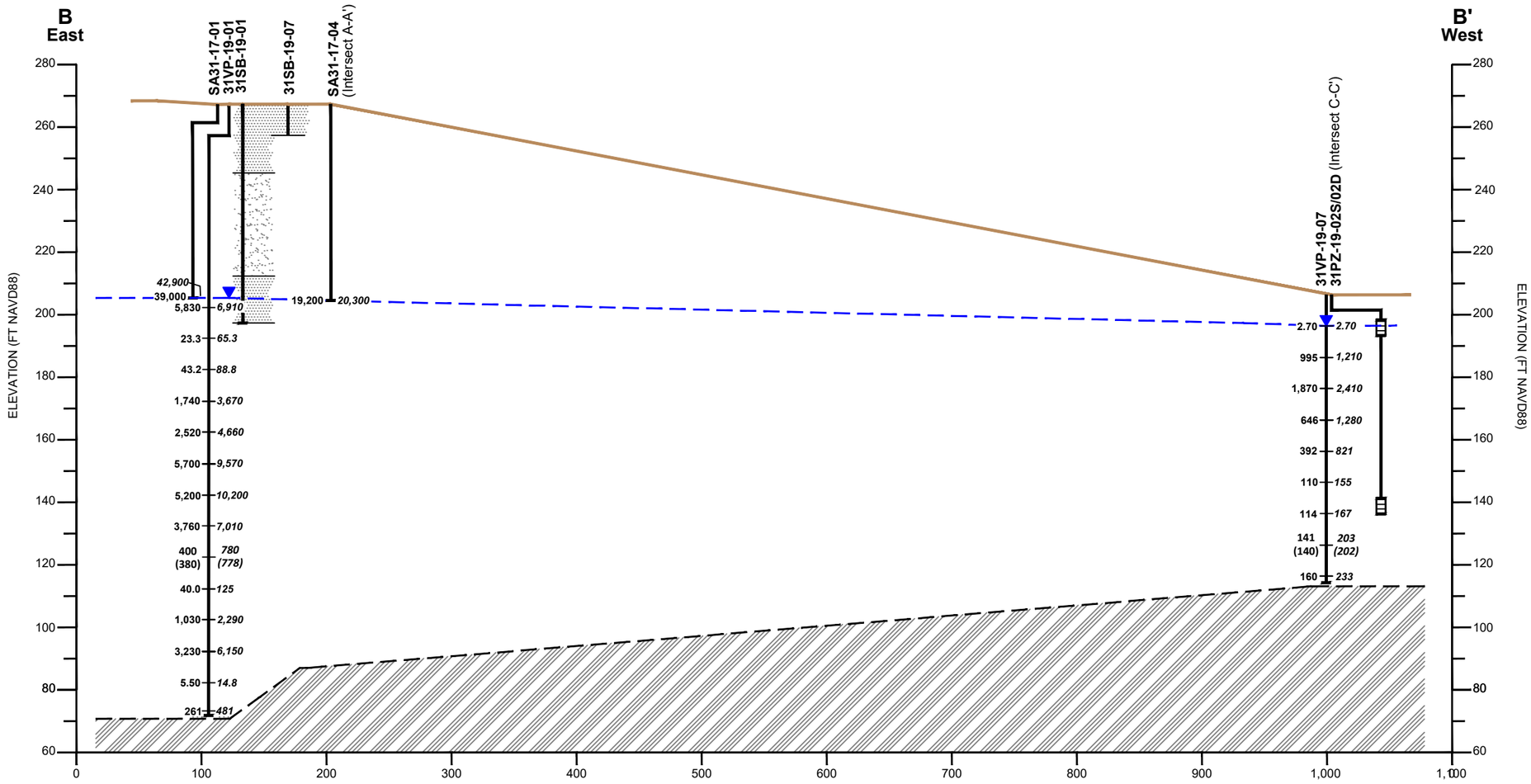
VERTICAL SCALE IN FEET: 40
HORIZONTAL SCALE IN FEET: 100

AOC 31 Cross Section A-A'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/14/2020	Figure 5-4	KGS



Legend

Vertical Profile

1.39 U
EPA LHA Concentration (sum of PFOA and PFOS)

2.59 U
MassDEP Concentration (sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA)

Monitoring Well

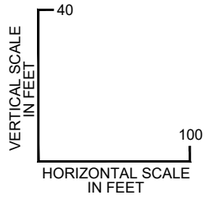
Screened Interval

- Medium to Coarse Sand
- Fine Sand
- Sand with Silt/Silty Sand
- Till
- Bedrock
- Unknown
- Water Table
- Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

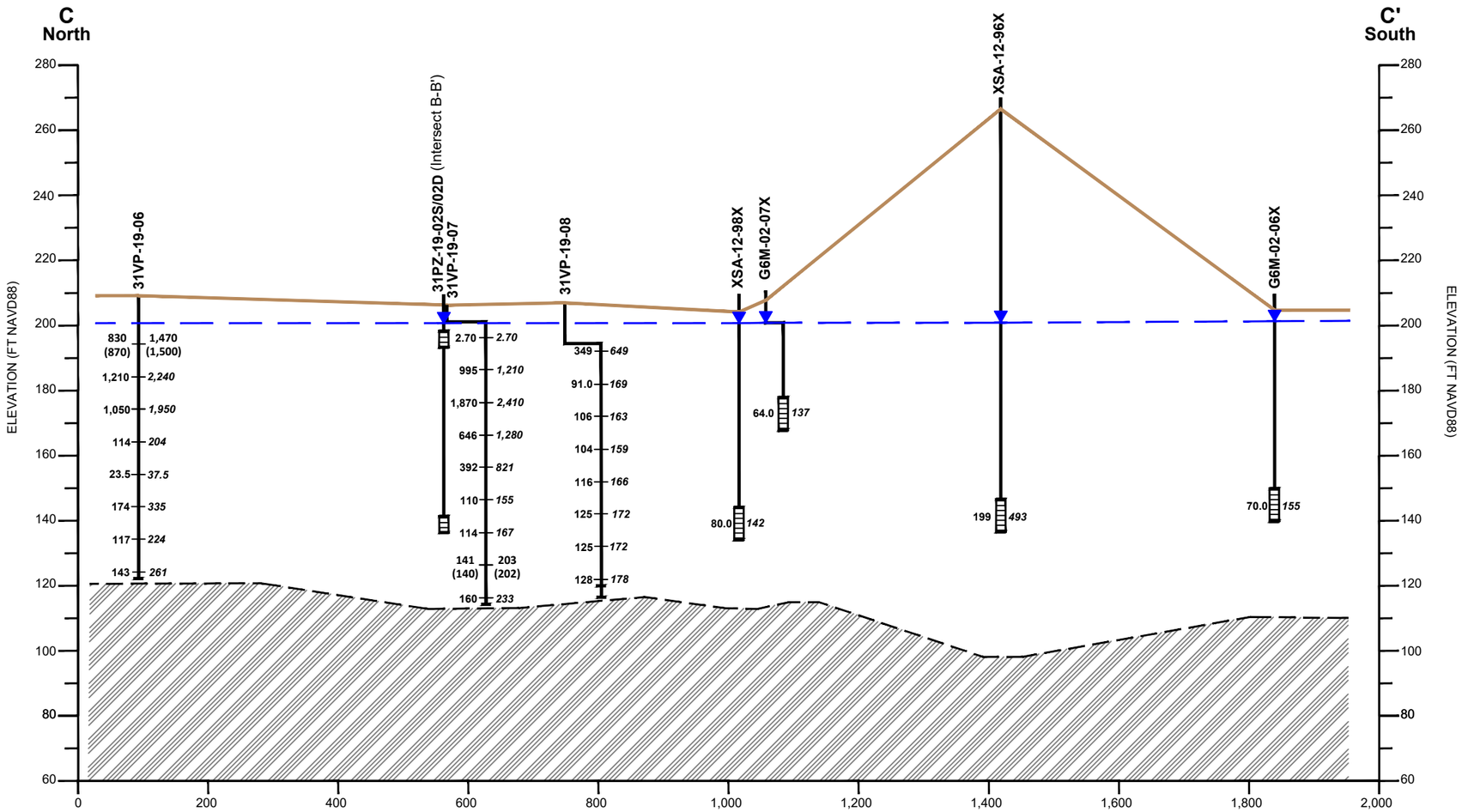


AOC 31 Cross Section B-B'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/14/2020	Figure 5-5	KGS



Legend

Vertical Profile

1.39 U
EPA LHA Concentration (sum of PFOA and PFOS)

2.59 U
MassDEP Concentration (sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA)

Monitoring Well

Screened Interval

- Medium to Coarse Sand
- Fine Sand
- Sand with Silt/Silty Sand
- Till
- Bedrock
- Unknown
- Water Table
- Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

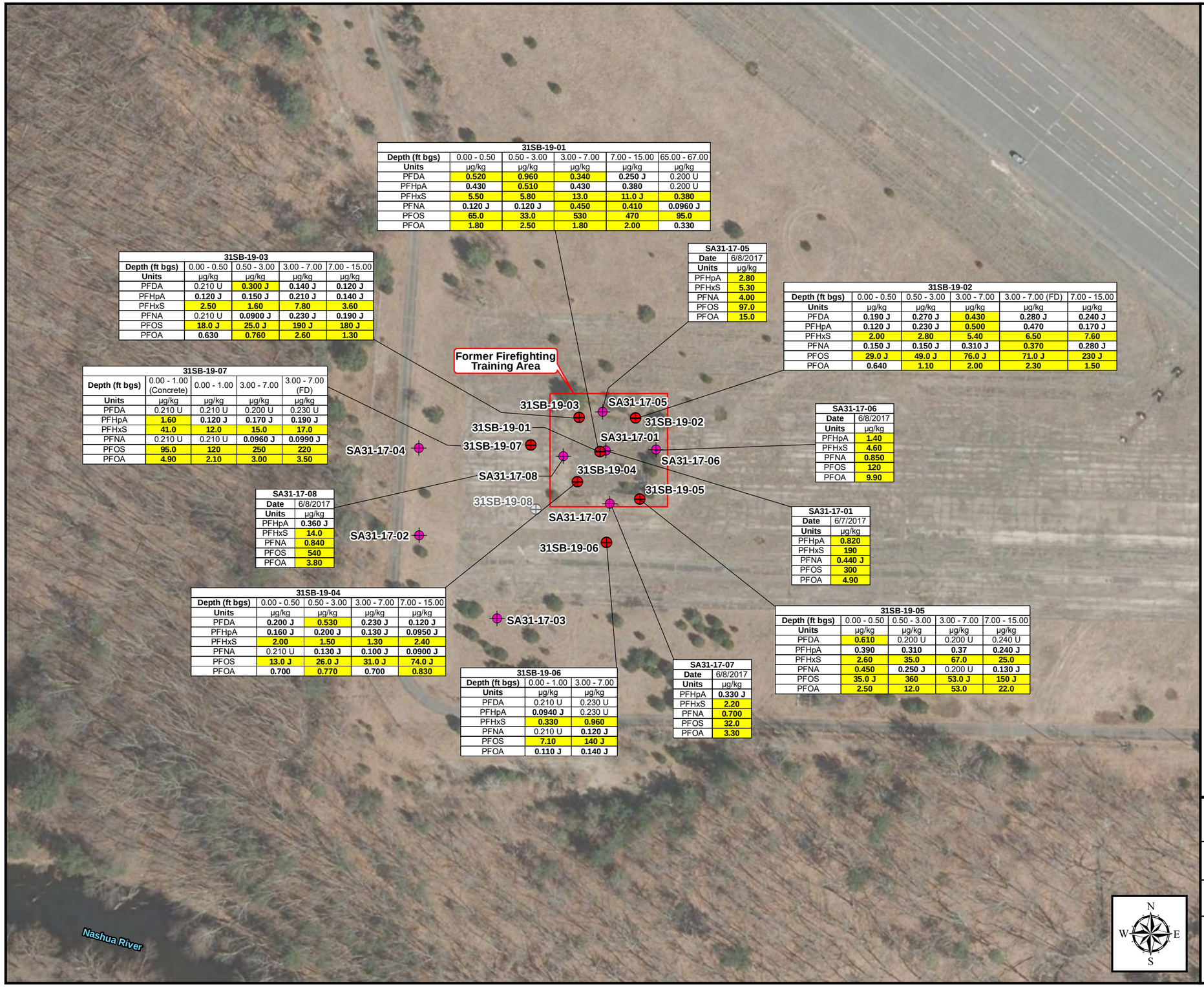
VERTICAL SCALE IN FEET: 40
HORIZONTAL SCALE IN FEET: 200

AOC 31 Cross Section C-C'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/14/2020	Figure 5-6	KGS



31SB-19-01

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	65.00 - 67.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.520**	**0.960**	**0.340**	**0.250 J**	0.200 U
PFHpA	**0.430**	**0.510**	**0.430**	**0.380**	0.200 U
PFHxS	**5.50**	**5.80**	**13.0**	**11.0 J**	**0.380**
PFNA	**0.120 J**	**0.120 J**	**0.450**	**0.410**	**0.0960 J**
PFOS	**65.0**	**33.0**	**530**	**470**	**95.0**
PFOA	**1.80**	**2.50**	**1.80**	**2.00**	**0.330**

31SB-19-03

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.210 U	**0.300 J**	**0.140 J**	**0.120 J**
PFHpA	**0.120 J**	**0.150 J**	**0.210 J**	**0.140 J**
PFHxS	**2.50**	**1.60**	**7.80**	**3.60**
PFNA	0.210 U	**0.0900 J**	**0.230 J**	**0.190 J**
PFOS	**18.0 J**	**25.0 J**	**190 J**	**180 J**
PFOA	**0.630**	**0.760**	**2.60**	**1.30**

SA31-17-05

Date	6/8/2017
Units	µg/kg
PFHpA	**2.80**
PFHxS	**5.30**
PFNA	**4.00**
PFOS	**97.0**
PFOA	**15.0**

31SB-19-02

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	3.00 - 7.00 (FD)	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.190 J**	**0.270 J**	**0.430**	**0.280 J**	**0.240 J**
PFHpA	**0.120 J**	**0.230 J**	**0.500**	**0.470**	**0.170 J**
PFHxS	**2.00**	**2.80**	**5.40**	**6.50**	**7.60**
PFNA	**0.150 J**	**0.150 J**	**0.310 J**	**0.370**	**0.280 J**
PFOS	**29.0 J**	**49.0 J**	**76.0 J**	**71.0 J**	**230 J**
PFOA	**0.640**	**1.10**	**2.00**	**2.30**	**1.50**

31SB-19-07

Depth (ft bgs)	0.00 - 1.00 (Concrete)	0.00 - 1.00	3.00 - 7.00	3.00 - 7.00 (FD)
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.210 U	0.210 U	0.200 U	0.230 U
PFHpA	**1.60**	**0.120 J**	**0.170 J**	**0.190 J**
PFHxS	**41.0**	**12.0**	**15.0**	**17.0**
PFNA	0.210 U	0.210 U	**0.0960 J**	**0.0990 J**
PFOS	**95.0**	**120**	**250**	**220**
PFOA	**4.90**	**2.10**	**3.00**	**3.50**

SA31-17-06

Date	6/8/2017
Units	µg/kg
PFHpA	**1.40**
PFHxS	**4.60**
PFNA	**0.850**
PFOS	**120**
PFOA	**9.90**

SA31-17-08

Date	6/8/2017
Units	µg/kg
PFHpA	**0.360 J**
PFHxS	**14.0**
PFNA	**0.840**
PFOS	**540**
PFOA	**3.80**

SA31-17-01

Date	6/7/2017
Units	µg/kg
PFHpA	**0.820**
PFHxS	**190**
PFNA	**0.440 J**
PFOS	**300**
PFOA	**4.90**

31SB-19-04

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.200 J**	**0.530**	**0.230 J**	**0.120 J**
PFHpA	**0.160 J**	**0.200 J**	**0.130 J**	**0.0950 J**
PFHxS	**2.00**	**1.50**	**1.30**	**2.40**
PFNA	0.210 U	**0.130 J**	**0.100 J**	**0.0900 J**
PFOS	**13.0 J**	**26.0 J**	**31.0 J**	**74.0 J**
PFOA	**0.700**	**0.770**	**0.700**	**0.830**

31SB-19-06

Depth (ft bgs)	0.00 - 1.00	3.00 - 7.00
Units	µg/kg	µg/kg
PFDA	0.210 U	0.230 U
PFHpA	**0.0940 J**	0.230 U
PFHxS	**0.330**	**0.960**
PFNA	0.210 U	**0.120 J**
PFOS	**7.10**	**140 J**
PFOA	**0.110 J**	**0.140 J**

SA31-17-07

Date	6/8/2017
Units	µg/kg
PFHpA	**0.330 J**
PFHxS	**2.20**
PFNA	**0.700**
PFOS	**32.0**
PFOA	**3.30**

31SB-19-05

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.610**	0.200 U	0.200 U	0.240 U
PFHpA	**0.390**	**0.310**	**0.37**	**0.240 J**
PFHxS	**2.60**	**35.0**	**67.0**	**25.0**
PFNA	**0.450**	**0.250 J**	0.200 U	**0.130 J**
PFOS	**35.0 J**	**360**	**53.0 J**	**150 J**
PFOA	**2.50**	**12.0**	**53.0**	**22.0**

Legend

- Soil Boring Location Installation Phase 1
- Temporary Well Location from SI
- Soil Boring Location Not Completed
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Notes:

Criteria = S-1/GW-1,Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

PFAS	Limits (µg/kg)
Perfluorodecanoic acid (PFDA)	0.300
Perfluoroheptanoic acid (PFHpA)	0.500
Perfluorohexanesulfonic acid (PFHxS)	0.300
Perfluorononanoic acid (PFNA)	0.320
Perfluorooctanesulfonic acid (PFOS)	2.00
Perfluorooctanoic acid (PFOA)	0.720

2.00 = detection of PFAS

2.00 = detection of PFAS above criteria

Data reported to three significant figures

µg/kg = micrograms per kilogram
U = non-detect
J = estimated result

AST = Above ground storage tank
UST = Underground storage Tank
DRMO = Defense Reutilization and Marketing Office
TPHC = Total petroleum hydrocarbons

SI Sample locations were not analyzed for PFDA

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOC 31 Soil Sampling Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

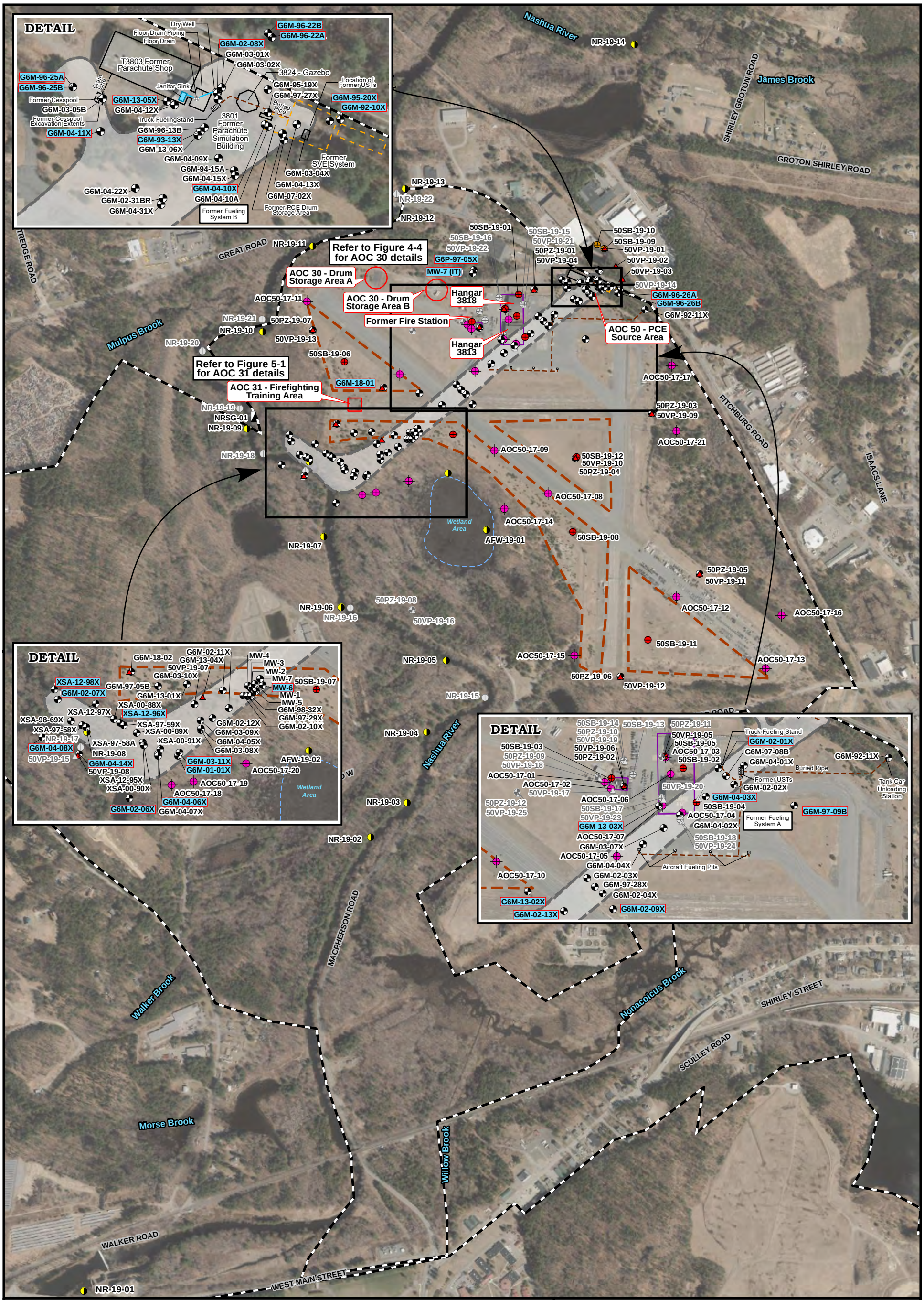
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 50 100
Feet

Date: 01/12/2021

Figure 5-7

File: PFAS_RI_A3_PSCS_F5-7_AOC31_SoilResults.mxd



Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Soil Boring Location Installation Phase 1
- Soil Boring Location Installation Phase 2
- Staff Gauge
- Surface Water and Sediment Sampling
- Temporary Well Location from SI
- Monitoring Well/Piezometer Not Completed
- Soil Boring Location Not Completed
- Vertical Profiling Location Not Completed
- Surface Water and Sediment Sampling Location Not Completed
- MW-6 — Wells Sampled as Part of PFAS RI
- Site Inspection Study Area Boundary
- Interpretive (2004) Tetrachloroethene (PCE) Contour (µg/L)
- Approximate Areas of Sludge Disposal
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOC 50 Field Activities
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

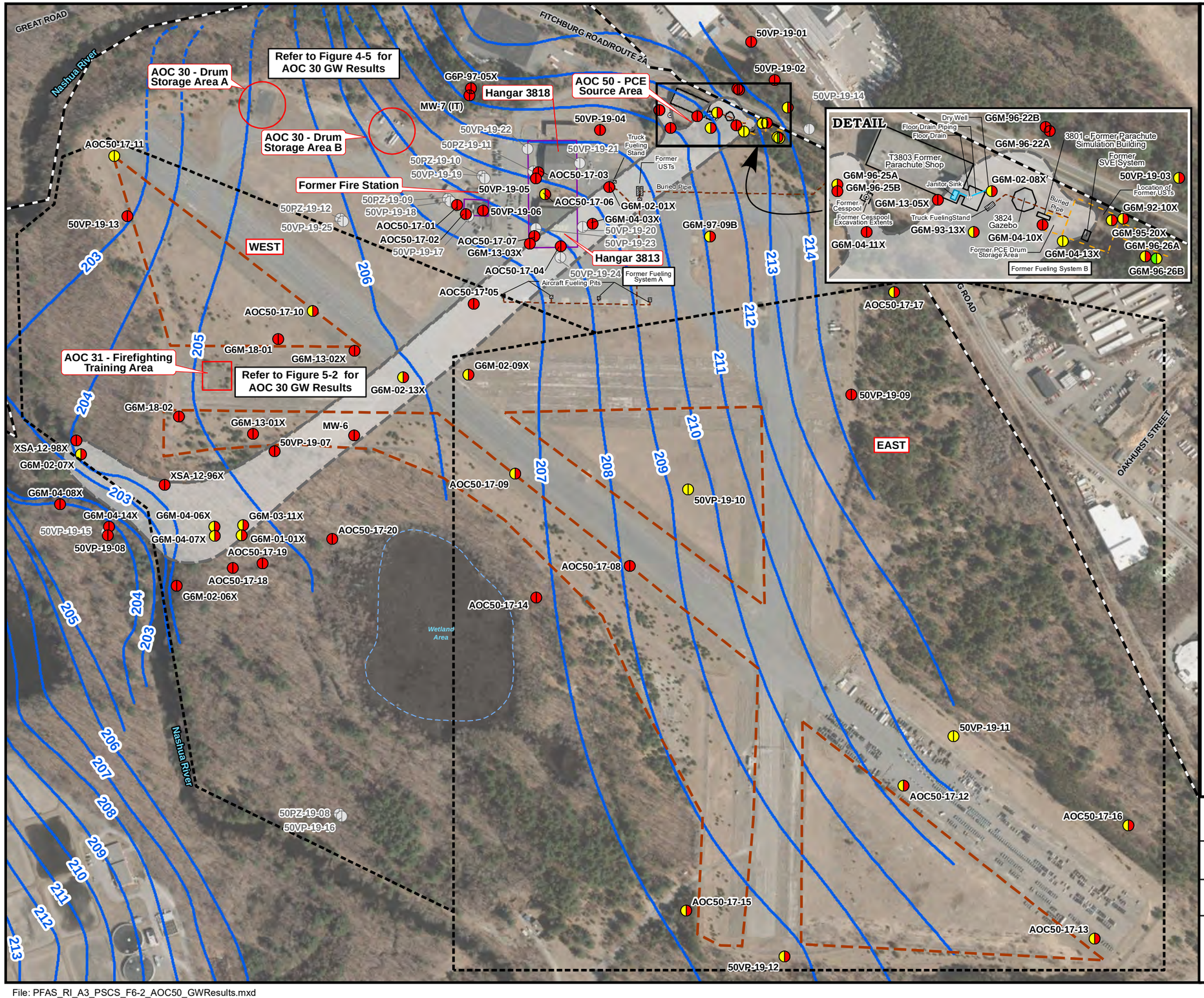
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 400 800
Feet

Date: 01/12/2021

Figure 6-1

File: PFAS_RI_A3_PSCS_F6-1_AOC50_FieldActivities.mxd



Legend

- Monitoring Well/Vertical Profiling Location
- Piezometer/Vertical Profiling Locations Not Completed

EPA LHA
(sum of PFOA and PFOS) (ng/L)

- EPA LHA ≥ 70 ng/L
- EPA LHA < 70 ng/L
- EPA LHA No detection

MassDEP
(sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA) (ng/L)

- MassDEP ≥ 20 ng/L
- MassDEP < 20ng/L
- MassDEP no detection
- Groundwater Contour (April 27, 2020) (Contour Interval = 1 Foot) (ft NAVD88)
- Inferred Groundwater Contour (April 27, 2020) (Contour Interval = 1 Foot) (ft NAVD88)
- Interpretive (2004) Tetrachloroethene (PCE) Contour (µg/L)
- Site Inspection Study Area Boundary
- Approximate Areas of Sludge Disposal
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Notes:

MassDEP GW-1 = sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA
MassDEP Exceedance Criteria is defined as equal to or greater than 20 ng/L

EPA LHA (Lifetime Health Advisory) = sum of PFOA and PFOS
EPA LHA Exceedance Criteria is defined as equal to or greater than 70 ng/L

SI GW results were not analyzed for PFDA.

Refer to Figure 2-9 for Groundwater Elevation Data

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOC 50 Groundwater Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

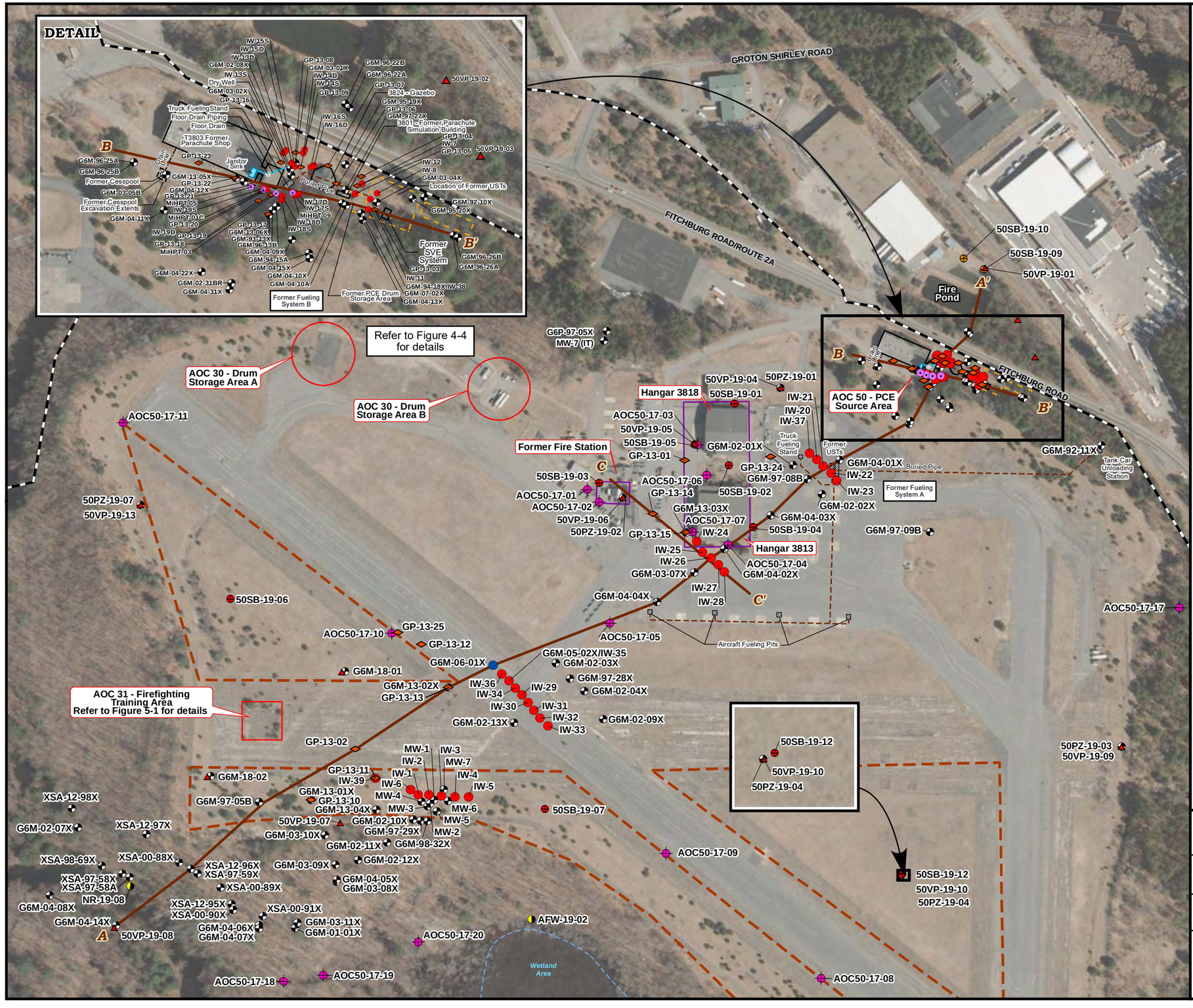
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400
Feet

Date: 02/05/2021

Figure 6-2

File: PFAS_RI_A3_PSCS_F6-2_AOC50_GWResults.mxd



Legend

- Monitoring Well/Piezometer
- Vertical Profiling Location Installation Phase 1
- Soil Boring Location Installation Phase 1
- Soil Boring Location Installation Phase 2
- Surface Water and Sediment Sampling
- Monitoring Well Converted to Injection Well
- Temporary Well Location from SI
- MiHPT Investigation Location
- Vertical Groundwater Profiling Location
- Injection Well
- Cross Section Location
- Site Inspection Study Area Boundary
- Approximate Areas of Sludge Disposal
- Area of Contamination (AOC)
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

AOC 50 Cross Section Locations
Devens PFAS RI – Area 3 PSCS

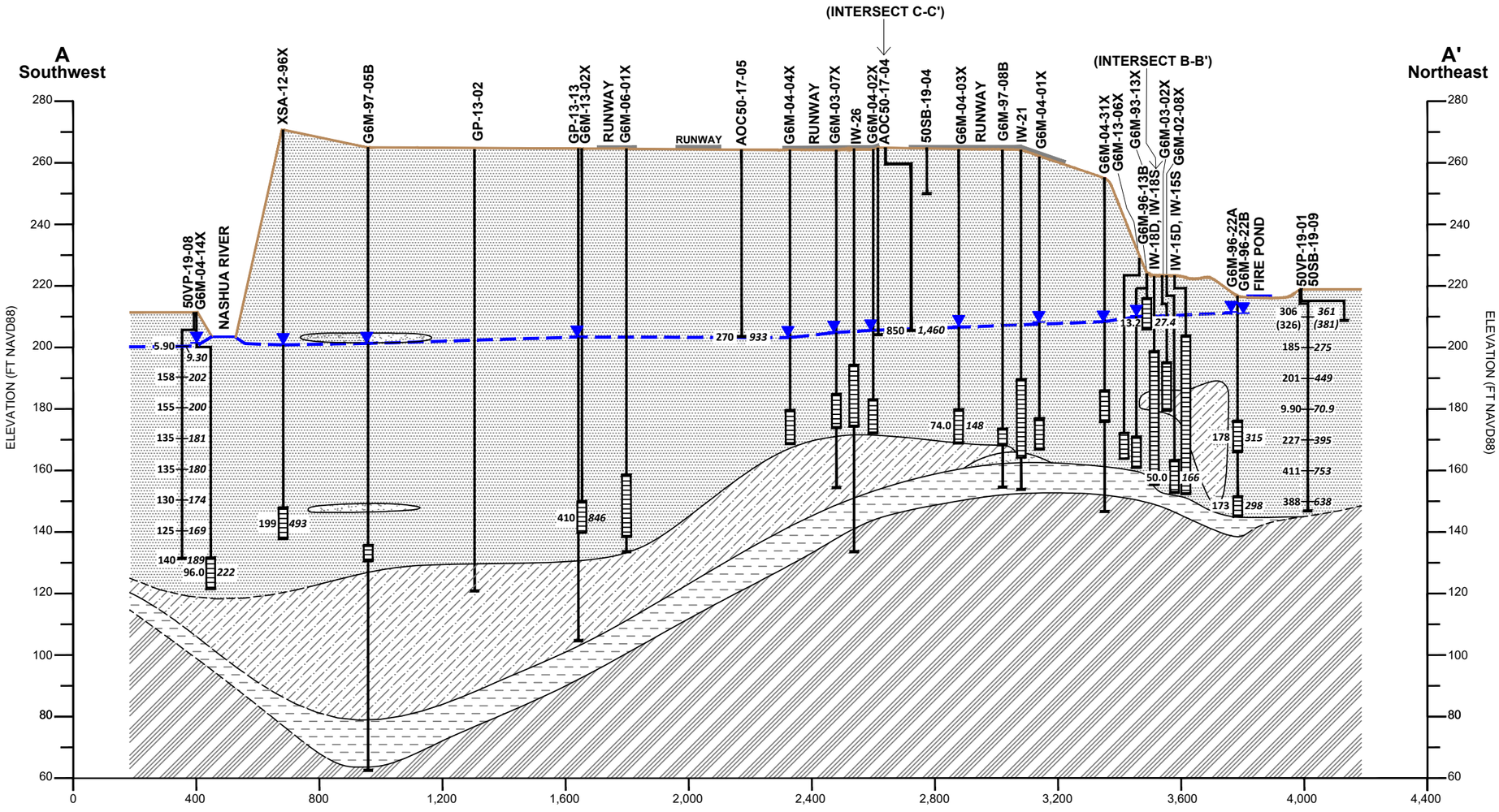
Former Fort Devens Army Installation and Sudbury Annex
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 150 300
Feet

Date: 10/19/2020

Figure 6-3



Legend

Vertical Profile

1.39 U
EPA LHA Concentration (sum of PFOA and PFOS)

2.59 U
MassDEP Concentration (sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA)

Monitoring Well

Screened Interval

- Medium to Coarse Sand
- Fine Sand
- Sand with Silt/Silty Sand
- Till
- Bedrock
- Unknown
- Water Table
- Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
NS = no sample
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

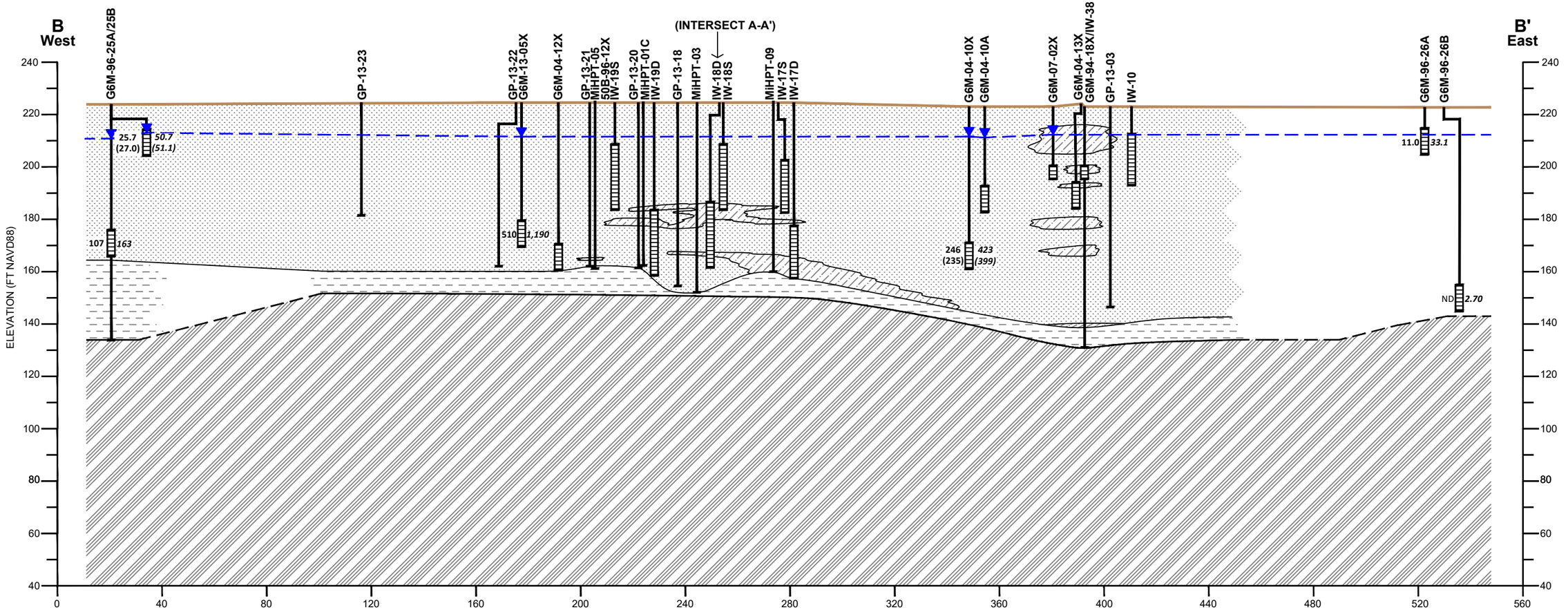
VERTICAL SCALE IN FEET: 40
HORIZONTAL SCALE IN FEET: 400

AOC 50 Cross Section A-A'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/15/2020	Figure 6-4	KGS



Legend

Vertical Profile

1.39 U
EPA LHA
Concentration
(sum of PFOA
and PFOS)

2.59 U
MassDEP
Concentration
(sum of PFOS + PFOA
+ PFDA + PFHpA +
PFHxS + PFNA)

Monitoring Well

Screened
Interval

- Medium to Coarse Sand
- Fine Sand
- Sand with Silt/Silty Sand
- Till
- Bedrock
- Unknown
- Water Table
- Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

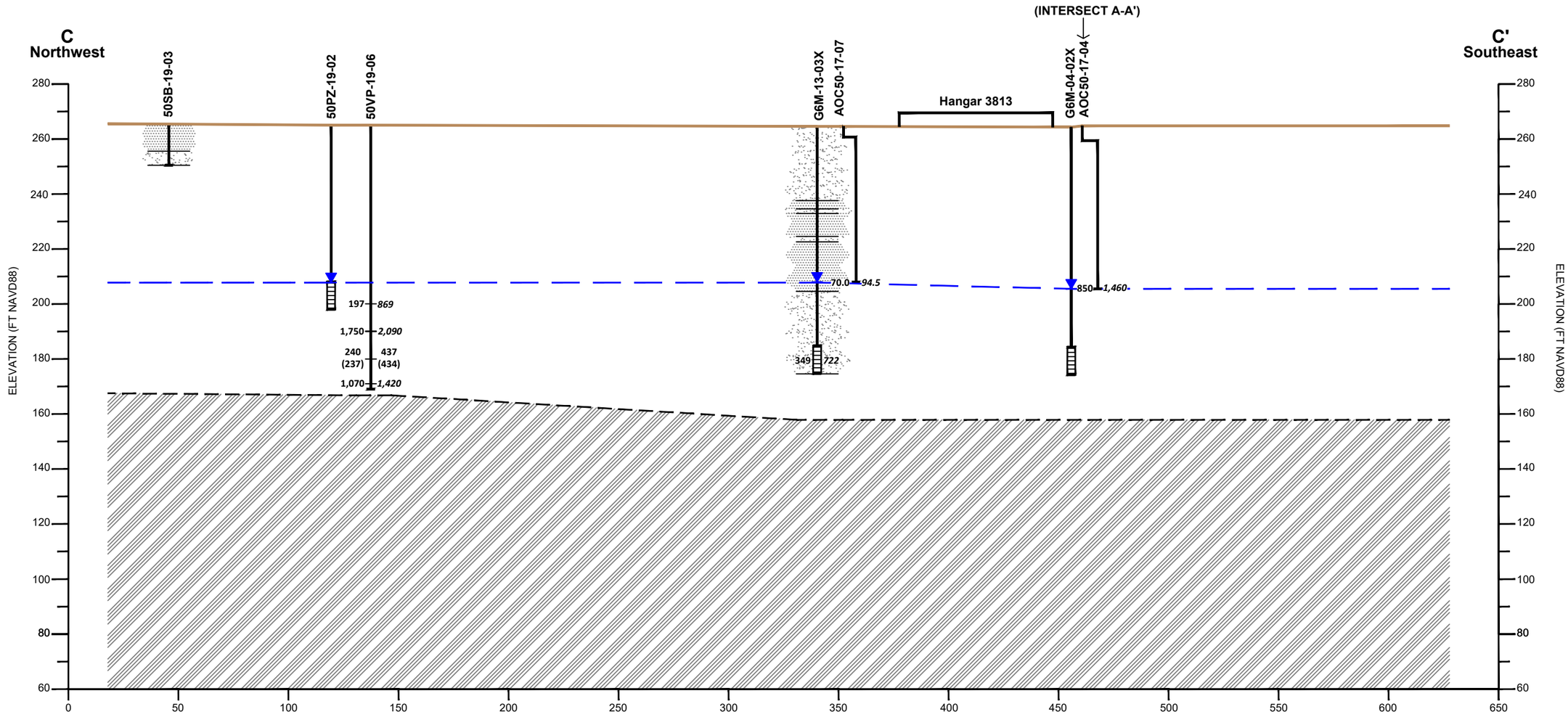
VERTICAL SCALE IN FEET: 40
HORIZONTAL SCALE IN FEET: 40

AOC 50 Cross Section B-B'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/15/2020	Figure 6-5	KGS



Legend

Vertical Profile

1.39 U
EPA LHA
Concentration
(sum of PFOA
and PFOS)

2.59 U
MassDEP
Concentration
(sum of PFOS + PFOA
+ PFDA + PFHpA +
PFHxS + PFNA)

Monitoring Well

Screened
Interval

Medium to Coarse Sand

Fine Sand

Bedrock

Unknown

Water Table

Inferred Top of Bedrock

Notes:

All results in ng/L
ng/L = nanograms per liter
ND = non-detect
( ) = field duplicate

Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorodecanoic acid (PFDA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)

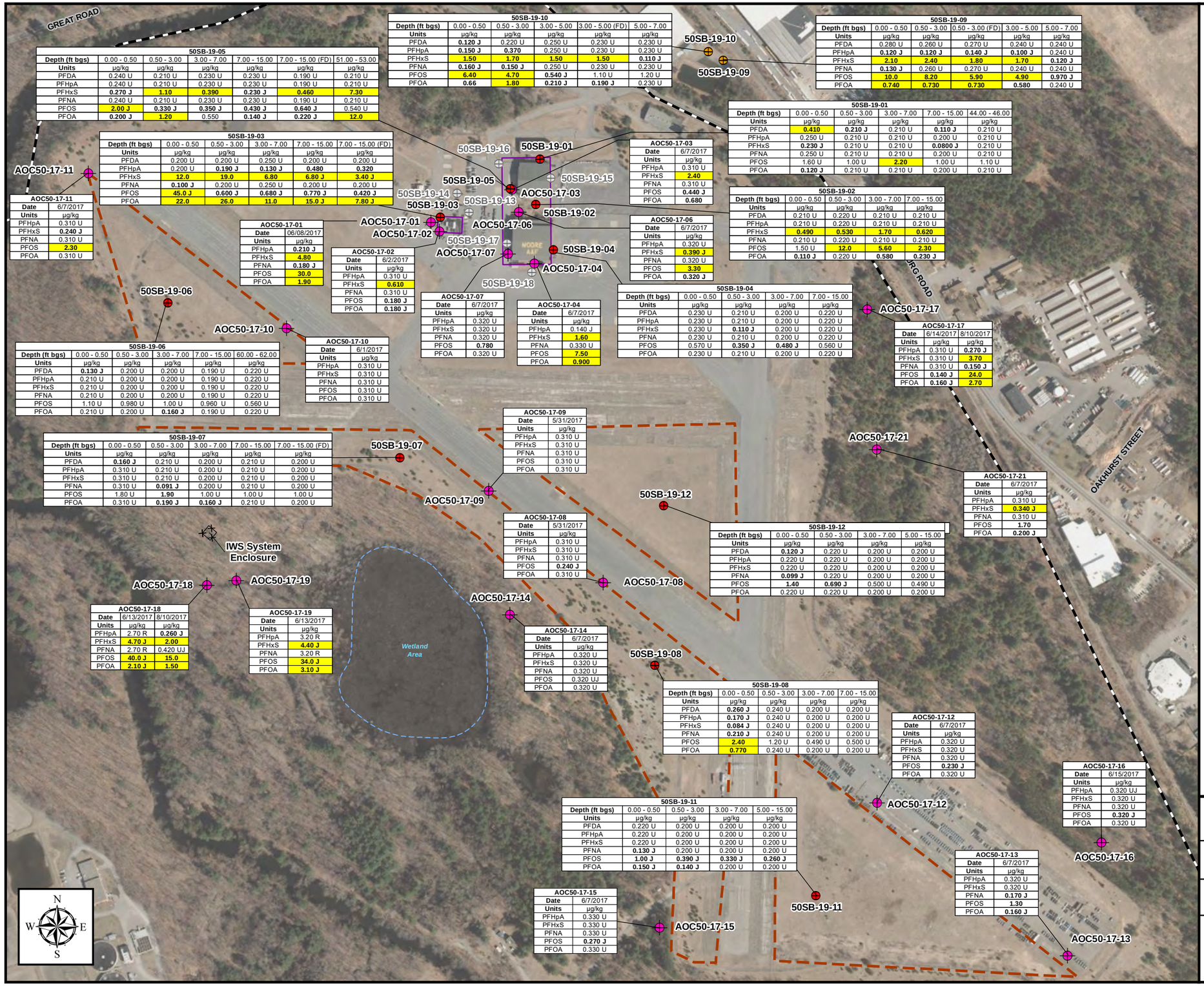
VERTICAL SCALE IN FEET
40
HORIZONTAL SCALE IN FEET
40

AOC 50 Cross Section C-C'
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

Scale as Shown	Date: 10/15/2020	Figure 6-6	KGS



50SB-19-10

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 5.00	3.00 - 5.00 (FD)	5.00 - 7.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.120 J**	0.220 U	0.250 U	0.230 U	0.230 U
PFHpA	**0.150 J**	**0.370**	0.250 U	0.230 U	0.230 U
PFHxS	**1.50**	**1.70**	**1.50**	**1.50**	**0.110 J**
PFNA	**0.160 J**	**0.150 J**	0.250 U	0.230 U	0.230 U
PFOS	**6.40**	**4.70**	**0.540 J**	1.10 U	1.20 U
PFOA	**0.66**	**1.80**	**0.210 J**	**0.190 J**	0.230 U

50SB-19-09

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	0.50 - 3.00 (FD)	3.00 - 5.00	5.00 - 7.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.280 U	0.260 U	0.270 U	0.240 U	0.240 U
PFHpA	**0.120 J**	**0.120 J**	**0.140 J**	**0.100 J**	0.240 U
PFHxS	**2.10**	**2.40**	**1.80**	**1.70**	**0.120 J**
PFNA	**0.130 J**	0.260 U	0.270 U	0.240 U	0.240 U
PFOS	**10.0**	**8.20**	**5.90**	**4.90**	**0.970 J**
PFOA	**0.740**	**0.730**	**0.730**	**0.580**	0.240 U

50SB-19-05

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00 (FD)	51.00 - 53.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
PFHpA	0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
PFHxS	**0.270 J**	**1.10**	**0.390**	**0.230 J**	**0.460**	**7.30**
PFNA	0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
PFOS	**2.00 J**	**0.330 J**	**0.350 J**	**0.430 J**	**0.640 J**	0.540 U
PFOA	**0.200 J**	**1.20**	0.550	**0.140 J**	**0.220 J**	**12.0**

50SB-19-01

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	44.00 - 46.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.410**	**0.210 J**	0.210 U	**0.110 J**	0.210 U
PFHpA	0.250 U	0.210 U	0.210 U	0.200 U	0.210 U
PFHxS	**0.230 J**	0.210 U	0.210 U	**0.0800 J**	0.210 U
PFNA	0.250 U	0.210 U	0.210 U	0.200 U	0.210 U
PFOS	1.60 U	1.00 U	**2.20**	1.00 U	1.10 U
PFOA	**0.120 J**	0.210 U	0.210 U	0.200 U	0.210 U

50SB-19-03

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00 (FD)
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.200 U	0.200 U	0.250 U	0.200 U	0.200 U
PFHpA	0.200 U	**0.190 J**	**0.130 J**	**0.480**	**0.320**
PFHxS	**12.0**	**19.0**	**6.80**	**6.80 J**	**3.40 J**
PFNA	**0.100 J**	0.200 U	0.250 U	0.200 U	0.200 U
PFOS	**45.0 J**	**0.600 J**	**0.680 J**	**0.770 J**	**0.420 J**
PFOA	**22.0**	**26.0**	**11.0**	**15.0 J**	**7.80 J**

AOC50-17-03

Date	6/7/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	**2.40**
PFNA	0.310 U
PFOS	**0.440 J**
PFOA	**0.680**

AOC50-17-11

Date	6/7/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	**0.240 J**
PFNA	0.310 U
PFOS	**2.30**
PFOA	0.310 U

AOC50-17-01

Date	06/08/2017
Units	µg/kg
PFHpA	**0.210 J**
PFHxS	**4.80**
PFNA	**0.180 J**
PFOS	**30.0**
PFOA	**1.90**

AOC50-17-02

Date	6/2/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	**0.610**
PFNA	0.310 U
PFOS	**0.180 J**
PFOA	**0.180 J**

AOC50-17-06

Date	6/7/2017
Units	µg/kg
PFHpA	0.320 U
PFHxS	**0.390 J**
PFNA	0.320 U
PFOS	**3.30**
PFOA	**0.320 J**

50SB-19-02

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.210 U	0.220 U	0.210 U	0.210 U
PFHpA	0.210 U	0.220 U	0.210 U	0.210 U
PFHxS	**0.490**	**0.530**	**1.70**	**0.620**
PFNA	0.210 U	0.220 U	0.210 U	0.210 U
PFOS	1.50 U	**12.0**	**5.60**	**2.30**
PFOA	**0.110 J**	0.220 U	**0.580**	**0.230 J**

50SB-19-04

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.230 U	0.210 U	0.200 U	0.220 U
PFHpA	0.230 U	0.210 U	0.200 U	0.220 U
PFHxS	0.230 U	**0.110 J**	0.200 U	0.220 U
PFNA	0.230 U	0.210 U	0.200 U	0.220 U
PFOS	0.570 U	**0.350 J**	**0.480 J**	0.560 U
PFOA	0.230 U	0.210 U	0.200 U	0.220 U

AOC50-17-07

Date	6/7/2017
Units	µg/kg
PFHpA	0.320 U
PFHxS	0.320 U
PFNA	0.320 U
PFOS	**0.780**
PFOA	0.320 U

AOC50-17-04

Date	6/7/2017
Units	µg/kg
PFHpA	0.140 J
PFHxS	**1.60**
PFNA	0.330 U
PFOS	**7.50**
PFOA	**0.900**

AOC50-17-17

Date	6/14/2017	8/10/2017
Units	µg/kg	µg/kg
PFHpA	0.310 U	**0.270 J**
PFHxS	0.310 U	**3.70**
PFNA	0.310 U	**0.150 J**
PFOS	**0.140 J**	**24.0**
PFOA	**0.160 J**	**2.70**

50SB-19-06

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	60.00 - 62.00
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.130 J**	0.200 U	0.200 U	0.190 U	0.220 U
PFHpA	0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
PFHxS	0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
PFNA	0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
PFOS	1.10 U	0.980 U	1.00 U	0.960 U	0.560 U
PFOA	0.210 U	0.200 U	**0.160 J**	0.190 U	0.220 U

AOC50-17-10

Date	6/1/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	0.310 U
PFNA	0.310 U
PFOS	0.310 U
PFOA	0.310 U

50SB-19-07

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00 (FD)
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.160 J**	0.210 U	0.200 U	0.210 U	0.200 U
PFHpA	0.310 U	0.210 U	0.200 U	0.210 U	0.200 U
PFHxS	0.310 U	0.210 U	0.200 U	0.210 U	0.200 U
PFNA	0.310 U	**0.091 J**	0.200 U	0.210 U	0.200 U
PFOS	1.80 U	**1.90**	1.00 U	1.00 U	1.00 U
PFOA	0.310 U	**0.190 J**	**0.160 J**	0.210 U	0.200 U

AOC50-17-09

Date	5/31/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	0.310 U
PFNA	0.310 U
PFOS	0.310 U
PFOA	0.310 U

AOC50-17-08

Date	5/31/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	0.310 U
PFNA	0.310 U
PFOS	**0.240 J**
PFOA	0.310 U

50SB-19-12

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	5.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.120 J**	0.220 U	0.200 U	0.200 U
PFHpA	0.220 U	0.220 U	0.200 U	0.200 U
PFHxS	0.220 U	0.220 U	0.200 U	0.200 U
PFNA	**0.099 J**	0.220 U	0.200 U	0.200 U
PFOS	**1.40**	**0.690 J**	0.500 U	0.490 U
PFOA	0.220 U	0.220 U	0.200 U	0.200 U

AOC50-17-21

Date	6/7/2017
Units	µg/kg
PFHpA	0.310 U
PFHxS	**0.340 J**
PFNA	0.310 U
PFOS	**1.70**
PFOA	**0.200 J**

AOC50-17-18

Date	6/13/2017	8/10/2017
Units	µg/kg	µg/kg
PFHpA	2.70 R	**0.260 J**
PFHxS	**4.70 J**	**2.00**
PFNA	2.70 R	0.420 UJ
PFOS	**40.0 J**	**15.0**
PFOA	**2.10 J**	**1.50**

AOC50-17-19

Date	6/13/2017
Units	µg/kg
PFHpA	3.20 R
PFHxS	**4.40 J**
PFNA	3.20 R
PFOS	**34.0 J**
PFOA	**3.10 J**

AOC50-17-14

Date	6/7/2017
Units	µg/kg
PFHpA	0.320 U
PFHxS	0.320 U
PFNA	0.320 U
PFOS	0.320 UJ
PFOA	0.320 U

50SB-19-08

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	**0.260 J**	0.240 U	0.200 U	0.200 U
PFHpA	**0.170 J**	0.240 U	0.200 U	0.200 U
PFHxS	**0.084 J**	0.240 U	0.200 U	0.200 U
PFNA	**0.210 J**	0.240 U	0.200 U	0.200 U
PFOS	**2.40**	1.20 U	0.490 U	0.500 U
PFOA	**0.770**	0.240 U	0.200 U	0.200 U

AOC50-17-12

Date	6/7/2017
Units	µg/kg
PFHpA	0.320 U
PFHxS	0.320 U
PFNA	0.320 U
PFOS	**0.230 J**
PFOA	0.320 U

AOC50-17-16

Date	6/15/2017
Units	µg/kg
PFHpA	0.320 UJ
PFHxS	0.320 U
PFNA	0.320 U
PFOS	**0.320 J**
PFOA	0.320 U

50SB-19-11

Depth (ft bgs)	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	5.00 - 15.00
Units	µg/kg	µg/kg	µg/kg	µg/kg
PFDA	0.220 U	0.200 U	0.200 U	0.200 U
PFHpA	0.220 U	0.200 U	0.200 U	0.200 U
PFHxS	0.220 U	0.200 U	0.200 U	0.200 U
PFNA	**0.130 J**	0.200 U	0.200 U	0.200 U
PFOS	**1.00 J**	**0.390 J**	**0.330 J**	**0.260 J**
PFOA	**0.150 J**	**0.140 J**	0.200 U	0.200 U

AOC50-17-13

Date	6/7/2017
Units	µg/kg
PFHpA	0.320 U
PFHxS	0.320 U
PFNA	**0.170 J**
PFOS	**1.30**
PFOA	**0.160 J**

AOC50-17-15

Date	6/7/2017
Units	µg/kg
PFHpA	0.330 U
PFHxS	0.330 U
PFNA	0.330 U
PFOS	**0.270 J**
PFOA	0.330 U

Legend

- Soil Boring Location Installation Phase 1
- Soil Boring Location Installation Phase 2
- Temporary Well Location from SI
- Soil Boring Location Not Completed
- Site Inspection Study Area Boundary
- Approximate Areas of Sludge Disposal
- Former Fort Devens Boundary

Notes:

Criteria = S-1/GW-1,Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

PFAS	Limits (µg/kg)
Perfluorodecanoic acid (PFDA)	0.300
Perfluoroheptanoic acid (PFHpA)	0.500
Perfluorohexanesulfonic acid (PFHxS)	0.300
Perfluorononanoic acid (PFNA)	0.320
Perfluorooctanesulfonic acid (PFOS)	2.00
Perfluorooctanoic acid (PFOA)	0.720

2.00 = detection of PFAS

2.00 = detection of PFAS above criteria

Data reported to three significant figures

µg/kg = micrograms per kilogram
U = non-detect
J = estimated result

AST = Above ground storage tank
UST = Underground storage Tank
DRMO = Defense Reutilization and Marketing Office
TPHC = Total petroleum hydrocarbons

SI Sample locations were not analyzed for PFDA

Aerial Source: USGS, MassGIS 2019 Orthoimagery

AOC 50 Soil Sampling Results
Devens PFAS RI – Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400
Feet

Date: 01/12/2021

Figure 6-7

File: PFAS_RI_A3_PSCS_F6-7_AOC50_SoilResults.mxd

DETAIL

SR-19-01				
Sample	12/18/2019	12/18/2019 (FD)	12/18/2019	12/18/2019 (FD)
Units:	ng/L	ng/L	µg/kg	µg/kg
PFBS	**0.600 J**	**0.550 J**	0.290 U	0.300 U
PFOS	**2.80 J**	**2.60 J**	**7.90**	**7.50**
PFOA	**7.80**	**7.90**	**2.70**	**2.80**

DETAIL

FP-20-01		
Sample	5/20/2020	5/20/2020
Units:	ng/L	µg/kg
PFBS	**0.780 J**	0.330 U
PFOS	**3.20 J**	0.910 U
PFOA	**4.30**	0.360 U

FP-20-02				
Sample	5/20/2020	5/20/2020 (FD)	5/20/2020	5/20/2020 (FD)
Units:	ng/L	ng/L	µg/kg	µg/kg
PFBS	**0.830 J**	**0.950 J**	0.250 U	0.400 U
PFOS	**5.70**	**5.40**	0.700 U	1.10 U
PFOA	**11.0**	**10.0**	0.280 U	0.440 U

BP-18-01		
Sample	12/21/2018	12/21/2018
Units:	ng/L	µg/kg
PFBS	**1.00 J**	0.260 U
PFOS	**6.50**	0.710 U
PFOA	**16.0**	**0.160 J**

DETAIL

WAB-19-01		
Sample	12/18/2019	12/18/2019
Units:	ng/L	µg/kg
PFBS	**7.80**	0.220 U
PFOS	**1.50 J**	**0.720 J**
PFOA	**6.20**	0.240 U

DETAIL

NRBK-19-01		
Sample	12/20/2019	12/20/2019
Units:	ng/L	µg/kg
PFBS	**2.90**	0.270 U
PFOS	**4.00**	**0.420 J**
PFOA	**10.0**	0.300 U

DETAIL

BB-20-01		
Sample	5/20/2020	5/20/2020
Units:	ng/L	µg/kg
PFBS	**1.10 J**	9.60 U
PFOS	**2.40 J**	27.0 U
PFOA	**3.30**	11.0 U

DETAIL

NRBK-19-02		
Sample	12/20/2019	12/20/2019
Units:	ng/L	µg/kg
PFBS	**3.20**	0.260 U
PFOS	**4.20**	**0.750 J**
PFOA	**10.0**	**0.180 J**

Legend

- Area 1 - Grove Pond, Patton and Shabokin Supply Wells, AOCs 40, 43G, 43J, 57, 74, and 75
- Area 2 - MacPherson Water Supply Wells, SHL, AOCs 32/43A, and 76
- Area 3 - AOCs 20, 21, 30, 31, and 50
- Background Surface Water and Sediment Sampling Location
- Background Surface Water and Sediment Sampling Location (Not Collected)

National Hydrography Dataset

- Stream/River
- Connector
- Lake/Pond
- Swamp/Marsh
- City/Town Boundary
- Former Fort Devens Boundary

Aerial Source:
USGS, MassGIS Orthoimagery 2019

EPA PFAS Site Specific Screening Levels for Former Fort Devens

Surface Water		Sediment	
Units:	ng/L	Units:	µg/kg
PFOA	2,030	PFOA	609
PFOS	2,030	PFOS	609
PFBS	2,030,000	PFBS	609,000

Notes:
Perfluorooctane Sulfonic Acid (PFOS)
Perfluorooctanoic Acid (PFOA)
ng/L = nanograms per liter
(Surface Water Result Value)
µg/kg = microgram per kilogram
(Sediment Result Value)

J = estimated result
U= not detected above the reported sample quantitation limit
Bold = detection

Background Surface Water and Sediment Sample Results
Devens PFAS RI - Area 3 PSCS

Former Army Installation Devens
Devens, Massachusetts

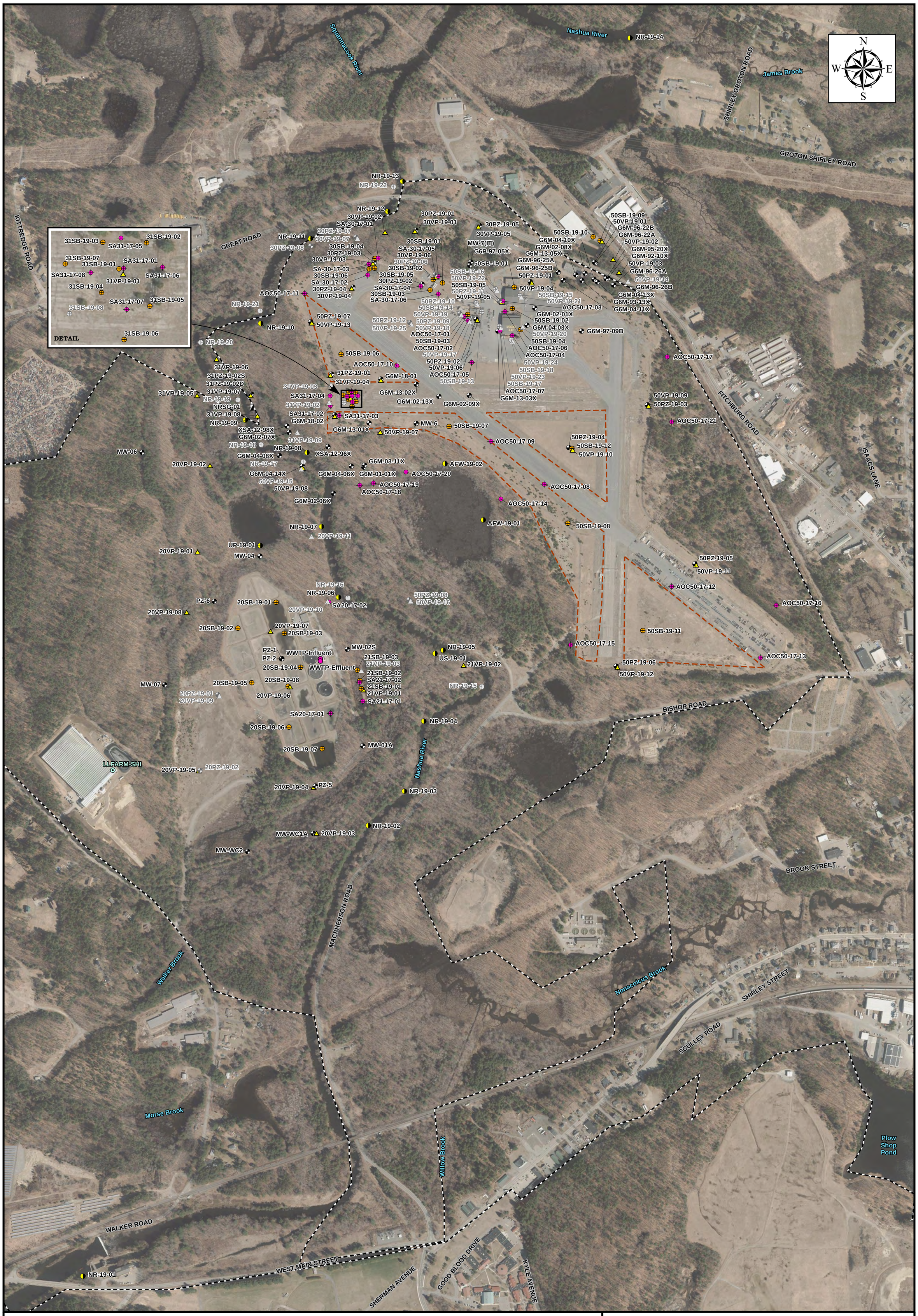
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 2,000 4,000
Feet

Date: 02/03/2021

Figure 7-1

File: PFAS_RI_A3_PSCS_F7-1_BkgrndPond_SampleResults.mxd



Legend

- Monitoring Well/Piezometer
- Soil Boring
- Vertical Profiling Location
- Surface Water and Sediment Sampling
- Staff Gauge
- Temporary Well Location from SI
- Irrigation Well
- Monitoring Well/Piezometer Not Completed
- Soil Boring Location Not Completed
- Vertical Profiling Location Not Completed
- Surface Water and Sediment Sampling Location Not Completed
- Approximate Areas of Sludge Disposal
- Former Fort Devens Boundary

Aerial Source: USGS, MassGIS Orthoimagery 2019

Area 3 Sample Locations
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

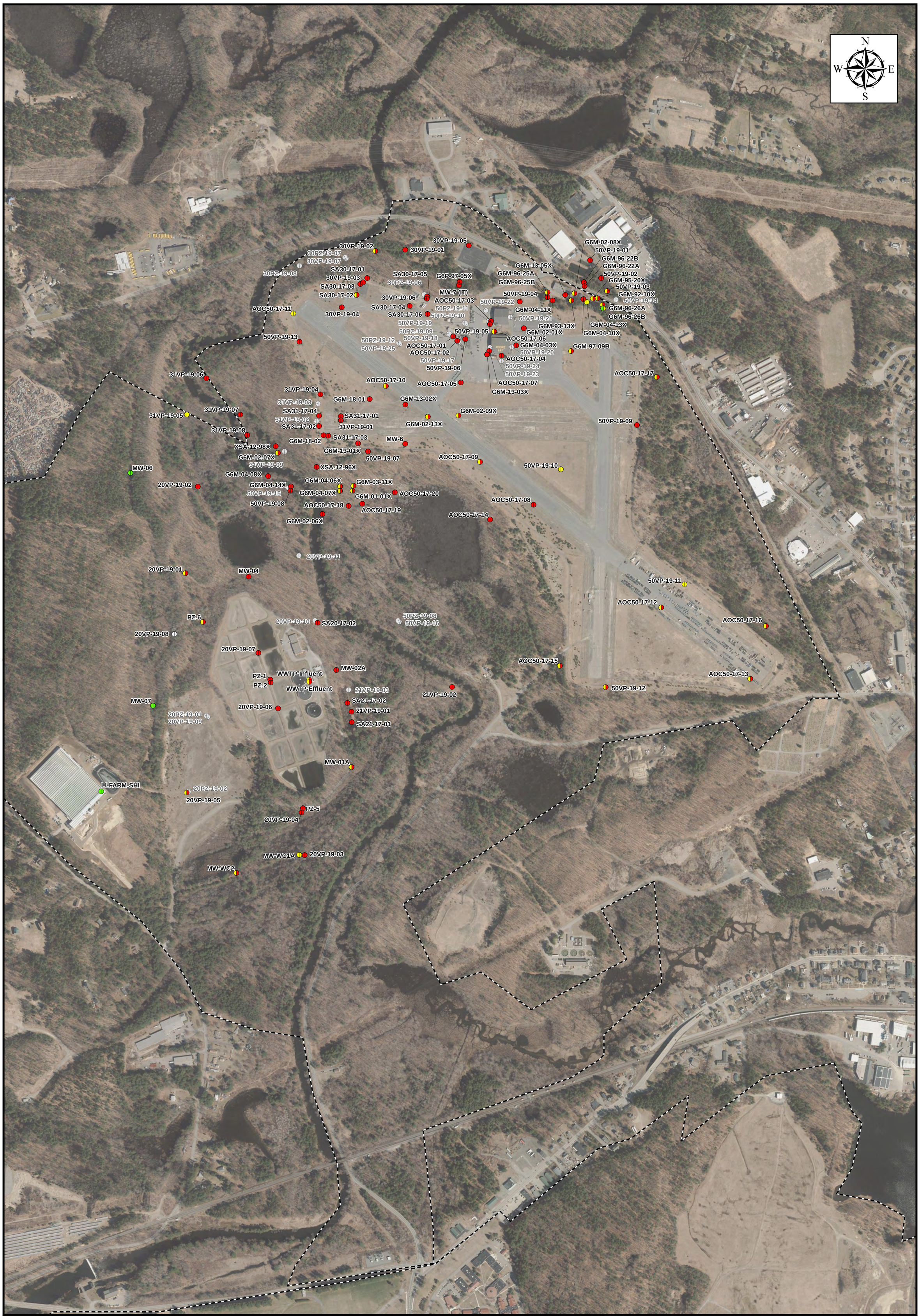
KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400 800
Feet

Date: 01/25/2021

Plate 1

File: PFAS_RI_A3_PSCS_Plate_Samples_Dsize.mxd



Legend

- Monitoring Well/Vertical Profiling Location
- Monitoring Well/Vertical Profiling Location Not Completed
- Former Fort Devens Boundary

EPA LHA
(sum of PFOA and PFOS) (ng/L)

- EPA LHA ≥ 70 ng/L
- EPA LHA < 70 ng/L
- EPA LHA No detection

MassDEP
(sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA) (ng/L)

- MassDEP ≥ 20 ng/L
- MassDEP < 20ng/L
- MassDEP no detection

Notes:

MassDEP GW-1 = sum of PFOS + PFOA + PFDA + PFHpA + PFHxS + PFNA
MassDEP Exceedance Criteria is defined as equal to or greater than 20 ng/L

EPA LHA (Lifetime Health Advisory) = sum of PFOA and PFOS
EPA LHA Exceedance Criteria is defined as equal to or greater than 70 ng/L

Vertical profile 20VP-19-08 was attempted but no saturated overburden was encountered.

SI GW Results not analyzed for PFDA

Aerial Source: USGS, MassGIS Orthoimagery 2019

Area 3 Groundwater Results
Devens PFAS RI - Area 3 PSCS

Former Fort Devens Army Installation
Devens, Massachusetts

KOMAN Government Solutions, LLC
293 Boston Post Road West, Suite 100, Marlborough, MA 01752

0 200 400 800
Feet

Date: 01/12/2021

Plate 2

File: PFAS_RI_A3_PSCS_Plate_GWResults_Dsize.mxd

APPENDIX A MONITORING WELL FIELD SHEETS

Area 3 Existing Monitoring Well Sampling
Field Low Flow Forms

AOC 20

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: ~~MW01A~~ MW-01A

Project: Dennis PFAS RI EW
Location: AOC 21/20
Date: 4/30/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	13.06
Depth to bottom (ft BTOR)	30.66
Pump Set Depth (ft BTOR)	27
Screen Interval (ft ~~BTOR~~)	18-33 bgs
Total volume purged (gal)	3.25

Sampling Type

Purging Method: Peri
Purge start/stop time: 1025-1105
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: –

Field Instrument (Model/S/N): YSI ~~556~~ 556 : 0602657 A1 LaMotte 5108-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1040	300	13.06	7.72	6.56	940	8.81	134.9	4.46	clear/clear
1045	↑	↓	7.74	6.55	928	8.64	134.3	4.35	↓
1050			7.70	6.46	919	8.50	135.6	4.06	
1055			7.64	6.39	920	8.45	137.7	3.35	
1100	✓	↓	7.61	6.37	920	8.37	139.5	3.19	↓

Acceptance Criteria:	<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N	–			→	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: MW-01A-APR19
Sample Time: 1100
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): –
Dup ID: –
Filter Size: –
Dup Time: –

Comments DO seems a bit high, but stabilized otherwise

Signature

4/30/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MW-02A

Project: PFAS RI FW
Location: AOC 20/21
Date: 4/30/19
Sampler: BKA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	16.62
Depth to bottom (ft BTOR)	34.75
Pump Set Depth (ft BTOR)	30
Screen Interval (ft ~~BTOR~~)	18-33
Total volume purged (gal)	3.5

bgs

Sampling Type

Purging Method: Peri
Purge start/stop time: 1315-
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): —
Air source: —

Field Instrument (Model/S/N): YSI 650 XL 02E0534
Lemotte 2020t 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1325	250	16.65	11.32	6.74	2162	1.92	204.3	4.19	clear
1330	250	16.65	11.29	6.69	2151	1.82	203.6	1.46	clear
1335	250	16.65	11.15	6.67	2149	1.64	203.4	1.28	clear
1340	250	16.65	11.14	6.66	2145	1.74	202.7	1.13	clear
1345	250	16.65	11.15	6.64	2135	1.55	201.9	1.10	clear
1350	250	16.65	11.15	6.64	2133	1.63	201.4	1.08	clear
1355	250	16.65	11.16	6.63	2132	1.60	200.9	1.03	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: MW-02A-APR19
Sample Time: 1355
Duplicate (Y/N): N
MS/MSD (Y/N): Y
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments: DPW lock

Signature

4/30/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MW-04

Project: PFAS RI EW
Location:
Date: 4/30/19
Sampler: B.A

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	8.00
Depth to bottom (ft BTOR)	24.96
Pump Set Depth (ft BTOR)	20
Screen Interval (ft BTOR)	7-22 bgs
Total volume purged (gal)	3.0

Sampling Type

Purging Method: Peri
Purge start/stop time: 1225-
Tubing type: HDPE
Tubing diameter: 1/4"OD
Dedicated pump (Y/N): N
Air source: —

Field Instrument (Model/S/N): YSI 605DXL 02E0534
Lamotte 2020t: 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1235	250	8.00	10.54	6.53	1818	0.15	212.7	5.13	clear
1240	250	8.00	10.32	6.53	1826	0.40	211.9	2.26	clear
1245	250	8.00	10.31	6.53	1828	0.54	211.2	2.07	clear
1250	250	8.00	10.34	6.53	1831	0.71	210.1	1.96	clear
1255	250	8.00	10.36	6.52	~~18.37~~ 1837	0.75	209.4	2.03	clear
1300	250	8.00	10.39	6.50	~~16.40~~ 1840	0.73	208.9	1.99	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: MW-04-APR19
Sample Time: 1300
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

4/30/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MW-06

Project: PFAS RI EW A3 Date: 5/6/19
Location: AOC 20/21 Sampler: B&A

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	12.30
Depth to bottom (ft BTOR)	31.75
Pump Set Depth (ft BTOR)	25
Screen Interval (ft ~~BTOR~~)	14-29 bgs
Total volume purged (gal)	3.5

Sampling Type

Purging Method: Peri Tubing type: HDPE Dedicated pump (Y/N): —
Purge start/stop time: 1020-1130 Tubing diameter: ¼"OD Air source: —

Field Instrument (Model/S/N): YSI 650 XL: 02E0534
Lamotte 2020e: 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1030	250	12.35	6.20	7.31	159	3.05	262.4	5.73	clear
1035	250	12.35	6.00	6.83	76	2.13	258.1	4.11	clear
1040	250	12.35	5.97	6.45	71	1.82	253.6	4.93	clear
1045	250	12.35	6.10	6.19	68	2.77	251.4	5.07	clear
1050	250	12.35	6.04	6.04	67	2.79	251.2	4.86	clear
1055	250	12.35	5.99	6.00	67	2.67	248.0	4.79	clear
1100	250	12.35	5.91	5.91	67	2.54	247.1	4.70	clear
1105	250	12.35	6.08	5.84	66	2.59	244.7	4.69	clear
1110	250	12.35	6.02	5.79	66	2.61	244.2	3.96	clear
1115	250	12.35	6.04	5.76	66	0.58	243.7	3.81	clear
1120	250	12.35	6.06	5.78	66	0.57	241.6	3.79	clear
1125	250	12.35	6.05	5.77	66	0.56	240.3	3.76	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	—	—	—	—	

Sampling Details

Sampling ID: MW-06-MAY19
Sample Time: 1125 Duplicate (Y/N): N MS/MSD (Y/N): N
Field Filtered (Y/N): N Dup ID: —
Filter Size: — Dup Time: —

Comments

Signature

5/6/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MW-07

Project: PFAS RI EW
Location: AOC 20/21
Date: 4/30/19
Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	22.85
Depth to bottom (ft BTOR)	38.0
Pump Set Depth (ft BTOR)	34.0
Screen Interval (ft ~~BTOR~~)	20-35.0 SS
Total volume purged (gal)	3.0

Sampling Type

Purging Method: Peri
Purge start/stop time: 1030-
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): —
Air source: —

Field Instrument (Model/S/N): YSI 650XL : 02E[illegible]534
Lamotte 2020e: 1116-0713

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1045	200	22.98	6.01	7.71	124	0.15	160.0	6.30	clear
1050	200	22.98	6.02	7.09	91	0.04	171.2	5.45	"
1055	200	22.98	6.06	6.98	88	0.01	171.8	4.19	"
1100	200	22.98	6.06	6.89	86	0.02	172.6	3.43	"
1105	200	22.98	6.05	6.81	85	0.03	173.3	3.07	"
1110	200	22.98	6.06	6.79	84	0.03	173.9	2.96	"
1115	200	22.98	6.09	6.77	84	0.04	174.0	3.01	"
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: MW-07-APR19
Sample Time: 1115
Duplicate (Y/N): Y
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: A3-MW-DUP-043019
Filter Size: —
Dup Time: 1120

Comments: DRO lock, DUP

Signature

4/30/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: ~~MW-WC1A~~ WC1A

Project: PFAS RI EW A3 Date: 5/16/15
Location: AOC20/21 Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present		✓	
Bolts present			✓
Locked (stickup wells)	—		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	4.39
Depth to bottom (ft BTOR)	20.90
Pump Set Depth (ft BTOR)	15
Screen Interval (ft ~~BTOR~~)	6.45-17.55 bgs
Total volume purged (gal)	3.0

Sampling Type

Purging Method Peri Tubing type HDPE Dedicated pump (Y/N) —
Purge start/stop time 1150 Tubing diameter 1/4"OD Air source —

Field Instrument (Model/S/N) YSI 650XL 02E0534
Lamotte 2020e 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1200	200	4.50	4.57	5.03	203	0.07	251.9	15.7	clear
1205	200	4.50	4.56	4.67	179	0.19	258.0	12.9	clear
1210	200	4.50	4.48	4.59	180	0.70	267.7	7.50	clear
1215	200	4.50	4.51	4.57	181	0.74	266.8	6.92	clear
1220	200	4.50	4.40	4.53	181	0.96	267.0	6.84	clear
1225	200	4.50	4.41	4.53	183	1.05	266.0	6.81	clear
1230	200	4.50	4.46	4.53	185	1.06	264.9	6.79	clear
1235	200	4.50	4.47	4.53	186	1.08	264.8	6.78	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N					0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: MW-WC1A-MAY15
Sample Time: 1235 Duplicate (Y/N): N MS/MSD (Y/N): N
Field Filtered (Y/N): N Dup ID: —
Filter Size: — Dup Time: —

Comments _____

Signature 5/16/15 Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MW-WC2

Project: PFAS RI EWA3 Date: 5/6/19
Location: AOC 20/21 Sampler: BMA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		✓
PVC casing intact	✓		
Well gripper present	✓		✓
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	7.50
Depth to bottom (ft BTOR)	22.10
Pump Set Depth (ft BTOR)	15
Screen Interval (ft ~~BTOR~~)	
Total volume purged (gal)	4.5

by (?)

Sampling Type

Purging Method: Peri Tubing type: HDPE Dedicated pump (Y/N): N
Purge start/stop time: 1250- Tubing diameter: 1/4"OD Air source:

Field Instrument (Model/S/N): YSI 650XL 02E0534
Lamotte 2020c 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1255	300	7.60	8.14	5.11	176	1.81	157.5	7.13	clear
1300	300	7.60	8.25	5.19	176	2.09	129.1	6.37	clear
1305	300	7.60	8.61	5.34	178	2.05	92.7	5.01	clear
1310	300	7.60	8.66	5.37	177	1.77	85.4	4.26	clear
1315	300	7.60	8.64	5.41	178	1.65	79.4	3.10	clear
1320	300	7.60	8.48	5.45	177	1.42	74.7	3.05	clear
1325	300	7.60	8.60	5.45	177	1.42	73.9	2.99	clear
1330	300	7.60	8.62	5.45	178	1.41	73.2	2.96	clear
1335	300	7.60	8.61	5.45	176	1.46	72.9	3.02	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N					

Sampling Details

Sampling ID: MW-WC2-MAY19
Sample Time: 1335 Duplicate (Y/N): N MS/MSD (Y/N): N
Field Filtered (Y/N): N Dup ID: —
Filter Size: — Dup Time: —

Comments

Signature

5/6/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: PZ-1

Project: PFAS RI EW
Location: AOC 20/21
Date: 5/7/19
Sampler: B.A

Well Integrity

	Yes	No	N/A
Casing Secure	~		
Concrete Pad intact			~
PVC casing intact	~		
Well gripper present		~	
Bolts present			~
Locked (stickup wells)		~	

Well Information

Diameter	1"
Material	PVC
Depth to water (ft BTOR)	61.33
Depth to bottom (ft BTOR)	78.10
Pump Set Depth (ft BTOR)	72
Screen Interval (ft BTOR)	70-75
Total volume purged (gal)	3.0

Sampling Type
Purging Method: 0.85" mB
Purge start/stop time: 1215-1330
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): (N)
Air source: N_2

Field Instrument (Model/S/N): YSI 650XL 09E0534
Lamotte 2020e 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1235	100	61.33	15.46	6.71	2433	1.18	112.4	>4,000	cloudy
1240	100	61.33	14.83	6.54	2423	0.84	114.6	87.1	cloudy
1245	100	61.33	15.07	6.50	2421	0.84	115.1	62.6	cloudy
1250	100	61.33	14.23	6.49	2409	0.84	114.8	58.9	cloudy
1255	100	61.33	13.73	6.49	2405	0.82	114.5	51.8	cloudy
1300	100	61.33	13.75	6.49	2387	0.80	113.7	44.6	cloudy
1305	100	61.33	13.56	6.49	2376	0.99	112.9	36.9	cloudy
1310	100	61.33	13.47	6.49	2368	0.96	111.6	37.1	clear
1315	100	61.33	13.31	6.49	2365	0.97	111.7	37.6	clear
1320	100	61.33	13.02	6.49	2370	0.96	111.7	37.4	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N					0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: PZ-1-MAY19
Sample Time: 1320
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N):
Dup ID:
Filter Size:
Dup Time:

Comments

Signature

5/7/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: PZ-2

Project: PFAS RI EW
Location: AOC 20/21
Date: 5/7/19
Sampler: BM

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present		✓	
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	1"
Material	PVC
Depth to water (ft BTOR)	59.86
Depth to bottom (ft BTOR)	102.40
Pump Set Depth (ft BTOR)	~~92~~ 97
Screen Interval (ft BTOR)	95-100
Total volume purged (gal)	2.5

Sampling Type
Purging Method: 0.85" mB
Purge start/stop time: 1030/1150
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): N
Air source: N_2

Field Instrument (Model/S/N): YSI 650XL 02E05341
Lamotte 2020t 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1050	100	60.05	14.43	6.86	1838	0.15	117.0	25.4	clear-brown tint
1055	100	60.05	14.05	6.58	2055	0.10	122.7	20.7	clear
1100	100	60.05	13.47	6.54	2170	0.12	121.3	14.1	clear
1105	100	60.05	13.24	6.51	2230	0.16	119.1	10.7	clear
1110	100	60.05	13.28	6.50	2263	0.15	116.3	8.62	clear
1115	100	60.05	13.24	6.50	2296	0.23	113.2	8.14	clear
1120	100	60.05	13.35	6.50	2281	0.16	110.9	7.23	clear
1125	100	60.05	13.82	6.49	2283	0.28	107.3	6.19	clear
1130	100	~~60.05~~ 60.05	14.05	6.49	2282	0.31	105.6	5.66	clear
1135	100	60.05	13.90	6.49	2296	0.31	102.9	3.93	clear
1140	100	60.05	13.86	6.49	2297	0.38	101.9	3.89	clear
1145	100	60.05	13.84	6.49	2297	0.39	100.6	3.86	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N)				N					

Sampling Details

Sampling ID: PZ-2-MAY19
Sample Time: 1145
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time:

Comments

Signature

5/7/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: PZ-5

Project: Devens PFAS RI EW
Location: AOC 20/21
Date: 04/30/19
Sampler: CW

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present		✓	
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	1"
Material	PVC
Depth to water (ft BTOR)	18.27
Depth to bottom (ft BTOR)	31.76
Pump Set Depth (ft BTOR)	28
Screen Interval (ft ~~BTOR~~)	25-30 bgs
Total volume purged (gal)	3.25

Sampling Type

Purging Method: Peri
Purge start/stop time: 1120 - 1200
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: –
Field Instrument (Model/S/N): YSI 556 : 06072657 A1 Lamotte: 5108-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1135	300	18.27	11.75	6.71	2,239	2.71	155.7	1.38	clear/clear
1140	↓	↓	11.73	6.71	2,243	2.32	155.0	1.29	↓
1145	↓	↓	11.71	6.72	2,244	1.86	154.4	0.78	↓
1150	↓	↓	11.70	6.72	2,244	1.75	153.6	0.88	↓
1155	✓	✓	11.65	6.72	2,248	1.70	153.1	0.85	✓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	→	→	→	→	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: PZ-5-APR19
Sample Time: 1155
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: –
Filter Size: –
Dup Time: –

Comments

Signature

4/30/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: ~~MW~~ PZ-6

Project: PFAS RI EW
Location: AOC 20/21

Date: 4/30/19
Sampler: B/A

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		—
PVC casing intact	✓		
Well gripper present	~~✓~~	✓	
Bolts present			—
Locked (stickup wells)	—		

Well Information

Diameter	1"
Material	PVC
Depth to water (ft BTOR)	8.45
Depth to bottom (ft BTOR)	22.92
Pump Set Depth (ft BTOR)	~~20~~ 17
Screen Interval (ft BTOR)	15-20 bgs
Total volume purged (gal)	3.0

Sampling Type

Purging Method: Peri
Purge start/stop time: 1135.
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): N
Air source: —

Field Instrument (Model/S/N): YSI 650XL 02E0534
Lamotte 2020we 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1145	200	8.50	7.48	6.48	424	0.17	205.9	4.17	clear
1150	200	8.50	7.56	6.45	436	0.30	203.1	2.63	clear
1155	200	8.50	7.56	6.44	439	0.36	202.1	2.48	"
1200	200	8.50	7.59	6.43	443	0.40	201.8	2.33	"
1205	200	8.50	7.63	6.43	443	0.44	201.7	2.35	"
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: PZ-6-APR19
Sample Time: 1205
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

BAP
Signature

4/30/19
Date

AOC 50

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GOM-01-01X (1/2)

Project: PFAS RI EW
Location: ADC50

Date: 5/1/19
Sampler: B.A

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	59.10
Depth to bottom (ft BTOR)	148.52
Pump Set Depth (ft BTOR)	145
Screen Interval (ft BTOR)	140-150 bgs
Total volume purged (gal)	5.0

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 0800-0930
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N)
Air source: N_2

Field Instrument (Model/S/N): YSI 605OXL 02E0534
Lamotte 2020t 11116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0820	200	59.30	7.73	6.33	961	1.27	72.5	>4,000	cloudy
0825	200	59.30	7.66	6.27	961	1.12	58.9	>4,000	cloudy
0830	200	59.30	7.70	6.24	961	1.03	46.2	>4,000	cloudy
0835	200	59.30	7.66	6.22	959	0.63	33.5	>4,000	cloudy
0840	200	59.30	7.73	6.23	958	0.51	26.4	>4,000	cloudy
0845	200	59.30	7.31	6.25	961	0.47	22.7	>4,000	cloudy
0850	200	59.30	7.43	6.26	956	0.47	21.7	>4,000	cloudy
0855	200	59.30	7.72	6.26	955	0.44	20.5	>4,000	cloudy
0900	200	59.30	7.73	6.28	955	0.38	19.1	>4,000	cloudy
0905	200	59.30	7.76	6.28	954	0.38	18.4	>4,000	cloudy
0910	200	59.30	7.77	6.29	953	0.39	17.0	>4,000	cloudy
0915	200	59.30	7.78	6.29	953	0.41	16.5	>4,000	cloudy
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	N	

Sampling Details

Sampling ID: GOM-01-01X-MAY19
Sample Time: 0925
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments: PG 1/2, Turbidity not stable, approve to sample (JCM)

Signature

5/1/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: Glen-01+01X (cont) (2/2)

Project: _____ Date: _____
Location: _____ Sampler: _____

Well Integrity

	Yes	No	N/A
Casing Secure			
Concrete Pad intact			
PVC casing intact			
Well gripper present			
Bolts present			
Locked (stickup wells)			

Well Information

Diameter	
Material	
Depth to water (ft BTOR)	
Depth to bottom (ft BTOR)	
Pump Set Depth (ft BTOR)	
Screen Interval (ft BTOR)	
Total volume purged (gal)	

Sampling Type

Purging Method _____ Tubing type _____ Dedicated pump (Y/N) _____
Purge start/stop time _____ Tubing diameter _____ Air source _____

Field Instrument (Model/S/N) _____

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0920	200	59.30	7.85	6.30	953	0.35	16.7	>4,000	cloud
0925	200	59.30	7.84	6.28	953	0.36	17.1	>4,000	cloudy
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: _____
Sample Time: 0925 Duplicate (Y/N): _____ MS/MSD (Y/N): _____
Field Filtered (Y/N): _____ Dup ID: _____
Filter Size: _____ Dup Time: _____

Comments Sample 1

Signature

5/1/15
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GWM-02-01X

Project: PFAS RI EW
Location: AOC 50

Date: 4/26/19
Sampler: BA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	52.10
Depth to bottom (ft BTOR)	89.5
Pump Set Depth (ft BTOR)	~~89~~ 85
Screen Interval (ft BTOR)	80-95 (85)
Total volume purged (gal)	3.0

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 1100 -
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): N
Air source: N_2

Field Instrument (Model/S/N): YSI 650 XL 02E05534
Lamotte 2020t 1116 0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1120	250	52.20	9.74	6.99	2940	0.51	-80.5	50.8	clear / black flocting solids
1125	250	52.20	9.67	7.12	2937	0.47	-85.1	47.3	clear / "
1130	250	52.20	9.67	7.18	2930	0.50	-93.1	44.0	clear / "
1135	250	52.20	9.65	7.23	2924	0.34	-92.9	33.9	"
1140	250	52.20	9.66	7.26	2926	0.29	-99.2	28.1	"
1145	250	52.20	9.65	7.30	2927	0.33	-102.5	23.6	"
1150	250	52.20	9.62	7.31	2923	0.35	-105.6	20.1	"
1155	250	52.20	9.66	7.33	2933	0.27	-104.6	20.7	"
* 1200	250	52.20	9.65	7.34	2926	0.34	-105.8	19.9	"
1205	250	52.20	9.67	7.34	2929	0.28	-105.0	19.3	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N	N	N	N	N		0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GWM-02-01X_APR19
Sample Time: 1205
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

4/26/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-02-06X

Project: Deums PFAS RI GW
Location: AOC 50

Date: 5/6/19
Sampler: CW

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	4.36
Depth to bottom (ft BTOR)	66.41
Pump Set Depth (ft BTOR)	60
Screen Interval (ft ~~BTOR~~)	55 - ~~60~~ 65 BGS
Total volume purged (gal)	2.5

Sampling Type

Purging Method: Peri
Purge start/stop time: 0830 - 0915
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: —

Field Instrument (Model/S/N): YSI 556 - 0602657 A1 LaMotte: 5708-5814

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0845	200	4.36	10.55	7.61	159	5.35	145.9	4.96	clear/clear
0850	↓	↓	10.55	7.61	159	5.28	144.3	2.19	↓
0855			10.57	7.62	159	5.27	143.5	2.57	
0900			10.60	7.62	159	5.09	139.7	1.77	
0905			10.61	7.62	159	5.05	138.1	1.45	
0910	↓	↓	10.62	7.62	160	5.01	137.4	1.42	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: GGM-02-06X_MAY19
Sample Time: 0910
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

5/6/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

KGS

Well Identification: G6M-02-07X

Project: Dorms PFAS RI EW
Location: AOC 50
Date: 04/29/19
Sampler: CW

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	3.45
Depth to bottom (ft BTOR)	40.57
Pump Set Depth (ft BTOR)	35
Screen Interval (ft ~~BTOR~~)	30-40 bgs
Total volume purged (gal)	~2.75

Sampling Type
Purging Method: Peri
Purge start/stop time: 0900-0940
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -

Field Instrument (Model/S/N): YSI 556: 0602657 A1 LaMotte: 5083-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0915	250	3.45	10.41	7.18	773	4.91	153.7	9.86	clear/clear
0920	↓	↓	10.49	7.31	779	3.52	146.0	8.73	↓
0925	↓	↓	10.52	7.43	784	2.31	141.0	6.77	↓
0930	↓	↓	10.55	7.49	789	2.21	135.2	6.53	↓
0935	↓	↓	10.60	7.50	795	2.15	133.4	6.43	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	Y	

Sampling Details

Sampling ID: G6M-02-07X_APR19
Sample Time: 0935
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments

[signature]
Signature

4/29/19
Date

G6M-01-07X

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-02-08X

Project: Drums PFAS RI EW
Location: AOC 50
Date: 5/2/19
Sampler: CW

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		✓
Bolts present	✓		✓
Locked (stickup wells)	✓		

Well Information

Diameter	2.5"	
Material	PVC	
Depth to water (ft ~~BTOR~~)	11.25	~~BGS~~ BTOR
Depth to bottom (ft ~~BTOR~~)	21.27	BGS BTOR
Pump Set Depth (ft ~~BTOR~~)	65	BGS BTOR
Screen Interval (ft ~~BTOR~~)	60-70	BGS
Total volume purged (gal)	2.25	

Sampling Type
Purging Method: Peri
Purge start/stop time: 1115 - 1155
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: –
Field Instrument (Model/S/N): YSI 556, 06D2657 A1 LaMotte, 5108-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1125	200	11.64	10.25	6.48	1,476	4.01	-81.7	10.87	yellow hue / clear
1130	↓	11.66	10.23	6.47	1,479	3.46	-81.6	9.92	↓
1135		11.71	9.64	6.47	1,482	2.52	-84.4	9.67	
1140		↓	9.52	6.48	1,480	2.01	-88.2	8.81	
1145			9.45	6.48	1,481	1.93	-91.4	8.63	
1150	↓	↓	9.44	6.49	1,482	1.84	-93.7	8.32	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	Y	

Sampling Details

Sampling ID: GGM-02-08X_MAY19
Sample Time: 1150
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: –
Filter Size: –
Dup Time: –

Comments

Signature

5/2/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GOM-02-09X

Project: PFAS RI EW
Location: AOC50

Date: 5/2/19
Sampler: B/A

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	56.78
Depth to bottom (ft BTOR)	~~100.52~~ 106.52
Pump Set Depth (ft BTOR)	100
Screen Interval (ft ~~BTOR~~ bgs)	95-105
Total volume purged (gal)	3.0

Sampling Type

Purging Method: 1.75" Bladder
Purge start/stop time: 0930
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): —
Air source: N_2

Field Instrument (Model/S/N): YSI 650 XL 02E0534
Lamotte 2020e 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0945	200	56.80	8.76	5.76	736	5.71	95.7	49.8	cloudy
0950	200	56.80	8.70	5.73	730	5.63	99.8	32.6	cloudy
0955	200	56.80	8.67	5.72	717	5.42	107.4	30.3	cloudy
1000	200	56.80	8.67	5.72	713	5.43	109.4	30.2	clear
1005	200	56.80	8.68	5.73	710	5.43	112.3	30.1	↓
1010	200	56.80	8.65	5.73	707	5.45	118.9	28.7	↓
1015	200	56.80	8.66	5.73	706	5.44	119.9	28.6	↓
1020	200	56.80	8.65	5.72	705	5.44	121.7	28.5	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N				→	

Sampling Details

Sampling ID: GOM-02-09X_MAY19
Sample Time: 1020
Duplicate (Y/N): —
MS/MSD (Y/N): —
Field Filtered (Y/N): —
Dup ID: —
Filter Size: —
Dup Time: —

Comments: _____

Signature

5/2/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-02-13X

Project: Denny PFAS RI EW
Location: AOC 58

Date: 5/2/19
Sampler: CN

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present		✓	
Locked (stickup wells)			✓

Well Information

Diameter	2"	
Material	PVC	
Depth to water (ft ~~BTOR~~)	56.45	BGS
Depth to bottom (ft ~~BTOR~~)	120.67	BGS
Pump Set Depth (ft ~~BTOR~~)	115	BGS
Screen Interval (ft ~~BTOR~~)	110-120	BGS
Total volume purged (gal)	1.5	

Sampling Type
Purging Method: Bladder Pump
Purge start/stop time: 0825-0920
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): Y
Air source: Nitrogen
Field Instrument (Model/S/N): YSI 556 : 0B02657 A1 LaMotte : 5108-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0845	~~200~~ 100	56.45	11.45	6.94	1,106	5.61	-2.2	7.54	clear/clear
0850	↓	↓	11.66	6.81	1,117	4.51	-13.1	4.69	↓
0855			11.78	6.71	1,119	3.49	-17.4	4.33	
0900			11.79	6.53	1,121	2.95	-21.2	4.15	
0905			11.78	6.53	1,125	2.73	-26.4	3.99	
0910			11.78	6.54	1,130	2.61	-28.7	3.88	
0915	↓	↓	11.78	6.54	1,134	2.53	-30.2	3.89	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N	N	N	N	Y		0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GGM-02-13X_MAY19
Sample Time: 0915
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments Dedicated Pump taken out during sampling and put back in afterwards

Signature

5/2/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-03-11X (1/2)

Project: PFAS RI EW
Location: ~~BRA~~ AOC50
Date: 5/1/19
Sampler: BJA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	58.99
Depth to bottom (ft BTOR)	131.52
Pump Set Depth (ft BTOR)	125
Screen Interval (ft ~~BTOR~~)	120-130 bgs
Total volume purged (gal)	3.0

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 1000-1140
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N)
Air source: N_2

Field Instrument (Model/S/N): YSI 650 XL 02E05534
Lamotte 2020e 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1015	200	59.00	7.30	6.29	784	1.18	6.6	66.7	cloudy
1020	200	59.00	7.11	6.24	780	0.87	6.3	60.9	cloudy
1025	200	59.00	7.31	6.25	714	0.66	7.9	52.7	clear
1030	200	59.00	7.34	6.24	640	0.62	12.8	40.8	cloudy
1035	200	59.00	7.40	6.21	607	0.47	16.2	38.9	clear, black specs
1040	200	59.00	7.43	6.20	572	0.47	17.3	37.1	clear, black specs
1045	200	59.00	7.46	6.20	545	0.48	19.7	33.3	clear, black specs
1050	200	59.00	7.48	6.18	483	0.34	27.0	26.4	clear
1055	200	59.00	7.47	6.15	436	0.65	32.5	19.8	clear
1100	200	59.00	7.46	6.15	426	0.69	34.8	15.7	clear
1105	200	59.00	7.50	6.14	413	0.87	37.9	14.3	clear
1110	200	59.00	7.51	6.13	391	1.00	40.1	12.1	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: G6M-03-11X-MAY19
Sample Time: 1130
Duplicate (Y/N): Y
MS/MSD (Y/N): N
Field Filtered (Y/N): —
Dup ID: A3-MW-DUP-050119
Filter Size: —
Dup Time: 1135

Comments: DUP

Signature

5/1/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-03-11X (cont) (2/2)

Project: _____ Date: _____
Location: _____ Sampler: _____

Well Integrity

	Yes	No	N/A
Casing Secure			
Concrete Pad intact			
PVC casing intact			
Well gripper present			
Bolts present			
Locked (stickup wells)			

Well Information

Diameter	
Material	
Depth to water (ft BTOR)	
Depth to bottom (ft BTOR)	
Pump Set Depth (ft BTOR)	
Screen Interval (ft BTOR)	
Total volume purged (gal)	

Sampling Type

Purging Method _____ Tubing type _____ Dedicated pump (Y/N) _____
Purge start/stop time _____ Tubing diameter _____ Air source _____

Field Instrument (Model/S/N) _____

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1115	200	59.00	7.53	6.12	386	1.08	40.6	10.9	clear
1120	200	59.00	7.58	6.12	371	1.10	43.3	9.97	clear
1125	200	59.00	7.59	6.12	365	1.13	44.8	9.81	clear
1130	200	59.00	7.60	6.12	363	1.09	45.9	9.93	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	N	

Sampling Details

Sampling ID: G6M-03-11X-MAY19
Sample Time: 1130 Duplicate (Y/N): Y MS/MSD (Y/N): _____
Field Filtered (Y/N): _____ Dup ID: A3-MW-DUP-050119
Filter Size: _____ Dup Time: 1135

Comments steps 1

Signature

5/1/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-04-03X

Project: PFAS RI EW
Location: AOC5D
Date: 4/26/15
Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	54.70
Depth to bottom (ft BTOR)	93.10
Pump Set Depth (ft BTOR)	90
Screen Interval (ft ~~BTOR~~)	85-95 bgs
Total volume purged (gal)	3.0

Sampling Type

Purging Method: 1.75" Bladder
Purge start/stop time: 0840
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/(N))
Air source: N_2

Field Instrument (Model/S/N): YSI 650XL 02E0534
Lamotte 2020e 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
~~0855~~	250	54.70	9.72	6.50	2663	1.17	-42.6	2.64	clear
0900	250	54.79	9.65	6.40	2768	0.77	-45.6	2.14	clear
0905	250	54.79	9.57	6.36	2883	0.59	-56.0	3.64	clear
0910	250	54.79	9.60	6.37	2874	0.71	-58.6	3.90	clear
0915	250	54.79	9.55	6.37	2376	1.00	-53.1	4.71	clear
0920	250	54.79	9.55	6.34	2399	1.15	-49.7	3.96	clear
0925	250	54.79	9.52	6.30	2397	0.80	-47.1	3.81	↓
0930	250	54.79	9.50	6.31	23.70	0.55	-48.7	2.90	
0935	250	54.79	9.49	6.32	23.30	0.60	-49.1	2.90	
0940	250	54.79	9.46	6.32	2376	0.49	-51.1	2.88	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: G6M-04-03X-APR15
Sample Time: 0940
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

4/26/15
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-04-06X

Project: PFAS RI EW
Location: AOC50
Date: 5/1/19
Sampler: _____

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present		✓	
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	57.53
Depth to bottom (ft BTOR)	106.8
Pump Set Depth (ft BTOR)	~~95~~ 100
Screen Interval (ft ~~BTOR~~)	95-105 bgs
Total volume purged (gal)	3.0

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 1210-1300
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): Removed for PFAS
Air source: N_2

Field Instrument (Model/S/N): YSI 650XL 02E0534
Lamotte 2020E 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1225	250	57.60	8.45	5.90	231	1.13	104.0	2.16	clear
1230	250	57.60	8.49	5.90	231	1.41	105.2	3.41	clear
1235	250	57.60	8.45	5.87	230	1.00	111.6	2.73	clear
1240	250	57.60	8.40	5.86	230	0.65	117.2	1.93	clear
1245	250	57.60	8.38	5.86	230	0.25	120.4	2.09	clear
1250	250	57.60	8.36	5.86	230	0.21	122.9	1.99	clear
1255	250	57.60	8.37	5.85	229	0.30	123.6	1.89	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: G6M-04-06X-MAY19
Sample Time: 1255
Duplicate (Y/N): —
MS/MSD (Y/N): —
Field Filtered (Y/N): —
Dup ID: —
Filter Size: —
Dup Time: —

Comments _____

Signature

5/1/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

KGS

Well Identification: 66M-04-08X

Project: Devens PFAS RI EW
Location: AOC 50
Date: 04/30/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	2.61
Depth to bottom (ft BTOR)	90.5
Pump Set Depth (ft BTOR)	85
Screen Interval (ft ~~BTOR~~)	80-90 bgs
Total volume purged (gal)	3 gal

Sampling Type

Purging Method: Peri
Purge start/stop time: 0850-0935
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -

Field Instrument (Model/S/N): YSI 556: 0602657 A1 LaMotte: 5708-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0900	250	2.61	11.66	6.74	1,803	3.90	142.4	26.9	clear/clear
0905	↓	↓	11.72	6.78	1,812	2.58	129.3	21.6	↓
0910			11.82	6.81	1,810	2.01	123.0	23.3	
0915			11.84	6.84	1,830	1.49	110.8	9.64	
0920			11.89	6.88	1,861	1.30	104.9	7.60	
0925			11.86	6.88	1,867	1.31	103.2	7.55	
0930			11.85	6.88	1,873	1.31	102.4	7.77	
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N					

Sampling Details

Sampling ID: 66M-04-08X_APR19
Sample Time: 0930
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments

Signature

4/30/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

KGS

Identification: G6M-04-10X

Project: Dmms PFAS RI FW
Location: AOC 50

Date: 04/29/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	11.08
Depth to bottom (ft BTOR)	64.07
Pump Set Depth (ft BTOR)	[redacted] 57
Screen Interval (ft ~~BTOR~~)	[redacted] 52-62 bgs
Total volume purged (gal)	~1.75

Sampling Type

Purging Method: Peri
Purge start/stop time: 1230 - 1310
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -

Field Instrument (Model/S/N): YSI 556 : 0602657 A1 LaMotte, 5083-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1240	150	11.08	9.97	9.91	1,383	4.45	86.9	36.2	clear / clear
1245	↓	↓	9.98	9.89	1,405	3.49	80.3	40.1	↓
1250			10.01	9.89	1,409	3.18	76.8	38.7	
1255			10.05	9.93	1,415	3.01	75.4	38.3	
1300	↓	↓	10.08	9.98	1,417	2.92	74.9	38.2	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	Y	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: G6M-04-10X_APR19
Sample Time: 1300
Duplicate (Y/N): Y
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: A3-G6M-04-10X-DUP-042919
Filter Size: -
Dup Time: 1305

Comments: pH seems a bit high

Signature

04/29/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GCM - 04 - 11X

Project: Devens PFAS RI Existing well
Location: AOC 50
Date: 4/25/2019
Sampler: ES

Well Integrity

	Yes	No	N/A
Casing Secure	X		
Concrete Pad intact	X		
PVC casing intact	X		
Well gripper present	X		
Bolts present			X
Locked (stickup wells)		X	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	17.46
Depth to bottom (ft BTOR)	46.97
Pump Set Depth (ft BTOR)	40
Screen Interval (ft BTOR)	35-45
Total volume purged (gal)	8.0 L (2.1 gal)

Sampling Type

Purging Method: Peri
Purge start/stop time: 1233 / 1308
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): no
Air source: -

Field Instrument (Model/S/N): YSI 556 MPS 06C2657AI
LaMotte 2020t 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1235	260	18.62	11.08	6.60	231	10.76	110.8	40.7	hazy
1240	260	18.68	10.94	6.60	233	9.39	113.6	18.8	clear
1245	250	18.78	10.95	6.60	233	8.72	115.8	8.09	clear
1250	250	18.88	10.93	6.59	233	8.38	118.9	6.03	Clear
1255	250	~~18.93~~ 18.68	10.92	6.58	234	8.10	121.9	6.37	Clear
1300	250	19.06	10.99	6.56	236	8.01	123.8	6.74	Clear
1305	250	19.10	10.81	6.54	238	8.03	127.4	6.66	Clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				no	no	yes	no	yes	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GCM-04-11X-[redacted] APR19
Sample Time: 1305
Duplicate (Y/N): no
MS/MSD (Y/N): no
Field Filtered (Y/N): no
Dup ID: -
Filter Size: -
Dup Time: -

Comments

Signature

4/25/2019
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-04-13X

Project: Devens PFAS RI EW
Location: AOC 50

Date: 5/8/19
Sampler: CW

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present		✓	
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	12.10
Depth to bottom (ft BTOR)	41.31
Pump Set Depth (ft BTOR)	35
Screen Interval (ft ~~BTOR~~)	30-40 BGS
Total volume purged (gal)	2.0

Sampling Type

Purging Method: Peri
Purge start/stop time: 0755-0845
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -

Field Instrument (Model/S/N): YSI 556: 0602657 A1 LaMotte: 5108-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0810	~~200~~ 150	12.10	9.48	5.80	185	4.35	92.4	10.33	clear/clear
0815	↓	↓	9.44	5.80	182	3.15	86.1	5.78	↓
0820			9.52	5.79	181	2.45	74.8	5.11	
0825			9.67	5.84	179	1.82	64.6	4.00	
0830			9.69	5.84	180	1.75	62.9	3.87	
0835			9.73	5.85	180	1.65	60.8	3.68	
0840	↓	↓	9.75	5.86	179	1.62	60.1	3.55	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N	N	N	N	N		0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GGM-04-13X_MAY19
Sample Time: 0840
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments

Signature

5/8/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

KGS

Well Identification: G6M-04-14X

Project: PFAS RI EW
Location: AOC 50
Date: 4/30/19
Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	3.57
Depth to bottom (ft BTOR)	92.92
Pump Set Depth (ft BTOR)	85
Screen Interval (ft ~~BTOR~~)	80-90 bgs
Total volume purged (gal)	3.5

Sampling Type

Purging Method: Peri
Purge start/stop time: 0825-0935
Tubing type: HDPE
Tubing diameter: ____
Dedicated pump (Y/N): —
Air source: —

Field Instrument (Model/S/N): YSI 1050XL 02E0534
Lamotte 2020t 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0830	250	3.75	9.47	7.78	342	2.92	250.5	6.81	clear
0835	250	3.75	9.42	7.01	471	1.36	249.7	5.28	↓
0840	↓	↓	9.40	6.64	519	0.10	249.5	4.00	↓
0845	↓	↓	9.50	6.80	632	0.05	238.0	2.60	↓
0850	↓	↓	9.50	6.83	642	0.06	237.2	2.51	↓
0855	↓	↓	9.48	6.91	661	0.08	231.8	2.03	↓
0900	↓	↓	9.53	7.01	884	0.12	227.1	1.72	↓
0905	↓	↓	9.57	7.13	945	0.12	220.1	1.70	↓
0910	↓	↓	9.50	7.22	951	0.06	216.7	1.68	↓
0915	↓	↓	9.46	7.26	952	0.09	213.4	1.72	↓
0920	↓	↓	9.43	7.28	958	0.06	208.9	1.65	↓
0925	↓	↓	9.40	7.32	962	0.08	202.1	1.69	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: G6M-04-14X-APR19
Sample Time: 0925
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments: Pulled teflon tubing @ 0810

[signature]
Signature

4/30/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-13-02X

Project: PFAS RI EW
Location: AOC 50
Date: 5/2/19
Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	56.75
Depth to bottom (ft BTOR)	125.12
Pump Set Depth (ft BTOR)	120
Screen Interval (ft ~~BTOR~~)	115-125 bgs
Total volume purged (gal)	3.0

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 0730
Tubing type: HDPE
Tubing diameter: Y4"OD
Dedicated pump (Y/(N)):
Air source: N/A

Field Instrument (Model/S/N): YSI 650XL 02E0534
Lamotte 2020t 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0750	200	56.80	8.90	6.00	1327	0.84	-2.3	5.96	clear
0755	200	56.80	8.96	6.01	FR 1325	0.86	-3.1	5.03	clear
0800	200	56.80	8.98	6.01	1320	0.86	-4.8	4.71	clear
0805	200	56.80	8.97	5.99	1319	0.89	-5.6	3.54	clear
0810	200	56.80	9.25	5.99	1328	0.84	-4.0	3.03	clear
0815	200	56.80	9.30	5.98	1340	0.90	-2.8	2.98	clear
0820	200	56.80	9.31	5.98	1339	0.88	-2.9	2.97	clear
0825	200	56.80	9.32	5.99	1341	0.91	-3.0	2.97	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N						0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: G6M-13-02X-MAY19
Sample Time: 0825
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

5/2/19
Date

DO < 1
Turb < 5

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-13-03X

Project: PFAS RI EW
Location: AOC50
Date: 5/3/19
Sampler: B/A

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present		✓	
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	55.60
Depth to bottom (ft BTOR)	90.40
Pump Set Depth (ft BTOR)	~~80~~ 85 bgs
Screen Interval (ft BTOR)	80-90 bgs
Total volume purged (gal)	2.0

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 0800-
Tubing type: HDPE
Tubing diameter: 1/4"OD
Dedicated pump (Y/N): (Y)
Air source: N_2

Field Instrument (Model/S/N): YSI 650XL 02E0534
Lamotte 2020t 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0815	200	55.65	9.15	5.87	2575	2.50	234.1	7.83	clear
0820	200	55.65	9.16	5.50	2623	2.21	225.8	4.92	clear
0825	200	55.65	9.09	5.41	2654	2.39	226.6	3.05	clear
0830	200	55.65	9.04	5.36	2673	2.50	227.5	2.68	clear
0835	200	55.65	9.04	5.33	2681	2.51	230.4	2.75	clear
0840	200	55.65	9.07	5.32	2682	2.55	232.1	2.78	clear
0845	200	55.65	9.08	5.32	2683	2.56	233.0	2.80	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):									

Sampling Details

Sampling ID: G6M-13-03X_MAY19
Sample Time: 0845
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): —
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

5/3/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-13-05X

Project: PFAS I21 & EW
Location: —
Date: 4/26/19
Sampler: BA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	·	✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	12.18
Depth to bottom (ft BTOR)	56.72
Pump Set Depth (ft BTOR)	54
Screen Interval (ft BTOR)	
Total volume purged (gal)	3.0

Sampling Type

Purging Method: Peristaltic
Purge start/stop time: 1240 -
Tubing type: HDPE
Tubing diameter: ¼" OD
Dedicated pump (Y/N): —
Air source: —

Field Instrument (Model/S/N): YSI 650XL 02E05534
Lamotte 2020we 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1255	150	12.40	8.26	6.08	1082	0.87	12.3	8.40	clear
1300	150	12.40	8.07	6.03	1070	0.71	13.1	6.73	"
1305	150	12.40	7.95	5.99	1069	0.67	13.3	4.41	"
1310	150	12.40	7.86	5.98	1066	0.63	12.5	3.27	"
1315	150	12.40	7.81	5.97	1053	0.58	11.5	3.01	"
1320	150	12.40	7.81	5.96	1050	0.54	9.8	2.96	"
1325	150	12.40	7.80	5.95	1049	0.57	9.6	2.94	"
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: G6M-13-05X-APR19
Sample Time: 1325
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments: Substituted for G6M-04

Signature

4/26/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: 66M-92-10X

Project: Dorms PFAS RI EW
Location: AOC 50

Date: 4/26/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		✓
Concrete Pad intact	✓		✓
PVC casing intact	✓	✓	
Well gripper present		✓	
Bolts present		✓	✓
Locked (stickup wells)		✓	

Well Information

Diameter	4"
Material	PVC
Depth to water (ft BTOR)	10.41
Depth to bottom (ft BTOR)	21.35
Pump Set Depth (ft BTOR)	17.0
Screen Interval (ft ~~BTOR~~)	~~30-40~~ 9-19 bgs
Total volume purged (gal)	1.5

Sampling Type

Purging Method: Peri
Purge start/stop time: 0925 - 1020
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -

Field Instrument (Model/S/N): YSI 556: 10H100928 LaMotte: 5083-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0940	100	10.52	7.83	5.53	6059	7.57	74.4	7.43	clear/clear
0945	↓	↓	7.81	6.72	6081	7.55	77.0	5.09	↓
0950			7.77	5.80	6095	7.95	81.5	4.77	
0955			7.75	5.70	6,190	8.50	86.4	4.61	
1000			7.45	5.68	6,105	8.58	89.5	4.56	
1005			7.30	5.70	6,090	8.01	92.4	4.73	
1010			7.29	5.69	6,085	8.49	93.2	4.33	
1015	↓	↓	7.28	5.70	6,084	8.61	90.2	4.71	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: 66M-92-10X-APR19
Sample Time: 1015
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments: _____

Signature

4/26/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: 66M-93-13X

Project: Navy PFAS RI EW
Location: AOC 50

Date: 4/29/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	4"
Material	PVC
Depth to water (ft BTOR)	10.55
Depth to bottom (ft BTOR)	19.66
Pump Set Depth (ft BTOR)	16.0
Screen Interval (ft ~~BTOR~~)	9-19 bgs
Total volume purged (gal)	~2.25

Sampling Type
Purging Method: Pmi
Purge start/stop time: 1155 - 1215
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -
Field Instrument (Model/S/N): YSI 556 : 0602657 A1 LaMotte: 5083-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1150	200	10.55	8.05	7.39	108	8.80	97.4	20.80	clear/clear
1155	↓	↓	8.15	7.10	102	7.41	96.5	17.50	↓
1200			8.29	6.90	102	7.01	99.9	14.70	
1205			8.35	6.86	102	6.70	101.3	14.86	
1210	↓	↓	8.40	6.81	101	6.51	104.5	14.13	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	Y	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: 66M-93-13X_APR19
Sample Time: 1210
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments

Signature

4/29/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-95-20X

Project: Dmms PFAS RI EW
Location: AOC 50

Date: 4/26/19
Sampler: CN

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	10.45
Depth to bottom (ft BTOR)	24.9
Pump Set Depth (ft BTOR)	21.0
Screen Interval (ft ~~BTOR~~)	18-23 bgs
Total volume purged (gal)	1.0

Sampling Type
Purging Method: Peri
Purge start/stop time: 0820-0853
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: —
Field Instrument (Model/S/N): YSI 556 : 10H100928 LMHe: 5083-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0830	100	11.71	8.62	6.61	707	0.82	-15.7	5.96	clear/clear
0835	↓	11.75	8.69	6.28	704	0.49	-57.8	4.74	↓
0840		11.81	8.71	6.26	706	0.46	-56.7	4.93	
0845		11.86	8.75	6.24	705	0.39	-57.1	4.67	
0850	↓	11.94	8.78	6.23	706	0.38	-60.2	4.70	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: GGM-95-20X-APR19
Sample Time: 0850
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments: _____

Signature

4/26/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-96-22A

Project: Downs PFAS RI EW
Location: AOC 50

Date: 5/6/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	3.27
Depth to bottom (ft BTOR)	57.30
Pump Set Depth (ft BTOR)	45
Screen Interval (ft ~~BTOR~~)	40-50
Total volume purged (gal)	2.25

1365

Sampling Type

Purging Method: Peri
Purge start/stop time: 1100 - 1140
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: –

Field Instrument (Model/S/N): YSI 556: 0602657 A1 LaMotte: 5108-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1110	200	3.27	10.58	6.38	1,457	5.35	129.4	10.70	clear/clear
1115	↓	↓	10.53	6.35	1,452	4.99	146.5	5.05	↓
1120			10.57	6.30	1,453	4.57	148.2	5.44	
1125			10.64	6.20	1,464	4.04	153.3	3.61	
1130			10.61	6.16	1,471	3.90	153.6	3.65	
1135	↓	↓	10.65	6.14	1,480	3.82	153.9	2.62	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: GGM-96-22A_MAY19
Sample Time: 1135
Duplicate (Y/N): N
MS/MSD (Y/N): Y
Field Filtered (Y/N): N
Dup ID: –
Filter Size: –
Dup Time: –

Comments: MS/MSD taken

Signature

5/6/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-96-22B

Project: Davis PFAS RI FW
Location: AOC 50
Date: 5/6/19
Sampler: CW

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	3.16
Depth to bottom (ft BTOR)	71.6
Pump Set Depth (ft BTOR)	68.0
Screen Interval (ft BTOR)	65.5-70.5
Total volume purged (gal)	2.75

Sampling Type
Purging Method: Peri
Purge start/stop time: 1005-1053
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -
Field Instrument (Model/S/N): YSI 556: 06072657 A1 LaMotte, 5708-5814

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1026	700	3.16	10.12	6.88	2,098	5.40	174.8	13.00	clear/clear
1025	↓	↓	10.19	6.79	2,102	3.94	173.1	6.53	↓
1030			10.28	6.72	2,103	3.05	172.8	4.75	
1035			10.39	6.61	2,107	2.50	167.4	2.25	
1040			10.39	6.52	2,105	2.03	163.7	2.57	
1045			10.38	6.51	2,105	1.94	162.9	2.76	
1050	↓	↓	10.35	6.49	2,106	1.85	161.5	2.72	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GGM-96-22B MAY19
Sample Time: 1050
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments

Signature

5/6/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: ~~GGM-95-26A~~ GGM-96-25A

Project: Devens PFAS RI Existing well
Location: AOC 508
Date: 4/25/2019
Sampler: ES

Well Integrity

	Yes	No	N/A
Casing Secure	X		
Concrete Pad intact	X		
PVC casing intact	X		
Well gripper present	X		
Bolts present			X
Locked (stickup wells)		X	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	10.71
Depth to bottom (ft BTOR)	21.30
Pump Set Depth (ft BTOR)	13.5
Screen Interval (ft BTOR)	9 - 18.7
Total volume purged (gal)	6.75 L (1.7gal)

Sampling Type

Purging Method: Peri
Purge start/stop time: 1323 / 1403
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): no
Air source: —

Field Instrument (Model/S/N): YSI 556 MPS 06C2657 AI
Lamotte 2020t 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1325	250	10.73	9.06	6.92	44	11.63	115.4	13.5	Clear
1330	250	10.73	9.15	6.71	42	10.93	120.3	12.1	Clear
1335	250	10.73	8.84	6.53	40	10.92	123.8	11.7	Clear
1340	250	10.73	8.87	6.50	39	10.58	126.7	13.9	Clear
1345	250	10.73	8.84	6.48	38	10.61	130.6	14.7	Clear
1350	250	10.73	8.83	6.44	38	10.60	133.0	14.2	Clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				no	no	yes	no	yes	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GGM-96-25A-~~0419~~ APR19
Sample Time: 1350
Duplicate (Y/N): yes
MS/MSD (Y/N): yes
Field Filtered (Y/N): no
Dup ID: AS-GGM-96-25A-DUP-042519
Filter Size: —
Dup Time: 1355

Comments

Signature

4/25/2019
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

KGS

Well Identification: G6M-96-~~[illegible]~~25B

Project: Dunns PFAS RI EW
Location: AOC 50
Date: 5/2/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2.5	
Material	PVC	
Depth to water (ft ~~BTOR~~)	13.35	~~BGS~~ BTOR
Depth to bottom (ft ~~BTOR~~)	59.31	~~BGS~~ BTOR
Pump Set Depth (ft ~~BTOR~~)	53	~~BGS~~ BTOR
Screen Interval (ft ~~BTOR~~)	48-58	BGS
Total volume purged (gal)	1.75	

Sampling Type

Purging Method: Peri
Purge start/stop time: 1225-1305
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: —

Field Instrument (Model/S/N): YSI 556 - 0602657 A1 LaMotte - 5108-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1240	150	13.35	9.58	7.84	94	4.85	-54.6	7.18	clear/clear
1245	↓	↓	9.63	8.22	93	4.71	-26.8	4.28	↓
1250	↓	↓	9.70	8.55	91	4.65	-5.4	3.74	↓
1255	↓	↓	9.76	8.61	89	4.52	3.0	3.60	↓
1300	↓	↓	9.79	8.63	88	4.45	4.1	3.61	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	Y	

Sampling Details

Sampling ID: G6M-96-~~[illegible]~~25B_MAY19
Sample Time: 1300
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

5/2/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-96-26A

Project: Orms PFAS RI EW
Location: AOC 50
Date: 5/3/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"	
Material	PV	
Depth to water (ft ~~BTOR~~)	9.41	~~BGS~~ BTOR
Depth to bottom (ft ~~BTOR~~)	19.1	~~BGS~~ BTOR
Pump Set Depth (ft ~~BTOR~~)	15.0	~~BGS~~ BTOR
Screen Interval (ft ~~BTOR~~)	8-18	BGS
Total volume purged (gal)	~2.0	

Sampling Type
Purging Method: Pmi
Purge start/stop time: 0830-0915
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -
Field Instrument (Model/S/N): YSI 556 : 0602657 A1 WM MH : 5708-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0840	150	9.41	6.68	6.13	134	5.50	120.4	36.8	clear/clear
0845	↓	9.45	6.71	6.14	121	5.31	130.1	9.74	↓
0850		9.47	6.52	6.14	111	5.00	132.5	6.02	
0855		9.48	6.50	6.13	111	4.96	133.4	4.80	
0900		↓	6.56	6.13	111	4.94	134.0	4.10	
0905			6.56	6.13	111	4.88	134.7	3.79	
0910	↓	↓	6.58	6.13	110	4.82	135.1	3.02	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N					→	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GGM-96-26A_MAY19
Sample Time: 0910
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments

Signature

5/3/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

KGS

Well Identification: GGM-96-26B

Project: Downs PFAS RI EW
Location: AOC 50
Date: 5/3/19
Sampler: W

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2.5"	
Material	PVC	
Depth to water (ft ~~BTOR~~)	11.54	~~BGS~~ BTOR
Depth to bottom (ft ~~BTOR~~)	79.51	~~BGS~~ BTOR
Pump Set Depth (ft ~~BTOR~~)	73.0	~~BGS~~ BTOR
Screen Interval (ft ~~BTOR~~)	68-78	BGS
Total volume purged (gal)	~2.0	

Sampling Type
Purging Method: Peri
Purge start/stop time: 0740-0825
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: –

Field Instrument (Model/S/N): YSI 556 : ~~0206~~ 0602657A1 LaMotte: 5708-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0755	150	11.57	8.50	7.01	289	4.59	140.1	15.7	clear/clear
0800	↓	11.59	8.49	7.05	275	4.10	137.2	11.0	↓
0805	↓	11.60	8.46	7.09	268	3.79	135.3	9.16	↓
0810	↓	↓	8.45	7.15	267	3.50	131.0	7.01	↓
0815	↓	↓	8.43	7.19	267	3.45	128.4	7.17	↓
0820	↓	↓	8.42	7.24	266	3.37	126.3	7.11	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	→	→	→	→	

Sampling Details

Sampling ID: GGM-96-26B_MAY19
Sample Time: 0820
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: –
Filter Size: –
Dup Time: –

Comments

Signature

5/3/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GeM-97-09B (1/2)

Project: PFAS RI EW
Location: AOC 50

Date: 5/3/19
Sampler: BCA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	48.10
Depth to bottom (ft BTOR)	84.90
Pump Set Depth (ft BTOR)	80
Screen Interval (ft ~~BTOR~~)	71.5-81.5
Total volume purged (gal)	

Sampling Type

Purging Method: 1.75" Bladder
Purge start/stop time: 0955-
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/(N)): -
Air source: N_2

Field Instrument (Model/S/N): YSI 650 XL 02E0534
Lamotte 2020e 1116-078

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1015	200	48.12	8.95	6.02	470	7.44	199.6	22.3	cloudy
1020	200	48.12	8.93	6.00	401	6.30	199.3	20.1	clear
1025	200	48.12	8.91	5.93	333	5.21	198.6	17.5	clear
1030	200	48.12	8.92	5.90	310	5.13	199.0	16.2	clear
1035	200	48.12	8.92	5.88	291	5.09	199.2	15.5	clear
1040	200	48.12	8.97	5.87	285	6.03	198.8	13.7	clear
1045	200	48.12	8.98	5.87	277	5.10	198.2	11.2	clear
1050	200	48.12	8.96	5.85	267	5.12	197.6	10.0	clear
1055	200	48.12	9.00	5.85	260	5.00	197.4	8.25	clear
1100	200	48.12	9.01	5.85	261	4.99	196.8	6.73	clear
1105	200	48.12	9.02	5.86	262	4.97	196.1	5.99	clear
1110	200	48.12	9.06	5.84	251	4.96	194.8	6.00	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):									

Sampling Details

Sampling ID: GeM-97-09B-MAY19
Sample Time: 1125
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments: Pulled 3/8" TUBE @ 0940, purge extra

Signature

5/3/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-97-09B (2/2)

Project: _____ Date: _____
Location: _____ Sampler: _____ See pg 1

Well Integrity

	Yes	No	N/A
Casing Secure			
Concrete Pad intact			
PVC casing intact			
Well gripper present			
Bolts present			
Locked (stickup wells)			

Well Information

Diameter	
Material	
Depth to water (ft BTOR)	
Depth to bottom (ft BTOR)	
Pump Set Depth (ft BTOR)	
Screen Interval (ft BTOR)	
Total volume purged (gal)	

See pg 1

Sampling Type

Purging Method _____ Tubing type _____ Dedicated pump (Y/N) _____
Purge start/stop time _____ Tubing diameter _____ Air source _____

Field Instrument (Model/S/N) _____ See pg 1

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1115	200	48.12	9.09	5.84	249	4.71	194.4	6.08	clear
1120	200	48.12	9.09	5.84	248	4.70	194.6	6.03	clear
1125	200	48.12	9.05	5.84	248	4.72	194.5	6.01	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):									0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: _____
Sample Time: 1125 Duplicate (Y/N): _____ MS/MSD (Y/N): _____
Field Filtered (Y/N): _____ Dup ID: _____
Filter Size: _____ Dup Time: _____

Comments _____

_____ _____
Signature Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGP-97-05X

Project: Devens PFAS RI EW
Location: AOC 50
Date: 5/8/19
Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		✓
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present	✓		
Bolts present		✓	✓
Locked (stickup wells)		✓	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	23.95
Depth to bottom (ft BTOR)	44.14
Pump Set Depth (ft BTOR)	40 (as 5/10/19)
★ Screen Interval (ft ~~BTOR~~)	~~35-45~~ 33-43 BGS
Total volume purged (gal)	1.25

Sampling Type

Purging Method: Peri
Purge start/stop time: 0930-1015
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: -

Field Instrument (Model/S/N): YSI 556: 0602657 A1 LaMotte: 5708-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0945	100	24.09	10.24	5.50	119	5.60	140.8	11.54	clear/clear
0950	↑	24.25	10.23	5.54	118	5.15	140.9	6.00	↑
0955		24.30	10.48	5.62	118	4.73	133.5	4.62	
1000		24.38	10.32	5.63	118	4.64	128.9	2.00	
1005		24.45	10.35	5.63	117	4.51	132.0	1.53	
1010	↓	24.62	10.34	5.63	117	4.46	132.7	1.43	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: GGP-97-05X_MAY19
Sample Time: 1010
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments: ★ Screen interval is estimated as we have no data besides OTB (Grab measurement). Update spoke w/ RM. Screen is 33-43 bgs 5/8/19
- low recharge rate; must pump w/ a slow flow rate

Signature
5/8/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MW-06

Project: PFAS RI EW
Location: AOC 50

Date: 5/8/19
Sampler: BMA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		
Well gripper present		✓	
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	58.65
Depth to bottom (ft BTOR)	134.85
Pump Set Depth (ft BTOR)	130
Screen Interval (ft ~~BTOR~~)	120-130 bgs
Total volume purged (gal)	3.0

Sampling Type
Purging Method: 1.75" BP
Purge start/stop time: 0730-
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N)
Air source: N2

Field Instrument (Model/S/N): YSI 650XL 02E0534
Lamotte 2020t 1116-0719

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0750	250	58.70	9.99	6.26	1555	3.74	-43.4	28.6	clear
0755	250	58.70	10.03	6.22	1576	3.89	-61.1	12.1	clear
0800	250	58.70	9.99	6.26	1566	4.02	-62.1	11.7	clear
0805	250	58.70	10.05	6.30	1565	3.86	-72.6	11.9	clear
0810	250	58.70	10.06	6.31	1563	3.74	-67.7	12.50	clear
0815	250	58.70	10.17	6.34	1562	4.12	-70.8	12.23	clear
0820	250	58.70	10.20	6.35	1562	4.09	-72.0	12.16	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	-	-	-	-	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: MW-06-MA419
Sample Time: 0820
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments

Signature

5/8/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: XSA-12-96X

Project: PFAS RI EW
Location: ADC50
Date: 5/7/19
Sampler: B, A

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact			✓
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	1"
Material	Steel
Depth to water (ft BTOR)	65.10
Depth to bottom (ft BTOR)	132.25
Pump Set Depth (ft BTOR)	125
Screen Interval (ft ~~BTOR~~)	120-130 bgs
Total volume purged (gal)	~~8~~ 1.0 gal

Sampling Type

Purging Method: 0.5" mB
Purge start/stop time: 0750 - 0850
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): (N)
Air source: N_2

Field Instrument (Model/S/N): YSI 650 XL 02EDS34
Lamotte 2020t 1116-0715

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0815	75	65.10	9.10	6.86	1356	0.70	-48.3	15.6	clear
0820	75	65.10	8.85	6.51	1361	0.51	-34.8	9.42	clear
0825	75	65.10	8.91	6.44	1362	0.46	-22.1	8.19	clear
0830	75	65.10	8.85	6.41	1365	0.32	-16.4	5.43	clear
0835	75	65.10	8.84	6.40	1364	0.26	-13.0	5.26	clear
0840	75	~~65.~~ 65.10	8.85	6.39	1361	0.31	-9.3	5.20	clear
0845	75	65.10	8.82	6.39	1361	0.37	-8.6	5.31	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N					0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: XSA-12-96X-MAY19
Sample Time: 0845
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: —
Filter Size: —
Dup Time: —

Comments

Signature

5/7/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

KGS

Well Identification: XSA-12-98X

Project:	Devens PFAS RI EW	Date:	4/29/19
Location:	AOC 50	Sampler:	CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact			✓
Well gripper present		✓	
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	1"	
Material	Steel	
Depth to water (ft BTOR)	1.51	
Depth to bottom (ft BTOR)	70.45	
Pump Set Depth (ft BTOR)	65	
Screen Interval (ft ~~BTOR~~)	60-70	bgs
Total volume purged (gal)	~2.75	

Sampling Type

Purging Method: Pori
Tubing type: HDPE
Dedicated pump (Y/N): N
Purge start/stop time: 0950 - 1030
Tubing diameter: 1/4"
Air source: –

Field Instrument (Model/S/N): YSI 556: 0602657 A1 LaMotte - 5083-5014

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1005	250	1.51	9.82	7.80	663	3.05	-28.0	3.57	clear / clear
1010	↓	↓	9.86	7.78	665	2.64	-24.4	2.59	↓
1015	↓	↓	9.83	7.77	671	1.75	-18.1	2.10	↓
1020	↓	↓	9.81	7.75	672	1.70	-14.9	2.01	↓
1025	↓	↓	9.80	7.74	672	~~1.4~~ 1.64	-13.2	2.03	↓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	Y	N	N	Y	

Sampling Details

Sampling ID: XSA-12-98X_APR19
Sample Time: 1025
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: –
Filter Size: –
Dup Time: –

Comments

[signature]
Signature

4/29/19
Date

Supplemental Sampling

Fall 2019

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-13-05X

Project: LTM - Fall 2019 AOC50
Location: Fort Devens, Massachusetts
Date: 10/10/19
Sampler: Melissa Miller

Well Integrity

	Yes	No	N/A
Casing Secure		X	
Concrete Pad intact	X		
PVC casing intact	X		
Well gripper present	X		
Bolts present			X
Locked (stickup wells)	X		

Well Information

Diameter	2"
Material	PVC (Locked cap)
Depth to water (ft BTOR)	14.68
Depth to bottom (ft BTOR)	56.83
Pump Set Depth (ft BTOR)	50.00
Screen Interval (ft bgs)	45-55
Total volume purged (gal)	3.75

Sampling Type

Purging Method: Peristaltic
Purge start/stop time: 1230/
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: NA

Field Instrument (Model/S/N): YSI 556 MPS (14A100102)
Lamotte 2020we (926-1811)

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1250	200	15.35	12.30	7.34	931	4.43	-35.5	15.20	Clear
1255	200	15.51	12.13	7.50	932	3.25	-43.8	10.13	Clear
1300	200	15.60	11.98	7.80	944	0.21	-56.7	7.91	Clear
1305	175	15.50	12.07	7.82	947	0.17	-63.1	6.37	Clear
1310	175	15.51	12.06	7.83	949	0.15	-64.2	6.49	Clear
1315	175	15.50	12.05	7.81	950	0.14	-64.7	6.57	Clear
1320	175	15.50	12.04	7.80	953	0.14	-65.6	6.98	Clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: GGM-13-05X_FAL19
Sample Time: 1320
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): Y
Dup ID:
Filter Size: 0.45µ
Dup Time:

Comments

Signature

10/10/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GOM-18-01

Project: LTM - Fall 2019 AOC 50
Location: Fort Devens, Massachusetts
Date: 10/14/19
Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	61.64
Depth to bottom (ft BTOR)	125.88
Pump Set Depth (ft BTOR)	120
Screen Interval (ft bgs)	116-126
Total volume purged (gal)	4.0

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 1000-1120
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): N
Air source: N2

Field Instrument (Model/S/N): YSI 556 MPS (15F101567)
Hach 2100Q (11601C047207)

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1015	250	61.70	13.20	6.13	140	7.65	180.3	250	cloudy
1020	250	61.70	13.22	5.73	136	7.63	173.0	137	cloudy
1025	250	61.70	13.32	5.75	133	7.60	147.8	125	cloudy
1030	250	61.70	13.59	6.00	132	7.58	132.8	47.4	cloudy
1035	250	61.70	13.23	5.84	134	7.68	137.0	39.8	cloudy
1040	250	61.70	13.07	5.74	136	7.35	140.4	34.3	cloudy
1045	250	61.70	13.17	5.94	138	7.21	132.0	26.7	clear
1050	250	61.70	13.29	5.98	139	6.99	131.8	10.2	clear
1055	250	61.70	13.40	5.98	140	6.87	131.0	7.81	clear
1100	250	61.70	13.43	5.99	140	6.94	128.8	5.50	clear
1105	250	61.70	13.45	5.98	141	6.89	135.0	5.41	clear
1110	250	61.70	13.40	6.02	141	6.81	134.5	5.53	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):			N	N	N	N	N	N	

Sampling Details

Sampling ID: GOM-18-01-FALL9
Sample Time: 1110
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): Y
Dup ID: —
Filter Size: 0.45µm
Dup Time: —

Comments Full Suite + PFAS

Signature

10/14/19
Date

27.75

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGP-97-05X

Project: LTM - Fall 2019 AOC 50
Location: Fort Devens, Massachusetts
Date: 10/15/2019
Sampler: E. Seiler

Well Integrity

	Yes	No	N/A
Casing Secure	X		
Concrete Pad intact			X
PVC casing intact	X		
Well gripper present	X		
Bolts present			X
Locked (stickup wells)		X	

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	27.47
Depth to bottom (ft BTOR)	44.44
Pump Set Depth (ft BTOR)	38
Screen Interval (ft ~~BTOR~~)	33 - 43 BGS
Total volume purged (gal)	1.05

Sampling Type

Purging Method: Peri.
Purge start/stop time: 1346 / 1446
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): no
Air source: —
Field Instrument (Model/S/N): YSI 560 MDS 11G100386
HACH 2100Q 17060C059342

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1351	80	28.17	11.34	6.06	426	5.74	139.3	83.3	Hazy
1356	80	28.21	11.19	5.67	431	5.97	152.1	48.3	Hazy/clear
1401	80	28.21	11.00	5.49	432	4.64	152.8	41.3	Clear
1406	80	~~28.21~~	11.06	5.43	433	5.70	150.8	22.7	Clear
1411	80	27.98	11.13	5.41	432	4.83	147.4	7.34	Clear
1416	80	28.00	11.16	5.39	432	5.50	145.0	5.56	Clear
1421	80	27.98	11.40	5.36	432	5.36	142.2	7.45	Clear
1426	80	28.02	11.16	5.41	432	5.36	140.0	4.40	Clear
1431	80	28.08	11.06	5.46	429	5.36	137.7	2.74	Clear
1436	80	28.12	10.96	5.37	428	5.34	134.8	2.00	Clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				no	yes	no	no	no	

Sampling Details

Sampling ID: GGP-97-05X-FAL19
Sample Time: 1436
Duplicate (Y/N): yes
MS/MSD (Y/N): no
Field Filtered (Y/N): no
Dup ID: AOC50-DUP-101519
Filter Size: —
Dup Time: 1439

Comments

Signature

10/15/2019
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MW-7 (IT)

Project: LTM - Fall 2019 AOC 5D
Location: Fort Devens, Massachusetts
Date: 10/18/19
Sampler: Michael Spaulding

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	good		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)		✓	

Well Information

Diameter	4"
Material	PVC
Depth to water (ft BTOR)	28.31
Depth to bottom (ft BTOR)	34.27
Pump Set Depth (ft BTOR)	~30
Screen Interval (ft ~~BTOR~~)	22-32 bgs
Total volume purged (gal)	~2.5

Sampling Type

Purging Method: Peristaltic
Tubing type: HDPE
Dedicated pump (Y/N): N
Purge start/stop time: 1015
Tubing diameter: 1/4"
Air source: N/A

Field Instrument (Model/S/N): YSI 650 MDS (11G100386)
HACH 2100Q (17060C09342)

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1025	120	28.36	10.24	5.24	385	5.98	205.2	14.7	clear
1030	110	28.35	10.16	5.14	381	6.07	200.6	11.5	clear
1035	100	28.38	10.14	5.20	378	5.92	193.3	8.48	clear
1040	100	28.38	10.12	5.20	373	5.96	187.2	5.32	clear
1045	100	28.38	10.06	5.20	367	5.95	183.4	5.36	clear
1050	100	28.40	10.04	5.21	359	5.99	173.6	5.54	clear
1055	100	28.40	10.01	5.21	355	5.99	164.7	4.78	clear
1100	100	28.40	10.01	5.21	350	6.04	157.8	4.12	clear
1105	100	28.40	10.00	5.22	346	6.07	152.2	4.00	clear
1110	100	28.40	9.99	5.22	342	6.10	148.3	3.67	clear
1115	100	28.40	9.99	5.22	342	6.10	146.4	3.81	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N	N	N	N	N	Y	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: MW-7 (IT)_FAL19
Sample Time: 1115
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: N/A
Filter Size: N/A
Dup Time: N/A

Comments

Signature

10/18/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: G6M-02-01X (Pg 1/2)

Project: LTM - Fall 2019 AOC 50 Date: 10/16/19
Location: Fort Devens, Massachusetts Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	54.62
Depth to bottom (ft BTOR)	89.36
Pump Set Depth (ft BTOR)	85
Screen Interval (~~ft bgs~~)	79.44 - 94.44 ft BTOR
Total volume purged (gal)	4.0

Sampling Type
Purging Method 1.75" Bladder Tubing type HDPE Dedicated pump (Y/N) Y - pulled for HDPE (PFAS)
Purge start/stop time 0820- Tubing diameter 1/4"OD Air source N_2

Field Instrument (Model/S/N) YSI 556MPS 15F101567
Horiba U-52 G 16010C047202

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0835	200	54.71	13.29	6.70	2908	1.46	-74.4	275	cloudy
0840	200	54.71	12.70	6.76	2927	0.67	-100.7	153	cloudy
~~0845~~ 0845	200	54.71	12.49	6.83	2913	0.36	-112.8	89.1	cloudy
0850	200	54.71	12.42	6.83	2899	0.32	-115.2	67.5	cloudy
0855	200	54.71	12.44	6.86	2890	0.21	-118.5	60.9	cloudy
0900	200	54.71	12.48	6.88	2879	0.22	-117.4	51.3	cloudy
0905	200	54.71 ✓	12.46 ✓	6.89 ✓	2866 ✓	0.21 ✓	-120.0 ✓	48.6	cloudy
0910	200	54.71	12.54	6.92	2843	0.15	-117.1	27.2	cloudy
0915	200	54.71	12.49	6.92	2818	0.09	-114.8	24.0	~~cloudy~~ clear
0920	200	54.71	12.52	6.93	2768	0.13	-114.3	20.1	clear
0925	200	54.71	12.52	6.94	2771	0.13	-114.2	17.2	clear
0930	200	54.71	12.47	6.94	2754	0.13	-114.7	16.8	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):			N						

Sampling Details

Sampling ID: G6M-02-01X-FAL19
Sample Time: ~~0930~~ 0940 Duplicate (Y/N): Y MS/MSD (Y/N): PFAS MS/MSD only
Field Filtered (Y/N): Y Dup ID: AOC50-DUP03-FAL19
Filter Size: 0.45µm Dup Time: 0945

Comments VOCs, FF metals, PFAS (MS/MSD)

Signature

10/16/19
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GWM-02-01R (Pg 2/2)

Project: LTM - Fall 2019 AOC 50 Date: 10/16/19
Location: Fort Devens, Massachusetts Sampler: B+A

Well Integrity See Page 1 of 2

	Yes	No	N/A
Casing Secure			
Concrete Pad intact			
PVC casing intact			
Well gripper present			
Bolts present			
Locked (stickup wells)			

Well Information See Pg 1/2

Diameter	
Material	
Depth to water (ft BTOR)	
Depth to bottom (ft BTOR)	
Pump Set Depth (ft BTOR)	
Screen Interval (ft bgs)	
Total volume purged (gal)	

Sampling Type

Purging Method _____ Tubing type _____ Dedicated pump (Y/N) _____
Purge start/stop time _____ Tubing diameter _____ Air source _____

Field Instrument (Model/S/N) _____

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0935	200	54.71	12.44	6.55	2690	0.13	-115.5	16.4	clear
0940	200	54.71	12.45	6.56	2651	0.13	-116.9	16.0	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):									

Sampling Details

Sampling ID: _____
Sample Time: _____ Duplicate (Y/N): _____ MS/MSD (Y/N): _____
Field Filtered (Y/N): _____ Dup ID: _____
Filter Size: _____ Dup Time: _____

Comments _____

_____ _____
Signature **Date**

KOMAN GOVERNMENT SOLUTIONS LLC

Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: XSA-12-96X

Project: LTM - Fall 2019 AOC50 Date: 11/6/19

Location: Fort Devens, Massachusetts Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact	✓		✓
Well gripper present	—		
Bolts present		ND	✓
Locked (stickup wells)		✓	

Well Information

Diameter	1"
Material	Steel
Depth to water (ft BTOR)	68.70
Depth to bottom (ft BTOR)	136.75
Pump Set Depth (ft BTOR)	130
Screen Interval (ft BTOR)	122.97-132.97
Total volume purged (gal)	2.5

Sampling Type

Purging Method 0.675" microbladder Tubing type HDPE Dedicated pump (Y/N) N

Purge start/stop time 0855 - 1005 Tubing diameter ¼"OD Air source N2

Field Instrument (Model/S/N) YSI 556 MPS 15F101567

Hach 2100Q 16010C047202

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0915	70	68.58	8.84	8.12	597	0.72	-154.3	39.1	clear
0920	70	68.58	8.84	7.66	832	0.33	-147.8	36.4	clear
0925	70	68.58	8.81	7.55	896	0.31	-139.0	24.5	clear
0930	70	68.58	9.08	7.22	1056	0.28	-115.6	16.8	clear
0935	70	68.58	9.20	7.10	1109	0.26	-106.7	9.96	clear
0940	70	68.58	9.12	6.91	1166	0.27	-95.2	8.32	clear
0945	70	68.58	9.00	6.77	1200	0.28	-86.4	7.18	clear
0950	70	68.58	9.14	6.70	1223	0.31	-81.6	5.37	clear
0955	70	68.58	9.29	6.64	1236	0.23	-76.9	5.20	clear
1000	70	68.58	9.51	6.63	1244	0.23	-74.5	5.08	clear
1005	70 ✓	68.58 ✓	9.53 ✓	6.59 ✓	1244 ✓	0.20 ✓	-72.8	5.01	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):			N						0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: XSA-12-96X

Sample Time: 1005 Duplicate (Y/N): N MS/MSD (Y/N): N

Field Filtered (Y/N): Y Dup ID:

Filter Size: 0.45µm Dup Time:

Comments VOCs + FF metals + PFAS (M537)

Signature

11/6/19

Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: XSA-12-98X

Project: LTM - Fall 2019 AOC 86 | Date: 10/9/19
Location: Fort Devens, Massachusetts | Sampler: CV

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact			✓
Well gripper present			✓
Bolts present	✓		✓
Locked (stickup wells)	✓		

Well Information

Diameter	0.5"
Material	steel
Depth to water (ft BTOR)	8.90
Depth to bottom (ft BTOR)	71.60
Pump Set Depth (ft BTOR)	69.0
Screen Interval (ft BTOR)	62.97 - 72.97
Total volume purged (gal)	~2.75

Sampling Type

Purging Method: Peri-Pump | Tubing type: HDPE | Dedicated pump (Y/N): N
Purge start/stop time: 1000 - 1050 | Tubing diameter: 1/4" | Air source: -

Field Instrument (Model/S/N): YSI 650 MDS: 16100386 HACH 2100Q: 17060C059342

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1015	200	8.90	11.18	7.68	376	1.41	17.0	6.86	c/per /c/ear
1020	↓	↓	11.18	7.68	376	0.90	-3.0	4.77	↓
1025			11.19	7.69	376	0.75	-24.2	4.52	
1030			11.19	7.69	376	0.69	-41.1	4.33	
1035			11.19	7.70	375	0.73	-49.5	3.79	
1040			11.20	7.70	375	0.63	-57.0	3.84	
1045			11.20	7.70	375	0.62	-61.4	3.63	
1050	✓	✓	11.20	7.70	375	0.62	-65.2	3.47	✓
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: XSA-12-98X_FAL19
Sample Time: 1050 | Duplicate (Y/N): N | MS/MSD (Y/N): Y
Field Filtered (Y/N): Y* | Dup ID: -
Filter Size: 0.45 µm | Dup Time: -

Comments Teflon tubing removed before sampling; HDPE used for sampling and teflon tubing was put back after sampling was finished; sampled for PFAS

Signature | Date: 10/9/19

*Y c) Field filtered for metals only

Supplemental Sampling

Spring 2020

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GWM-02-01X **AOC Name:** AOC 50

Project: Spring 2020 Supplemental Event
Location: Fort Devens, Massachusetts
Date: 5/7/2020
Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	52.83
Depth to bottom (ft BTOR)	89.32
Pump Set Depth (ft BTOR)	
Screen Interval (ft BTOR)	
Total volume purged (gal)	3.0

Sampling Type
Purging Method 1.75" Bladder
Purge start/stop time 0925 - 1015
Tubing type HDPE
Tubing diameter 1/4" OD
Dedicated pump (Y/N) N (used d.ft. pump)
Air source N2

Field Instrument (Model/S/N) YSI 556 MPS 05G101941AD
Lamotte 2020we 951-2111

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
0935	250	53.05	12.83	6.68	2807	2.49	-85.7	12.8	clear
0940	250	53.05	12.65	6.79	2730	1.91	-108.4	5.57	clear
0945	250	53.05	12.66	6.81	2686	1.80	-116.9	5.70	clear
0950	250	53.05	12.61	6.82	2678	1.89	-120.9	5.91	clear
0955	250	53.05	12.63	6.82	2650	1.81	-125.5	5.68	clear
1000	250	53.05	12.62	6.83	2638	1.83	-128.3	5.49	clear
1005	250	53.05	12.57	6.83	2599	1.81	-134.3	5.51	clear
1010	250	53.05	12.57	6.83	2596	1.84	-137.1	5.46	clear
1015	250	53.05	12.59	6.83	2586	1.85	-138.9	5.40	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):									

Sampling Details

Sampling ID: GWM-02-01X_SPR20
Sample Time: 1015
Duplicate (Y/N): N
MS/MSD (Y/N): Y
Field Filtered (Y/N): N
Dup ID: -
Filter Size: -
Dup Time: -

Comments PFAS only (MS37); Pulled dedicated BP w/ TLPE @ 0915 prior to setting different pump w/ HDPE.

Signature

5/7/20
Date

KOMAN GOVERNMENT SOLUTIONS LLC
Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: GGM-18-01 **AOC Name:** AOC 50

Project: Spring 2020 Supplemental Event
Location: Fort Devens, Massachusetts
Date: 5/7/2020
Sampler: BrA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present	✓		
Locked (stickup wells)			✓

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	58.35
Depth to bottom (ft BTOR)	—
Pump Set Depth (ft BTOR)	120
Screen Interval (ft BTOR)	116-126
Total volume purged (gal)	3.0

- Too deep for LLSM

Sampling Type
Purging Method: 1.75" Bladder
Purge start/stop time: 1105-1200
Tubing type: HDPE
Tubing diameter: 1/4" OD
Dedicated pump (Y/N): N
Air source: N_2

Field Instrument (Model/S/N): YSI 5556 MPS 05G1941AD
Lamotte 2020we 081-2111

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1115	250	58.40	13.38	7.12	177	8.09	-1.3	18.4	clear
1120	250	58.40	12.88	6.55	144	7.40	17.1	5.65	clear
1125	250	58.40	13.05	6.48	141	7.27	19.2	3.70	clear
1130	250	58.40	13.20	6.43	141	7.08	20.3	2.58	clear
1135	250	58.40	12.86	6.40	141	7.28	21.7	1.38	clear
1140	250	58.40	12.36	6.32	140	7.31	26.8	1.15	clear
1145	250	58.40	12.85	6.25	140	7.20	28.8	1.07	clear
1150	250	58.40	12.90	6.32	139	7.19	25.0	0.90	clear
1155	250	58.40	12.83	6.32	140	7.22	24.8	0.93	clear
1200	250	58.40	12.86	6.32	140	7.25	25.1	0.96	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N					

Sampling Details

Sampling ID: GGM-18-01-SP220
Sample Time: 1200
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: -
Filter Size: —
Dup Time: -

Comments PFAS only (M537)

Signature

5/7/2020
Date

KOMAN GOVERNMENT SOLUTIONS LLC

Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: 66P-97-05X **AOC Name:** 50

Project: Spring 2020 Supplemental Event
Location: Fort Devens, Massachusetts
Date: 5/7/20
Sampler: VGA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	25.01
Depth to bottom (ft BTOR)	44.54
Pump Set Depth (ft BTOR)	38'
Screen Interval (ft BTOR)	33-43
Total volume purged (gal)	1.0

Sampling Type

Purging Method: geotech
Purge start/stop time: 910/955
Tubing type: HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): N
Air source: N/A

Field Instrument (Model/S/N): YSI 556MPS ~~06C~~ 06C2657A1
Lamotte 2020WF 3711-3913

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
910	75	25.57	10.09	6.11	258	3.74	92.7	12.70	clear
915	75	25.52	10.13	6.03	257	3.30	99.6	13.90	clear
920	75	25.52	10.12	6.01	256	3.30	103.2	18.63	clear
925	75	25.52	10.18	6.00	256	3.27	123.1	16.99	clear
930	75	25.52	10.22	5.99	257	3.13	131.4	17.21	clear
935	75	25.52	10.27	5.99	253	3.18	130.7	16.87	clear
940	75	25.52	10.22	5.98	252	3.17	131.6	16.87	clear
945	75	25.52	10.19	5.97	256	3.16	132.7	16.83	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: 66P-97-05X-SPR20
Sample Time: 950
Duplicate (Y/N): Y
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: AOC50-DUP-5720
Filter Size: N/A
Dup Time: 955

Comments PFAS

Signature

5/7/20
Date

KOMAN GOVERNMENT SOLUTIONS LLC

Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: MSA-12-96X **AOC Name:** 50

Project: Spring 2020 Supplemental Event Date: 5/8/20

Location: Fort Devens, Massachusetts Sampler: MA

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact			✓
Well gripper present			✓
Bolts present			✓
Locked (stickup wells)		X	

Well Information

Diameter	4"
Material	Steel
Depth to water (ft BTOR)	49.27
Depth to bottom (ft BTOR)	132.84
Pump Set Depth (ft BTOR)	125
Screen Interval (ft BTOR)	120-130
Total volume purged (gal)	1.0

Sampling Type

Purging Method: Microblader Tubing type: HDPE (x2) Dedicated pump (Y/N): Tubing

Purge start/stop time: 855/935 Tubing diameter: ¼" Air source: N

Field Instrument (Model/S/N): YSI 556MPS 06C265 7A1

LaMotte 2020we 3711-3913

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
855	50	50.27	9.67	8.70	759	3.49	-165.4	23.7	Clear
900	50	50.27	10.89	8.64	801	2.81	-147.1	21.6	Clear
905	50	50.27	10.37	8.63	817	2.60	-133.7	20.3	Clear
910	50	50.27	10.31	8.62	821	2.53	-131.7	21.7	Clear
915	50	50.27	10.37	8.62	823	2.52	-130.6	22.0	Clear
920	50	50.27	10.41	8.61	824	2.50	-130.6	21.8	Clear
925	50	50.27	10.43	8.61	825	2.49	-129.3	21.7	Clear
930	50	50.27	10.37	8.60	827	2.47	-129.1	21.4	Clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: MSA-12-96X-SPR20

Sample Time: 935 Duplicate (Y/N): N MS/MSD (Y/N): N

Field Filtered (Y/N): N Dup ID: N/A

Filter Size: N/A Dup Time: N/A

Comments: PFAS

Signature

5/8/20
Date

KOMAN GOVERNMENT SOLUTIONS LLC

Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: VSA-12-98X **AOC Name:** 50

Project: Spring 2020 Supplemental Event Date: 5/7/20

Location: Fort Devens, Massachusetts Sampler: [illegible]

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact			✓
PVC casing intact			✓
Well gripper present			✓
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	0.5"
Material	SS (SP)
Depth to water (ft BTOR)	3.05
Depth to bottom (ft BTOR)	12.74
Pump Set Depth (ft BTOR)	65
Screen Interval (ft BTOR)	60-70
Total volume purged (gal)	3.0

Sampling Type

Purging Method Geotech Tubing type HDPE Dedicated pump (Y/N) ~~Dskg~~ ~~Removed~~

Purge start/stop time 1110/1150 Tubing diameter 1/4" Air source N/A

Field Instrument (Model/S/N) YSI 556 MPS 06E2657A1

Lamotte 2020wf 3711~3713

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
1110	200	✱	11.20	7.88	974	0.44	11.5	5.75	clear
1115	200	✱	11.09	7.89	970	0.30	9.9	5.30	clear
1120	200	✱	11.05	7.90	968	0.29	8.9	5.20	clear
1125	200	✱	11.08	7.87	967	0.28	8.8	5.17	clear
1130	200	✱	11.07	7.86	964	0.26	8.6	5.09	clear
1135	200	✱	11.04	7.84	963	0.25	8.5	5.08	clear
1140	200	✱	11.10	7.84	961	0.24	8.4	5.07	clear
1145	200	✱	11.09	7.84	960	0.23	8.3	5.08	clear

Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume =
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	0.163 gal/ft or 616 ml/ft

Sampling Details

Sampling ID: VSA-12-98X-SPR20

Sample Time: 1150 Duplicate (Y/N): N MS/MSD (Y/N): N

Field Filtered (Y/N): N Dup ID: N/A

Filter Size: N/A Dup Time: N/A

Comments PFAS

[signature] 5/7/20

Signature **Date**

KOMAN GOVERNMENT SOLUTIONS LLC

Low Flow/ Low Stress Groundwater Sampling Log

Well Identification: 66M-13-05X **AOC Name:** 50

Project: Spring 2020 Supplemental Event
Location: Fort Devens, Massachusetts
Date: 5/7/20
Sampler: [illegible]

Well Integrity

	Yes	No	N/A
Casing Secure	✓		
Concrete Pad intact	✓		
PVC casing intact	✓		
Well gripper present	✓		
Bolts present			✓
Locked (stickup wells)	✓		

Well Information

Diameter	2"
Material	PVC
Depth to water (ft BTOR)	12.94
Depth to bottom (ft BTOR)	56.60
Pump Set Depth (ft BTOR)	50
Screen Interval (ft BTOR)	15-55
Total volume purged (gal)	3.0

Sampling Type

Purging Method: geotech
Purge start/stop time: 740/820
Tubing type: ~~[illegible]~~ HDPE
Tubing diameter: 1/4"
Dedicated pump (Y/N): Tubing
Air source: N/A

Field Instrument (Model/S/N): YSI 556 MPS 06C2657A1
Lamotte 2020 WE 3711-3913

Stabilization Parameters

Time (hhmm)	Flow Rate (ml/min)	Depth to Water (ft)	Temp (°C)	pH (STD)	SPC (µS/cm^c)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Color/Clarity
740	200	12.94	10.69	7.90	998	0.69	-141.7	31.6	clear
745	200	12.94	10.66	7.86	994	0.57	-130.3	31.6	clear
750	200	12.94	10.64	7.47	987	0.63	-100.2	28.7	clear
755	200	12.94	10.62	7.43	980	0.76	-92.0	27.1	clear
800	200	12.94	10.60	7.42	979	0.74	-91.7	26.9	clear
805	200	12.94	10.57	7.40	977	0.72	-90.6	26.4	clear
810	200	12.94	10.53	7.41	976	0.69	-91.0	26.4	clear
815	200	12.94	10.49	7.39	975	0.68	-89.7	26.3	clear
Acceptance Criteria:		<0.3ft	±3%	±0.1	±3%	±10%	± 10mv	10%	2" Screen Volume = 0.163 gal/ft or 616 ml/ft
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N	

Sampling Details

Sampling ID: 66M-13-05X-SPR20
Sample Time: 820
Duplicate (Y/N): N
MS/MSD (Y/N): N
Field Filtered (Y/N): N
Dup ID: N/A
Filter Size: N/A
Dup Time: N/A

Comments ~~[illegible]~~ PFAS

[signature] **Signature**

5/7/20 **Date**

Calibration Sheets

KGS

Field Instrument Calibration Log

Date: 4/25/2019 **Weather:**

Project/Site Name: Devens PFAS RI Existing well **Instrument:** YSI 556 MPS

Calibrated By: Seiler **Serial Number:** 06C2657 AI

Parameters	Solution Expiration Date	AM Calibration Time 0605		Cal. Temp. (°C)	PM Post Cal. Check Time 1425	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1381	1413	16.58	1416 → 1413	16.90	±10 µS/cm	no
pH (7)	10/2020	6.89	7.00	16.81	6.89 → 7.00	16.72	± 0.3 Ph *	no
pH (4)	3/2020	3.98	4.00	16.60	4.02 → 4.00	16.61	± 0.3 Ph *	no
pH (10)	12/31/2019	10.22	10.04	16.57	10.26 → 10.04	16.89	± 0.3 Ph *	no
ORP (240 mv)	10/2019	238.0	240.0	16.63	241.1 → 240.0	16.94	±10 mv	no
Dissolved Oxygen (%)	—	108.9	100.0	15.78	82.9 → 100.1	17.88	-	—
Dissolved Oxygen (mg/L)	—	10.82	9.92	15.78	7.88 → 9.51	17.88	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	yes
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Rosalie Seiler **Date:** ~~4/25/2019~~ 4/25/2019

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Deven PFAS RI Existing Well **Instrument:** LaMotte 2020t

Calibrated By: Seiler **Serial Number:** 1116-0719

	AM Calibration				PM Post Calibration Check		
Date	**Pre-Cal 1 Ø NTU**	**Post-Cal 1 Ø NTU**	**Pre-Cal 10 NTU**	**Post-Cal 10 NTU**	**1 Ø NTU**	**10 NTU**	**Variance Noted**
4/25/2019	1.21	0.94 → 1.00	7.91	9.80 → 10.02	1.46 → 1.21	10.74 → 9.80	yes

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: Erich Seiler **Date:** 4/25/2019

KGS

Field Instrument Calibration Log

Date: 4/26/19 **Weather:** Rainy 50's

Project/Site Name: Orms PFAS RI EW **Instrument:** YSI 556

Calibrated By: CV **Serial Number:** ~~[illegible]~~ 10H100928

Parameters	Solution Expiration Date	AM Calibration Time 0645		Cal. Temp. (°C)	PM Post Cal. Check Time 1205	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1,472	1,413	17.72	1,419	17.71	±10 µS/cm	N
pH (7)	3/2020	7.17	7.00	17.16	7.15	17.25	± 0.3 Ph *	N
pH (4)	3/2020	4.09	4.00	17.54	4.16	17.49	± 0.3 Ph *	N
pH (10)	3/2020	9.76	10.00	17.62	9.80	17.55	± 0.3 Ph *	N
ORP (240 mv)	10/2019	233.0	240.0	17.66	237.4	17.56	±10 mv	N
Dissolved Oxygen (%)	-	99.8	100.0	17.50	99.6	17.01	-	-
Dissolved Oxygen (mg/L)	-	9.60	9.73	17.50	10.11	17.01	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	-	760	-	-	760	-	-	-

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

4/26/19

Turbidity Instrument Calibration Log

Project/Site Name: Davis PFAS RI EW **Instrument:** LaMotte

Calibrated By: CV **Serial Number:** 5083-5014

	AM Calibration				PM Post Calibration Check		
Date	**Pre-Cal 0 NTU**	**Post-Cal 0 NTU**	**Pre-Cal 10 NTU**	**Post-Cal 10 NTU**	**0 NTU**	**10 NTU**	**Variance Noted**
4/26/19	0.01	0.00	6.56	9.85	0.01	9.47	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature] **Date:** 4/26/19

KGS

Field Instrument Calibration Log

Date: 4/26/19 **Weather:** Rain, 48°F

Project/Site Name: PFAS RI EW AOC50 **Instrument:** YSI 650XL

Calibrated By: BMA **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0600		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm[c])		1417	1413	14.57	1411	13.20	±10 µS/cm	N
pH (7)		7.00	7.00	14.95	7.01	13.38	± 0.3 Ph *	
pH (4)		3.66	4.00	14.94	3.99	14.04	± 0.3 Ph *	
pH (10)		9.68	10.00	14.86	9.98	13.60	± 0.3 Ph *	
ORP (240 mv)		240.0	240.0	14.63	239.7	14.03	±10 mv	
Dissolved Oxygen (%)		96.6	100	14.52	98.9	13.51	-	
Dissolved Oxygen (mg/L)		9.85	10.05	14.52	9.99	13.51	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)		760	760	—	760	—	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: BMA **Date:** 4/26/19

KGS

Field Instrument Calibration Log

Date: 4/29/19 **Weather:** Sun, 50°F

Project/Site Name: PEASE WP A1 **Instrument:** 451 650XL

Calibrated By: BrA **Serial Number:** 12E0534

Parameters	Solution Expiration Date	AM Calibration Time 0640		Cal. Temp. (°C)	PM Post Cal. Check Time 1415	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)		1347	1413	14.19	1405	15.83	±10 µS/cm	N
pH (7)		7.13	7.00	14.60	7.01	15.55	± 0.3 Ph *	N
pH (4)		3.57	4.00	14.41	4.01	15.82	± 0.3 Ph *	N
pH (10)		9.84	10.00	14.39	10.14	15.79	± 0.3 Ph *	N
ORP (240 mv)		237.3	240.1	14.20	243.7	15.80	±10 mv	N
Dissolved Oxygen (%)		~~7.6~~ ~~7.53~~	100	13.90	98.1	15.63	-	N
Dissolved Oxygen (mg/L)		7.83	10.12	13.90	10.03	15.63	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)		760.5	760.5	—	760.0	-	-	✓

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: BrA **Date:** 4/29/19

Turbidity Instrument Calibration Log

Project/Site Name: PFAS RI WP A1 **Instrument:** Lamotte 2020t

Calibrated By: BnA **Serial Number:** 1116-0715

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
4/25/19	0.04	0.01	10.90	10.0	0.02	10.1	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: BnA **Date:** 4/25/19

Field Instrument Calibration Log

Date: 4/29/19 **Weather:** Sunny 40's - 50's

Project/Site Name: Devens PFAS RI EW **Instrument:** YSI 556 MPS

Calibrated By: CW **Serial Number:** 0602657 A1

Parameters	Solution Expiration Date	AM Calibration Time 0615		Cal. Temp. (°C)	PM Post Cal. Check Time 1345	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1,423	1,413	15.63	1,391	16.87	±10 µS/cm	Y
pH (7)	10/2020	7.04	7.00	15.84	7.13	16.69	± 0.3 Ph *	N
pH (4)	3/2020	4.03	4.06	15.64	4.10	17.00	± 0.3 Ph *	N
pH (10)	12/31/2019	10.00	10.00	15.84	9.94	16.78	± 0.3 Ph *	N
ORP (240 mv)	10/2019	238.7	240.0	15.76	238.4	16.90	±10 mv	N
Dissolved Oxygen (%)	—	108.4	100.0	16.42	101.7	16.35	-	—
Dissolved Oxygen (mg/L)	—	10.60	9.79	16.42	9.96	16.35	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 4/29/19

Field Instrument Calibration Log

Date: 4/30/19 **Weather:** Rainy 40's - 50's

Project/Site Name: Dorms PFAS RI EW **Instrument:** YSI 556 MPS

Calibrated By: CW **Serial Number:** 0602657 A1

Parameters	Solution Expiration Date	AM Calibration Time 0630		Cal. Temp. (°C)	PM Post Cal. Check Time 1255	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1,394	1,413	17.42	1,405	17.29	±10 µS/cm	N
pH (7)	10/2020	6.84	7.00	17.54	6.94	17.15	± 0.3 Ph *	N
pH (4)	3/2020	3.93	4.00	17.39	4.18	17.27	± 0.3 Ph *	N
pH (10)	12/31/2019	10.05	10.00	17.40	10.00	17.34	± 0.3 Ph *	N
ORP (240 mv)	10/2019	239.2	240.0	17.43	240.6	17.33	±10 mv	N
Dissolved Oxygen (%)	—	99.9	100.0	16.60	100.0	15.10	-	—
Dissolved Oxygen (mg/L)	—	9.71	9.64	16.60	10.01	15.16	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 4/30/19

KGS

Field Instrument Calibration Log

Date: 5/2/19 **Weather:** Overcast, 40's-50's

Project/Site Name: Dorms PFAS RI EW **Instrument:** YSI 556 MPS

Calibrated By: CV **Serial Number:** 0602657 A1

Parameters	Solution Expiration Date	AM Calibration Time 0545		Cal. Temp. (°C)	PM Post Cal. Check Time 1355	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1,418	1,413	16.89	1,418	17.58	±10 µS/cm	N
pH (7)	10/2026	7.09	7.00	16.90	6.94	17.22	± 0.3 Ph *	N
pH (4)	3/2020	3.90	4.00	16.94	4.08	17.58	± 0.3 Ph *	N
pH (10)	12/31/2019	10.00	10.00	17.05	10.15	17.68	± 0.3 Ph *	N
ORP (240 mv)	10/2019	237.4	240.0	16.99	240.1	17.62	±10 mv	N
Dissolved Oxygen (%)	—	99.8	100.0	16.96	98.6	15.91	-	—
Dissolved Oxygen (mg/L)	—	9.70	9.65	16.96	9.65	15.91	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 5/2/19

KGS

Field Instrument Calibration Log

Date: 5/3/19 **Weather:** Partly Sunny, 40's

Project/Site Name: Downs PFAS RI EW **Instrument:** YSI 556

Calibrated By: CW **Serial Number:** 0602657 A1

Parameters	Solution Expiration Date	AM Calibration Time 0630		Cal. Temp. (°C)	PM Post Cal. Check Time 0955	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1,413	1,413	17.22	1,409	16.54	±10 µS/cm	N
pH (7)	10/2020	6.95	7.00	17.12	6.98	16.77	± 0.3 Ph *	N
pH (4)	3/2020	4.05	4.00	17.22	4.12	16.78	± 0.3 Ph *	N
pH (10)	12/31/2019	10.02	10.00	17.15	9.97	17.00	± 0.3 Ph *	N
ORP (240 mv)	00/2019	239.5	240.0	17.31	241.3	16.94	±10 mv	N
Dissolved Oxygen (%)	—	99.9	100.0	17.10	99.8	16.57	-	
Dissolved Oxygen (mg/L)	—	9.69	9.70	17.10	10.01	16.57	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—			-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 5/3/19

Turbidity Instrument Calibration Log

Project/Site Name: Dorms PFAS RI EW

Instrument: LaMotte

Calibrated By: CV

Serial Number: 5083-5014 / 5708-5014

	AM Calibration				PM Post Calibration Check		
Date	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	Variance Noted
5083-5014 4/29/19	0.02 ~~Pass~~	0.00	6.79	10.00	0.02	8.33	Y
5708-5014 4/30/19	0.10	0.01	6.81	9.96	0.00	10.37	N
5708-5014 5/2/19	0.01	0.01	6.96	10.00	0.04	6.98	Y
5708-5014 5/3/19	0.00	0.00	6.95	10.00	0.04	10.11	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 5/3/19

KGS

Field Instrument Calibration Log

Date: 4/30/19 **Weather:** Rain, 45°F

Project/Site Name: PFAS R1 EW **Instrument:** YSI 650XL

Calibrated By: BrA **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0600		Cal. Temp. (°C)	PM Post Cal. Check Time 1445	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm^c)	11/19	1450	1413	16.09	1420	14.92	±10 µS/cm	N
pH (7)	10/20	7.21	7.00	15.30	7.15	14.78	± 0.3 Ph *	N
pH (4)	07/20	3.77	4.00	15.12	4.00	14.90	± 0.3 Ph *	N
pH (10)	02/20	9.63	10.00	15.10	10.13	14.89	± 0.3 Ph *	N
ORP (240 mv)	10/19	237.8	240.0	14.98	243.6	15.07	±10 mv	N
Dissolved Oxygen (%)	—	155	100	15.18	103.8	15.01	-	N
Dissolved Oxygen (mg/L)	—	15.60	10.02	15.18	10.13	15.01	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	757.7	757.7	15.18	759.3	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 4/30/19

KGS

Field Instrument Calibration Log

Date: 5/1/19 **Weather:** Sun, 50°F

Project/Site Name: PFAS RI EW **Instrument:** YSI 650XL

Calibrated By: BCA **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0555		Cal. Temp. (°C)	PM Post Cal. Check Time 1480	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1418	1413	15.01	1409	14.38	±10 µS/cm	Y
pH (7)	10/20	7.07	7.00	14.92	7.03	14.47	± 0.3 Ph *	N
pH (4)	07/20	3.67	4.00	14.94	4.02	14.50	± 0.3 Ph *	N
pH (10)	02/20	9.60	9.92	14.82	9.96	14.41	± 0.3 Ph *	N
ORP (240 mv)	10/19	~~25~~ 239.3	240.0	14.71	240.8	14.39	±10 mv	N
Dissolved Oxygen (%)	-	55.5	100.0	14.62	91.7	14.20	-	N
Dissolved Oxygen (mg/L)	-	5.64	10.20	14.62	10.08	14.20	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	-	763.1	763.1	-	759.3	-	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: BCA **Date:** 5/1/19

KGS

Field Instrument Calibration Log

Date: 5/2/19 **Weather:** Rain, 45°F

Project/Site Name: PFAS R1 EW **Instrument:** YSI 650XL

Calibrated By: BA **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0545		Cal. Temp. (°C)	PM Post Cal. Check Time _____	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm^c)	11/19	1442	1413	14.46	1411	15.13	±10 µS/cm	N
pH (7)	10/20	6.92	7.00	14.43	7.01	15.10	± 0.3 Ph *	
pH (4)	07/20	3.94	4.00	14.43	3.98	15.01	± 0.3 Ph *	
pH (10)	02/20	10.01	10.00	14.35	10.05	15.20	± 0.3 Ph *	
ORP (240 mv)	10/19	242.3	~~[illegible]~~ 240.0	14.21	241.3	15.38	±10 mv	
Dissolved Oxygen (%)	—	137.8	99.2	14.29	108.0	15.03	-	
Dissolved Oxygen (mg/L)	—	14.12	10.16	14.29	10.31	15.03	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	—	754.8	—	—	756.1	—	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 5/2/19

Field Instrument Calibration Log

Date: 5/3/19 **Weather:** Clouds, 45°F

Project/Site Name: PFAS RI EW **Instrument:** YSI 650XL

Calibrated By: B.A **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0545		Cal. Temp. (°C)	PM Post Cal. Check Time 1315	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm^c)	11/19	1428	1413	14.61	1411	14.46	±10 µS/cm	N
pH (7)	10/20	7.12	7.00	14.62	6.99	14.42	± 0.3 Ph *	N
pH (4)	07/20	3.96	4.00	14.67	4.04	14.49	± 0.3 Ph *	N
pH (10)	02/20	9.86	10.00	14.54	9.85	14.48	± 0.3 Ph *	N
ORP (240 mv)	10/19	239.0	240.0	14.42	238.7	240	±10 mv	N
Dissolved Oxygen (%)	-	57.8	99.3	14.46	96.4	100	-	N
Dissolved Oxygen (mg/L)	-	5.89	10.19	14.46	10.02	10.20	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	-	756.6	-	14.46	761.3	-	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: B.A **Date:** 5/3/19

Field Instrument Calibration Log

Date: ~~PFAS RI EW~~ 5/6/19 **Weather:** Sun, 45°F

Project/Site Name: PFAS RI EW A3 **Instrument:** 451 650 XL

Calibrated By: BrA **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0625		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1447	1413	1481	1411	15.42	±10 µS/cm	N
pH (7)	10/20	7.18	7.00	14.83	7.06	15.40	± 0.3 Ph *	
pH (4)	07/20	3.78	4.00	14.88	4.02	15.28	± 0.3 Ph *	
pH (10)	02/20	960	9.92	14.86	10.13	15.31	± 0.3 Ph *	
ORP (240 mv)	10/19	240.9	240.0	14.30	240.1	15.12	±10 mv	
Dissolved Oxygen (%)	—	170	98.8	14.92	98.6	14.99	-	
Dissolved Oxygen (mg/L)	—	17.17	9.98	14.92	9.97	14.99	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	—	750.9	750.9	—	758.9	—	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: BrA **Date:** 5/6/19

Field Instrument Calibration Log

Date: 5/7/19 **Weather:** Sun, 45°F

Project/Site Name: PFAS RI EW **Instrument:** YSI 650 XL

Calibrated By: B.A **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0900		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/19	1355	1413	15.01	1404	17.58	±10 µS/cm	N
pH (7)	10/20	6.98	7.00	15.18	7.13	17.20	± 0.3 Ph *	
pH (4)	07/20	3.90	4.00	15.24	4.01	17.30	± 0.3 Ph *	
pH (10)	02/20	9.84	9.97	15.81	10.16	17.58	± 0.3 Ph *	
ORP (240 mv)	10/19	238.6	240.0	15.72	235.6	17.20	±10 mv	
Dissolved Oxygen (%)	-	92.1	100.1	15.30	90.3	16.88	-	
Dissolved Oxygen (mg/L)	-	9.52	9.90	15.30	9.50	16.88	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	-	755.3	-	-	758.6	-	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: B.A **Date:** 5/7/19

Field Instrument Calibration Log

Date: 5/8/15 **Weather:** Sun.

Project/Site Name: PFAS RI EW **Instrument:** YSI 650XL

Calibrated By: B.A **Serial Number:** 02E0534

Parameters	Solution Expiration Date	AM Calibration Time 0600		Cal. Temp. (°C)	PM Post Cal. Check Time 1325	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/15	1414	1413	15.54	1404	16.20	±10 µS/cm	N
pH (7)	10/20	7.00	7.00	15.56	7.00	15.92	± 0.3 Ph *	
pH (4)	07/20	4.01	4.00	15.73	3.99	16.15	± 0.3 Ph *	
pH (10)	02/20	9.80	10.00	15.72	10.04	16.07	± 0.3 Ph *	
ORP (240 mv)	10/15	237.2	240.0	15.34	235.8	16.20	±10 mv	
Dissolved Oxygen (%)	—	43.2	99.8	15.10	96.4	15.92	-	
Dissolved Oxygen (mg/L)	—	4.35	10.04	15.10	9.81	15.92	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	—	757.4	757.4	15.10	760.1	15.92	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 5/8/15

Turbidity Instrument Calibration Log

Project/Site Name: PFAS RI EW - AOC50 **Instrument:** Lamotte 2020e

Calibrated By: B/A **Serial Number:** 1116-0719

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
4/26/19	0.03	0.01	11.0	10.05	0.09	10.07	N
4/30/19	0.05	0.02	12.6	10.2	0.03	10.21	N
5/1/19	0.07	0.06	11.3	10.5	0.05	10.6	N
5/2/19	0.08	0.05	10.9	10.8	0.06	10.9	N
5/3/19	0.12	0.05	11.7	10.9	0.06	11.1	N
5/6/19	0.26	0.10	10.8	10.6	0.13	11.0	N
5/7/19	0.08	0.04	6.27	10.0	0.06	10.2	W
5/8/19	0.02	0.01	10.07	10.00	0.04	10.07	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 5/8/19

KGS

Field Instrument Calibration Log

Date: 5/6/19 **Weather:** Cloudy 40's - 50's

Project/Site Name: Dunns PFAS RIEW **Instrument:** YSI 556

Calibrated By: AOC 57 **Serial Number:** 06O2657 A1

Parameters	Solution Expiration Date	AM Calibration Time 0705		Cal. Temp. (°C)	PM Post Cal. Check Time 1215	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1,401	1,413	17.53	1,404	17.61	±10 µS/cm	N
pH (7)	10/2020	7.07	7.00	17.56	7.09	17.65	± 0.3 Ph *	N
pH (4)	3/2020	3.89	4.00	17.51	4.10	17.58	± 0.3 Ph *	N
pH (10)	12/31/2019	10.00	10.00	17.52	9.89	17.63	± 0.3 Ph *	N
ORP (240 mv)	10/2019	240.5	240.0	17.39	237.4	17.49	±10 mv	N
Dissolved Oxygen (%)	–	102.1	100.0	17.12	101.3	17.19	-	–
Dissolved Oxygen (mg/L)	–	9.69	9.37	17.12	9.70	17.19	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	–	760	–	–	760	–	-	–

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 5/6/19

Field Instrument Calibration Log

Date: 5/8/19 **Weather:** Partly Cloudy, Sunny 50's-60's

Project/Site Name: Downs PFAS RIEW **Instrument:** YSI 556

Calibrated By: CV **Serial Number:** 0602657 A1

Parameters	Solution Expiration Date	AM Calibration Time 0700		Cal. Temp. (°C)	PM Post Cal. Check Time 1250	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1,405	1,413	18.61	1,404	18.12	±10 µS/cm	N
pH (7)	10/2020	7.08	7.00	18.44	6.88	18.15	± 0.3 Ph *	N
pH (4)	3/2020	3.96	4.00	18.57	4.06	18.31	± 0.3 Ph *	N
pH (10)	12/31/2019	9.90	10.00	18.38	10.00	18.20	± 0.3 Ph *	N
ORP (240 mv)	10/2019	237.4	240.0	18.50	240.9	18.18	±10 mv	N
Dissolved Oxygen (%)	—	95.6	100.0	17.21	98.6	18.05	-	—
Dissolved Oxygen (mg/L)	—	9.11	9.55	17.21	9.34	18.05	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: **Date:** 5/8/19

Turbidity Instrument Calibration Log

Project/Site Name: Downs PFAS RT EW **Instrument:** LaMotte

Calibrated By: W **Serial Number:** 5108-5014

	AM Calibration				PM Post Calibration Check		
Date	**Pre-Cal 0 NTU**	**Post-Cal 0 NTU**	**Pre-Cal 10 NTU**	**Post-Cal 10 NTU**	**0 NTU**	**10 NTU**	**Variance Noted**
5/6/19	0.19	0.01	6.70	10.00	0.14	9.83	N
5/8/19	0.06	0.00	10.20	10.00	0.08	9.73	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature] **Date:** 5/8/19

KGS

Field Instrument Calibration Log

Date: 10/9/19 **Weather:** Cloudy -> Rainy ; 50's-60's (°F)

Project/Site Name: LTM - Fall 2019 **Instrument:** YSI 650 MDS

Calibrated By: CV **Serial Number:** 16100386

Parameters	Solution Expiration Date	AM Calibration Time 0700		Cal. Temp. (°C)	PM Post Cal. Check Time 1415	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])	11/2019	1,406	1,413	18.21	1,414	18.61	±10 µS/cm	N
pH (7)	02/2021	6.93	7.00	18.07	7.01	17.99	± 0.3 Ph *	N
pH (4)	03/2021	3.99	4.00	18.08	4.03	18.31	± 0.3 Ph *	N
pH (10)	02/2021	10.01	10.00	18.06	10.00	18.32	± 0.3 Ph *	N
ORP (240 mv)	12/2019	245.9	240.0	18.41	239.3	18.59	±10 mv	N
Dissolved Oxygen (%)	–	93.9	100.0	18.01	103.2	18.01	-	–
Dissolved Oxygen (mg/L)	–	8.67	9.23	18.01	9.51	18.01	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	–	760	–	–	760	–	-	–

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/9/19

Turbidity Instrument Calibration Log

Project/Site Name: Downs Fall LTM 2019 **Instrument:** HACH 2100Q

Calibrated By: CAC **Serial Number:** 17060C059342

	AM Calibration				PM Post Calibration Check				
Date	Pre/Post - Cal 10 NTU	Pre/Post - Cal 20 NTU	Pre/Post - Cal 100 NTU	Pre/Post - Cal 800 NTU	10 NTU	20 NTU	100 NTU	800 NTU	Variance Noted
10/9/19	10.1/10.0	20.2/20.0	106/100	799/800	10.1	19.9	95.6	800	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria			
± 0.5	± 1	± 5	± 40

Signature: [signature] **Date:** 10/9/19

Field Instrument Calibration Log

Date: 10/10/19 **Weather:** Rain, 50°F

Project/Site Name: Devens LTM - AOC50 **Instrument:** YSI 556 MPS

Calibrated By: BvA **Serial Number:** 15F101567

Parameters	Solution Expiration Date	AM Calibration Time 0600		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	03/20	1447	1413	16.65	1410	17.61	±10 µS/cm	N
pH (7)	01/21	7.09	7.00	16.42	6.80	17.59	± 0.3 Ph *	N
pH (4)	03/20	3.97	4.00	16.65	4.28	17.64	± 0.3 Ph *	N
pH (10)	02/20	9.96	10.00	16.43	10.23	17.59	± 0.3 Ph *	N
ORP (240 mv)	06/23	240.8	240.0	16.80	238.6	17.50	±10 mv	N
Dissolved Oxygen (%)	-	111.0	99.9	16.74	100.0	15.94	-	N
Dissolved Oxygen (mg/L)	-	10.80	9.70	16.74	9.89	15.94	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	-	760	760	16.74	760	15.94	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/10/19

Turbidity Instrument Calibration Log

Project/Site Name: Devens LTM 436 / A0C50

Calibrated By: B.A

Instrument: Hach 2100Q

Serial Number: 16010C047202

	AM Calibration				PM Post Calibration Check				
Date	**Pre/Post - Cal 10 NTU**	**Pre/Post - Cal 20 NTU**	**Pre/Post - Cal 100 NTU**	**Pre/Post - Cal 800 NTU**	**10 NTU**	**20 NTU**	**100 NTU**	**800 NTU**	**Variance Noted**
10/9/19	10.0/10.0	19.5/20.0	99.0/100	803/800	10.3/10	20.8/20	97/100	804/800	N
10/10/19	10.1/10.0	17.9/20.0	96.2/100	803/800	10.4/10	20.7/20	101/100	817/800	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria			
± 0.5	± 1	± 5	± 40

Signature: [signature]

Date: 10/10/19

KGS

Field Instrument Calibration Log

Date: 10/16/19 **Weather:** Cool, 36°F (AM)

Project/Site Name: Devens LTM - AOC30 **Instrument:** YSI 556MPS

Calibrated By: BrA **Serial Number:** 15F101567

Parameters	Solution Expiration Date	AM Calibration Time 0600		Cal. Temp. (°C)	PM Post Cal. Check Time 1515	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])	03/20	1400	143	15.55	1416	18.63	±10 µS/cm	N
pH (7)	01/21	7.38	7.00	15.79	6.89	17.91	± 0.3 Ph *	
pH (4)	03/20	3.89	4.00	15.66	4.05	18.87	± 0.3 Ph *	
pH (10)	02/20	9.81	10.00	15.75	9.96	18.46	± 0.3 Ph *	
ORP (240 mv)	06/23	239.0	240.0	15.81	237.9	18.50	±10 mv	
Dissolved Oxygen (%)	—	107	100	16.49	95.2	18.87	-	
Dissolved Oxygen (mg/L)	—	10.46	9.80	16.49	9.52	18.87	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	—	760	760	16.45	760	18.87	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/16/19

Turbidity Instrument Calibration Log

Project/Site Name: Devens LTM - AOC50 SHL

Calibrated By: B/A

Instrument: ~~YSI~~ Hach 2100Q

Serial Number: 16010C047202

	AM Calibration				PM Post Calibration Check				
Date	Pre/Post - Cal 10 NTU	Pre/Post - Cal 20 NTU	Pre/Post - Cal 100 NTU	Pre/Post - Cal 800 NTU	10 NTU	20 NTU	100 NTU	800 NTU	Variance Noted
10/14/19	9.94/10	17.5/20	82.5/100	776/800	10.2	19.3/20	97	810	N
10/15/19	9.98/10	20.8/20	98.8/100	799/800	9.93/10	20.1/20	97.5/100	800	N
10/16/19	10.3/10	19.2/20	101/100	807/800	9.91/10	20.6/20	101/100	795/800	N
10/18/19	10.3/10	19.4/20	98.6/100	799/800	9.95/10	20.4/20	102/100	808/800	N
10/28/19	10.1/10	19.8/20	99.1/100	801/800	9.90/10	20.1/20	98/100	796/800	N
10/29/19	10.0/10	20.7/20	103./100	803/800	10.0/10	20.2/20	102.0/100	801/800	N
10/30/19	10.2/10	17.5/20	92.4/100	773/800	10.2/10	19.8/20	98/100	794/800	N
10/31/19	10.3/10	20.1/	104/100	802/800	~~23~~ 10.1/10	20.2/20	98.8/100	800/800	N
					Post Calibration Criteria				
					± 0.5	± 1	± 5	± 40	

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 10/14 - 10/31

KGS

Field Instrument Calibration Log

Date: 11/6/15 **Weather:** Sun, 45°F

Project/Site Name: Devens LTM **Instrument:** YSI 556 MPS

Calibrated By: BnA **Serial Number:** 15F101567

Parameters	Solution Expiration Date	AM Calibration Time 0600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	03/20	1428	1413	17.41	1410	17.30	±10 µS/cm	N
pH (7)	01/21	7.20	7.00	17.68	7.04	17.25	± 0.3 Ph *	
pH (4)	03/21	3.81	4.00	17.53	3.96	18.01	± 0.3 Ph *	
pH (10)	03/20	9.91	10.00	18.10	10.05	17.57	± 0.3 Ph *	
ORP (240 mv)	06/23	256.1	240	17.08	235.1	18.10	±10 mv	
Dissolved Oxygen (%)	-	96.4	100	16.41	103.8	16.90	-	
Dissolved Oxygen (mg/L)	/	9.28	9.33	16.41	9.40	16.90	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	/	760	760	16.41	760	16.90	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Brett Q **Date:** 11/6/15

Turbidity Instrument Calibration Log

Project/Site Name: Devens 4th

Instrument: Hach 2100Q

Calibrated By: B.A

Serial Number: 160100 47202

Date	AM Calibration				PM Post Calibration Check				Variance Noted
	Pre/Post - Cal 10 NTU	Pre/Post - Cal 20 NTU	Pre/Post - Cal 100 NTU	Pre/Post - Cal 800 NTU	10 NTU	20 NTU	100 NTU	800 NTU	
11/1/19	10.3/10	19.8/20	97.8/100	800/800	10/10	20.6/20	102/100	800/800	N
11/5/19	10.4/10	20.8/20	100/100	799/800	10.2/10	20.4/20	101/100	800/800	N
11/6/19	10.6/10	19.7/20	101/100	808/800	10.2/10	19.9/20	104/100	806/800	N
11/7/19	10.2/10	19.3/20	96.7/100	798/800	10.1/10	20.1/20	103/100	804/800	N
11/8/19	10.1/10	19.4/20	97.1/100	796/800	10.0/10	20.0/20	101/100	790/800	N
11/11/19	10.1/10	19.6/20	97.6/100	803/800	10.2/10	19.2/20	103/100	799/800	N
11/12/19	10.1/10	20.5/20	96.9/100	800/800	10.1/10	19.8/20	101/100	796/800	N
11/13/19	10.2/10	20.1/20	97.1/100	801/800	10.1/10	19.9/20	104/100	795/800	N
					Post Calibration Criteria				
					± 0.5	± 1	± 5	± 40	

Notes: Mark Noted Variences on Field Forms

Signature:

Date: 11/1 - 11/13/19

KGS

Field Instrument Calibration Log

Date: 5/7/2020 **Weather:** 40°F, Sun.

Project/Site Name: Devens Supplemental Sampling **Instrument:** YSI 556 MPS

Calibrated By: BrA **Serial Number:** 05G1941AD

Parameters	Solution Expiration Date	AM Calibration Time 0600		Cal. Temp. (°C)	PM Post Cal. Check Time 1300	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])	10/20	1391	1413	16.39	1411	17.28	±10 µS/cm	N
pH (7)	10/21	7.00	7.00	16.32	7.01	17.51	± 0.3 Ph *	
pH (4)	10/21	4.01	4.00	16.39	3.99	17.43	± 0.3 Ph *	
pH (10)	10/21	9.94	10.00	16.42	10.08	17.28	± 0.3 Ph *	
ORP (240 mv)	05/20	241.5	240.0	16.41	239.6	17.50	±10 mv	
Dissolved Oxygen (%)	–	99.3	98.0	16.60	97.1	17.20	-	
Dissolved Oxygen (mg/L)	–	9.68	9.55	16.60	9.49	17.20	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	–	745.1	745.1	16.60	746.5	17.20	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: BrA **Date:** 5/7/20

KGS

Field Instrument Calibration Log

Date: 5/8/2020 **Weather:** 45°F, Sun

Project/Site Name: Devers Spng 2020 Supplemental **Instrument:** YSI 556 MPS

Calibrated By: BrA **Serial Number:** 05G1941AD

Parameters	Solution Expiration Date	AM Calibration Time 0615		Cal. Temp. (°C)	PM Post Cal. Check Time 1230	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])	10/20	1415	1413	16.43	1416	17.81	±10 µS/cm	N
pH (7)	10/21	7.02	7.00	16.35	7.01	18.04	± 0.3 Ph *	
pH (4)	10/21	3.95	4.00	16.30	3.97	17.90	± 0.3 Ph *	
pH (10)	10/21	9.98	10.00	16.42	10.08	17.96	± 0.3 Ph *	
ORP (240 mv)	05/20	238.8	240.0	16.12	241.6	18.02	±10 mv	
Dissolved Oxygen (%)	—	98.5	98.5	16	99.9	17.50	-	
Dissolved Oxygen (mg/L)	—	9.72	9.71	16	9.74	17.50	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)	—	747.5	747.5	16	749.6	17.50	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: BrA G **Date:** 5/8/20

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens Supplemental

Instrument: Lamotte 2020we

Calibrated By: BrA

Serial Number: 981-2111

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
5/6/2020	0.15	0.14	8.86	10.00	0.18	9.88	N
5/7/2020	0.19	0.14	9.17	10.00	0.16	9.91	N
5/8/2020	0.16	0.14	9.90	10.00	0.17	9.80	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: Brett Cantor

Date: 5/6/2020
5/7/2020
5/8/2020

KGS

Field Instrument Calibration Log

Date: 5/7/20 **Weather:** 50's

Project/Site Name: Dam **Instrument:** YSI 556 MPS

Calibrated By: MA **Serial Number:** 06C657A1

Parameters	Solution Expiration Date	AM Calibration Time 640		Cal. Temp. (°C)	PM Post Cal. Check Time 1230	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])	10/20	1.447	1.413	16.94	1.410	17.81	±10 µS/cm	N
pH (7)	2/21	7.09	7.00	16.78	7.11	17.77	± 0.3 Ph *	N
pH (4)	10/21	4.11	4.09	16.81	4.00	17.69	± 0.3 Ph *	N
pH (10)	10/21	9.63	10.00	17.01	10.03	17.83	± 0.3 Ph *	N
ORP (240 mv)	5/20	220.3	240.0	16.90	237.7	17.81	±10 mv	N
Dissolved Oxygen (%)	N/A	91.0%	100.0%	15.11	101.1%	17.80	-	N
Dissolved Oxygen (mg/L)	N/A	9.70	10.00	14.61	10.09	16.87	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 5/7/20

KGS

Field Instrument Calibration Log

Date: 5/8/20 **Weather:** 50's

Project/Site Name: Devers **Instrument:** YSI 556 MPS

Calibrated By: MA **Serial Number:** 06C2657A1

Parameters	Solution Expiration Date	AM Calibration Time 650		Cal. Temp. (°C)	PM Post Cal. Check Time 1215	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	10/20	1.478	1.413	16.99	1.410	16.39	±10 µS/cm	N
pH (7)	2/21	7.30	7.00	16.83	7.03	16.47	± 0.3 Ph *	N
pH (4)	10/21	4.18	4.00	17.21	4.01	16.50	± 0.3 Ph *	N
pH (10)	10/21	9.83	10.00	17.09	10.00	16.51	± 0.3 Ph *	N
ORP (240 mv)	5/20	231.0	249.0	16.87	241.1	16.42	±10 mv	N
Dissolved Oxygen (%)	N/A	90.0%	100.0%	16.79	100.0%	16.39	-	N
Dissolved Oxygen (mg/L)	MA	9.47	10.00	16.89	9.81	16.27	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	MA	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 5/8/20

Turbidity Instrument Calibration Log

Project/Site Name: Davis **Instrument:** LaMotte 2020we

Calibrated By: MA **Serial Number:** 3711-3913

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
5/5/20	0.09	0.00	10.18	10.00	0.07	10.00	N
5/7/20	0.39	0.00	10.47	10.00	0.02	10.13	N
5/8/20	0.29	0.00	9.73	10.00	0.00	10.18	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: _____ **Date:** 5/8/20

Field Instrument Calibration Log

Date: 10/10/19 **Weather:** 50°F Partially Cloudy

Project/Site Name: LTM - Fall 2019 **Instrument:** YSI 556 MPS

Calibrated By: Melissa Miller **Serial Number:** 14A100102

Parameters	Solution Expiration Date	AM Calibration Time 0740		Cal. Temp. (°C)	PM Post Cal. Check Time 1415	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	03/20	1410	1413	19.55	1405	15.73	±10 µS/cm	N
pH (7)	02/21	7.25	7.00	19.63	6.91	15.89	± 0.3 Ph *	N
pH (4)	03/21	3.99	4.00	19.37	3.98	15.65	± 0.3 Ph *	N
pH (10)	02/21	9.98	10.00	19.10	9.95	15.92	± 0.3 Ph *	N
ORP (240 mv)	~~10/19~~	237.8	240	19.53	237.1	15.77	±10 mv	N
Dissolved Oxygen (%)	—	104.2	100.0	19.10	95.1	13.85	-	N
Dissolved Oxygen (mg/L)	—	9.81	9.45	19.10	9.89	13.85	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	760	—	—	—	—	—	—	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 10/10/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Ft. Devens, MA FAL'19 LTM

Instrument: Lamotte 2020WE

Calibrated By: Melissa Miller

Serial Number: 926-1811

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
10/9/19	0.06	0.00	9.24	9.45	0.71	9.90	N
10/10/19	0.05	0.00	9.68	9.73	0.61	10.00	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature:

Date: 10/10/19

Field Instrument Calibration Log

Date: 10/15/15 **Weather:** Sun, 45°F

Project/Site Name: Devons LTM - ACC50 **Instrument:** YSI 556MPS

Calibrated By: B.A **Serial Number:** 15F10154767

Parameters	Solution Expiration Date	AM Calibration Time 0615		Cal. Temp. (°C)	PM Post Cal. Check Time _____	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])		1414	1413	17.36	1411	19.99	±10 µS/cm	N
pH (7)		6.99	7.00	17.22	6.90	19.33	± 0.3 Ph *	
pH (4)		3.96	4.00	16.92	4.20	19.43	± 0.3 Ph *	
pH (10)		10.09	10.00	17.44	9.98	19.55	± 0.3 Ph *	
ORP (240 mv)		245.6	240.0	17.69	238.7	19.90	±10 mv	
Dissolved Oxygen (%)		111.5	99.5	17.24	100.2	20.03	-	
Dissolved Oxygen (mg/L)		10.72	9.61	17.24	9.65	20.03	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	
Barometric Pressure (mmHg)		760	760	17.24	760	20.03	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: _____ **Date:** 10/15/15

Turbidity Instrument Calibration Log

Project/Site Name: Devens LTM - AOC50 SHL

Calibrated By: B+A

Instrument: ~~YSI~~ Hach 2100Q

Serial Number: 16010C047202

	AM Calibration				PM Post Calibration Check				
Date	**Pre/Post - Cal 10 NTU**	**Pre/Post - Cal 20 NTU**	**Pre/Post - Cal 100 NTU**	**Pre/Post - Cal 800 NTU**	**10 NTU**	**20 NTU**	**100 NTU**	**800 NTU**	**Variance Noted**
10/14/19	9.94/10	17.5/20	82.9/100	776/800	10.2	19.3/20	97	810	N
10/15/19	9.98/10	20.8/20	98.8/100	799/800	9.93/10	20.1/20	97.5/100	800	N
10/16/19	10.3/10	19.2/20	101/100	807/800	9.91/10	20.6/20	101/100	795/800	N
10/18/19	10.3/10	19.4/20	98.6/100	799/800	9.95/10	20.4/20	102/100	808/800	N
10/28/19	10.1/10	19.8/20	99.1/100	801/800	9.90/10	20.1/20	98/100	796/800	N
10/29/19	10.0/10	20.7/20	103./100	803/800	10.0/10	20.2/20	102.0/100	801/800	N
10/30/19	10.2/10	17.5/20	92.4/100	773/800	10.2/10	19.8/20	98/100	794/800	N
10/31/19	10.3/10	20.1/	104/100	802/800	~~9.8~~ 10.1/10	20.2/20	98.8/100	800/800	N
					Post Calibration Criteria				
					± 0.5	± 1	± 5	± 40	

Notes: Mark Noted Variences on Field Forms

Signature: B+A

Date: 10/14 - 10/31

Field Instrument Calibration Log

Date: 10/15/2019 **Weather:** clear, sunny, ≈ 50-65°F

Project/Site Name: LTM - Fall 2019 **Instrument:** YSI 560 mDS

Calibrated By: E. Seiler **Serial Number:** 11G100386

Parameters	Solution Expiration Date	AM Calibration Time 0635		Cal. Temp. (°C)	PM Post Cal. Check Time 1520	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])	11/2019 ~~2020~~	1409	1413	18.49	1392 → 1413	19.15	±10 µS/cm	yes
pH (7)	2/2021	6.97	7.00	18.89	6.85 → 7.00	19.26	± 0.3 Ph *	no
pH (4)	3/2021	3.93	4.00	18.99	4.09 → 4.06	18.83	± 0.3 Ph *	no
pH (10)	2/2021	10.23	10.04	18.82	10.15 → 10.03	19.35	± 0.3 Ph *	no
ORP (240 mv)	12/2019	244.1	240.0	18.72	236.1 → 240.0	19.15	±10 mv	no
Dissolved Oxygen (%)	–	103.4	100.0	17.72	100.3 → 100.0	20.99	-	–
Dissolved Oxygen (mg/L)	–	9.85	9.52	17.27	8.95 → 8.91	20.99	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	yes ~~no~~
Barometric Pressure (mmHg)	760	–	–	–	760	–	-	–

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: E. Seiler **Date:** 10/15/2019

Turbidity Instrument Calibration Log

Project/Site Name: Devens LTM

Instrument: HACH 2100Q

Calibrated By: E. Seiler

Serial Number: 170600059342
*16010C047202

Date	AM Calibration				PM Post Calibration Check				Variance Noted
	Pre/Post - Cal 10 NTU	Pre/Post - Cal 20 NTU	Pre/Post - Cal 100 NTU	Pre/Post - Cal 800 NTU	10 NTU	20 NTU	100 NTU	800 NTU	
10/14/2019	10.3/10	20.4/20	106/100	812/800	10.0/10	20.1/20	103/100	796/800	NO
10/15/2019	10.4/10	19.3/20	96.5/100	799/800	9.71/10	20.6/20	96.9/100	790/800	no
10/16/2019	9.87/10	20.4/20	103/100	816/800	10.0/10	19.6/20	102/100	793/800	no
10/17/2019	10.1/10	19.7/20	98.6/100	810/800	10.02/10	19.9/20	97.2/100	779/800	no
10/21/2019	9.06/10	20.2/20	104/100	814/800	10.09/10	19.8/20	95.3/100	779/800	no
10/23/2019	12.3/10	20.6/20	103/100	811/800	10.2/10	20.3/20	103/100	802/800	no
10/24/2019	9.90/10	20.1/20	102/100	804/800	10.02/10	20.2/20	110 +40/100	791/800	yes
* 10/25/2019	10.0/10	20.5/20	102/100	790/800	10.6/10	20.2/20	96.8/100	810/800	~~yes~~ no
					Post Calibration Criteria				
					± 0.5	± 1	± 5	± 40	

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 10/25/2019

KGS

Field Instrument Calibration Log

Date: 10/16/19 **Weather:** 50-60°

Project/Site Name: Dennys Mall LTM **Instrument:** YSI 650 MDS

Calibrated By: Michael Spaulding **Serial Number:** 11G100 386

Parameters	Solution Expiration Date	AM Calibration Time 0620		Cal. Temp. (°C)	PM Post Cal. Check Time 1520	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	11/2019	1399	1414	17.48	1417 / 1413	18.46	±10 µS/cm	N
pH (7)	2/2021	6.99	7.00	17.65	7.00 / 7.00	19.80	± 0.3 Ph *	N
pH (4)	3/2021	4.00	4.00	17.55	4.08 / 4.00	18.79	± 0.3 Ph *	N
pH (10)	2/2021	10.18	10.03	17.63	10.01 / 10.00	18.60	± 0.3 Ph *	N
ORP (240 mv)	12/2019	238.1	240.1	17.59	236.7 / 239.9	18.61	±10 mv	N
Dissolved Oxygen (%)		102.6	100.0	17.75	102.6 / 100.0	18.82	-	N
Dissolved Oxygen (mg/L)		~~10.26~~ 9.76	9.51	17.75	~~10.26~~ 9.50 / 9.31	18.82	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)		760		17.75	760	18.82	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/16/19

Turbidity Instrument Calibration Log

Project/Site Name: FT Peck Fall LTM

Calibrated By: Michael Spalding

Instrument: ~~YSI 650 MDS~~ HACH 2100Q

Serial Number: ~~[illegible]~~ 17060C053432

	AM Calibration				PM Post Calibration Check				
Date	**Pre/Post - Cal 10 NTU**	**Pre/Post - Cal 20 NTU**	**Pre/Post - Cal 100 NTU**	**Pre/Post - Cal 800 NTU**	**10 NTU**	**20 NTU**	**100 NTU**	**800 NTU**	**Variance Noted**
10/18/19	9.92/10	20.4/20	104/100	811/800	9.68	19.4	44.4	793	Y

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria			
± 0.5	± 1	± 5	± 40

Signature: [signature]

Date: 10/18/19

APPENDIX B SYNOPTIC WATER LEVEL EVENT FIELD SHEETS

Airfield Overburden Synoptic Event, August 14, 2019

Groundwater Water Level Measurement Sheet

Project/Site Name: Fort Devens/Area 3 Synoptic Water Level Summer 2019

Date : 8/14/2019

Field Team Member: Brett Anchukaitis

Weather: 75 sunny

Water Level Meter Model: Heron Dipper-T

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition
Area 1	G6M-96-22A	1216	4.74	52.48	N		Y	Good
Area 1	G6M-96-22B	1215	5.10	72.87	N		Y	Good
Area 1	G6M-96-25A	0754	12.22	21.26	N		Y	Good
Area 1	G6M-96-25B	0752	14.81	61.61	N		Y	Dedicated Tubing, Good
Area 1	G6M-04-11X	0756	18.55	46.96	N		Y	Dedicated Tubing, Good
Area 1	G6M-13-05X	0746	13.41	56.65	N		Y	Dedicated Tubing, Good
Area 1	G6M-02-08X	0742	12.35	71.99	Y		Y	Dedicated Bladder Pump, Good
Area 1	G6M-95-19X	0728	11.65	58.65	Y		Y	Good
Area 1	G6M-95-20X	0725	12.19	24.98	N		Y	Good
Area 1	G6M-07-02X	0732	12.79	29.85	Y		Y	Dedicated Bladder pump, good
Area 1	G6M-04-10X	0734	12.50	63.48	Y		Y	Dedicated Tubing, Good
Area 1	G6M-04-10A	0738	11.95	42.08	Y		Y	Dedicated Bladder pump, good
Area 1	G6M-04-22X	0834	45.08	85.42	Y		Y	Dedicated Tubing, Good
Area 1	G6M-04-31X	0830	44.96	80.15	Y		Y	Dedicated Tubing, top PVC section loose
Area 1	G6M-04-15X	0826	41.55	81.01	Y		Y	Dedicated Tubing, Good
AOC 50	50PZ-19-01	0821	42.10	54.62	N		Y	VP location 50VP-19-04
Area 2	30PZ-19-05	0815	11.08	29.05		Y	Y	VP location 30VP-19-05
Area 2	30PZ-19-01	0808	17.65	30.72	N		Y	VP location 30VP-19-01
Area 2	G6P-97-05B	0849	26.00	44.45	N		Y	Good, 4" PVC
Area 2	50PZ-19-02	0844	57.90	66.94		Y	Y	VP location 50VP-19-06
Area 2	G6M-02-01X	0944	53.35	89.40		Y	Y	Dedicated Bladder Pump, Good
Area 2	G6M-04-01X	0948	51.38	89.67		N	Y	Dedicated Tubing, Good
Area 2	G6M-04-03X	0954	55.95	93.04		N	Y	Dedicated Tubing, Good
Area 2	30PZ-19-02	0855	60.88	79.81		Y	Y	Good
Area 2	30PZ-19-03	0904	64.65	79.72		Y	Y	VP location 30VP-19-03

Groundwater Water Level Measurement Sheet

Project/Site Name: Fort Devens/Area 3 Synoptic Water Level Summer 2019

Date : 8/14/2019

Field Team Member: Brett Anchukaitis

Weather: 75 sunny

Water Level Meter Model: Heron Dipper-T

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition
Area 2	30PZ-19-04	0915	64.25	76.40		Y	Y	VP location 30VP-19-04
Area 3	G6M-04-02X	0959	59.14	92.31	Y		Y	Good
Area 3	G6M-13-03X	1210	57.28	90.28		N	Y	Dedicated Tubing, Good
Area 3	G6M-03-07X	1003	56.00	88.26		N	Y	Dedicated Bladder Pump, Good
Area 3	G6M-04-04X	1006	57.35	104.15		N	Y	Dedicated Tubing, Good
Area 4	G6M-02-04X	1017	60.13	106.75	Y		Y	Dedicated Tubing, Good
Area 4	G6M-97-28X	1014	60.96	107.10	Y		Y	Dedicated Tubing, Good
Area 4	GM-02-03X	1010	58.15	103.67		Y	Y	soft bottom, Good
Area 4	G6M-13-02X	1020	59.31	125.04		Y	Y	Dedicated Tubing, Good
Area 4	G6M-18-01	1155	60.46	124.94		Y	Y	Dedicated Tubing, Good
Area 5	G6M-02-11X	1140	60.40	136.90	Y		Y	Dedicated Bladder Pump, Good
Area 5	G6M-03-10X	1129	62.53	136.81	Y		Y	Dedicated Bladder Pump, Good
Area 5	G6M-04-05X	1135	54.90	112.36	Y		Y	Dedicated Bladder Pump, Good
Area 5	G6M-13-01X	1100	63.40	136.50	N		Y	Dedicated Tubing, Good
Area 5	G6M-13-04X	1145	63.65	137.40	Y		Y	Dedicated Tubing, Good
Area 5	G6M-97-05B	1055	65.13	137.61	Y		Y	Dedicated Tubing, Good
Area 5	G6M-18-02	1039	65.80	135.89	Y		Y	Dedicated Tubing, Good
Area 5	31PZ-19-01	1046	66.89	78.72	N		Y	VP location 31VP-19-04; locking part broken off

Airfield Overburden Synoptic Event, October 7, 2019

Groundwater Water Level Measurement Sheet

Project/Site Name: Fort Devens - AOC 50 Fall 2019
Field Team Member: michael Spalding
Water Level Meter Model: Solinst 101 Snt 268249

Date : 10/7/19
Weather: 70-75°F overcast

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
CV	G6M-96-22A							See well evaluation form	4.74
CV	G6M-96-22B							See well evaluation form	5.10
	G6M-02-08X	0747	14.68	72.59	Y	NA	Y	See well evaluation form	14.97
	G6M-04-09X	0930	31.95	66.81	Y	NA	Y	See well evaluation form	30.87
	G6M-04-10X	0911	13.58	63.52	Y	NA	Y	See well evaluation form	13.97
	G6M-04-10A	0902	13.08	42.14	Y	NA	Y	See well evaluation form	13.3
	G6M-04-11X	1015	14.61	47.04	N	NA	Y	See well evaluation form	20.14
	G6M-04-13X	0818	14.86	42.11	N	NA	N	See well evaluation form	15.18
	G6M-04-15X	0939	42.65	81.09	Y	NA	Y	See well evaluation form	43.04
1	G6M-04-22X	1000	46.13	85.67	Y	NA	Y	See well evaluation form	46.57
	G6M-04-31X	0951	46.02	80.33	Y	NA	Y	See well evaluation form	51.29
	G6M-07-02X	~~0829~~ 0835	14.54	29.65	Y	NA	Y	See well evaluation form	14.58
	G6M-13-05X	0735	14.49	56.46	N	NA	Y	See well evaluation form	14.97
	G6M-13-06X	0922	13.99	62.21	Y	NA	Y	See well evaluation form	14.42
	G6M-95-19X	0800	12.73	58.45	Y	NA	Y	See well evaluation form	13.04
	G6M-95-20X	0810	13.32	25.00	N	NA	Y	See well evaluation form	13.62
PFAS	30PZ-19-05	1033	12.30	28.96	NA	Y	Y	See well evaluation form	11.08
	30PZ-19-01	1050	21.16	30.73	N	NA	Y	See well evaluation form	17.65
	~~50PZ-19-01~~ MW-7 (IT)	1115	Dry	31.00	Y	NA	Y	See well evaluation form	~~42.10~~ N/A
	G6P-97-05X	1103	27.26	30.14	N	NA	Y	See well evaluation form	26.00
	~~MW-7 (IT)~~ 50PZ-19-01	1130	42.98	54.85	N	NA	Y	See well evaluation form	~~N/A~~ 42.10
	G6M-02-01X	1205	54.32	89.38	NA	Y	Y	See well evaluation form	55.19
2 CV	G6M-04-01X							See well evaluation form	52.88
	G6M-04-03X	1224	57.02	93.10	NA	N	Y	See well evaluation form	57.46

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
PFAS	50PZ-19-02	1255	59.03	66.88	NA	Y	Y	See well evaluation form	57.90
	30PZ-19-02	1310	62.02	78.81	NA	Y	Y	See well evaluation form	60.88
	30PZ-19-03	1339	65.68	78.78	NA	Y	Y	See well evaluation form	64.65
	30PZ-19-04	1325	65.14	76.46	NA	Y	Y	See well evaluation form	64.25
3	G6M-03-07X							See well evaluation form	57.70
	G6M-04-02X							See well evaluation form	60.67
	G6M-04-04X							See well evaluation form	58.80
	G6M-13-03X							See well evaluation form	58.85
	50PZ-19-03							See well evaluation form	N/A
	50PZ-19-04							See well evaluation form	N/A
4	G6M-02-03X							See well evaluation form	58.15
	G6M-02-04X							See well evaluation form	60.13
	G6M-02-13X							See well evaluation form	61.63
	G6M-13-02X							See well evaluation form	60.73
	G6M-97-28X							See well evaluation form	62.43
	50PZ-19-07							See well evaluation form	N/A
	31PZ-19-01							See well evaluation form	66.89
	50PZ-19-05							See well evaluation form	N/A
	50PZ-19-06							See well evaluation form	N/A
	G6M-02-06X							See well evaluation form	9.37
	G6M-02-07X							See well evaluation form	10.23
	G6M-02-11X							See well evaluation form	61.97
	G6M-02-12X							See well evaluation form	60.65
	G6M-03-08X							See well evaluation form	56.88
	G6M-03-09X							See well evaluation form	57.27
	G6M-03-10X							See well evaluation form	64.07
	G6M-04-05X							See well evaluation form	56.48
	G6M-04-06X							See well evaluation form	63.27

Mike

Groundwater Water Level Measurement Sheet

Project/Site Name: Fort Devens - AOC 50 Fall 2019 **Date :** 10/7/19
Field Team Member: Kristen Essex **Weather:** Cloudy 70's
Water Level Meter Model: Solinst 101

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
1	G6M-96-22A							See well evaluation form	4.74
	G6M-96-22B							See well evaluation form	5.10
	G6M-02-08X							See well evaluation form	14.97
	G6M-04-09X							See well evaluation form	30.87
	G6M-04-10X							See well evaluation form	13.97
	G6M-04-10A							See well evaluation form	13.3
	G6M-04-11X							See well evaluation form	20.14
	G6M-04-13X							See well evaluation form	15.18
	G6M-04-15X							See well evaluation form	43.04
	G6M-04-22X							See well evaluation form	46.57
	G6M-04-31X							See well evaluation form	51.29
	G6M-07-02X							See well evaluation form	14.58
	G6M-13-05X							See well evaluation form	14.97
	G6M-13-06X							See well evaluation form	14.42
	G6M-95-19X							See well evaluation form	13.04
	G6M-95-20X							See well evaluation form	13.62
2	30PZ-19-05							See well evaluation form	11.08
	30PZ-19-01							See well evaluation form	17.65
	50PZ-19-01							See well evaluation form	42.10
	G6P-97-05X							See well evaluation form	26.00
	MW-7 (IT)							See well evaluation form	N/A
	G6M-02-01X							See well evaluation form	55.19
	G6M-04-01X							See well evaluation form	52.88
	G6M-04-03X							See well evaluation form	57.46

Kristen

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
	50PZ-19-02							See well evaluation form	57.90
	30PZ-19-02							See well evaluation form	60.88
	30PZ-19-03							See well evaluation form	64.65
	30PZ-19-04							See well evaluation form	64.25
3	G6M-03-07X	1227	57.45	89.95	NA	N	Y	See well evaluation form	57.70
	G6M-04-02X	1248	60.80	94.88	Y	NA	Y	See well evaluation form	60.67
	G6M-04-04X	1215	58.90	106.80	NA	N	Y	See well evaluation form	58.80
	G6M-13-03X	1258	58.90	92.40	NA	N	Y	See well evaluation form	58.85
PFAS	50PZ-19-03	1144	45.10	52.85	Y	NA	Y	See well evaluation form	N/A
PFAS	50PZ-19-04	1157	52.20	58.60	Y	NA	Y	See well evaluation form	N/A
4	G6M-02-03X	1340	59.97	100.30	NA	Y	Y	See well evaluation form	58.15
	G6M-02-04X	1324	62.03	109.55	Y	NA	Y	See well evaluation form	60.13
	G6M-02-13X	0958	60.85	122.70	NA	N	Y	See well evaluation form	61.63
	G6M-13-02X	1022	60.85	127.80	Y	NA	Y	See well evaluation form	60.73
	G6M-97-28X	1313	62.50	109.65	Y	NA	Y	See well evaluation form	62.43
PFAS	50PZ-19-07	0745	69.15	77.10	N	NA	Y	See well evaluation form	N/A
PFAS	31PZ-19-01	0730	68.7	79.25	N	NA	Y	See well evaluation form	66.89
PFAS	50PZ-19-05	1124	44.40	52.80	Y	NA	Y	See well evaluation form	N/A
PFAS	50PZ-19-06	1108	51.05	63.09	NA	N	Y	See well evaluation form	N/A
	G6M-02-06X							See well evaluation form	9.37
	G6M-02-07X							See well evaluation form	10.23
	G6M-02-11X							See well evaluation form	61.97
	G6M-02-12X							See well evaluation form	60.65
	G6M-03-08X							See well evaluation form	56.88
	G6M-03-09X							See well evaluation form	57.27
	G6M-03-10X							See well evaluation form	64.07
	G6M-04-05X							See well evaluation form	56.48
	G6M-04-06X							See well evaluation form	63.27

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
5	G6M-04-07X							See well evaluation form	63.14
	G6M-13-01X	0850	56.51	139.40	N	NA	Y	See well evaluation form	64.93
	G6M-13-04X	0900	63.9	140.45	Y	NA	Y	See well evaluation form	64.25
	G6M-13-10X							See well evaluation form	64.07
	G6M-97-05B	0910	66.35	140.80	Y	NA	Y	See well evaluation form	66.64
CV	MW-3							See well evaluation form	64.12
	MW-7	0935	63.20	138.45	Y	NA	Y	See well evaluation form	62.64
	XSA-12-95X							See well evaluation form	74.34
	G6M-18-01	1044	61.95	128.9	NA	Y	Y	See well evaluation form	57.0
	G6M-18-02	0828	67.20	138.8	Y	NA	Y	See well evaluation form	62.2
	XSA-12-96X							See well evaluation form	69.57
	XSA-12-97X							See well evaluation form	74.28
	XSA-12-98X							See well evaluation form	3.04
	31PZ-19-02S							See well evaluation form	N/A
	31PZ-19-02D							See well evaluation form	N/A
Nashua River	G6M-04-08X							See well evaluation form	63.27
	G6M-04-14X							See well evaluation form	20.42

Groundwater Water Level Measurement Sheet

Project/Site Name: Fort Devens - AOC 50 Fall 2019 **Date :** 10/7/19
Field Team Member: Chris Vigneault **Weather:** Cloudy, 70-75°F
Water Level Meter Model: Solinst 101

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
1	G6M-96-22A	1519	5.77	52.55	N	N	Y	See well evaluation form	4.74
	G6M-96-22B	1522	6.05	71.80	N	N	Y	See well evaluation form	5.10
	G6M-02-08X							See well evaluation form	14.97
	G6M-04-09X							See well evaluation form	30.87
	G6M-04-10X							See well evaluation form	13.97
	G6M-04-10A							See well evaluation form	13.3
	G6M-04-11X							See well evaluation form	20.14
	G6M-04-13X							See well evaluation form	15.18
	G6M-04-15X							See well evaluation form	43.04
	G6M-04-22X							See well evaluation form	46.57
	G6M-04-31X							See well evaluation form	51.29
	G6M-07-02X							See well evaluation form	14.58
	G6M-13-05X							See well evaluation form	14.97
	G6M-13-06X							See well evaluation form	14.42
	G6M-95-19X							See well evaluation form	13.04
	G6M-95-20X							See well evaluation form	13.62
2	30PZ-19-05							See well evaluation form	11.08
	30PZ-19-01							See well evaluation form	17.65
	50PZ-19-01							See well evaluation form	42.10
	G6P-97-05X							See well evaluation form	26.00
	MW-7 (IT)							See well evaluation form	N/A
	G6M-02-01X							See well evaluation form	55.19
	G6M-04-01X	1308	52.49	90.60	N	N	Y	See well evaluation form	52.88
	G6M-04-03X							See well evaluation form	57.46

Chris

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
	50PZ-19-02							See well evaluation form	57.90
	30PZ-19-02							See well evaluation form	60.88
	30PZ-19-03							See well evaluation form	64.65
	30PZ-19-04							See well evaluation form	64.25
3	G6M-03-07X							See well evaluation form	57.70
	G6M-04-02X							See well evaluation form	60.67
	G6M-04-04X							See well evaluation form	58.80
	G6M-13-03X							See well evaluation form	58.85
	50PZ-19-03							See well evaluation form	N/A
	50PZ-19-04							See well evaluation form	N/A
4	G6M-02-03X							See well evaluation form	58.15
	G6M-02-04X							See well evaluation form	60.13
	G6M-02-13X							See well evaluation form	61.63
	G6M-13-02X							See well evaluation form	60.73
	G6M-97-28X							See well evaluation form	62.43
	50PZ-19-07							See well evaluation form	N/A
	31PZ-19-01							See well evaluation form	66.89
	50PZ-19-05							See well evaluation form	N/A
	50PZ-19-06							See well evaluation form	N/A
	G6M-02-06X	0925	8.44	62.95	Y	N	Y	See well evaluation form	9.37
	G6M-02-07X	1057	9.65	40.45	Y	N	Y	See well evaluation form	10.23
	G6M-02-11X	1130	61.64	136.90	Y	N	Y	See well evaluation form	61.97
	G6M-02-12X	1139	59.30	135.00	N	N	Y	See well evaluation form	60.65
	G6M-03-08X	1208	56.61	139.45	Y	N	Y	See well evaluation form	56.88
	G6M-03-09X	1149	56.89	141.01	Y	N	Y	See well evaluation form	57.27
	G6M-03-10X	1220	63.69	136.81	Y	N	Y	See well evaluation form	64.07
	G6M-04-05X	1201	56.11	112.15	Y	N	Y	See well evaluation form	56.48
	G6M-04-06X	0914	62.68	105.99	Y	N	Y	See well evaluation form	63.27

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
5	G6M-04-07X	0904	62.42	131.85	Y	N	Y	See well evaluation form	63.14
	G6M-13-01X							See well evaluation form	64.93
	G6M-13-04X							See well evaluation form	64.25
not on 77.7 map	G6M-13-10X ?	DNE	—					See well evaluation form	64.07
	G6M-97-05B							See well evaluation form	66.64
	MW-3	1342	63.25	137.35	Y	N	Y	See well evaluation form	64.12
	MW-7							See well evaluation form	62.64
	XSA-12-95X	0943	70.40	131.86	N	N	Y	See well evaluation form	74.34
	G6M-18-01							See well evaluation form	57.0
	G6M-18-02							See well evaluation form	62.2
	XSA-12-96X	0955	69.00	131.75	N	N	Y	See well evaluation form	69.57
	XSA-12-97X	1015	71.23	132.59	N	N	Y	See well evaluation form	74.28
	XSA-12-98X	1049	8.94	71.58	Y	N	Y	See well evaluation form	3.04
	31PZ-19-02S ?	1037	8.81	16.14	Y	N	N	See well evaluation form	N/A
	31PZ-19-02D ?	1028	8.60	72.62	Y	N	Y	See well evaluation form	N/A
Nashua River	G6M-04-08X	0831	8.27	97.4	N	N	Y	See well evaluation form	63.27 ?
	G6M-04-14X	0823	9.33	92.27	N	N	Y	See well evaluation form	20.42 ?

Area 3 Synoptic Event, April 27, 2020

KGS

Groundwater Water Level Measurement Sheet

Project/Site Name: Fort Devens - Area 3 Synoptic (PFAS RI) **Date :** 4/27/2020

Field Team Member: Michael Spurlin **Weather:** 40-45°F light rain

Water Level Meter Model: Skinny Dipper A00225

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
1	G6M-96-22A	1005	3.24	52.26	Y	–	Y	Good	4.74
	G6M-96-22B	0958	3.85	71.68	Y	–	Y	good	5.10
	G6M-03-01X	0739	12.40	72.67	Y	–	Y	good	
	G6M-02-08X	0751	13.29	71.73	Y	–	Y	good ded Tubing	14.97
	G6M-04-09X	0940	30.51	66.81	Y	–	Y	good ded tubing	30.87
	G6M-04-10X	0847	12.12	63.20	Y	–	Y	good Ded. Tubing	13.97
	G6M-04-10A	0842	11.36	41.81	Y	–	Y	good Ded. BP	13.3
	G6M-04-11X	0857	18.43	46.72	Y	–	Y	good casing loose Ded. Tubing	20.14
	G6M-04-13X	0837	13.14	41.70	Y	–	Y	good ded Tubing	15.18
	G6M-04-15X	0926	41.12	80.80	Y	–	Y	good ded. Tubing	43.04
	G6M-04-22X	0906	45.13	63.84	Y	–	Y	good ded tubing	46.57
	G6M-04-31X	0920	44.66	80.38	Y	–	Y	ded tubing Riser pipe loose	51.29
	G6M-07-02X	0814	13.09	29.64	Y	–	Y	ded BP	14.58
	G6M-13-05X	0720	13.49	56.18	Y	–	Y	ded tubing	14.97
	G6M-13-06X	0730	12.75	61.79	Y	–	Y	ded tubing	14.42
	G6M-95-19X	0759	11.09	58.67	Y	–	Y	ded tubing	13.04
	G6M-95-20X	0806	11.47	24.65	Y	–	Y	ded tubing	13.62
2	30PZ-19-05	1015	9.81	28.75	–	Y	Y	good	11.08
	30PZ-19-01	1030	15.55	30.40	Y	–	Y	good	17.65
	50PZ-19-01	1105	41.80	54.61	Y	–	Y	OK	42.10
	G6P-97-05X	1040	25.18	44.16	Y	–	Y	good	26.00
	MW-7 (IT)	1046	25.44	33.83	N	–	Y	good no lock	N/A
	G6M-02-01X	1120	53.15	89.37	–	Y	Y	Road Box no threads	55.19
	G6M-04-01X	1130	51.25	75.79	–	Y	Y	Ded tubing OK	52.88

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
2	G6M-04-03X	1149	55.50	92.84	-	Y	Y	Dent tubing poor drainage	57.46
	50PZ-19-02	1106	57.23	66.66	-	Y	Y	good	57.90
	30PZ-19-02	1215	60.12	79.96	-	Y	Y	good	60.88
	30PZ-19-03	1227	62.80	73.66	-	Y	Y	good	64.65
	30PZ-19-04	1240	62.01	76.10	-	Y	Y	good RB poor drainage	64.25
3	G6M-03-07X								57.70
	G6M-04-02X								60.67
	G6M-04-04X								58.80
	G6M-13-03X								58.85
	50PZ-19-03								N/A
	50PZ-19-04								N/A
4	G6M-02-03X								58.15
	G6M-02-04X								60.13
	G6M-02-13X								61.63
	G6M-06-01X								
	G6M-13-02X								60.73
	G6M-97-28X								62.43
	50PZ-19-07								N/A
	31PZ-19-01								66.89
	50PZ-19-05								N/A
	50PZ-19-06								N/A
	G6M-02-06X								9.37
	G6M-02-07X								10.23
	G6M-02-11X								61.97
	G6M-02-12X								60.65
	G6M-03-08X								56.88
	G6M-03-09X								57.27
	G6M-03-10X								64.07

UGA plot 2

DP = dedicated pump
DT = dedicated tubing

UGA

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
	G6M-04-03X								57.46
	50PZ-19-02							MS	57.90
	30PZ-19-02								60.88
	30PZ-19-03								64.65
	30PZ-19-04								64.25
3	G6M-03-07X	723	55.48	88.67		1/3	✓	DP 1/3 ears on RB	57.70
	G6M-04-02X	725	58.81	92.45	✓		✓	DT	60.67
	G6M-04-04X	732	56.30	104.68		1/2	✓	DT 1/2 ears on RB	58.80
	G6M-13-03X	711	56.61	90.11	N/A	1/2	✓	D.T	58.85
	50PZ-19-03	850	43.58	51.97	✓		✓		N/A
	50PZ-19-04	840	51.03	57.88	✓		✓		N/A
4	G6M-02-03X	739	56.68	104.42		2/2	✓	DT	58.15
	G6M-02-04X	745	58.62	107.78	✓		✓	DT	60.13
	G6M-02-13X	821	57.72	120.09		2/2	✓	DP	61.63
	G6M-06-01X	750	58.57	127.44		2/2	I	Injection cap stuck in place	
	G6M-13-02X	809	57.81	126.01		3/3	✓	DT	60.73
	G6M-97-28X	742	59.46	107.43	✓		✓	DT	62.43
5	50PZ-19-07	858	67.52	75.05	✓		✓		N/A
	31PZ-19-01	903	64.68	78.53	✓		✓	1" Rayer cover cracked.	66.89
	50PZ-19-05	1131	43.64	51.83	✓		✓		N/A
	50PZ-19-06	846	47.90	62.08		2/2	✓		N/A
	~~G6M-02-06X~~	BA							9.37
	~~G6M-02-07X~~	BA							10.23
	G6M-02-11X	1021	58.48	138.22	✓		✓	DP	61.97
	G6M-02-12X	1028	57.11	134.94	X		✓	DT Rayer ear broken	60.65
	G6M-03-08X	1042	53.38	140.28	✓		✓	DT	56.88
	G6M-03-09X	1031	53.67	141.43	✓		✓	DP	57.27
	G6M-03-10X	1046	60.53	126.25	✓		✓	DP	64.07

WA p2of2

DP = Dedicated pump
DT = Dedicated Tubing

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
	G6M-04-05X	1038	52.97	112.74	✓		✓	DP	56.48
	G6M-04-06X	1053	59.54	106.48	✓		✓	DP	63.27
5	G6M-04-07X	1057	59.53	132.62	✓		✓	DP	63.14
	G6M-13-01X	938	61.17	137.20	✓		✓	DT	64.93
	G6M-13-04X	942	60.76	138.17	✓		✓	DT	64.25
	G6M-97-05B	930	63.18	137.98	✓		✓	DT	66.64
	MW-3	954	60.16	138.11	✓		✓	DP	64.12
	MW-7	958	59.38	135.27	✓		✓	DT	62.64
	XSA-12-95X	~~1059~~ 1104	65.37	131.57			✓	DP	74.34
	G6M-18-01	1116	58.64	126.47		2/2	✓	DT	57.0
	G6M-18-02								62.2
	XSA-12-96X								69.57
	XSA-12-97X							BA	74.28
	XSA-12-98X								3.04
	31PZ-19-02S								N/A
	31PZ-19-02D								N/A
Nashua River	G6M-04-08X								63.27
	G6M-04-14X								20.42
	NRSG-01			-					

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
	G6M-04-03X								57.46
	50PZ-19-02								57.90
	30PZ-19-02								60.88
	30PZ-19-03								64.65
	30PZ-19-04								64.25
	G6M-03-07X								57.70
	G6M-04-02X								60.67
	G6M-04-04X								58.80
3	G6M-13-03X								58.85
	50PZ-19-03								N/A
	50PZ-19-04								N/A
	G6M-02-03X								58.15
	G6M-02-04X								60.13
	G6M-02-13X								61.63
4	G6M-06-01X								
	G6M-13-02X								60.73
	G6M-97-28X								62.43
	50PZ-19-07								N/A
	31PZ-19-01								66.89
	50PZ-19-05								N/A
	50PZ-19-06								N/A
	G6M-02-06X	1028	5.30	66.68	Y	-	Y	Good, 2" PVC SCH Tubing	9.37
	G6M-02-07X	1011	6.48	40.28	Y	-	Y	Good, 2" PVC SCH Tubing	10.23
	G6M-02-11X								61.97
	G6M-02-12X								60.65
	G6M-03-08X								56.88
	G6M-03-09X								57.27
	G6M-03-10X								64.07

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
5	G6M-04-05X								56.48
	G6M-04-06X								63.27
	G6M-04-07X								63.14
	G6M-13-01X								64.93
	G6M-13-04X								64.25
	G6M-97-05B								66.64
	MW-3								64.12
	MW-7								62.64
	XSA-12-95X								74.34
	G6M-18-01								57.0
	G6M-18-02	1120	63.67	137.24	Y	-	Y	Good, 2" PVC S/U, tubing	62.2
	XSA-12-96X	1059	65.80	131.47	N	-	Y	Good, 1.5" Steel S/U Ded. ~~pump~~ tubing	69.57
	XSA-12-97X	1047	66.38	132.65	N	-	Y	Good, 1.5" steel S/U Ded BP (Union)	74.28
	XSA-12-98X	1017	2.88	72.95	Y	-	Y	Good, 5/8" Steel S/U Ded tubing	3.04
	31PZ-19-02S	1002	5.90	15.90	Y	-	Y	Good, 1" PVC S/U	N/A
	31PZ-19-02D	1000	5.54	72.35	Y	-	Y	Good, 1" PVC S/U	N/A
	G6M-04-08X	0800	4.98	92.12	Y	-	Y	Good, 2" PVC S/U Tubing	63.27
Nashua River	G6M-04-14X	0754	9.01	92.44	Y	-	Y	Good, 2" PVC S/U Tubing	20.42
	NRSG-01	0955	202	-	-	—	-		

S/U = Stickup casing

KGS

Groundwater Water Level Measurement Sheet

Project/Site Name: Fort Devens - Area 3 Synoptic (PFAS RI) **Date :** 4/27/2020

Field Team Member: BrA **Weather:** Rain, 37°F

Water Level Meter Model: Heron Slunny Dipper T

Area	Well ID	Time	DTW (ft bTOR)	DTB (ft bTOR)	Lock Y/N	Bolts Y/N	Cap Y/N	Well Condition	Historical DTW
AOC 20	MW-01A	0845	14.63	30.78	Y	–	Y	Good, 2" PVC Stickup	–
	MW-02A	0810	18.65	34.50	Y	-	Y	Good, 2" PVC Stickup	–
	MW-04	0744	9.25	24.72	Y	–	Y	Good, 2" PVC Stickup	-
	MW-06	0727	11.83	31.43	Y	–	Y	Good, 2" PVC Stickup	–
	MW-07	0718	22.65	37.78	Y	-	Y	Good, 2" PVC Stickup	-
	MW-WC1A	0820	5.35	20.58	Y	–	N	Good, 2" PVC Stickup	–
	MW-WC2	0830	7.56	21.80	Y	-	N	Good, 2" PVC Stickup	-
	PZ-1	0902	62.73	77.85	N	–	N	Good, 1" PVC Stickup	–
	PZ-2	0900	DRY	57.51	N	–	N	Good, 1" PVC Stickup	–
	PZ-5	0840	19.23	31.88	Y	–	N	Good, 1" PVC Stickup	-
	PZ-6	0735	17.94	22.68	Y	-	N	Good, 1" PVC Stickup	-
	WWTMW-02	0915	–	–	–	–	–	Well is grouted to ground surface w/in PVC	
Nashua River	G6M-04-08X	0800	4.98	92.12	Y	-	Y	Good, 2" PVC Stickup, tubing	-
	NRSG-01	0955	2.02	-	-	–	–	Good, Flagged + labeled	–
	G6M-04-14X	0754	9.01	92.44	Y	–	Y	Good, 2" PVC Stickup, Tubing	–

APPENDIX C VERTICAL PROFILING FIELD SHEETS

Vertical Profile Field Sheets

AOC 20

KOMAN Gove nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 20VP-19-01 Date: 7/30/19
Project No.: 1082	Drilling Co.: TDS
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Kortjohn	Depth to Water: 17.0' bgs
Total Boring Depth: 21 ft. bgs (refusal)	Drilling Method: DPT Pump type: peristaltic
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	Drilling Equip: Geoprobe 6712DT / SP22 tooling Tubing: HDPE
	YSI (model/serial number): Pro DSS / 17401163

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
17-21	0.12	0.75	16.6	7.26	232	8.06	55.8	654	1040	20VP-19-01-17-21	

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

- step out boring completed to confirm refusal @ 21' bgs

KGS

KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI (Rig #2)	Boring No.: 20VP-19-02 Date: 9/3/19; 9/4/19
Project No.: 1082-0011-531	Drilling Co.: TDS
Address: ABC 20/21 (Area 3)	Driller: Jay Jumonville Depth to Water: 9.0 ft BGS
Logger: Chris Vignola	Drilling Method: SP22 (with SP16 sized tooling put in afterwards) Pump type: Peristaltic Pump (Geopump)
Total Boring Depth: 34' BGS	Drilling Equip: Geoprobe 6712 DT Tubing: 1/4" HDPE
Turbidimeter (model/serial number): LaMotte 2020WE: 1828:0412	YSI (model/serial number): YSI Pro DSS: 18L100145

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged (gallons)	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9/3/19	9-13	0.29	1.0	14.0	6.29	295	7.30	101.5	10.59	1420	20VP-19-02-9-13	clear/little sand
9/4/19	19-23	0.61	1.0	14.3	6.91	417	6.16	67.6	652	0925	20VP-19-02-19-23	very light brown/cloudy FD taken ST: 0930
	29-33	0.93	1.25	15.0	7.32	618	2.93	-48.2	overrange	1030	20VP-19-02-29-33	brown/opaque
	34 ft Refusal										→	@1140, refusal was reached @34' BGS
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N				

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot 0.32/10 ft
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:
Refusal was reached @ 34' BGS

KGS

KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 20VP-19-03 Date: 7/31/19 - 8-1-19
Project No.: 1082	Drilling Co.: TDS
Address: AOC20	Driller: Jay Jumonville
Logger: Dave Kortjohn/Garrett Hinebaugh	Depth to Water: 9.0' bgs
Total Boring Depth: 58'	Drilling Method: DPT Pump type: peristaltic
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	Drilling Equip: Geoprobe 6712 Tubing: HDPE
	YSI (model/serial number): Pro DSS / 17401163

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9-13	0.12	0.75	15.4	5.30	240	3.07	197.8	39.1	857	20VP-19-03-9-13	
19-23	0.92	~~1.00~~ 1.25 (D4)	17.2	6.10	173	8.92	183.0	29.3	1015	20VP-19-03-19-23	
29-33	0.72	1.25	19.4	6.64	191	4.84	-33.4	2523	1240	20VP-19-03-29-33	
39-43	1.02	1.50	20.1	6.55	474	7.35	-29.8	1754	1415	20VP-19-03-39-43	
49-53	1.32	1.80	15.4	6.44	283	1.8	-61.2	2152	940	20VP-19-03-49-53	09:40
~~54-58~~	1.60	2.02	18.4	7.02	994	2.63	-89.1	952	1200	20VP-19-03-59-63	refusal @ 58'BGS

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

KGS

KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 20VP-19-04 ~~19~~ Date: 7/22/19
Project No.: 1082	Drilling Co.: TDS
Address: AOC 20	Driller: Jay Jumonville Depth to Water: 21.0' bgs
Logger: Dave Kortjohn	Drilling Method: DPT Pump type: peristaltic
Total Boring Depth: 56 ft. bgs (refusal)	Drilling Equip: Geoprobe 6712DT, SP22 tooling Tubing: HDPE
Turbidimeter (model/serial number): LaMotte 2020we # 1828-0412	YSI (model/serial number): 650 MDS/4268

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
19-23	0.06	0.50	15.33	6.84	1832	9.51	175.8	10.79	1320	20VP-19-04-19-23	
29-33	0.36	~~1.00~~ 0.75 OK	14.71	6.34	1923	5.20	129.1	1253	1422	20VP-19-04-29-33	
39-43	0.66	1.25	14.48	6.50	1977	2.89	24.9	>4000	845	20VP-19-04-39-43	
49-53	0.96	1.50	14.75	6.74	1519	1.21	33.1	>4000	1108	20VP-19-04-49-53	

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

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KOMAN Gov[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 20VP-19-05
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen
Logger: KGA	Drilling Method: DPT
Total Boring Depth: 22.5'	Drilling Equip: Geoprobe 7822
Turbidimeter (model/serial number): Lamotte 2020WE 5083-5014	YSI (model/serial number): YSI 650XL 11B100186

Date: 7/22/19

Depth to Water: ~~[illegible]~~ 16'

Pump type: geotech/water

Tubing: HDPE

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
18-22	0.18	1.5	14.71	7.60	286	0.35	-12.1	2654	1220	20VP-19-05-18-22	geotech
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot x2

SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot ~~x2~~

Notes:
3-7' (Dry)
8-12' (Dry)
Refusal @ 22.5' (Bedrock) ~4" rock in sampler)

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KOMAN Gove[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Pease	Boring No.: 20VP-19-06	Date: 8/2/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: 61'	
Logger: VGL	Drilling Method: DPT	Pump type: Waterra	
Total Boring Depth: 156'	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): LaMotte 2020we 5083-5014	YSI (model/serial number): YSI 650XL 11B100186		

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
8/2	63-67	0.18	1.0	16.47	7.21	1997	4.28	2.9	2280	1130	20VP-19-06-63-67	waterra
	73-77	0.48	1.0	17.50	7.16	2031	3.97	3.7	2490	1310	20VP-19-06-73-77	waterra
	83-87	0.78	1.0	17.31	7.21	2087	4.07	4.9	74,000	855	20VP-19-06-83-87	waterra
8/5	93-97	1.08	2.0	17.87	7.30	2120	4.21	6.3	74,000	1130	20VP-19-06-93-97 ☆MS/MSD	waterra
	103-107	1.38	2.0	17.79	7.23	2160	4.09	7.1	74,000	1340	20VP-19-06-103-107	waterra
	113-117	1.68	2.5	16.12	7.37	1917	1.39	-21.7	>74,000	835	20VP-19-06-113-117	waterra
8/6	123-127	1.98	3.0	17.07	7.29	1971	1.89	-41.6	>74,000	1115	20VP-19-06-123-127	waterra
	133-137	2.28	3.5	17.21	7.28	1987	1.80	-52.6	74,000	1450	20VP-19-06-133-137	waterra
8/7	143-147	2.58	3.5	17.56	6.95	1893	1.40	-43.5	74,000	1130	20VP-19-06-143-147	waterra
8/8	152-156	2.88	4.0	17.21	7.11	1837	1.59	-50.6	>74,000	1000	20VP-19-06-152-156	waterra
	Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (22)

Notes:
☆ Refusal @ 156'

KGS

KOMAN Government Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 20VP-19-07 Date: 7/25, 7/26, 7/29
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen Depth to Water: 63'
Logger: LGA / MM	Drilling Method: DPT Pump type: waterra
Total Boring Depth: 157'	Drilling Equip: Geoprobe 7822 (SP22) Tubing: HDPE
Turbidimeter (model/serial number): Lamotte 2020we 5083-5014	YSI (model/serial number): YSI 650XL 11B100186

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
7/25	63-67	0.12	2.0	19.48	8.13	1874	1.20	-46.6	74,000	1420	20VP-19-07-63-67	waterra
7/26	73-77	0.42	2.5	17.33	8.57	1624	1.04	-21.8	2263	0955	20VP-19-07-73-77	waterra
(MM)	83-87	0.72	3.25	19.24	8.55	1935	1.83	-37.7	886	1150	20VP-19-07-83-87	waterra
	93-97	1.02	3.75	insufficient Recharge for parameters					74,000	945	20VP-19-07-93-97	waterra
7/29 (MP)	103-107	1.32	4.25	20.96	7.01	1198	6.45	-22.2	74,000	1225	20VP-19-07-103-107	waterra
7/30	113-117	1.62	3.0	20.88	7.04	1862	9.70	-40.6	74,000	1125	20VP-19-07-113-117	waterra
	123-127	1.92	3.0	21.12	7.19	1841	8.70	-38.1	74,000	1425/1420	20VP-19-07-123-127 / A3-VP-DUP-R1-20190729	waterra
7/31	133-137	2.22	2.75	18.96	6.86	1797	3.94	-53.5	74,000	1250	20VP-19-07-133-137	waterra
8/1	143-147	2.52	3.0	17.97	6.99	1820	3.87	-61.1	74,000	845	20VP-19-07-143-147	waterra
	153-157	2.82	3.0	18.91	6.87	1802	4.71	-58.7	74,000	1240	20VP-19-07-153-157 (very dark grey / heavy silt)	waterra
	Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (624)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes: (53-57) Dry
☆ after 107' interval (hole collapse) offset and redrilled
☆ after 147' interval (hole collapse) offset and redrilled.

157' assumed refusal (discussed w/ Russ)

KGS

KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 20VP-19-08 Date: 7/30/19
Project No.: 1082	Drilling Co.: TDS
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Korfjohn	Depth to Water: N/A
Total Boring Depth: 30'bgs (refusal)	Drilling Method: DPT
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	Drilling Equip: Geoprobe 7712DT / SP22 tooling
	Pump type: N/A
	Tubing: ~~N/A~~ HDPE
	YSI (model/serial number): Pro DSS / 17401163

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
				No samples collected							
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

No water encountered before refusal @ 30' bgs

KGS

AOC 21

KOMAN Gov[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 21VP-19-01
Project No.: PFAS RI	Date: 7/23/19
Address: Area 3	Drilling Co.: TDS
Logger: KWA	Driller: Alfred Allen
Total Boring Depth: 95'	Drilling Method: DPT
Turbidimeter (model/serial number): Lamotte 2020VE 5083-5014	Drilling Equip: 7822 SP22
	YSI (model/serial number): YSI 650XL 11B100186
	Depth to Water: 21'
	Pump type: geotech/water
	Tubing: HDPE

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
23-27	0.18	1.0	16.20	7.89	2267	0.69	-31.7	42.31	840	21VP-19-01-23-27	geotech
33-37	0.48	1.5	16.22	7.70	2161	1.49	-17.0	121	930	21VP-19-01-33-37	geotech
43-47	0.78	1.5	16.30	7.73	2179	1.37	-16.0	237	1050	21VP-19-01-43-47	geotech
53-57	1.08	1.5	16.21	7.70	2192	1.20	-17.3	490	1200/1205	21VP-19-01-53-57 / A3-VP-DVP-R1-72319	
63-67	1.38	2.0	16.33	7.63	2163	1.03	-15.2	521	1315	21VP-19-01-63-67	geotech
73-77	1.68	2.0	16.30	7.50	2130	1.60	-21.7	>4,000	1440	21VP-19-01-73-77	geotech
83-87	1.98	2.5	16.71	7.43	2156	2.07	-18.6	>4,000	1035	21VP-19-01-83-87	geotech
91-95	2.28	3.0	16.89	7.60	2173	2.31	-16.0	>4,000	1425	21VP-19-01-91-95	geotech

7/23

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (X2)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes: (13-17) Dry'

95' refusal

KGS

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KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 21VP-19-02 Date: 7/24/19
Project No.: 1082	Drilling Co.: TDS
Address: AOC 21	Driller: Jay Jumonville Depth to Water: ~~13.05~~ 13.0' bgs
Logger: Dave Kortjohn	Drilling Method: DPT Pump type: peristaltic/ waterra
Total Boring Depth:	Drilling Equip: Geoprobe 6712 DT/SP22 tooling Tubing: HDPE
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	YSI (model/serial number): 650 MDS/4268

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
13-17	0.12	0.50	16.44	5.72	284	6.90	168.2	1254	1215	21VP-19-02-13-17	peristaltic
23-27	0.42	0.75	17.08	5.68	837	6.35	156.5	6.0	1330	21VP-19-02-23-27	↓
33-37	0.72	1.00	18.35	5.53	1747	5.14	143.3	1345	1431	21VP-19-02-33-37	↓
43-47	1.02	1.50	17.54	6.44	1923	4.58	121.8	>4000	842	21VP-19-02-43-47	↓
53-57	1.32	2.00	18.31	6.64	1692	4.18	-25.9	>4000	1000	21VP-19-02-53-57	MS/MSD (waterra
63-67	1.62	2.25	20.23	7.19	1745	2.02	-191.4	>4000	1130	21VP-19-02-63-67	A3-VP-DUP-R2-072519 @1135
73-77	1.92	2.50	18.21	6.95	1838	4.29	-123.8	>4000	1358	21VP-19-02-73-77	
83-87	2.22	2.75	19.4	7.10	1674	1.46	-185.8	>4000	902	21VP-19-02-83-87	
93-97	2.52	3.00	21.5	7.09	1688	6.29	-84.5	>4000	1127	21VP-19-02-93-97	
103-107	2.82	3.25	21.5	7.31	1744	1.49	-193.2	>4000	1330	21VP-19-02-103-107	
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

KGS

KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 21VP-19-02 Date: 7/29/19
Project No.: 1082	Drilling Co.: TPS
Address: AOC 21	Driller: Jay Jumonville Depth to Water: 13.0' bgs
Logger: Dave Kortjohn	Drilling Method: DPT Pump type: waterra
Total Boring Depth: 129' bgs (refusal)	Drilling Equip: Geoprobe 6712DT/SP22 tooling Tubing: HDPE
Turbidimeter (model/serial number): LaMotte 2020we 1828-04:2	YSI (model/serial number): ~~E56 MDS/4268~~ OK Pro DPS/17H01163

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
113-117	3.12	3.50	21.7	7.25	1843	2.03	-183.2	>4000	1000	21VP-19-02-113-117	
123-127	3.42	3.50	21.2	6.95	1497	1.69	-122.7	>4000	1245	21VP-19-02-123-127	

Post Cal. Check Varience Observed (Y/N):

Notes:

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

KGS

AOC 30

KOMAN Gov[illegible]ent Solutions, LLC

Vertical Groundwater Profiling Log

Project: Davis	Boring No.: 30VP-19-01	Date: 7/17/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: ~19'	
Logger: WA	Drilling Method: DPT	Pump type: geotech	
Total Boring Depth: 32.5'	Drilling Equip: geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): Eutech 2020we 5083-5014	YSI (model/serial number): YSI 650XL 11B100186		

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
18-22	0.09	0.5	16.29	8.09	69	6.31	-13.1	1638	1025	30VP-19-01-18-22	geotech
28-32	0.39	1.0	16.89	7.79	89	5.26	-17.1	>4,000	1140	30VP-19-01-28-32	geotech
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

Refusal @ 32.5'

KGS

KOMAN Gov[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 30VP-19-02 Date: 7/18/19
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen Depth to Water: 17'
Logger: KGA	Drilling Method: DPT Pump type: geotech
Total Boring Depth: 45'	Drilling Equip: Geoprobe 7822 (SP22) Tubing: HDPE
Turbidimeter (model/serial number): LaMotte 2083- 5014	YSI (model/serial number): YSI 650XL 11B100184

7/18

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
18-22	0.15	1.0	11.73	7.97	32	0.66	-2.2	38.66	1400	30VP-19-02-18-22	geotech
28-32	0.45	1.0	12.91	7.63	62	1.97	-14.1	239	905/10	30VP-19-02-28-32/A3-VP-DUP-7AA	geotech
38-42	0.75	1.5	13.87	7.59	70	1.39	-19.7	621	1456	30VP-19-02-38-42	geotech

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (x2)

Notes:

Refusal @ 45'

KGS

KOMAN Gove[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 30VP-19-03 Date: 7/8/19
Project No.: PFAS RI	Drilling Co.: TDJ
Address: Area 3	Driller: Jay
Logger: KMA / DEK	Depth to Water: 69'
Total Boring Depth: 119' bgs (refusal)	Drilling Method: DPT Pump type: bladder
Turbidimeter (model/serial number): LaMotte 2020e 5083-5014	Drilling Equip: Geoprobe 6712 (SP22) (Ki, L) Tubing: HDPE
	YSI (model/serial number): YSI 650 XL 11B100186

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
73-77	0.30	0.50	18.62	7.74	55	7.64	226	74,000	1110	30VP-19-03-73-77	bottom
83-87	0.60	1.0	18.67	6.69	96	9.07	35.6	74,000	1400	30VP-19-03-83-87	bottom
93-97	0.90	1.5	17.83	5.96	216	8.71	169.4	>4,000	1033	30VP-19-03-93-97	
103-107	1.20	1.75	16.46	6.53	378	8.51	148.3	1603	942	30VP-19-03-103-107	
113-117	1.50	2.25	17.07	6.03	388	8.45	90.7	>4000	1430	30VP-19-03-113-117	

Post Cal. Check Varience Observed (Y/N):

Notes: 63-67' (~~no~~ H_2O)

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (x2)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

KGS

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Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 30VP-19-04 Date: 7/9/19
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen Depth to Water: ~68'
Logger: VGA	Drilling Method: DPT Pump type: waterra
Total Boring Depth: 135'	Drilling Equip: Geoprobe 7822 DT (SP22) Tubing: HDPE
Turbidimeter (model/serial number): LaMotte 2020-E 5983-3014	YSI (model/serial number): YSI 650XL 11B100186

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
7/9	73-77	0.27	1.5	15.59	7.52	61	9.97	39.8	74,000	950/955	30VP-19-04-73-77/A3	VP-DUP-RI-7/9/19
	83-87	0.57	1.5	18.86	6.03	64	5.83	51.2	74,000	1235	30VP-19-04-83-87	waterra
	93-97	0.87	1.5	18.69	6.19	71	4.21	69.7	74,000	1430	30VP-19-04-93-97	waterra
7/10	103-107	1.17	3.0	14.93	7.09	60	3.42	36.7	74,000	1025*	30VP-19-04-103-107	waterra *VGS/MSI
	113-117	1.47	2.0	15.89	7.01	58	3.37	35.1	74,000	1340	30VP-19-04-113-117	waterra
7/11	123-127	1.77	2.0	16.97	7.00	56	3.67	41.0	74,000	955	30VP-19-04-123-127	waterra
	131-135	2.07	2.5	16.99	7.18	55	3.79	46.1	74,000	1335	30VP-19-04-131-135	waterra

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (X2)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

* Refusal @ 135'

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KOMAN Government Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 30VP-19-05	Date: 7/16/19	
Project No.: PFAS RF	Drilling Co.: TPS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: ~21'	
Logger: LMA	Drilling Method: DPT	Pump type: geotech/whale	
Total Boring Depth: 49'	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): LaMotte 2020e 5083-5014	YSI (model/serial number): YSI 650XL 11B100186		

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
20-24	0.09	1.0	14.71	7.87	1769	6.05	-17.1	2240	1000	30VP-19-05-20-24	geotech
30-34	0.39	1.0	14.68	7.70	1890	6.00	-23.1	74,000	1110	30VP-19-05-30-34	geotech
40-44	0.69	1.0	14.89	7.50	1900	5.70	-31.7	74,000	1225	30VP-19-05-40-44	geotech
45-49	0.99	1.5	14.99	7.21	1871	4.90	-30.1	74,000	1430	30VP-19-05-45-49	geotech

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (x2)

Notes:

* Refusal @ 49'

KGS

KOMAN Gove ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 30VP-19-06	Date: 7/12/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: ~ 70'	
Logger: MA	Drilling Method: DPT	Pump type: Bennett	
Total Boring Depth: 89'	Drilling Equip: Geoprobe 7822 (SP16) (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): LaMotte 2020WE 5083-5014	YSI (model/serial number): YSI 650XL 11B100486		

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
73-77	0.2 L	0.5	18.05	8.10	614	1.53	-32.1	74.00 T	920	30VP-19-06-73-77	air in tubing
83-87	0.5 L	1.0	18.31	7.97	632	1.29	-41.6	74.00 T	1140	30VP-19-06-83-87	water
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (02)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

☆ Refusal @ 89'

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AOC 31

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Vertical Groundwater Profiling Log

Page (1 of 2)*

Project: Devens	Boring No.: 31VP-19-01
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen
Logger: VGA / MAM	Drilling Method: DPT
Total Boring Depth: 145.5	Drilling Equip: Geoprobe 7822 (SP22)
Turbidimeter (model/serial number): LaMotte 2020we 508 7-5014	YSI (model/serial number): YSI 630XL 11B100186

Date: 9/3/19
Depth to Water: 62'
Pump type: waterra
Tubing: HDPE

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
63-67	0.15	2.0	15.51	7.10	106	8.94	83.0	840	935	31VP-19-01-63-67	water
73-77	0.45	1.5	14.61	6.55	101	7.56	75.6	690	1105	31VP-19-01-73-77	water
83-87	0.75	2.0	14.95	6.17	114	5.31	82.3	74,000	1240	31VP-19-01-83-87	water
93-97	1.05	2.0	15.07	6.18	121	5.07	91.6	74,000	1445	31VP-19-01-93-97	water
103-107	1.35	2.0	15.20	6.30	127	4.89	93.7	74,000	850	31VP-19-01-103-107	water
113-117	1.65	2.5	15.17	6.27	130	4.47	87.9	74,000	1100	31VP-19-01-113-117 *MS/MSD	water
123-127	1.95	2.5	15.09	6.24	123	4.59	89.1	74,000	1300	31VP-19-01-123-127	water
133-137	~~2.25~~ *	minimal recharge / direct sample							1035	31VP-19-01-133-137	water
143-147	2.55	3.0	15.49	6.39	149	5.07	99.9	74,000	1350	31VP-19-01-143-147 (A3-VP-DUP-R1-9519 @ 1355)*	water
153-157	2.85	3.0	15.66	6.66	169	2.90	83.7	74,000	1020	31VP-19-01-153-157	water

9/3
9/4
9/5
9/16

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (62)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

Hole collapsed @ ~ 145/150'
will offset and redrill tomorrow

KGS

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Vertical Groundwater Profiling Log

Page 2 of 2 *

Project: Devens	Boring No.: 31VP-19-01 (Cont.) Date: 9/17/19
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen Depth to Water: 62'
Logger: MGA/MAM	Drilling Method: DPT Pump type: Waterra
Total Boring Depth: 195.5'	Drilling Equip: Geoprobe 7822 (SP22) Tubing: HDPE
Turbidimeter (model/serial number): LaMotte 2020we 5083-5014	YSI (model/serial number): YSI 650XL 11B100186

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
163-167	3.15	3.5	16.01	6.77	179	3.47	101.6	79,090	1445	31VP-19-01-163-167	water
173-177	3.45	3.50	Minimal Recharge/dried sample						1130	31VP-19-01-173-177	Waterra
183-187	3.75	4.0	14.48	8.05	395	2.25	31.6	1567	1415	31VP-19-01-183-187	Waterra
195-195.5	4.05	4.25	18.48	7.99	417	1.79	11.2	>4,000	1240	31VP-19-01-195-195.5	Waterra

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

See page 1

Refusal @ 195.5 ft

KGS

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Vertical Groundwater Profiling Log

Project: FT Devens RI	Boring No.: 31VP-19-04 Date: 8-5-14
Project No.: 1082	Drilling Co.: TDS
Address: AOC 34 - Airfield	Driller: Jay Jumonville 69.00' bgs
Logger: C. Hardbarger/D. Kortjohn	Drilling Method: DPT 6712 Depth to Water: ~~57.10~~ DTW
Total Boring Depth: 132 ft. bgs (refusal)	Drilling Equip: GeoProbe Pump type: Hydra
Turbidimeter (model/serial number): LaMotte 2020 SN-5083	YSI (model/serial number): YSI DSS/18L100145 Tubing: ITOPF

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC ~~(µS/cm)~~ mS/cm	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
69-73	0.5	0.5	17.4	6.88	0.164	5.21	7.40	633.7	10:30	31VP-19-04-69-73	
79-83	0.5	1.5	21.3	6.71	0.168	5.23	-45.9	824.50	1215	31VP-19-04-79-83	
89-93	0.5	2	21.6	6.70	0.155	3.29	-68.6	2350.71	1420	31VP-19-04-89-93	
99-103	1.38	2.25	23.0	6.80	0.088	7.29	7.3	2354	950	31VP-19-04-99-103	
109-113	1.68	2.50	19.0	6.68	0.092	6.77	-7.6	>4000	1258	31VP-19-04-109-113	A3-VP-DUP-R2-080619 @ 1302
119-123	1.98	2.50	20.1	6.34	0.149	7.01	17.6	>4000	1320	31VP-19-04-119-123	
128-132	2.25	2.50	21.7	7.39	0.222	1.18	-197.8	>4000	1130	31VP-19-04-128-132	
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:
~~Driller went too deep on first boring, first interval was planned for 59-63' but had to adjust to 69-73. Driller will step off to collect sample from 59-63'.~~ PK

KGS

KOMAN Gove nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI (Rig #2)	Boring No.: 31VP-19-05 Date: 9/4/19 | 9/5/19
Project No.: 1082-~~001~~ 0011-531	Drilling Co.: TDS
Address: AOC 20/21 (Area 3)	Driller: Jay Jamesville
Logger: Chris Vigeola	Depth to Water: 7' BGS
Total Boring Depth: 37.5' BGS	Drilling Method: SP22 (with SP16 sized tooling put in afterwards) Pump type: Peristaltic Pump (Geopump)
Turbidimeter (model/serial number): LaMotte 2020 WE : 1828-042	Drilling Equip: Geoprobe ~~DT~~ 6712 DT Tubing: ¼" HDPE
	YSI (model/serial number): YSI Pro DSS: 18L100145

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9/4/19											
4-8	0.032	0.50	~~6.65~~ 17.0 (cv)	6.65	86	8.52	29.5	1525	1405	31VP-19-05-4-8	brown/cloudy
14-18	0.36	1.00	12.3	6.66	84	8.50	122.1	17.7	0900	31VP-19-05-14-18	clear/very little sand
24-28	0.68	1.00	15.0	6.82	81	7.98	33.7	1568	1025	31VP-19-05-24-28	brown/cloudy
33.5-37.5	1.00	1.50	11.9	6.89	86	8.47	55.2	3777	~~3777~~ 1140 (cv)	31VP-19-05-33.5-37.5	brown/cloudy-opaque
Refusal @37.5 BGS											Refusal @ 37.5' BGS
Post Cal. Check Varience Observed (Y/N):				N	N	N	N	N			

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot 0.32/10 Ft
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

Hit refusal @ 37.5' BGS

Equipment blank taken on 09/05/19 @ 12 ; A3-VP-EB-R2-090519

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KOMAN Government Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: SVP-19-06	Date: 9/24/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: ~12'	
Logger: VMT	Drilling Method: DPT	Pump type: geotech	
Total Boring Depth: 87'	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): LaMotte 2020WE 6083-5014	YSI (model/serial number): YSI 650XL 11B101486		

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9/24	13-17	0.15	0.5	12.11	7.58	292	9.77	37.7	1282	1030	SVP-19-06-13-17 / AS-V2-DUP-R1-9241	geotech
	23-27	0.45	1.0	11.79	6.07	398	9.18	31.9	659	1120	SVP-19-06-23-27	geotech
	33-37	0.75	1.0	11.80	6.13	420	9.00	30.6	437	1210	SVP-19-06-33-37	geotech
	43-47	1.05	1.5	11.97	6.20	437	8.29	28.9	35.37	1350 ★	SVP-19-06-43-47 ★ MS/MSD	geotech
9/25	53-57	1.35	2.0	10.88	7.09	390	8.07	33.4	12.71	905	SVP-19-06-53-57	geotech
	63-67	1.65	2.5	11.02	6.49	390	7.93	34.9	10.90	1040	SVP-19-06-63-67	geotech
	73-77	1.95	2.5	11.18	6.66	347	7.80	37.8	2.59	1305	SVP-19-06-73-77	geotech
9/26	83-87	2.25	2.5	11.09	6.50	387	6.49	47.1	1247	1015	SVP-19-06-83-87	geotech

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (62)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot X

Notes:

★ 87' refusal

KGS

KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 31VP-19-07	Date: 9/26/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: ~10'	
Logger: VM	Drilling Method: DPT	Pump type: geotech	
Total Boring Depth: 92'	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): Lamotte 2020we 5083- 5014	YSI (model/serial number): YSI 650X2	11B100186	

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9/26 8-12	0.06	2.5	14.22	7.16	234	5.69	17.2	9.15	1350	31VP-19-07-8-12	geotech
18-22	0.36	2.0	10.65	7.05	59	8.70	12.5	139	855	31VP-19-07-18-22	geotech
9/27 28-32	0.66	1.5	11.03	7.11	119	6.90	11.6	19.27	955	31VP-19-07-28-32	geotech
38-42	0.96	1.5	11.20	7.06	139	6.80	19.7	7.69	1115	31VP-19-07-38-42	geotech
9/30 48-52	1.26	2.0	10.71	6.39	436	3.12	45.9	28.65	905	31VP-19-07-48-52	geotech
58-62	1.56	2.0	10.90	6.66	378	3.97	38.6	23.90	1025	31VP-19-07-58-62	geotech
68-72	1.86	2.0	11.07	6.70	380	3.20	42.1	19.20	1155	31VP-19-07-68-72	geotech
78-82	2.16	2.5	10.69	6.80	399	4.11	29.7	23.04	830/835	31VP-19-07-78-82 / A3	VP-DUP-RI-90119
10/1 88-92	2.46	3.0	10.55	6.93	327	4.90	31.7	74,000	1045	31VP-19-07-88-92	geotech
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (X4)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

Refusal @ 92'

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EB1255

KOMAN Gove[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 31VP-19-~~08~~ 08	Date: 10/2/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: ~~4.2'~~ 9' open hole	
Logger: KGA + Kristen Esser	Drilling Method: DPT	Pump type: geotech	
Total Boring Depth: 90.5' bgs	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): Lamotte 2020 WE 5083-5014	YSI (model/serial number): YSI 650XL 11B100186		

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
10/2	13-17	0.24	2.0	14.69	6.88	436	1.76	46.4	1232	1150	31VP-19-08-13-17	geotech
	23-27	0.54	1.5	14.06	6.39	662	1.34	56.6	1400	1320	31VP-19-08-23-27	geotech
	33-37	0.84	1.5	13.97	6.57	1200	2.43	58.9	>4,000	1405	31VP-19-08-33-37	geotech
10/3	43-47	1.14	2.0	11.90	7.30	1225	1.40	21.9	29.68	930	31VP-19-08-43-47	geotech
	53-57	1.44	2.5	12.09	6.89	1460	3.07	70.3	19.73	1100	31VP-19-08-53-57	geotech
	63-67	1.74	2.5	11.79	6.80	1396	2.89	91.6	1130	1235	31VP-19-08-63-67	geotech
10/4	73-77	2.04	2.5	12.2	5.02	1.151	3.76	196.2	9.86	0930	31VP-19-08-73-77	
	83-87	2.34	2.5	12.4	7.54	1.156	2.97	118.4	15.70	1140	31VP-19-08-83-87	

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (x2)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot x

Notes: Hit refusal @ 90.5' bgs

SP16 casing inside 22 casing

KGS

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293 Boston Post Road, Marlborough, MA

AOC 50

KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 50VP-19-01
Project No.: 1082	Date: 8/28/19 + 8/29/19
Address: AOC 50	Drilling Co.: TDS
Logger: Kristen Esther	Driller: Jay Jumonville
Total Boring Depth: 72' bgs	Depth to Water: 10.0' bgs
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	Drilling Method: DPT
	Pump type: Peristaltic / Waterra
	Drilling Equip: Geoprobe 6712DT / SP22 tooling
	Tubing: HDPE
	YSI (model/serial number): Pro DSS / 18L100145

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9-13	0.15	0.25	20.3	5.67	0.223	3.05	32.1	1233	1028	50VP-19-01-09-13	Field Dup taken
A-23	0.45	0.60	17.0	5.78	0.760	2.60	5.3	overrange >4000	1133	50VP-19-01-19-23	
9-13	0.15	0.25	20.3	5.67	0.223	3.05	32.1	1233	1033	A3-VP-DUP-R2-083319	Field Dup for 50VP-19-01-09-13
29-33	0.75	1.00	19.5	5.50	0.459	3.44	68.5	15.58	1300	50VP-19-01-29-33	
39-43	1.05	1.10	17.8	5.71	0.189	3.01	67.4	618	1419	50VP-19-01-39-43	
8/29 49-53	1.35	1.50	20.1	5.27	0.487	2.80	11.2	684	0920	50VP-19-01-49-53	
59-63	1.65	1.75	16.2	5.51	1.372	2.63	87.4	3473	1150	50VP-19-01-59-63	Waterra
69-72	1.95	2.10	19.0	6.45	1.511	2.62	52.7	3161	1348	50VP-19-01-69-72	Waterra Hit refusal @ 72' bgs
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot x2
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes: Field Dup @ 9-13' bgs
Hit refusal @ 72 Ft bgs

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KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: SOVP-19-02
Project No.: 6082	Date: 8/26/19 + 8/27/19
Address: AOC 50	Drilling Co.: TDS
Logger: Kristen Esser	Driller: Jay Jumonville
Total Boring Depth: 58' bgs	Drilling Method: DPT
Turbidimeter (model/serial number): Lamotte 2020 we 1828-0412	Drilling Equip: Geoprobe 6712/SP22 tooling
	YSI (model/serial number): Pro DSS/18L100145
	Depth to Water: 10.2 ftbgs
	Pump type: peristaltic Waterra
	Tubing: HDPE

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9-13	0.15	0.4	18.1	5.08	0.132	3.22	42.2	1456	1238	SOVP-19-02-09-13	
19-23	0.45	0.6	16.7	5.76	0.126	4.83	57.8	overrange >4000	1358	SOVP-A-02-19-23	
8/27 29-33	0.75	1.0	11.7	5.55	0.119	6.52	64.5	3060	0841	SOVP-19-02-29-33	
8/27 39-43	1.05	1.2	14.4	5.91	0.0716	5.16	52.1	730	1014	SOVP-19-02-39-43	
49-53	1.35	1.5	15.7	6.31	0.608	3.03	-8.6	643	1205	SOVP-19-02-49-53	
~~59-63~~	~~1.65~~									~~SOVP-19-02-59-63~~	MS/MSD
54-58	1.5	1.6	20.6	7.01	0.689	4.31	3.4	overrange >4000	1430	SOVP-19-02-54-58	MS/MSD Refusal @ 58' bgs Waterra

Post Cal. Check Varience Observed (Y/N):

Notes: Refusal at 58' bgs
MS/MDS taken at 54-58' bgs

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot x 2
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

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Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: SOVP-19-03 Date: 8/23/19+
Project No.: 1082	Drilling Co.: TDS
Address: AOC 50	Driller: Jay Jimonville
Logger: Dave Kortjohn / Kristen Esser	Depth to Water: 10.0' bgs
Total Boring Depth: 56' bgs	Drilling Method: DPT Pump type: peristaltic/ Waterra
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	Drilling Equip: Geoprobe 6712DT / SP22 tooling Tubing: HDPE
	YSI (model/serial number): Pro DSS / 18L100145

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
14-18	~~0.29~~ ~~0.15~~ (KE)	0.75	14.4	5.46	1308	8.16	139.4	~~5.71~~	950	SOVP-19-03-14-18	
24-28	~~0.54~~ ~~0.45~~ (KE)	1.0	14.0	5.98	0.719	4.87	25.9	2750	1100	SOVP-19-03-24-28	
34-38	~~0.84~~ ~~0.75~~ (KE)	1.25	14.10	6.27	0.076	4.51	35.9	2764	1230	SOVP-19-03-34-38	Waterra
44-48	~~1.14~~ ~~1.05~~ (KE)	1.5	14.1	6.15	0.100	5.22	47.6	3391	1350	SOVP-19-03-44-48	Waterra
~~54-56~~ (8/26 KE)	~~1.34~~	~~2.2~~	~~11.4~~	~~6.16~~	~~0.183~~	~~3.02~~	~~11.3~~	~~74000~~	0830 (8/26 KE)		~~Refusal @ 54'+ Waterra~~ (KE 8/26)
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (KE) x2
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (KE)

Notes: See 8/26/19 Log for 54-56 ft bgs + 9-13 ft bgs

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KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 50VP-19-03 Date: 8/26/19
Project No.: 1082	Drilling Co.: TDS
Address: AOC 50	Driller: Jay Jumonville
Logger: Kristen Esser	Depth to Water: 10.8 'bgs
Total Boring Depth: 56' bgs	Drilling Method: DPT Pump type: waterra / peristaltic
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	Drilling Equip: Geoprobe 6712 DT/SP22 tooling Tubing: HDPE
	YSI (model/serial number): Pro DSS / 18L100145

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
54-56	1.34	2.2	11.4	6.16	0.183	3.02	11.3	overrange 74000	0830	50VP-19-03-54-56	waterra Hit refusal @ 56' bgs
9-13	0.15	0.4	14.6	5.31	2.512	6.97	119.8	25.2	1005	50VP-19-03-09-13	Peristaltic; offset from initial boring
9-13	0.15	0.5	15.8	5.27	2.511	7.11	116.4	25.1	1010	~~A3-VP-EB-R2-082619~~ A3-VP-DUP-R2-082619	Peristaltic; offset from initial boring ~~Field Dup~~
Post Cal. Check Varience Observed (Y/N):											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot x2
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:
- Hit refusal at 56' bgs
- 9-13' bgs offset from original bore hole
- Field Dup taken @ 9-13' bgs
- See 8/23 log for 14-48' bgs

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Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 50VP-19-04 Date: 7/17/19
Project No.: 1082	Drilling Co.: TDS
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Depth to Water: ~~46.0~~ 45.01 bgs
Total Boring Depth: 94 ft. bgs (refusal)	Drilling Method: DPT Pump type: waterra
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	Drilling Equip: Geoprobe 6712DT / SP22 tooling Tubing: HDPE
	YSI (model/serial number): 650 MDS / 4268

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
49-53	0.24	0.75	17.06	5.89	211	6.59	112.7	2541	1015	50VP-19-04-49-53	A3-VP-DUP-R2-071719 @1020
59-63	0.54	1.50	17.25	4.76	1170	6.76	152.3	2358	1142	50VP-19-04-59-63	
69-73	0.84	1.75	17.52	5.01	1682	6.30	78.8	2120	1345	50VP-19-04-69-73	
79-83	1.14	2.00	15.63	6.64	1106	6.67	119.5	>4000	1010	50VP-19-04-79-83	
89-93	1.44	2.25	17.14	7.08	694	6.22	-102.6	>4000	1310	50VP-19-04-89-93	

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

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Vertical Groundwater Profiling Log

Project: Dovers	Boring No.: SOVP-19-05 Date: 10/18/19
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen Depth to Water: ~61'
Logger: VMA	Drilling Method: DPT Pump type: submerg
Total Boring Depth: 107'	Drilling Equip: Geoprobe 7822 (SP22) Tubing: HDPE
Turbidimeter (model/serial number): Lamotte 2020WE 5083-5014	YSI (model/serial number): YSI 650 XL 11B100186

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
63-67	0.18	1.5	13.40	5.99	552	4.23	32.9	1902	900	SOVP-19-05-63-67 ✱MS/MSD	water
73-77	0.48	1.5	13.26	6.13	1524	5.72	69.0	74,000	1040/1045	SOVP-19-05-73-77/A3-VP-DVP-RI-101819	
83-87	0.78	1.5	13.19	6.07	1769	4.97	83.1	74,000	1330	SOVP-19-05-83-87	water
93-97	1.08	2.5	13.07	6.11	1470	4.21	99.7	74,000	840	SOVP-19-05-93-97	water
103-107	1.38	2.5	13.29	6.18	1639	3.97	126.1	74,000	1040	SOVP-19-05-103-107	water
Post Cal. Check Varience Observed (Y/N):											

10/18

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (SP)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (SP)

Notes:

✱ tooling deflected / refusal after 107' sample (107' Final depth)

✱SP-16 inside SP-22 casing

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KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: SOVP-19-06 (P2)	Date: 7/1/19 (Event 19-03)	
Project No.: Devens	Drilling Co.: TDS		
Address: Area 3	Driller: Jay	Depth to Water: ~57'	
Logger: V.L.A	Drilling Method: DPT	Pump type: waterra	
Total Boring Depth: 96'	Drilling Equip: Geoprobe 6712 (SP22) (Rig 2)	Tubing: HDPE	
Turbidimeter (model/serial number): LaMotte 2020we 5083-5014	YSI (model/serial number): YSI 650XL	11B100186	

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
~~63-67~~ 67	0.30	0.50	18.71	7.79	520	9.69	0.9	74,000	10.45	SOVP-19-06-63-67	waterra
73-77	0.60	1.0	19.27	6.81	739	4.67	0.4	74,000	1315	SOVP-19-06-73-77	waterra
83-87	0.99	1.25	18.69	6.79	821	3.97	1.6	74,000	830/835	SOVP-19-06-83-87/A3-VP-DUP-R2-7219	
92-96	1.20	1.5	18.91	6.83	797	5.06	2.9	74,000	1145	SOVP-19-06-92-96 (X) MS/MSD	waterra

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = ~~0.0918~~ gal/ft or 347.5 ml per foot X (X2)

Notes:

~ 200' away DTW was 56.45' from 667-13-03X

(X) Refusal @ 96'

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Vertical Groundwater Profiling Log

Project: Devens	Boring No.: SOVP-19-07	Date: 10/7/19, 10/8/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Mike Allen	Depth to Water: ~62'	
Logger: WA / MM	Drilling Method: DPT	Pump type: Waterra	
Total Boring Depth: 164'	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): Lamotte 2020we 5083-5014	YSI (model/serial number): YSI 650 XL 11B101186		

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
10/7/19	63-67	0.15	1.5	15.90	7.28	111	9.78	77.5	74,000	1040	SOVP-19-07-63-67	waterra
	73-77	0.45	3.0	14.14	6.54	242	9.30	76.0	74,000	1205	SOVP-19-07-73-77	waterra
	83-87	0.75	2.0	14.30	6.67	269	8.70	79.6	74,000	1330	SOVP-19-07-83-87	waterra
10/8/19	93-97	1.05	~~1.25~~ 1.25	minimal		recharge. Direct sample				1050	SOVP-19-07-93-97	waterra
	103-107	1.35	2.00	14.39	6.84	296	6.60	~~50.0~~ 50.0	74,000	1410	SOVP-19-07-103-107,	waterra
10/9	113-117	1.65	3.0	14.11	6.63	238	7.80	67.1	74,000	945/950	SOVP-19-07-113-117 / A3-VP-DUP-R1-10/9/19	waterra
	123-127	1.95	3.0	14.26	7.11	299	7.30	74.1	74,000	1300	SOVP-19-07-123-127	waterra
10/10	133-137	2.25	3.0	14.49	6.79	320	6.97	81.7	74,000	1100	SOVP-19-07-133-137	waterra
	143-147	2.55	3.0	14.11	6.69	301	6.77	79.2	74,000	1410/1415	SOVP-19-07-143-147	waterra
10/14	153-157	2.85	3.0	14.50	6.80	389	7.03	91.6	74,000	1125*	SOVP-19-07-153-157 A3-VP-DUP-R1-10/10/19	
	Post Cal. Check Varience Observed (Y/N):											
10/15	160-164	3.15	2.0	14.7	6.97	421	6.50	102.6	74,000	955/1000	SOVP-19-07-160-164 / A3-VP-DUP-R1-10/15/19	

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (X)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot X

Notes:

* detection @ 155' unable to sample. will offset and try new hole to 157' next day

* SP+lb inside SP22 casing

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KOMAN Gove[illegible]nt Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: 50VP-19-08	Date: ~~9/6/19~~ 9/6/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Jay (9/10 Matt)	Depth to Water: 8'	
Logger: KGA	Drilling Method: DPT ~~67120T~~	Pump type: geotech	
Total Boring Depth: 83'	Drilling Equip: Geoprobe 67120T (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): Lamotte 2020WE ~~5083~~-5014	YSI (model/serial number): YSI 650 XL 11B100186		

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
9/6	9-13	0.15	1.0	12.79	6.97	191	1.97	-56.6	29.08	830	50VP-19-08-9-13	geotech
	19-23	0.45	1.0	12.38	5.69	1544	2.10	1.2	64.3	915	50VP-19-08-19-23	geotech
	29-33	0.75	1.0	13.05	5.54	1784	3.12	-2.0	37.90	1010	50VP-19-08-29-33	geotech
	39-43	1.05	1.5	13.68	6.73	1788	3.53	5.1	29.68	1115	50VP-19-08-39-43	geotech
	49-53	1.35	2.0	14.27	7.08	1828	3.28	7.0	12.00	1230	50VP-19-08-49-53	geotech
	59-63	1.65	2.0	14.31	7.00	1839	3.17	6.9	28.60	1345	50VP-19-08-59-63	geotech
9/10	69-73	1.95	2.0	14.01	7.09	1721	3.01	7.9	74,000	935	50VP-19-08-69-73	geotech
	79-83	2.25	2.5	13.92	7.11	1703	2.96	8.1	74,000	1135	50VP-19-08-79-83	geotech

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot ~~X~~ 2)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot ~~X~~

Notes:
☆ Stopped @ 83' due to nearby 80-90' screened well

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KOMAN Gove[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: SOVP-19-09-	Date: 8/16/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: 42'	
Logger: WGA	Drilling Method: DPT	Pump type: Waterra	
Total Boring Depth: 107.5'	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): LaMotte 2020we 5083-5014	YSI (model/serial number): YSI 650XL 11B100186		

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
8/16	53-57	0.45	1.5	15.32	7.83	77	1.60	16.9	2200	1135/1140	SOVP-19-09-53-57/A3-VP-DVP-RI-81619	
8/19	63-67	0.75	1.5	13.67	6.94	70	3.97	17.3	1930	855	SOVP-19-09-63-67	Waterra
	73-77	1.05	2.5	14.97	7.03	68	2.96	18.0	74,000	1030	SOVP-19-09-73-77	waterra
	83-87	1.35	3.0	14.87	6.00	64	1.21	45.3	74,000	1220	SOVP-19-09-83-87	waterra
8/14	93-97	—	no water accum, extremely fine sediment clogging screen / unable to sample									waterra
	103-107	1.95	2.0	15.21	6.31	63	1.87	59.0	74,000	1210	SOVP-19-09-103-107	waterra
•	43-47	0.15	1.5	16.07	7.09	84	2.63	12.9	384	1035	SOVP-19-09-43-47	waterra

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:
• offset for 43-47' interval
☆ Refusal @ 107.5'

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KOMAN Gove[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Revere	Boring No.: SOVP-19-10 Date: 8/14/19
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Alfred Allen Depth to Water: 52'
Logger: VMA	Drilling Method: DPT Pump type: waterra
Total Boring Depth:	Drilling Equip: Geoprobe 7822 (SP22) Tubing: TF HDPE
Turbidimeter (model/serial number): Hach 2100Q 6053-5014	YSI (model/serial number): YSI 650 XL 16B100486

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
8/14 53-57	0.15	1.0	15.93	7.01	278	2.71	-8.8	74,000	1145	SOVP-19-10-53-57	waterra
63-67	0.45	2.0	14.07	6.15	107	2.43	34.0	2630	1340	SOVP-19-10-63-67	waterra
73-77	0.75	1.5	17.55	6.55	91	0.90	31.7	74,000	850	SOVP-19-10-73-77	waterra

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (SP22)

Notes:

☆ Refusal @ 79'
☆ offset and redrilled Refusal @ 75.5'

KGS

1365

KOMAN Gov[illegible]ent Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens	Boring No.: SOVP-19-11	Date: 8/23/19 - 8/26/19 - 8/27/19 - 8/28/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen	Depth to Water: ~41'	
Logger: LHA / CLV	Drilling Method: DPT	Pump type: Waterra	
Total Boring Depth: 115' BGS	Drilling Equip: Geoprobe 7822 (SP22)	Tubing: HDPE	
Turbidimeter (model/serial number): LaMotte 2020we 2081-2014	YSI (model/serial number): YSI 650XL 11B100186		

	Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
8/23	43-47	0.18	2.0	17.68	8.01	48	9.78	15.8	2046	1135	SOVP-19-11-43-47	water
8/26	53-57	0.50	2.5	13.33	8.02	42	9.88	63.8	(overrange) ++++	0930	SOVP-19-11-53-57	brown/opaque
	63-67	0.82	2.5	15.52	5.68	~~53.0~~ 20 (cw)	7.87	53.0	(overrange) ++++	1125	SOVP-19-11-63-67	gray brown/opaque
	73-77	1.14	2.5	16.62	5.61	44	3.32	38.0	(overrange) ++++	1525	SOVP-19-11-73-77	gray brown/opaque
8/27	83-87	1.46	2.5	14.12	8.20	40	9.91	76.2	(overrange) ++++	0940	SOVP-19-11-83-87	dark brown/opaque
	93-97	1.78	3.0	15.40	6.57	44	9.63	42.1	(overrange) ++++	1220	SOVP-19-11-93-97	dark brown/opaque
8/28	103-107	2.10	3.0	15.91	7.34	145	1.63	47.6	(overrange) ++++	0945	SOVP-19-11-103-107	light gray/brown/opaque
	111-115	2.36	3.5	18.26	7.61	156	4.94	24.1	(overrange) +++	1230	SOVP-19-11-111-115	light gray/cloudy
Post Cal. Check Varience Observed (Y/N):												

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (x2)

Notes:

8/28/19: hit refusal @ 115' BGS

KGS

KOMAN Government Solutions, LLC
Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: SOV2-19-12	Date: 8/9/19	
Project No.: PFAS RI	Drilling Co.: TDS		
Address: Area 3	Driller: Alfred Allen		
Logger: KGA	Drilling Method: DPT	Depth to Water: ~52	
Total Boring Depth: 97.5'	Drilling Equip: Geoprobe 7822 (5722)	Pump type: Waterra	
Turbidimeter (model/serial number): LaMotte 2020we 5283-5014	YSI (model/serial number): YSI 650XL 11B100186	Tubing: HDPE	

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
53-57	0.15	0.75	17.29	7.38	80	9.80	21.8	74,000	1135	SOV2-19-12-53-57	Waterra
63-67	0.45	1.5	16.44	6.26	66	9.70	33.0	74,000	1335	SOV2-19-12-63-67	Waterra
73-77	0.75	1.5	15.76	6.88	92	8.54	26.9	74,000	900	SOV2-19-12-73-77	Waterra
83-87	1.05	2.5	16.07	6.73	94	8.37	25.1	74,000	1145	SOV2-19-12-83-87	Waterra
93-97	1.35	2.5	16.47	6.86	99	8.19	23.1	74,000	1340/1345	SOV2-19-12-93-97/A3-UP-DUP-R1-8124	

8/9
8/12

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot (62)

Notes:

☆ Refusal @ 97.5'

KGS

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Vertical Groundwater Profiling Log

Project: Devens PFAS RI	Boring No.: 50VP-19-13 Date: 8/12/19
Project No.: 1082	Drilling Co.: TDS
Address: AOC 50	Driller: Jay Jumonville Depth to Water: 68.0' bgs
Logger: Dave Kortjohn	Drilling Method: DPT Pump type: waterra
Total Boring Depth: 181 ft. bgs (refusal)	Drilling Equip: Geoprobe 6712DT / SP22 tooling Tubing: HDPE
Turbidimeter (model/serial number): LaMotte 2020we 1828-0412	YSI (model/serial number): Pro DSS / ~~17401163~~ (DE) 18L100145

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
69-73	0.15	0.50	17.1	5.96	49	8.13	69.8	2454	849	50VP-19-13-69-73	
79-83	0.45	1.00	19.7	5.94	40	8.49	113.5	3125	1120	50VP-19-13-79-83	
89-93	0.75	1.25	19.1	5.83	87	7.72	100.0	919	1342	50VP-19-13-89-93	
99-103	1.05	1.50	18.4	6.12	191	7.85	~~85.8~~ (DE) 85.0	691	917	50VP-19-13-99-103	
109-113	1.35	1.50	19.2	6.84	328	3.96	~~27.0~~ (DE)	>4000	1145	50VP-19-13-109-113	
119-123	1.65	2.00	19.1	7.09	321	1.80	-76.2	>4000	1400	50VP-19-13-119-123	
129-133	1.95	2.25	18.3	7.23	285	4.51	54.7	2411	940	50VP-19-13-129-133	A3-VP-DUP-A2-081519@945
139-143	2.25	2.50	18.9	7.09	256	2.52	-89.2	>4000	1350	50VP-19-13-139-143	MS/MSD
154-158	2.70	3.00	19.8	7.32	355	2.25	-37.7	>4000	1223	50VP-19-13-154-158	

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

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Vertical Groundwater Profiling Log

(Page 2 of 2)

Project: Devens	Boring No.: SOVP-19-13 (cont.) Date: 8/20/19
Project No.: PFAS RI	Drilling Co.: TDS
Address: Area 3	Driller: Jay
Logger: KLA	Depth to Water: 68'
Total Boring Depth: 181' (refusal)	Drilling Method: DPT Pump type: bladder
Turbidimeter (model/serial number): LaMotte 2020we 5083 - 5014	Drilling Equip: Geoprobe 6712DT (SP22) Tubing: HDPE
	YSI (model/serial number): YSI650XL 11B100186

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
164-168	3.00	4.0	17.90	7.01	369	1.97	-18.9	74,000	920	SOVP-19-13-164-168	water
174-178	3-30	4.0	17.77	6.89	372	2.39	-39.1	74,000	1325	SOVP-19-13-174-178	water

Post Cal. Check Varience Observed (Y/N):

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot (60.2)
SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot X

Notes:

* Refusal @ 181' (8/21)

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Vertical Groundwater Profiling Log

Project: Devens - AOC 50 Western Plume Delineation	Boring No.:	G6M-18-01	Date: 10/25/2018
Project No.: 1082-0005-005	Drilling Co.:	Cascade	
Address: Former Moore Army Airfield, Devens MA	Driller:	Christopher Aldrich	Depth to Water: 60.67
Logger: Brett Anchukaitis	Drilling Method:	Direct Push	Pump type: Hydrolift II Waterra
Total Boring Depth: 118 ft bgs	Drilling Equip:	Geoprobe Rig 7822; 0.625 and 1.5 inch diameter tooling; stainless steel screen	Tubing: 3/8x1/2 inch HDPE
Turbidimeter (model/serial number):	YSI (model/serial number):	YSI 556 MPS	

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
110-114	1.6	2.3	10.98	6.99	114	6.77	20.4	687	0830	G6M-18-01-GW-110-114	

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes:

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Vertical Groundwater Profiling Log

Project: Devens - AOC 50 Western Plume Delineation	Boring No.:	G6M-18- 01	Date: 10/24/2018
Project No.: 1082-0005-005	Drilling Co.:	Cascade	
Address: Former Moore Army Airfield, Devens MA	Driller:	Christopher Aldrich	Depth to Water: 57 ft BGS
Logger: C.V.	Drilling Method:	Direct Push	Pump type: Hydrolift II Waterra
Total Boring Depth: 104 ft BGS	Drilling Equip:	Geoprobe Rig 7822, 0.625 and 1.5 inch diameter tooling; stainless steel screen	Tubing: 3/8x1/2 inch HDPE
Turbidimeter (model/serial number): 5086 - 5014	YSI (model/serial number): 06H2823AL		

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks
60-64	0.22	0.50	11.98	6.55	93	6.02	0.4	1567	0830	G6M-18-01-GW-60-64	60'-64', DTW: 57ft
70-74	0.52	1.00	12.38	6.07	87	5.05	21.7	2935	0945	G6M-18-01-GW-70-74	70'-74' DTW: 57ft
80-84	[redacted]0.84	1.50	11.28	5.97	145	4.50	124.4	2385	1115	G6M-18-01-GW-80-84	FRS 80'-84' DTW 61ft
90-94	1.06	2.00	12.19	6.11	76	5.27	60.0	overrange HHH	1410	G6M-18-01-GW-90-94	90'-94' DTW: 61ft
100-104	1.38	2.50	12.28	6.33	157	4.25	32.6	overrange HHH	1545	G6M-18-01-GW-100-104	FD 100'-104' DTW: 61ft

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

Notes: purging a bit extra (double ~~the~~ of 2 well volumes) as it is extremely silty and a slow flow rate would allow silt to partially settle and clog tubing/valve.

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~~3 PFAS~~
~~94 VOC~~
~~3 VOC 94 PFAS on COC~~

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Vertical Groundwater Profiling Log

Project: Devens - AOC 50 Western Plume Delineation	Boring No.:	G6M-18-02	Date: 10/22/2018, 10/23/18
Project No.: 1082-0005-005	Drilling Co.:	Cascade	
Address: Former Moore Army Airfield, Devens MA	Driller:	Christopher Aldrich	Depth to Water: 62.6
Logger: L.K. C.V	Drilling Method:	Direct Push	Pump type: Hydrolift II Waterra
Total Boring Depth: 128 ft BGS	Drilling Equip:	Geoprobe Rig 7822; 0.625 and 1.5 inch diameter tooling; stainless steel screen	Tubing: 3/8x1/2 inch HDPE
Turbidimeter (model/serial number):	YSI (model/serial number):	06H2823AL	

Sample Interval (ft bgs)	Minimum Purge Volume	Total Volume Purged	Temp (°C)	pH (STD)	SPC (µS/cm°)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Sample Time	Sample Identifier	Remarks SP16
60-64	NA	–	–	–	–	–	–	–	1100	18-02-60-64	~~dry~~
64-68	~~0.86 0.96 gal~~ (EV)	1.90 gal	14.63	6.34	80	7.32	137.	785	1253	18-02-64-68	DTW: 63.8
74-78	~~0.50 2.71 gal~~ (EV)	1.0 gal	14.58	6.27	116	4.19	-8.3	3025	1430	18-02-74-78	DTW = 63.9 TB Sample
84-88	0.82 gal	1.0 gal	14.24	6.16	308	6.28	107.6	1718	1530	18-02-84-88	DTW: 64.0
94-98	1.14 gal	2.0 gal	10.35	5.94	390	6.12	71.7	625	0915	18-02-94-98	DTW: 62.0 MS/MSD
104-108	1.46 gal	2.0 gal	12.84	6.21	687	6.22	64.7	overrange >1111	~~1045~~ 1045	18-02-104-108	DTW - 62.0 FRB
114-118	1.78 gal	2.5 gal	12.69	6.20	838	4.54	30.9	3322	1205	18-02-114-118	DTW - 62.0 FD
124-128	2.10 gal	3.0 gal	12.91	6.42	705	5.20	17.2	3025	1445	18-02-124-128	DTW - 62.0 EB @ Rinsate 1448
~~VOA 128~~											

SP16 casing purge volume = 0.0159 gal/ft or 60.3 ml per foot SP22 casing purge volume = 0.0918 gal/ft or 347.5 ml per foot

10/22/18

10/23/18

Notes: 60-64 DTW: 62.6 DTB: 64.1 > not enough water to extract; 2 attempts

10/23/18 sand clogging lines, took extra time to sample

- overpurged 64-68, 74-78: ~~thought we were~~ to make sure sand/silt gets purged (and the rest)

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Calibration Sheets

KGS

Field Instrument Calibration Log

Date: 10/22/18 **Weather:** Sunny

Project/Site Name: AOC 50 Vertical Profiling **Instrument:** YSI 556 MPS

Calibrated By: Chris Vignola **Serial Number:** 06H2823AL

Parameters	Solution Expiration Date	Morning Calibration Time 0850		Cal. Temperature °C	Afternoon Calibration Time 1700		Cal. Temperature °C	Post Cal. Criteria
Specific Conductivity (1.413 µS/cm°)	12/31/2019	1,494 µs/cm°	1,413 µS/cm°	19.23	1,504 µs/cm°	1,413 µs/cm°	18.56	±10 µS/cm
pH (7)	02/29/2020	6.85	7.00	19.18	7.13	7.00	18.19	± 0.3 pH *
pH (4)	09/30/2019	3.92	4.00	19.21	4.00	4.00	17.85	± 0.3 pH *
pH (10)	12/31/2019	10.04	10.01	19.19	9.99	10.00	18.65	± 0.3 pH *
ORP (240 mv)	10/31/2022	242.8	240.0	19.11	242.2	240.0	18.27	±10 mv
Dissolved Oxygen (%)	–	102.4	100	–	87.6	100	–	-
Dissolved Oxygen (mg/L)	–	10.1	8.89	–	8.92	8.89	–	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value
Barometric Pressure (mmHg)	–	768	768	–	768	768	–	-

Notes:

*** pH Unit with pH 7 Buffer**

Variance Noted:

Signature: [signature] **Date:** 10/22/18

KGS

Field Instrument Calibration Log

Date: 10/23/18 **Weather:** 45°F Cloudy, afternoon rain

Project/Site Name: AOC 50 Vertical Profiling **Instrument:** YSI 556 MPS

Calibrated By: Chris Vigwla **Serial Number:** 06H2823AL

Parameters	Solution Expiration Date	Morning Calibration Time 0545		Cal. Temperature °C	Afternoon Calibration Time 1730		Cal. Temperature °C	Post Cal. Criteria
Specific Conductivity (1.413 µS/cm°)	12/31/2018	1,416 µS/cm°	1,413 µS/cm°	20.67	1,418 µS/cm°	1,413 µS/cm°	14.35	±10 µS/cm
pH (7)	02/29/2020	7.03	7.00	20.65	7.05	7.00	14.67	± 0.3 pH *
pH (4)	09/30/2019	3.99	4.00	20.56	3.98	4.00	14.72	± 0.3 pH *
pH (10)	12/31/2019	9.93	10.00	20.68	10.01	10.00	14.71	± 0.3 pH *
ORP (240 mv)	10/31/2022	235.8	240.0	20.68	244.3	240.0	14.78	±10 mv
Dissolved Oxygen (%)	—	~~100~~ 86.8	100	—	80.4	100	—	-
Dissolved Oxygen (mg/L)	—	8.15	8.89	—	8.57	8.89	—	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value
Barometric Pressure (mmHg)	—	768	768	—	768	768	—	-

Notes:

*** pH Unit with pH 7 Buffer**

Variance Noted:

Signature: [signature] **Date:** 10/23/18

KGS

Field Instrument Calibration Log

Date: 10/24/18 **Weather:** 50° Partly Sunny, some light rain

Project/Site Name: AOC Vertical Profiling **Instrument:** YSI 556

Calibrated By: Chris Vignola **Serial Number:** 06142823AL

Parameters	Solution Expiration Date	Morning Calibration Time 0645		Cal. Temperature °C	Afternoon Calibration Time 1700		Cal. Temperature °C	Post Cal. Criteria
Specific Conductivity (1.413 µS/cm°)	12/31/2018	1,477µS/cm°	1,413µS/cm°	14.24	1,470µS/cm°	1,413µS/cm°	12.11	±10 µS/cm
pH (7)	02/29/2020	6.98	7.00	15.05	6.99	7.00	11.98	± 0.3 pH *
pH (4)	09/30/2019	3.94	4.00	14.03	3.91	4.00	11.78	± 0.3 pH *
pH (10)	12/31/2019	9.96	10.00	14.65	9.94	10.00	12.02	± 0.3 pH *
ORP (240 mv)	10/31/2022	246.1	240.0	14.82	243.5	240.0	12.09	±10 mv
Dissolved Oxygen (%)	–	98.6	100	–	97.1	100	–	-
Dissolved Oxygen (mg/L)	–	10.5	8.83	–	10.21	8.83	–	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value
Barometric Pressure (mmHg)	–	760	760	–	760	760	–	-

Notes:

*** pH Unit with pH 7 Buffer**

Variance Noted:

Signature: [signature] **Date:** 10/24/18

KGS

Field Instrument Calibration Log

Date: 10/25/18 **Weather:** Cloudy, 34°F

Project/Site Name: AOC50 PFAS Vertical Profiling **Instrument:** ~~YSI~~ YSI 556MPS

Calibrated By: BrA **Serial Number:**

Parameters	Solution Expiration Date	Morning Calibration Time 0430		Cal. Temperature °C	Afternoon Calibration Time 1230		Cal. Temperature °C	Post Cal. Criteria
Specific Conductivity (1.413 ~~µS~~ mS/cm°)	12/31/2018	1.362	1.413	14.15	1412	1413	9.72	±10 µS/cm
pH (7)	2/29/2020	7.02	7.00	14.05	7.01	7.00	9.84	± 0.3 Ph *
pH (4)	9/31/2019	4.00	4.00	14.03	3.98	4.00	9.76	± 0.3 Ph *
pH (10)	12/31/2019	9.96	9.99	14.11	10.00	10.00	9.78	± 0.3 Ph *
ORP (240 mv)	10/31/2022	237.5	240.0	14.15	239.3	240.0	9.41	±10 mv
Dissolved Oxygen (%)	—	85.9	100.0	10.22	98.6	100.0	9.21	-
Dissolved Oxygen (mg/L)	—	9.78	11.29	10.22	10.74	10.81	9.21	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value
Barometric Pressure (mmHg)	—	768	—	10.22	768	—	9.21	-

Notes:

*** Ph Unit with Ph 7 Buffer**

Variance Noted:

Signature: [signature] **Date:** 10/25/18

KGS

Instrument Calibration Log

Project/Site Name: AOC 50 Drilling **Calibrated By:** Chris Vignola

Instrument/Serial Number	Pre-Cal 0-AM (NTU)	Pre-Cal 0-PM (NTU)	Pre-Cal 10-AM (NTU)	Pre-Cal 10-PM (NTU)	Post-Cal 0-AM (NTU)	Post-Cal 0-PM (NTU)	Post-Cal 10-AM (NTU)	Post-Cal 10-PM (NTU)	Date
5086-5014	0.05	0.06	9.87	9.81	0.00	0.00	10.0	10.0	10/22/18
5086-5014	0.07	0.08	9.85	9.90	0.01	0.01	10.0	10.0	10/23/18
5086-5014	0.07	0.09	9.83	9.87	0.01	0.01	9.99	10.0	10/24/18
"	0.06	0.08	9.84	9.88	0.01	0.01	9.98	10.0	10/25/18

Signature: [signature]

Date: 10/22, 23, 24/18
10/25/18

KGS

Field Instrument Calibration Log

Date: 7/1/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	1/19	1.439	1.413	22.19°	1.418	22.87°	±10 µS/cm	N
pH (7)	10/20	7.46	7.00	22.27°	7.06	22.41°	± 0.3 Ph *	N
pH (4)	3/20	4.18	4.00	22.13°	4.11	22.21°	± 0.3 Ph *	N
pH (10)	2/20	9.70	10.00	22.09°	9.97	22.07°	± 0.3 Ph *	N
ORP (240 mv)	10/22	249.7	240.0	22.18°	237.7	22.06°	±10 mv	N
Dissolved Oxygen (%)	N/A	109.7%	100.0%	22.00°	101.6%	22.07°	-	N
Dissolved Oxygen (mg/L)	N/A	10.39	10.00	21.78°	9.97	22.01°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/1/19

KGS

Field Instrument Calibration Log

Date: 7/2/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: RP VBA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.401	1.413	21.78°	1.418	20.31°	±10 µS/cm	N
pH (7)	10/20	7.31	7.00	21.69°	7.11	20.21°	± 0.3 Ph *	N
pH (4)	3/20	4.29	4.00	21.54°	4.00	20.20°	± 0.3 Ph *	N
pH (10)	2/20	10.31	10.00	21.45°	10.01	20.33°	± 0.3 Ph *	N
ORP (240 mv)	10/22	246.7	240.0	21.67°	241.1	20.47°	±10 mv	N
Dissolved Oxygen (%)	N/A	92.6%	100.0%	21.30°	98.2%	20.51°	-	N
Dissolved Oxygen (mg/L)	N/A	9.62	10.00	21.20°	9.90	20.01°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/2/19

KGS

Field Instrument Calibration Log

Date: 7/8/19 **Weather:** 70's

Project/Site Name: Devens **Instrument:** YSI 650 XL

Calibrated By: WGL **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.397	1.413	22.07°	1.418	23.07°	±10 µS/cm	N
pH (7)	10/20	6.87	7.00	22.37°	7.07	23.01°	± 0.3 Ph *	N
pH (4)	3/20	4.31	4.00	22.30°	4.07	23.00°	± 0.3 Ph *	N
pH (10)	2/20	9.72	10.00	22.21°	9.89	22.90°	± 0.3 Ph *	N
ORP (240 mv)	10/22	252.1	240.0	22.17°	241.7	22.93°	±10 mv	N
Dissolved Oxygen (%)	N/A	131.6%	100.0%	22.19°	107.6%	22.90°	-	N
Dissolved Oxygen (mg/L)	N/A	9.62	10.00	22.10°	9.80	22.79°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: _____ **Date:** 7/8/19

KGS

Field Instrument Calibration Log

Date: 7/9/19 **Weather:** 80's

Project/Site Name: Devins **Instrument:** YSI 650 XL

Calibrated By: VGA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 645		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.403	1.413	22.10°	1.419	21.70°	±10 µS/cm	N
pH (7)	10/20	7.11	7.00	22.18°	7.01	21.50°	± 0.3 Ph *	N
pH (4)	3/20	4.03	4.00	22.27°	4.06	21.47°	± 0.3 Ph *	N
pH (10)	2/20	9.97	10.00	22.27°	10.00	21.57°	± 0.3 Ph *	N
ORP (240 mv)	10/22	247.1	240.0	21.79°	241.7	21.60°	±10 mv	N
Dissolved Oxygen (%)	N/A	92.6%	100.0%	21.77°	92.6%	21.55°	-	N
Dissolved Oxygen (mg/L)	N/A	9.90	10.00	21.39°	9.99	21.30°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/9/19

KGS

Field Instrument Calibration Log

Date: 7/10/19 **Weather:** 80's

Project/Site Name: Devons **Instrument:** YSI 650XL

Calibrated By: KGA **Serial Number:** 11B109 186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1440	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.378	1.413	21.70°	1.411	20.17°	±10 µS/cm	N
pH (7)	10/20	7.21	7.00	21.67°	7.00	20.20°	± 0.3 Ph *	N
pH (4)	3/20	4.11	4.00	21.80°	4.03	20.17°	± 0.3 Ph *	N
pH (10)	2/20	9.90	10.00	21.73°	10.00	20.20°	± 0.3 Ph *	N
ORP (240 mv)	10/22	249.7	240.0	21.56°	237.7	20.19°	±10 mv	N
Dissolved Oxygen (%)	N/A	119.7%	100.0%	21.78°	96.1%	20.20°	-	N
Dissolved Oxygen (mg/L)	N/A	9.62	10.00	21.30°	9.93	20.03°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/10/19

KGS

Field Instrument Calibration Log

Date: 7/11/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: KGA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1445	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.439	1.413	22.03°	1.412	21.03°	±10 µS/cm	N
pH (7)	10/20	7.13	7.00	22.00°	7.11	21.00°	± 0.3 Ph *	N
pH (4)	3/20	4.11	4.00	21.93°	4.01	20.87°	± 0.3 Ph *	N
pH (10)	2/20	9.93	10.00	21.90°	9.83	20.77°	± 0.3 Ph *	N
ORP (240 mv)	10/22	237.1	240.0	21.87°	242.7	20.66°	±10 mv	N
Dissolved Oxygen (%)	N/A	101.6%	100.0%	20.92°	101.7%	20.50°	-	N
Dissolved Oxygen (mg/L)	N/A	9.90	10.00	20.81°	9.97	20.41°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/11/19

KGS

Field Instrument Calibration Log

Date: 7/12/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: VHT **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1345	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.409	1.413	24.02°	1.407	22.91°	±10 µS/cm	N
pH (7)	10/20	6.87	7.00	24.36°	7.03	22.80°	± 0.3 Ph *	N
pH (4)	3/20	4.39	4.00	24.20°	4.06	22.79°	± 0.3 Ph *	N
pH (10)	2/20	9.39	10.00	24.30°	10.11	22.67°	± 0.3 Ph *	N
ORP (240 mv)	10/22	244.3	240.0	24.42	237.1	22.69°	±10 mv	N
Dissolved Oxygen (%)	N/A	98.2%	100.0%	23.97°	102.1%	22.62°	-	N
Dissolved Oxygen (mg/L)	N/A	9.20	10.00	23.77°	9.87	22.39°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/12/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devers

Instrument: LaMotte 2020we

Calibrated By: VA

Serial Number: 5083 5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
7/1/19	0.17	0.00	9.71	10.00	0.06	10.03	N
7/2/19	0.03	0.00	10.01	10.00	0.09	9.87	N
7/8/19	0.09	0.00	9.80	10.00	0.10	9.97	N
7/9/19	0.17	0.00	9.92	10.00	0.03	10.01	N
7/10/19	0.06	0.00	9.93	10.00	0.02	10.10	N
7/11/19	0.09	0.00	9.90	10.00	0.09	10.11	N
7/12/19	0.11	0.00	10.47	10.00	0.02	10.03	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: _____

Date: 7/12/19

KGS

Field Instrument Calibration Log

Date: 7/16/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: [redacted] MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.439	1.413	22.17°	1.410	22.61°	±10 µS/cm	N
pH (7)	10/20	7.31	7.00	22.47°	7.03	22.79°	± 0.3 Ph *	N
pH (4)	3/20	4.18	4.00	22.59°	3.93	22.81°	± 0.3 Ph *	N
pH (10)	2/20	9.87	10.00	22.47°	10.11	22.71°	± 0.3 Ph *	N
ORP (240 mv)	10/22	229.7	240.0	22.30°	232.6	22.67°	±10 mv	N
Dissolved Oxygen (%)	N/A	87.6%	100.0%	22.27°	92.1%	22.09°	-	N
Dissolved Oxygen (mg/L)	N/A	9.71	10.00	22.03°	9.79	22.01°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	769	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [redacted] **Date:** 7/16/19

KGS

Field Instrument Calibration Log

Date: 7/17/19 **Weather:** 80's

Project/Site Name: Devons **Instrument:** YSI 650XL

Calibrated By: RLA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.397	1.413	21.70°	1.407	20.97°	±10 µS/cm	N
pH (7)	10/20	6.71	7.00	21.89°	7.07	20.87°	± 0.3 Ph *	N
pH (4)	3/20	4.20	4.00	21.67°	4.01	20.79°	± 0.3 Ph *	N
pH (10)	2/20	9.90	10.00	21.73°	9.90	20.83°	± 0.3 Ph *	N
ORP (240 mv)	10/22	230.6	240.0	21.69°	242.7	20.72°	±10 mv	N
Dissolved Oxygen (%)	N/A	91.6%	100.0%	20.97°	97.1%	20.81°	-	N
Dissolved Oxygen (mg/L)	N/A	10.47	10.00	20.67°	9.87	20.21°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: RLA **Date:** 7/17/19

KGS

Field Instrument Calibration Log

Date: 7/18/19 **Weather:** ~~[illegible]~~ 70s

Project/Site Name: Devers **Instrument:** RT YSI 650XL

Calibrated By: WA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 615		Cal. Temp. (°C)	PM Post Cal. Check Time 1415	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.436	1.413	22.78°	1.407	20.03°	±10 µS/cm	N
pH (7)	10/20	7.21	7.00	22.69°	7.03	19.76°	± 0.3 Ph *	N
pH (4)	3/20	4.00	4.00	22.63°	4.01	19.69°	± 0.3 Ph *	N
pH (10)	2/20	10.03	10.00	22.71°	9.93	19.71°	± 0.3 Ph *	N
ORP (240 mv)	10/22	227.1	240.0	22.76°	242.2	19.79°	±10 mv	N
Dissolved Oxygen (%)	N/A	96.6%	100.0%	22.11°	96.1%	19.70°	-	N
Dissolved Oxygen (mg/L)	N/A	10.47	10.00	22.01°	9.88	19.21°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	769	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/18/19

KGS

Field Instrument Calibration Log

Date: 7/19/19 **Weather:** 90's

Project/Site Name: Devas **Instrument:** YSI 650XL

Calibrated By: PCA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 620		Cal. Temp. (°C)	PM Post Cal. Check Time 1300	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.521	1.413	23.19°	1.407	21.16°	±10 µS/cm	N
pH (7)	10/20	7.31	7.00	23.21°	7.03	21.21°	± 0.3 Ph *	N
pH (4)	3/20	4.19	4.00	23.10°	4.00	21.13°	± 0.3 Ph *	N
pH (10)	2/20	10.47	10.00	23.21°	10.01	21.02°	± 0.3 Ph *	N
ORP (240 mv)	10/22	249.7	240.0	23.07°	241.1	21.00°	±10 mv	N
Dissolved Oxygen (%)	N/A	123.3%	100.0%	23.00°	92.1%	20.97°	-	N
Dissolved Oxygen (mg/L)	N/A	7.57	10.09	22.87°	9.99	20.81°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760		760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/19/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens

Instrument: YSI 650XL

Calibrated By: JGA

Serial Number: 11B100186

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
7/16/19	0.40	0.00	9.80	10.00	0.09	9.90	N
7/17/19	0.21	0.00	9.92	10.00	0.01	9.93	N
7/18/19	0.03	0.00	10.27	10.00	0.07	10.09	N
7/19/19	0.21	0.00	10.07	10.00	0.11	10.10	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 7/19/19

KGS

Field Instrument Calibration Log

Date: 7/17/19 **Weather:** 75°F, cloudy

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Kortjohn **Serial Number:** 4268

Parameters	Solution Expiration Date	AM Calibration Time 800		Cal. Temp. (°C)	PM Post Cal. Check Time 1420	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	~~1.43~~ 1.398 (DK)	1.413	28.84	1.407	28.50	±10 µS/cm	N
pH (7)	3/2020	6.98	7.00	26.08	7.02	28.34	± 0.3 Ph *	N
pH (4)	3/2020	3.71	3.95	26.63	3.92	28.22	± 0.3 Ph *	N
pH (10)	2/2020	9.81	10.00	25.83	9.95	28.03	± 0.3 Ph *	N
ORP (240 mv)	1/2023	254.2	240.0	28.00	242.3	28.09	±10 mv	N
Dissolved Oxygen (%)	—	127.3	100.0	28.07	~~102.3~~ ~~102.3~~ (DK)	28.52	-	N
Dissolved Oxygen (mg/L)	—	9.95	7.17	28.07	7.49	28.52	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 7/17/19

KGS

Field Instrument Calibration Log

Date: 7/18/19 **Weather:** 65°F, cloudy

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Korfjohn **Serial Number:** 4268

Parameters	Solution Expiration Date	AM Calibration Time 745		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.411	1.413	23.90	1.409	23.27	±10 µS/cm	N
pH (7)	3/2020	6.98	7.00	24.70	7.03	23.98	± 0.3 Ph *	N
pH (4)	3/2020	4.07	4.01	22.98	4.03	23.29	± 0.3 Ph *	N
pH (10)	2/2020	10.08	10.00	23.39	10.02	23.45	± 0.3 Ph *	N
ORP (240 mv)	1/2023	237.6	240.0	24.10	238.2	23.94	±10 mv	N
Dissolved Oxygen (%)	—	82.8	100.0	21.82	98.3	22.12	-	N
Dissolved Oxygen (mg/L)	—	7.24	8.76	21.82	8.44	22.12	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Korfjohn **Date:** 7/18/19

KGS

Field Instrument Calibration Log

Date: 7/19/19 **Weather:** 85°F, partly cloudy

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Kortjohn **Serial Number:** 4268

Parameters	Solution Expiration Date	AM Calibration Time 745		Cal. Temp. (°C)	PM Post Cal. Check Time 1320	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.388	1.413	23.17	1.409	26.48	±10 µS/cm	N
pH (7)	3/2020	7.06	7.00	22.83	7.02	26.34	± 0.3 Ph *	N
pH (4)	3/2020	4.21	4.03	22.81	4.10	26.83	± 0.3 Ph *	N
pH (10)	2/2020	9.91	10.00	22.38	9.98	26.45	± 0.3 Ph *	N
ORP (240 mv)	1/2023	236.6	240.0	23.16	239.3	26.48	±10 mv	N
Dissolved Oxygen (%)	—	84.1	100.0	22.98	99.3	28.56	-	N
Dissolved Oxygen (mg/L)	—	7.23	8.58	22.98	8.43	28.56	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 7/19/19

KGS

Field Instrument Calibration Log

Date: 7/22/19 **Weather:** 80°F, muggy/cloudy

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Korfjohn **Serial Number:** 4268

Parameters	Solution Expiration Date	AM Calibration Time 800		Cal. Temp. (°C)	PM Post Cal. Check Time 1435	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.427	1.413	28.68	1.414	28.52	±10 µS/cm	N
pH (7)	3/2020	7.03	7.00	28.49	7.01	28.59	± 0.3 Ph *	N
pH (4)	1/2021	3.62	4.00	27.60	3.89	28.29	± 0.3 Ph *	N
pH (10)	2/2020	9.91	10.00	27.29	10.02	28.35	± 0.3 Ph *	N
ORP (240 mv)	1/2023	229.0	240.0	28.06	235.6	28.42	±10 mv	N
Dissolved Oxygen (%)	–	142.2	100.0	25.85	114.5	25.92	-	Y
Dissolved Oxygen (mg/L)	–	11.55	8.13	25.85	10.68	25.92	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	–	760	–	–	760	–	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Korfjohn **Date:** 7/22/19

KGS

Field Instrument Calibration Log

Date: 7/23/19 **Weather:** 65°F, rainy

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Kortjohn **Serial Number:** 4268

Parameters	Solution Expiration Date	AM Calibration Time 740		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm[c])	11/2019	1.368	1.413	21.90	1.413	22.54	±10 µS/cm	N
pH (7)	3/2020	7.07	7.00	22.20	7.03	22.59	± 0.3 Ph *	N
pH (4)	3/2020	3.71	3.97	22.18	3.92	22.39	± 0.3 Ph *	N
pH (10)	2/2020	9.96	10.00	22.06	9.93	22.48	± 0.3 Ph *	N
ORP (240 mv)	1/2023	251.2	240.1	22.10	245.2	22.51	±10 mv	N
Dissolved Oxygen (%)	—	122.4	100.0	21.09	103.6	21.39	-	N
Dissolved Oxygen (mg/L)	—	10.87	8.90	21.09	9.32	21.39	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 7/23/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens PFAS RI

Instrument: ~~YSI 650 MDS~~ (DK) LaMotte 2020we

Calibrated By: Dave Kortjohn

Serial Number: ~~42~~ 1828-0412

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
7/10/19	0.04	0.03	8.75	10.00	0.03	9.93	
7/11/19	0.04	0.04	9.83	10.00	0.03	9.73	
7/12/19	0.03	0.03	9.72	10.00	0.03	9.92	
7/17/19	0.03	0.03	9.53	10.00	0.02	9.86	
7/18/19	0.00	0.00	10.06	10.00	0.00	10.09	
7/19/19	0.01	0.01	10.12	10.00	0.01	10.03	
7/22/19	0.00	0.00	9.59	10.00	0.00	9.79	
7/23/19	0.01	0.01	9.85	10.00	0.01	9.93	

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: Dave Kortjohn

Date: 7/23/19

KGS

Field Instrument Calibration Log

Date: 7/22/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: V/A **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 620		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.379	1.413	22.21°	1.407	20.15°	±10 µS/cm	N
pH (7)	10/20	6.81	7.00	22.31°	7.11	20.20°	± 0.3 Ph *	N
pH (4)	3/20	4.39	4.00	22.18°	4.02	20.13°	± 0.3 Ph *	N
pH (10)	2/20	9.62	10.00	22.19°	10.03	20.14°	± 0.3 Ph *	N
ORP (240 mv)	10/22	259.7	240.0	22.07°	240.3	20.18	±10 mv	N
Dissolved Oxygen (%)	N/A	118.6%	100.0%	21.70°	91.6%	19.27°	-	N
Dissolved Oxygen (mg/L)	N/A	10.17	10.00	21.68°	9.90	19.30°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/22/19

KGS

Field Instrument Calibration Log

Date: 7/23/19 **Weather:** 70's Heavy Rain

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: VLA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.432	1.413	21.31°	1.407	19.78°	±10 µS/cm	N
pH (7)	10/20	7.30	7.00	21.20°	7.00	19.67°	± 0.3 Ph *	N
pH (4)	3/20	4.19	4.00	21.17°	4.03	19.73°	± 0.3 Ph *	N
pH (10)	2/20	10.40	10.00	21.40°	10.15	19.80°	± 0.3 Ph *	N
ORP (240 mv)	10/22	227.1	240.0	21.37°	241.1	19.77°	±10 mv	N
Dissolved Oxygen (%)	N/A	87.1%	100.0%	21.01°	109.1%	19.73°	-	N
Dissolved Oxygen (mg/L)	N/A	9.47	10.00	20.97°	9.79	19.51°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/23/19

KGS

Field Instrument Calibration Log

Date: 7/24/19 **Weather:** 70's

Project/Site Name: Devens **Instrument:** YSI 650XL

Calibrated By: WA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 615		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.381	1.413	21.70°	1.411	19.90°	±10 µS/cm	N
pH (7)	10/20	7.46	7.00	21.63°	7.02	19.87°	± 0.3 Ph *	N
pH (4)	3/20	4.31	4.00	21.58°	4.01	19.93°	± 0.3 Ph *	N
pH (10)	2/20	10.21	10.00	21.68°	10.00	19.87°	± 0.3 Ph *	N
ORP (240 mv)	10/22	253.7	240.0	21.72°	240.3	19.86°	±10 mv	N
Dissolved Oxygen (%)	N/A	121.6%	100.0%	21.30°	100.2%	19.31°	-	N
Dissolved Oxygen (mg/L)	N/A	9.52	10.00	21.27°	10.01	19.20°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/24/19

KGS

Field Instrument Calibration Log

Date: 7/25/19 **Weather:** Dewns

Project/Site Name: Devons **Instrument:** YSI 650XL

Calibrated By: MM **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.451	1.413	19.21°	1.420	20.18°	±10 µS/cm	N
pH (7)	10/20	7.21	7.00	19.19°	7.03	20.17°	± 0.3 Ph *	N
pH (4)	3/20	4.13	4.00	19.17°	4.01	20.39°	± 0.3 Ph *	N
pH (10)	2/20	9.90	10.00	19.27°	10.01	20.41°	± 0.3 Ph *	N
ORP (240 mv)	10/22	231.6	240.0	19.29°	237.1	20.32°	±10 mv	N
Dissolved Oxygen (%)	N/A	92.1%	100.0%	19.07°	101.6%	20.00°	-	N
Dissolved Oxygen (mg/L)	N/A	9.63	10.00	19.00°	9.81	19.92	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 7/25/19

KGS

Field Instrument Calibration Log

Date: 7/26/19 **Weather:** Devens, MA 70°F Sunny

Project/Site Name: Devens MA PFAS RI **Instrument:** YSI 650 XL

Calibrated By: Melissa Miller **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 710		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	11/19	1410	1413	18.98	1411	24.16	±10 µS/cm	N
pH (7)	10/20	6.98	7.00	19.05	6.98	24.13	± 0.3 Ph *	N
pH (4)	3/20	3.97	4.00	19.10	3.99	23.98	± 0.3 Ph *	N
pH (10)	2/20	9.95	10.00	19.07	9.98	23.89	± 0.3 Ph *	N
ORP (240 mv)	10/22	232.5	240.0	19.20	235.2	23.92	±10 mv	N
Dissolved Oxygen (%)	NA	95.3	100%	18.75	96.8	33.00	-	—
Dissolved Oxygen (mg/L)	NA	9.78	10.00	18.75	9.55	33.00	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	—
Barometric Pressure (mmHg)	NA	—	760	—	—	760	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 7/26/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens

Instrument: LaMotte 2020 we

Calibrated By: VGL / MM

Serial Number: 5083-514

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
7/22	0.30	0.00	10.29	10.00	0.09	10.03	N
7/23	0.27	0.00	10.27	10.00	0.07	10.01	N
7/24	0.19	0.00	9.80	10.00	0.10	10.03	N
7/25	0.07	0.00	9.93	10.00	0.06	10.10	N
7/26/19	0.25	0.00	9.56	9.97	0.05	10.13	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 7/25/19
7/26/19

KGS

Field Instrument Calibration Log

Date: 07/29/19 **Weather:** 70°F, Devens, 90°F

Project/Site Name: Devens, MA PFAS RI **Instrument:** YSI 650XL

Calibrated By: Melissa Miller **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 0655		Cal. Temp. (°C)	PM Post Cal. Check Time 1405	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1346	1413	27.79	1410	32.47	±10 µS/cm	N
pH (7)	10/20	7.65	7.00	27.62	6.91	32.67	± 0.3 Ph *	N
pH (4)	3/20	4.08	4.00	28.10	3.98	32.59	± 0.3 Ph *	N
pH (10)	2/20	10.00	10.00	27.97	9.89	32.65	± 0.3 Ph *	N
ORP (240 mv)	10/22	232.6	240.0	28.18	234.0	32.61	±10 mv	N
Dissolved Oxygen (%)	NA	94.2	100.0	27.87	96.0	34.18	-	N
Dissolved Oxygen (mg/L)	NA	7.60	8.02	27.87	7.98	34.18	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	NA	—	753.7	27.87	—	758.9	-	NA

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 7/29/19

KGS

Field Instrument Calibration Log

Date: 7/30/19 **Weather:** 80's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: [redacted] **Serial Number:** 18B100186

Parameters	Solution Expiration Date	AM Calibration Time 715		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/19	1.397	1.413	24.21°	1.421	23.16°	±10 µS/cm	N
pH (7)	10/20	7.18	7.00	24.30°	7.11	23.18°	± 0.3 Ph *	N
pH (4)	3/20	4.16	4.00	24.32°	4.00	23.21°	± 0.3 Ph *	N
pH (10)	2/20	9.90	10.00	24.29°	10.11	23.07	± 0.3 Ph *	N
ORP (240 mv)	10/22	226.3	240.0	24.18°	241.1	23.00°	±10 mv	N
Dissolved Oxygen (%)	N/A	90.2%	100.0%	24.03°	102.6%	23.00°	-	N
Dissolved Oxygen (mg/L)	N/A	8.99	10.00	24.19°	9.90	22.62°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [redacted] **Date:** 7/30/19

KGS

Field Instrument Calibration Log

Date: 7/31/19 **Weather:** 80's

Project/Site Name: Dever **Instrument:** YSI 650XL

Calibrated By: VBM **Serial Number:** 11B109186

Parameters	Solution Expiration Date	AM Calibration Time 615		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.400	1.413	19.97°	1.426	22.60°	±10 µS/cm	N
pH (7)	2/21	7.31	7.00	20.18°	7.03	22.58°	± 0.3 Ph *	N
pH (4)	3/21	4.18	4.00	20.21°	4.07	22.63°	± 0.3 Ph *	N
pH (10)	2/21	10.46	10.00	20.20°	10.11	22.57°	± 0.3 Ph *	N
ORP (240 mv)	10/19	221.7	240.0	20.13°	241.7	22.53°	±10 mv	N
Dissolved Oxygen (%)	N/A	89.7%	100.0%	19.41°	118.6%	22.30°	-	N
Dissolved Oxygen (mg/L)	N/A	9.66	10.00	19.31°	9.87	22.27°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	←	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: _____ **Date:** 7/31/19

KGS

Field Instrument Calibration Log

Date: 8/1/19 **Weather:** 70s

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: [illegible] **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.429	1.413	21.16°	1.410	22.71°	±10 µS/cm	N
pH (7)	2/21	7.21	7.00	21.20°	7.03	22.68°	± 0.3 Ph *	N
pH (4)	3/21	4.18	4.00	21.29°	4.00	22.63°	± 0.3 Ph *	N
pH (10)	2/21	10.13	10.00	21.30°	10.01	22.81°	± 0.3 Ph *	N
ORP (240 mv)	10/19	242.7	240.0	21.23°	237.6	22.74°	±10 mv	N
Dissolved Oxygen (%)	N/A	91.1%	100.0%	21.01°	101.6%	22.30°	-	N
Dissolved Oxygen (mg/L)	N/A	9.90	10.00	20.97°	9.97	22.47°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/1/19

KGS

Field Instrument Calibration Log

Date: 8/2/19 **Weather:** Clear 80's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: VM **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 615		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.432	1.413	19.21°	1.420	18.37°	±10 µS/cm	N
pH (7)	2/21	7.31	7.00	19.17°	7.03	18.60°	± 0.3 Ph *	N
pH (4)	3/21	4.26	4.00	19.16°	4.09	18.47°	± 0.3 Ph *	N
pH (10)	2/21	10.03	10.00	19.37°	10.07	18.37°	± 0.3 Ph *	N
ORP (240 mv)	10/19	243.7	240.0	19.32°	240.6	18.27°	±10 mv	N
Dissolved Oxygen (%)	N/A	103.2%	60.0%	19.21°	101.1%	18.19°	-	N
Dissolved Oxygen (mg/L)	N/A	9.97	10.00	19.17°	9.98	18.26°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 8/2/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens

Instrument: Lamotte 2020 we

Calibrated By: MM / [illegible]

Serial Number: 5083- 5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
MM 07/29/19	0.0	0.0	9.94	10.0	0.03	9.90	N
7/30/19	0.19	0.00	10.15	10.00	0.09	10.18	N
7/31/19	0.20	0.00	9.87	10.00	0.00	10.07	N
8/1/19	0.17	0.00	9.97	10.00	0.20	10.17	N
8/2/19	0.20	0.00	10.10	10.00	0.13	10.31	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 07/29/19

8/2/19

KGS

Field Instrument Calibration Log

Date: 7/24/19 **Weather:** 78°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Kortjohn **Serial Number:** 4268

Parameters	Solution Expiration Date	AM Calibration Time 930		Cal. Temp. (°C)	PM Post Cal. Check Time 1450	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	1/2019	1.410	1.413	25.21	1.412	25.69	±10 µS/cm	N
pH (7)	3/2020	7.17	7.00	23.68	7.10	25.34	± 0.3 Ph *	N
pH (4)	~~3/20~~ 1/2021	3.62	4.00	25.20	3.90	25.31	± 0.3 Ph *	N
pH (10)	2/2020	9.68	10.00	24.75	9.83	25.26	± 0.3 Ph *	N
ORP (240 mv)	1/2023	238.1	240.0	25.54	239.3	25.39	±10 mv	N
Dissolved Oxygen (%)	—	101.0	100.0	24.97	79.3	26.83	-	Y
Dissolved Oxygen (mg/L)	—	8.39	8.28	24.97	6.73	26.83	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 7/24/19

Field Instrument Calibration Log

Date: 7/25/19 **Weather:** 75°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Kortjohn **Serial Number:** 4268

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.407	1.413	20.38	1.413	22.38	±10 µS/cm	N
pH (7)	3/2020	6.88	7.00	20.61	7.09	22.24	± 0.3 Ph *	N
pH (4)	1/2021	3.63	3.95	21.11	3.83	22.31	± 0.3 Ph *	N
pH (10)	2/2020	9.82	10.00	20.81	9.89	22.51	± 0.3 Ph *	N
ORP (240 mv)	1/2023	244.8	240.0	20.79	242.3	22.42	±10 mv	N
Dissolved Oxygen (%)	—	64.0	100.0	20.07	98.0	23.58	-	N
Dissolved Oxygen (mg/L)	—	5.85	9.10	20.07	8.30	23.58	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 7/25/19

Field Instrument Calibration Log

Date: 7/26/19 **Weather:** 80°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DDS ~~+10t~~ 626910-10

Calibrated By: Dave Korfjohn **Serial Number:** ~~18L100145~~ (DK) 17L101163

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.393	1.410	23.20	1.411	24.10	±10 µS/cm	N
pH (7)	2/2021	7.06	7.00	23.50	7.01	24.20	± 0.3 Ph *	N
pH (4)	3/2021	3.91	4.00	23.00	3.98	24.10	± 0.3 Ph *	N
pH (10)	2/2021	10.08	10.00	23.25	10.03	24.30	± 0.3 Ph *	N
ORP (240 mv)	10/2019	234.2	240.0	22.60	239.6	24.10	±10 mv	N
Dissolved Oxygen (%)	–	99.4	100.0	21.60	100.3	23.10	-	N
Dissolved Oxygen (mg/L)	–	8.91	8.94	21.60	8.95	23.10	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	–	760	–	–	760	–	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Korfjohn **Date:** 7/26/19

Turbidity Instrument Calibration Log

Project/Site Name: Devens PFAS RI

Instrument: ~~650~~ LaMotte 2020we

Calibrated By: Dave Kortjohn

Serial Number: 1828-0412

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
7/24/19	0.01	0.01	9.83	10.00	0.01	9.79	
7/25/19	0.01	0.01	9.11	10.00	0.01	9.85	
7/26/19	0.00	0.00	9.59	10.00	0.00	9.92	

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: Dave Kortjohn

Date: 7/26/19

Field Instrument Calibration Log

Date: 7/29/19 **Weather:** 85°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1410	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.409	1.413	26.9	1.412	27.9	±10 µS/cm	N
pH (7)	2/2021	7.18	7.00	27.0	7.03	27.9	± 0.3 Ph *	N
pH (4)	3/2021	4.19	4.01	26.8	4.02	28.3	± 0.3 Ph *	N
pH (10)	2/2021	9.78	9.98	26.7	9.97	27.8	± 0.3 Ph *	N
ORP (240 mv)	10/2019	226.6	240.0	26.5	236.7	28.1	±10 mv	N
Dissolved Oxygen (%)	—	99.5	8.10	25.8	99.8	26.3	-	N
Dissolved Oxygen (mg/L)	—	100.0	8.12	25.8	8.12	26.3	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	755.9	—	—	755.9	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 7/29/19

KGS

Field Instrument Calibration Log

Date: 7/30/19 **Weather:** 85°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.410	1.413	26.7	1.413	27.8	±10 µS/cm	N
pH (7)	2/2021	7.12	7.00	27.1	7.02	27.5	± 0.3 Ph *	N
pH (4)	3/2021	4.17	4.00	27.1	4.03	27.9	± 0.3 Ph *	N
pH (10)	2/2021	9.93	10.00	26.9	9.99	27.5	± 0.3 Ph *	N
ORP (240 mv)	10/2019	229.3	240.0	27.2	239.6	27.9	±10 mv	N
Dissolved Oxygen (%)	—	98.6	100.0	25.9	100.2	26.3	-	N
Dissolved Oxygen (mg/L)	—	8.09	8.13	25.9	8.10	26.3	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760.3	—	—	760.3	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 7/30/19

KGS

Field Instrument Calibration Log

Date: 7/31/19 **Weather:** 80°F, sunny - 90°F

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kerfjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time ~~1445~~ (OK) 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1445	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.377	1.413	30.3	1.413	30.9	±10 µS/cm	N
pH (7)	2/2021	6.90	7.00	30.0	6.98	30.7	± 0.3 Ph *	N
pH (4)	3/2021	4.03	4.00	30.3	4.02	30.5	± 0.3 Ph *	N
pH (10)	2/2021	9.92	10.00	30.5	9.98	30.6	± 0.3 Ph *	N
ORP (240 mv)	10/2019	218.2	240.0	30.3	238.1	30.9	±10 mv	N
Dissolved Oxygen (%)	—	99.5	99.8	27.5	100.7	28.7	-	N
Dissolved Oxygen (mg/L)	—	7.77	7.83	27.5	8.03	28.7	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	756.7	—	—	756.7	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kerfjohn **Date:** 7/31/19

Field Instrument Calibration Log

Date: 8/6/19 **Weather:** 80°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** ~~18100145~~ DK 17401163

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.621	1.413	23.0	1.415	22.8	±10 µS/cm	N
pH (7)	10/2020	7.02	7.00	21.4	7.00	22.3	± 0.3 Ph *	N
pH (4)	3/2021	3.73	4.00	22.4	3.98	22.5	± 0.3 Ph *	N
pH (10)	2/2021	10.24	10.02	22.6	10.02	22.7	± 0.3 Ph *	N
ORP (240 mv)	10/2019	249.0	240.0	23.1	242.3	23.2	±10 mv	N
Dissolved Oxygen (%)	—	101.1	100.0	19.5	99.6	20.2	-	N
Dissolved Oxygen (mg/L)	—	9.18	9.00	19.2	8.95	20.2	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	753.6	—	—	753.6	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: David K Kortjohn **Date:** 8/6/19

KGS

Field Instrument Calibration Log

Date: 8/7/19 **Weather:** 83°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Korfjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.371	1.413	25.5	1.412	25.9	±10 µS/cm	N
pH (7)	10/2020	7.00	7.00	26.1	7.02	25.8	± 0.3 Ph *	N
pH (4)	3/2021	3.71	4.00	25.8	3.99	26.1	± 0.3 Ph *	N
pH (10)	2/2021	10.23	9.99	26.0	10.00	26.3	± 0.3 Ph *	N
ORP (240 mv)	10/2019	234.8	240.0	25.6	239.4	26.2	±10 mv	N
Dissolved Oxygen (%)	—	100.6	99.9	23.7	100.8	23.9	-	N
Dissolved Oxygen (mg/L)	—	8.41	8.46	23.7	8.40	23.9	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	751.6	—	—	751.5	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/7/19

KGS

Field Instrument Calibration Log

Date: 8/8/19 **Weather:** 85°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time 740		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.401	1.413	25.5	1.414	26.3	±10 µS/cm	N
pH (7)	10/2020	7.07	7.00	25.3	7.03	26.1	± 0.3 Ph *	N
pH (4)	3/2021	3.82	4.01	25.4	4.00	25.9	± 0.3 Ph *	N
pH (10)	2/2021	10.23	10.00	25.4	10.01	26.3	± 0.3 Ph *	N
ORP (240 mv)	10/2019	237.2	240.0	25.6	239.3	26.1	±10 mv	N
Dissolved Oxygen (%)	–	98.5	100.0	24.2	98.9	25.3	-	N
Dissolved Oxygen (mg/L)	–	8.24	8.38	24.2	8.29	25.3	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	–	747.4	–	–	748.2	–	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 8/8/19

Field Instrument Calibration Log

Date: 8/12/19 **Weather:** 75°F, sunny

Project/Site Name: Devens PFAS AI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.394	1.413	21.8	1.410	24.9	±10 µS/cm	N
pH (7)	10/2020	~~7.02~~ 6.89 OK	7.00	21.6	7.01	25.4	± 0.3 Ph *	N
pH (4)	3/2021	3.78	4.00	21.5	3.98	25.3	± 0.3 Ph *	N
pH (10)	2/2021	10.24	10.02	21.3	10.13	25.6	± 0.3 Ph *	N
ORP (240 mv)	10/2019	245.1	240.0	21.6	241.3	25.2	±10 mv	N
Dissolved Oxygen (%)	—	97.6	99.2	20.3	100.7	24.1	-	N
Dissolved Oxygen (mg/L)	—	8.95	8.96	20.3	8.47	23.9	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	753.7	—	—	752.1	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/12/19

KGS

Field Instrument Calibration Log

Date: 8/13/19 **Weather:** 80°F, cloudy/rainy

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1320	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	1/5/2019	1.409	1.413	27.7	1.411	27.9	±10 µS/cm	N
pH (7)	10/2020	6.94	7.00	26.7	6.98	27.6	± 0.3 Ph *	N
pH (4)	3/2021	3.86	4.01	27.2	3.98	27.5	± 0.3 Ph *	N
pH (10)	2/2021	10.27	10.00	27.3	10.03	27.4	± 0.3 Ph *	N
ORP (240 mv)	10/2019	225.6	240.0	26.8	238.6	27.3	±10 mv	N
Dissolved Oxygen (%)	—	97.4	99.7	25.8	99.6	26.2	-	N
Dissolved Oxygen (mg/L)	—	7.99	8.01	25.8	8.04	26.2	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	750.0	—	—	751.3	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 8/13/19

Turbidity Instrument Calibration Log

Project/Site Name: Devens PFAS RI **Instrument:** LaMotte 2020 we

Calibrated By: Dave Kortjohn **Serial Number:** 1828-0412

	AM Calibration				PM Post Calibration Check		
Date	**Pre-Cal 0 NTU**	**Post-Cal 0 NTU**	**Pre-Cal 10 NTU**	**Post-Cal 10 NTU**	**0 NTU**	**10 NTU**	**Variance Noted**
7/29/19	0.01	0.01	9.82	10.00	0.01	9.95	
7/30/19	0.01	0.01	9.54	10.00	0.01	9.81	
7/31/19	0.00	0.00	10.42	10.00	0.00	10.13	
8/6/19	0.03	0.03	10.14	10.00	0.02	10.09	
8/7/19	0.01	0.01	10.19	10.00	0.01	10.08	
8/8/19	0.01	0.01	10.11	10.00	0.01	10.21	
8/12/19	0.03	0.03	8.31	10.00	0.03	9.58	
8/13/19	0.02	0.02	9.43	10.00	0.02	9.87	

Post Calibration Criteria	
-	±0.5

Notes: Mark Noted Variences on Field Forms

Signature: Dave Kortjohn **Date:** 8/13/19

KGS

Field Instrument Calibration Log

Date: 8/1/14 **Weather:** Sunny 80°

Project/Site Name: Olmen **Instrument:** YSI PRO DSS

Calibrated By: GH **Serial Number:** 18L00145

Parameters	Solution Expiration Date	AM Calibration Time 0700		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	03/2020	1.251	1.413	24.4	1.412	27.2	±10 µS/cm	N
pH (7)	2/2021	7.01	7.00	24.5	6.97	26.8	± 0.3 Ph *	N
pH (4)	03/2021	4.00	4.00	24.2	4.02	26.8	± 0.3 Ph *	N
pH (10)	2/2021	10.01	10.01	24.4	9.95	26.3	± 0.3 Ph *	N
ORP (240 mv)	10/2019	238	240	24.3	246.0	27.0	±10 mv	N
Dissolved Oxygen (%)		99.5	99.5	25.2	99.8	26.9	-	N
Dissolved Oxygen (mg/L)		8.37	8.37	25.2	7.96	26.9	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)		757.0	756.5	25.2	756.7	27.1	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8-1-2014

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devin

Instrument: Lamotte 2020

Calibrated By: CH

Serial Number: 1828

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
8/4/2016	1.12	0	6.84	10.0	0.40	9.34	NA

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: _____

Date: _____

KGS

Field Instrument Calibration Log

Date: 8-5-2019 **Weather:** Sunny 80°

Project/Site Name: Ft. Devens RI **Instrument:** YSI DO5

Calibrated By: GH **Serial Number:** 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 6:40		Cal. Temp. (°C)	PM Post Cal. Check Time 1520	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	3/2020	1.377	1.413	21.0	1.479	~~26.5~~ ~~1.413~~ (GH)	±10 µS/cm	Y
pH (7)	2/2020	7.08	7.01	21.1	7.04	26.6	± 0.3 Ph *	N
pH (4)	2/2021	4.09	4.00	21.1	3.98	26.6	± 0.3 Ph *	N
pH (10)	2/2021	9.94	10.01	21.0	10.09	26.4	± 0.3 Ph *	N
ORP (240 mv)	10/2019	238.2	240.0	21.1	238.5	~~26.0~~	±10 mv	N
Dissolved Oxygen (%)	-	97.3	99.6	21.8	98.2	~~99.6~~ 28.1 (GH)	-	N
Dissolved Oxygen (mg/L)	-	8.79	8.76	21.8	8.82	(GH) ~~8.76~~ 28.1	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	-	755.3	755.4	21.8	756.1	-	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8-5-19

Turbidity Instrument Calibration Log

Project/Site Name: FT ORD/MZ

Instrument: Lamotte 2020 WE

Calibrated By: GH

Serial Number: 5083

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
8-5-19	1.2	0.4	7.51	10.0	0.6	9.6	NA

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: _____

Date: _____

KGS

Field Instrument Calibration Log

Date: 8/5/19 **Weather:** 80's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: WA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.392	1.413	18.16°	1.420	18.47°	±10 µS/cm	N
pH (7)	2/21	7.26	7.00	18.18°	7.06	18.49°	± 0.3 Ph *	N
pH (4)	3/21	4.21	4.00	18.30°	4.00	18.50°	± 0.3 Ph *	N
pH (10)	2/21	10.31°	10.00	18.27°	9.90	18.47°	± 0.3 Ph *	N
ORP (240 mv)	10/19	249.7	240.0	18.26°	236.3	18.44°	±10 mv	N
Dissolved Oxygen (%)	N/A	87.6%	100.0%	18.40°	93.1%	18.40°	-	N
Dissolved Oxygen (mg/L)	N/A	10.29	10.00	18.18°	10.10	18.20°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	18.15°	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/5/19

KGS

Field Instrument Calibration Log

Date: 8/6/19 **Weather:** 80's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: KMR **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.451	1.413	19.92°	1.420	20.13°	±10 µS/cm	N
pH (7)	2/21	7.30	7.00	19.96°	6.87	20.18°	± 0.3 Ph *	N
pH (4)	3/21	4.11	4.00	19.91°	4.09	20.20°	± 0.3 Ph *	N
pH (10)	2/21	10.80	10.00	19.97°	9.79	20.17°	± 0.3 Ph *	N
ORP (240 mv)	10/19	246.1	240.0	19.58°	231.1	20.11°	±10 mv	N
Dissolved Oxygen (%)	N/A	103.3%	100.0%	19.40°	89.6%	20.00°	-	N
Dissolved Oxygen (mg/L)	N/A	9.60	10.00	19.32°	9.81	19.97°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/6/19

KGS

Field Instrument Calibration Log

Date: 8/7/19 **Weather:** ~~D~~ 70's Hazy Later Rain / Thunder

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: MBA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 615		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.387	1.413	21.16°	1.409	18.60°	±10 µS/cm	N
pH (7)	2/21	6.87	7.00	21.19°	7.11	18.57°	± 0.3 Ph *	N
pH (4)	3/21	4.13	4.00	21.17°	4.00	18.42°	± 0.3 Ph *	N
pH (10)	2/21	9.90	10.00	21.02°	10.11	18.39°	± 0.3 Ph *	N
ORP (240 mv)	10/19	252.6	240.0	21.03°	242.6	18.37°	±10 mv	N
Dissolved Oxygen (%)	N/A	100.0%	100.0%	21.10°	92.1%	18.36°	-	N
Dissolved Oxygen (mg/L)	N/A	9.72	10.00	20.97°	9.90	18.11°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	18.13°	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/7/19

KGS

Field Instrument Calibration Log

Date: 8/8/19 **Weather:** 70's

Project/Site Name: Devens **Instrument:** YSI 650XL

Calibrated By: WA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Variance Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.382	1.413	18.63°	1.403	19.87°	±10 µS/cm	N
pH (7)	2/21	7.18	7.00	18.79°	7.02	19.96°	± 0.3 Ph *	N
pH (4)	3/21	4.12	4.00	18.69°	4.02	20.31°	± 0.3 Ph *	N
pH (10)	2/21	10.27	10.00	18.73°	10.06	20.26°	± 0.3 Ph *	N
ORP (240 mv)	10/19	231.6	240.0	18.82°	237.2	20.24°	±10 mv	N
Dissolved Oxygen (%)	N/A	100.9%	100.0%	18.71°	111.1%	20.03°	-	N
Dissolved Oxygen (mg/L)	N/A	9.97	10.00	18.37°	10.07	20.09°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 8/8/19

KGS

Field Instrument Calibration Log

Date: 8/9/19 **Weather:** 80's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: VM **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varienc Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.431	1.413	20.06°	1.422	20.19°	±10 µS/cm	N
pH (7)	2/21	7.16	7.00	20.13°	7.10	20.01°	± 0.3 Ph *	N
pH (4)	3/21	4.09	4.00	20.20°	4.03	19.77°	± 0.3 Ph *	N
pH (10)	2/21	10.18	10.00	20.14°	10.01	19.86°	± 0.3 Ph *	N
ORP (240 mv)	10/19	241.1	240.0	20.18°	239.0	19.89°	±10 mv	N
Dissolved Oxygen (%)	N/A	127.6%	100.0%	19.79°	106.9%	19.50°	-	N
Dissolved Oxygen (mg/L)	N/A	10.40	10.00	19.96°	10.03	19.40°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Form

Signature: [signature] **Date:** 8/9/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens

Instrument: LaMotte 2020WE

Calibrated By: KGS

Serial Number: 5083-5014

Date	AM Calibration Pre-Cal 0 NTU	AM Calibration Post-Cal 0 NTU	AM Calibration Pre-Cal 10 NTU	AM Calibration Post-Cal 10 NTU	PM Post Calibration Check 0 NTU	PM Post Calibration Check 10 NTU	Variance Noted
☆ 8/5/19	0.09	0.00	10.07	10.00	0.11	10.02	N
8/6/19	0.31	0.00	9.91	10.00	0.22	10.18	N
8/7/19	0.18	0.00	10.02	10.00	0.03	10.09	N
8/8/19	0.12	0.00	10.27	10.00	0.06	10.02	N
8/9/19	0.09	0.00	10.13	10.00	0.00	10.21	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature]

Date: 8/9/19

☆ SN = 1828-0412

KGS

Field Instrument Calibration Log

Date: 8/14/19 **Weather:** 75°F, cloudy

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 17401163

Parameters	Solution Expiration Date	AM Calibration Time 740		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.408	1.413	24.1	1.413	24.3	±10 µS/cm	N
pH (7)	10/2020	7.41	7.00	23.8	7.10	24.2	± 0.3 Ph *	N
pH (4)	3/2021	4.43	4.00	24.3	4.08	24.3	± 0.3 Ph *	N
pH (10)	2/2021	9.87 ~~10.43~~ DK	10.00	25.1	9.98	24.6	± 0.3 Ph *	N
ORP (240 mv)	10/2019	246.4	240.0	24.2	241.2	24.8	±10 mv	N
Dissolved Oxygen (%)	–	98.9	99.9	21.5	98.8	22.6	-	N
Dissolved Oxygen (mg/L)	–	8.73	8.73	21.5	8.70	22.6	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	–	751.8	–	–	751.9	–	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 8/14/19

KGS

Field Instrument Calibration Log

Date: 8/15/19 **Weather:** 75°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Korfjohn **Serial Number:** ~~17401163~~ OK 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1420	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1413 µS/cm°)	11/2019	1.393	1.413	23.5	1.414	25.5	±10 µS/cm	N
pH (7)	10/2020	6.64	7.00	24.1	6.96	25.3	± 0.3 Ph *	N
pH (4)	3/2021	4.17	4.00	23.5	4.03	25.3	± 0.3 Ph *	N
pH (10)	2/2021	9.47	10.01	23.8	9.94	25.6	± 0.3 Ph *	N
ORP (240 mv)	10/2019	237.5	240.0	23.5	238.6	25.5	±10 mv	N
Dissolved Oxygen (%)	—	98.9	99.5	21.7	99.6	24.3	-	N
Dissolved Oxygen (mg/L)	—	8.74	8.74	21.7	8.79	24.3	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	755.7	—	—	756.3	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Korfjohn **Date:** 8/15/19

KGS

Field Instrument Calibration Log

Date: 8/16/19 **Weather:** 75 - 80°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.417	1.413	24.3	1.415	26.8	±10 µS/cm	N
pH (7)	10/2020	6.87	7.00	24.6	6.99	27.3	± 0.3 Ph *	N
pH (4)	3/2021	10.08	10.00	24.6	10.03	27.1	± 0.3 Ph *	N
pH (10)	2/2021	4.11	4.00	24.2	4.03	26.9	± 0.3 Ph *	N
ORP (240 mv)	10/2019	237.0	240.0	24.3	239.3	26.9	±10 mv	N
Dissolved Oxygen (%)	—	98.4	99.6	22.8	99.7	24.1	-	N
Dissolved Oxygen (mg/L)	—	8.63	8.63	22.8	8.68	24.1	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	757.0	—	—	757.3	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 8/16/19

KGS

Field Instrument Calibration Log

Date: 8/19/19 **Weather:** 80-85°F, sunny

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.403	1.413	28.1	1.413	30.7	±10 µS/cm	N
pH (7)	10/2020	6.86	7.00	27.5	6.94	30.4	± 0.3 Ph *	N
pH (4)	3/2021	4.14	4.01	27.8	4.03	30.5	± 0.3 Ph *	N
pH (10)	2/2021	10.01	10.00	27.6	10.00	30.6	± 0.3 Ph *	N
ORP (240 mv)	10/2019	229.7	240.0	27.9	239.6	30.5	±10 mv	N
Dissolved Oxygen (%)	—	99.2	100.0	26.9	99.7	29.3	-	N
Dissolved Oxygen (mg/L)	—	7.95	7.97	26.9	7.86	29.3	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	754.3	—	—	754.8	-	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 8/19/19

KGS

Field Instrument Calibration Log

Date: 8/21/19 **Weather:** 80°F, ~~sun~~ cloudy / rainy

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1240	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.411	1.413	26.5	1.412	27.6	±10 µS/cm	N
pH (7)	10/2020	6.89	7.00	26.7	7.01	27.7	± 0.3 Ph *	N
pH (4)	3/2021	4.11	4.00	26.5	4.02	27.5	± 0.3 Ph *	N
pH (10)	2/2021	10.06	10.00	26.6	10.00	27.7	± 0.3 Ph *	N
ORP (240 mv)	10/2019	232.4	240.0	26.3	238.3	27.7	±10 mv	N
Dissolved Oxygen (%)	–	99.3	100.0	24.5	99.8	25.9	-	N
Dissolved Oxygen (mg/L)	–	7.98	8.03	24.5	8.00	25.9	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	–	753.2	–	–	753.2	–	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: David Kortjohn **Date:** 8/21/19

KGS

Field Instrument Calibration Log

Date: 8/23/19 **Weather:** 75°F, cloudy

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Dave Kortjohn **Serial Number:** 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 745		Cal. Temp. (°C)	PM Post Cal. Check Time 1420	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	10/2019	1.406	1.413	24.9	1.423	26.1	±10 µS/cm	N
pH (7)	10/2020	6.82	7.00	25.3	6.89	25.9	± 0.3 Ph *	N
pH (4)	3/2021	4.09	4.01	24.9	4.12	25.7	± 0.3 Ph *	N
pH (10)	2/2021	10.02	10.00	24.9	10.12	25.8	± 0.3 Ph *	N
ORP (240 mv)	10/2019	241.0	240.0	25.0	238.4	26.0	±10 mv	N
Dissolved Oxygen (%)	—	97.3	99.4	22.9	99.6	24.1	-	N
Dissolved Oxygen (mg/L)	—	8.55	8.55	22.9	9.01	24.1	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	755.3	—	—	755.1	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Dave Kortjohn **Date:** 8/23/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens PFAS RI

Instrument: LaMotte 2020we

Calibrated By: Dave Kortjohn

Serial Number: 1828-0412

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
8/14/19	0.01	0.01	10.13	10.00	0.01	10.03	
8/15/19	0.00	0.00	8.42	10.00	0.00	9.58	
8/16/19	0.00	0.00	9.56	10.00	0.00	9.91	
8/19/19	0.01	0.01	9.84	10.00	0.01	10.11	
8/21/19	0.01	0.01	10.12	10.00	0.01	9.96	
8/23/19	0.02	0.02	10.93	10.00	0.01	8.99	

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: Dave Kortjohn

Date: 8/23/19

KGS

Field Instrument Calibration Log

Date: 8/12/19 **Weather:** 80's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: VM **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Variance Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.397	1.413	18.71°	1.404	18.99°	±10 µS/cm	N
pH (7)	2/21	7.36	7.00	18.62°	7.07	19.07°	± 0.3 Ph *	N
pH (4)	3/21	4.11	4.00	18.59°	4.00	19.11°	± 0.3 Ph *	N
pH (10)	2/21	10.07	10.00	18.70°	10.13	19.08°	± 0.3 Ph *	N
ORP (240 mv)	10/19	241.3	240.0	18.63°	237.1	19.13°	±10 mv	N
Dissolved Oxygen (%)	N/A	121.0%	100.0%	18.30°	91.1%	19.18°	-	N
Dissolved Oxygen (mg/L)	N/A	9.60	10.00	18.07°	10.09	19.41°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 8/12/19

KGS

Field Instrument Calibration Log

Date: ~~8/14/19~~ 8/14/19 **Weather:** 80's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: VBL **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 615		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.382	1.413	20.03°	1.399	18.78°	±10 µS/cm	N
pH (7)	2/21	7.49	7.00	20.18°	7.02	18.60°	± 0.3 Ph *	N
pH (4)	3/21	4.02	4.00	20.17°	4.11	18.71°	± 0.3 Ph *	N
pH (10)	2/21	10.11	10.00	20.30°	10.03	18.63°	± 0.3 Ph *	N
ORP (240 mv)	10/19	237.1	240.0	20.18°	237.7	18.59°	±10 mv	N
Dissolved Oxygen (%)	N/A	100.1%	100.0%	20.03°	100.6%	18.41°	-	N
Dissolved Oxygen (mg/L)	N/A	10.16	10.00	19.97	9.90	18.39°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 8/14/19

KGS

Field Instrument Calibration Log

Date: 8/15/19 **Weather:** 70's

Project/Site Name: Devens **Instrument:** YSI 650 XL

Calibrated By: KML **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1420	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.432	1.413	19.07°	1.416	17.31°	±10 µS/cm	N
pH (7)	2/21	7.20	7.00	19.13°	7.02	17.46°	± 0.3 Ph *	N
pH (4)	3/21	4.18	4.00	19.18°	4.01	17.36°	± 0.3 Ph *	N
pH (10)	2/21	9.73	10.00	19.03°	10.03	17.40°	± 0.3 Ph *	N
ORP (240 mv)	10/19	256.7	240.0	19.09°	241.1	17.27°	±10 mv	N
Dissolved Oxygen (%)	N/A	109.2%	100.0%	19.00°	101.2%	17.23°	-	N
Dissolved Oxygen (mg/L)	N/A	10.07	10.00	18.97°	9.97	17.18°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760		769	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/15/19

KGS

Field Instrument Calibration Log

Date: 8/16/19 **Weather:** 80's

Project/Site Name: Devens **Instrument:** YSI 650XL

Calibrated By: KBA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 615		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.378	1.413	21.17°	1.410	20.03°	±10 µS/cm	N
pH (7)	2/21	7.21	7.00	21.30°	7.03	20.09°	± 0.3 Ph *	N
pH (4)	3/21	4.06	4.00	21.13°	4.06	20.18°	± 0.3 Ph *	N
pH (10)	2/21	10.01	10.00	21.16°	10.11	20.27°	± 0.3 Ph *	N
ORP (240 mv)	10/19	252.6	240.0	21.21°	241.1	20.13°	±10 mv	N
Dissolved Oxygen (%)	N/A	131.7%	100.0%	21.20°	107.1%	19.78°	-	N
Dissolved Oxygen (mg/L)	N/A	9.87	10.00	21.01°	9.92	19.21°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/16/19

Turbidity Instrument Calibration Log

Project/Site Name: Devers

Instrument: LaMotte 2020we

Calibrated By: MA

Serial Number: ~~5044~~ 5083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
8/12/19	0.31	0.00	9.70	10.00	0.04	10.11	N
~~8/13/19~~	~~0.20~~	~~0.00~~	~~10.03~~	~~10.00~~	MA		
8/14/19	0.11	0.00	9.90	10.00	0.13	9.90	N
8/15/19	0.23	0.00	10.11	10.00	0.10	9.97	N
8/16/19	0.19	0.00	10.21	10.00	0.07	10.03	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 8/16/19

KGS

Field Instrument Calibration Log

Date: 8/19/19 **Weather:** 80's

Project/Site Name: Devens **Instrument:** YSI 650XL

Calibrated By: KA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.437	1.413	20.15°	1.410	19.70°	±10 µS/cm	N
pH (7)	2/21	7.21	7.00	20.18°	7.03	19.68°	± 0.3 Ph *	N
pH (4)	3/21	4.03	4.00	20.19°	4.11	19.60°	± 0.3 Ph *	N
pH (10)	2/21	9.60	10.00	20.09°	10.09	19.73°	± 0.3 Ph *	N
ORP (240 mv)	10/19	231.2	240.0	20.17°	247.7	19.71°	±10 mv	N
Dissolved Oxygen (%)	N/A	109.6%	100.0%	20.00°	91.6%	19.40°	-	N
Dissolved Oxygen (mg/L)	N/A	10.37	10.00	19.93°	10.07	19.50°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	769	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/19/19

KGS

Field Instrument Calibration Log

Date: 8/20/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: [illegible] **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.432	1.413	20.19°	1.411	22.60°	±10 µS/cm	N
pH (7)	2/21	7.21	7.00	20.37°	7.00	22.77°	± 0.3 Ph *	N
pH (4)	3/21	4.06	4.00	20.41°	4.11	22.80°	± 0.3 Ph *	N
pH (10)	2/21	10.20	10.00	20.40°	9.87	22.69°	± 0.3 Ph *	N
ORP (240 mv)	10/19	227.1	240.0	20.39°	241.1	22.70°	±10 mv	N
Dissolved Oxygen (%)	N/A	91.6%	100.0%	20.01°	93.2%	22.10°	-	N
Dissolved Oxygen (mg/L)	N/A	9.63	10.00	20.13°	9.80	22.03°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/20/19

KGS

Field Instrument Calibration Log

Date: 8/21/19 **Weather:** 70's heavy rain

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: RLG **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.430	1.413	17.89°	1.410	16.97°	±10 µS/cm	N
pH (7)	2/21	7.09	7.00	18.03°	7.02	17.11°	± 0.3 Ph *	N
pH (4)	3/21	4.16	4.00	18.11°	4.01	17.27°	± 0.3 Ph *	N
pH (10)	2/21	10.16	10.00	18.40°	10.15	17.80°	± 0.3 Ph *	N
ORP (240 mv)	10/19	253.1	240.0	18.24°	241.7	17.63°	±10 mv	N
Dissolved Oxygen (%)	N/A	91.0%	100.0%	18.12°	107.6%	17.30°	-	N
Dissolved Oxygen (mg/L)	N/A	10.47	10.00	18.17°	9.90	17.20°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/21/19

KGS

Field Instrument Calibration Log

Date: 8/22/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 620		Cal. Temp. (°C)	PM Post Cal. Check Time 1330	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.432	1.413	22.16°	1.403	24.18°	±10 µS/cm	N
pH (7)	2/21	7.18	7.00	22.30°	7.20	24.21°	± 0.3 Ph *	N
pH (4)	3/21	4.21	4.00	22.46°	4.09	24.30°	± 0.3 Ph *	N
pH (10)	2/21	10.36	10.00	22.38°	9.89	24.27°	± 0.3 Ph *	N
ORP (240 mv)	10/19	251.7	240.0	22.21°	243.7	24.23°	±10 mv	N
Dissolved Oxygen (%)	N/A	89.1%	100.0%	22.01°	96.1%	24.02°	-	N
Dissolved Oxygen (mg/L)	N/A	9.47	10.00	22.11°	9.82	24.11	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/24/19

KGS

Field Instrument Calibration Log

Date: 8/23/19 **Weather:** 80's

Project/Site Name: Davis **Instrument:** YSI 6560L

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 620		Cal. Temp. (°C)	PM Post Cal. Check Time 1345	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm[c])	3/20	1.447	1.413	21.16°	1.420	15.98°	±10 µS/cm	N
pH (7)	2/21	7.38	7.00	21.33°	7.11	15.87°	± 0.3 Ph *	N
pH (4)	3/21	4.11	4.00	21.39°	4.18	15.84°	± 0.3 Ph *	N
pH (10)	2/21	9.72	10.00	21.19°	9.90	15.93°	± 0.3 Ph *	N
ORP (240 mv)	10/19	231.6	240.0	21.47°	246.1	15.82°	±10 mv	N
Dissolved Oxygen (%)	N/A	139.2%	100.0%	21.00°	97.1%	15.71°	-	N
Dissolved Oxygen (mg/L)	N/A	9.47	10.00	20.92°	9.90	15.32°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms

Signature: _____ **Date:** 8/23/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens

Instrument: LaMotte 2020e

Calibrated By: NA

Serial Number: 5083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
8/19/19	0.13	0.00	9.97	10.00	0.03	9.70	N
8/20/19	0.27	0.00	9.99	10.00	0.00	10.03	N
8/21/19	0.09	0.00	10.14	10.00	0.07	10.01	N
8/22/19	0.31	0.00	9.80	10.00	0.20	10.15	N
8/23/19	0.29	0.00	10.16	10.00	0.03	10.02	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 8/23/19

KGS

Field Instrument Calibration Log

Date: 8/26/19 **Weather:** Sunny, 60's-70's (°F)

Project/Site Name: Downs PFAS; Rig #1 **Instrument:** YSI 650 MDS

Calibrated By: CV **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 0700		Cal. Temp. (°C)	PM Post Cal. Check Time 1415	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1,419	1,413	17.98	1,419	22.30	±10 µS/cm	N
pH (7)	2/21	7.21	~~7.00~~ 7.01	17.61	6.82	21.68	± 0.3 Ph *	N
pH (4)	3/21	4.00	4.00	17.70	4.10	22.15	± 0.3 Ph *	N
pH (10)	2/21	10.09	10.00	17.81	10.15	23.19	± 0.3 Ph *	N
ORP (240 mv)	10/19	231.6	240.0	18.08	231.7	22.71	±10 mv	N
Dissolved Oxygen (%)	—	113.2	99.9	17.50	93.5	19.01	-	—
Dissolved Oxygen (mg/L)	—	11.01	10.21	17.50	9.99	19.01	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/26/19

KGS

Field Instrument Calibration Log

Date: 8/27/19 **Weather:** Sunny, 70's (°F)

Project/Site Name: Downs PFAS RI; Rig #7 **Instrument:** YSI 650 MDS

Calibrated By: CV **Serial Number:** 11B100184

Parameters	Solution Expiration Date	AM Calibration Time 0630		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.4125	1,413	18.21	1,404	21.56	±10 µS/cm	N
pH (7)	2/21	6.89	7.00	18.25	6.94	21.24	± 0.3 Ph *	N
pH (4)	3/21	3.85	4.00	18.15	4.12	22.01	± 0.3 Ph *	N
pH (10)	2/21	9.86	10.00	18.08	9.94	21.41	± 0.3 Ph *	N
ORP (240 mv)	10/19	255.9	240.0	18.10	231.1	22.12	±10 mv	N
Dissolved Oxygen (%)	—	96.9	100.0	17.21	102.2	21.49	-	—
Dissolved Oxygen (mg/L)	—	8.99	9.68	17.21	8.28	21.49	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/27/19

KGS

Field Instrument Calibration Log

Date: 8/28/19 **Weather:** Sunny 70's - 80's

Project/Site Name: Dorms PFAS RI : R.g #1 **Instrument:** YSI 650 MDS

Calibrated By: AV **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 0625		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1,442	1,413	21.10	1,405	24.80	±10 µS/cm	N
pH (7)	2/21	7.40	7.00	21.01	6.88	24.29	± 0.3 Ph *	N
pH (4)	3/21	4.16	4.00	21.23	3.99	24.33	± 0.3 Ph *	N
pH (10)	2/21	10.04	10.00	20.99	9.85	24.71	± 0.3 Ph *	N
ORP (240 mv)	10/19	235.1	240.0	21.53	231.5	24.80	±10 mv	N
Dissolved Oxygen (%)	—	100.9	100.0	20.90	101.5	22.71	-	—
Dissolved Oxygen (mg/L)	—	9.19	8.89	20.90	8.98	22.71	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/28/19

KGS

Field Instrument Calibration Log

Date: 8/29/19 **Weather:** 70'-80's Sunny

Project/Site Name: Devens MA PFAS RI Rig #1 **Instrument:** YSI 650 MDS

Calibrated By: Melissa Miller **Serial Number:** 18B100186

Parameters	Solution Expiration Date	AM Calibration Time 0736		Cal. Temp. (°C)	PM Post Cal. Check Time 1415	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm[c])	3/20	1427	1,413	20.75	1410	24.87	±10 µS/cm	N
pH (7)	2/21	6.98	7.00	21.00	6.98	24.83	± 0.3 Ph *	N
pH (4)	3/21	3.99	4.00	20.89	3.90	24.79	± 0.3 Ph *	N
pH (10)	2/21	9.89	10.00	21.05	9.89	24.95	± 0.3 Ph *	N
ORP (240 mv)	10/19	2475	240.0	21.10	235.3	25.00	±10 mv	N
Dissolved Oxygen (%)	—	100.8	100.0	20.50	101.0	22.57	-	N
Dissolved Oxygen (mg/L)	—	9.10	8.85	20.50	8.99	22.57	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/29/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Dorms PFAS ; Rig #2 **Instrument:** LaMotte 1020 WE

Calibrated By: CV **Serial Number:** 5083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
8/26/19	0.02	0.00	9.85	10.00	0.02	9.95	N
CV 8/27/19	0.01	0.00	9.22	10.00	0.02	9.77	N
→ 8/28/19	0.01	0.00	9.10	10.00	0.08	9.62	N
MM 8/29/19	0.01	0.00	9.50	10.0	0.05	9.79	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 8/28/19

[signature] 8/29/19

KGS

Field Instrument Calibration Log

Date: 9/3/19 **Weather:** 70's - 80's Sunny (°F)

Project/Site Name: Dorms PFAS RI Rig 2 **Instrument:** YSI PRO DSS

Calibrated By: CV **Serial Number:** 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 0845		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1,506	1,413	21.3	1,419	23.1	±10 µS/cm	N
pH (7)	2/2021	6.78	7.00	21.4	7.21	22.7	± 0.3 Ph *	N
pH (4)	3/2021	4.28	4.00	21.5	3.75	22.5	± 0.3 Ph *	N
pH (10)	2/2021	10.05	10.00	21.6	10.25	22.8	± 0.3 Ph *	N
ORP (240 mv)	10/2019	225.5	240.0	21.8	248.3	22.9	±10 mv	N
Dissolved Oxygen (%)	-	96.0	100.0	20.1	98.6	22.5	-	-
Dissolved Oxygen (mg/L)	-	8.78	8.98	20.1	8.76	22.5	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	-	760	-	-	760	-	-	-

Notes: Calibration solutions very dirty; will change 9/4/19

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/3/19

KGS

Field Instrument Calibration Log

Date: 9/4/19 **Weather:** Sunny 70's - 80's (°F)

Project/Site Name: Dorms PFAS RI Rd 2 **Instrument:** YSI Pro DSS

Calibrated By: CV **Serial Number:** 18L100148

Parameters	Solution Expiration Date	AM Calibration Time 0630		Cal. Temp. (°C)	PM Post Cal. Check Time 1445	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1,547	1,413	20.8	1,404	23.4	±10 µS/cm	N
pH (7)	10/2020	6.78	7.00	21.2	7.01	23.3	± 0.3 Ph *	N
pH (4)	2/2020	3.08	4.00	21.2	4.01	22.9	± 0.3 Ph *	N
pH (10)	7/2020	10.62	10.00	21.4	10.00	22.8	± 0.3 Ph *	N
ORP (240 mv)	01/2023	257.8	240.0	20.9	237.7	23.7	±10 mv	N
Dissolved Oxygen (%)	—	98.6	100.0	21.2	99.6	22.5	-	—
Dissolved Oxygen (mg/L)	—	8.85	8.85	21.2	8.65	22.5	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes: Changed pH buffer solutions and ORP/Spcond calibrating solutions

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/4/19

KGS

Field Instrument Calibration Log

Date: 9/5/19 **Weather:** Sunny 70's - 80's (°F)

Project/Site Name: Downs PFAS RI; Rd 2 **Instrument:** YSI Pro DSS

Calibrated By: CV **Serial Number:** 18L100145

Parameters	Solution Expiration Date	AM Calibration Time 0630		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1,410	1,413	20.2	1,422	19.9	±10 µS/cm	N
pH (7)	10/2020	6.98	7.00	21.3	7.08	20.2	± 0.3 Ph *	N
pH (4)	02/2020	4.03	4.00	21.1	4.12	20.1	± 0.3 Ph *	N
pH (10)	07/2020	10.06	10.00	20.7	10.06	20.0	± 0.3 Ph *	N
ORP (240 mv)	01/2023	240.0	240.0	20.6	241.3	20.2	±10 mv	N
Dissolved Oxygen (%)	-	99.1	100.0	20.5	100.9	20.0	-	-
Dissolved Oxygen (mg/L)	-	9.08	9.09	20.5	9.06	20.0	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	-	760	-	-	760	-	-	-

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/5/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Downs PPAS RI RJ 2 **Instrument:** LaMotte

Calibrated By: CV **Serial Number:** 1828-0412

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
9/3/19	0.03	0.00	8.21	10.00	0.00	10.21	N
9/4/19	0.01	0.00	9.20	10.00	0.04	9.73	N
9/5/19	0.01	0.00	10.36	10.00	0.01	9.80	N
					Post Calibration Criteria		
					-	± 0.5	

Notes: Mark Noted Variences on Field Forms

Signature: CV **Date:** 9/5/19

KGS

Field Instrument Calibration Log

Date: 9/3/19 **Weather:** 70's

Project/Site Name: Devens **Instrument:** YSI 650XL

Calibrated By: MM **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 610		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.429	1.413	21.60°	1.409	22.16°	±10 µS/cm	N
pH (7)	2/21	7.31	7.00	21.57°	7.01	22.21°	± 0.3 Ph *	N
pH (4)	3/21	4.50	4.00	21.74°	4.03	22.40°	± 0.3 Ph *	N
pH (10)	2/21	9.39	10.00	21.39°	10.01	22.30°	± 0.3 Ph *	N
ORP (240 mv)	10/19	251.7	240.0	21.68°	237.9	22.29°	±10 mv	N
Dissolved Oxygen (%)	N/A	127.1%	100.0%	21.69°	96.7%	22.40°	-	N
Dissolved Oxygen (mg/L)	N/A	10.73	10.00	21.30°	9.91	22.37	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/3/19

KGS

Field Instrument Calibration Log

Date: 9/4/19 **Weather:** 70's

Project/Site Name: Devens **Instrument:** YSI 650XL

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 645		Cal. Temp. (°C)	PM Post Cal. Check Time 1340	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.439	1.413	22.49°	1.408	20.06°	±10 µS/cm	N
pH (7)	2/21	7.27	7.00	22.57°	7.07	20.11°	± 0.3 Ph *	N
pH (4)	3/21	3.80	4.00	22.59°	4.00	20.19°	± 0.3 Ph *	N
pH (10)	2/21	10.13	10.00	22.78°	10.02	20.01°	± 0.3 Ph *	N
ORP (240 mv)	10/19	221.1	240.0	22.91°	236.6	20.50°	±10 mv	N
Dissolved Oxygen (%)	N/A	140.1%	100.0%	22.70°	101.1%	19.97°	-	N
Dissolved Oxygen (mg/L)	N/A	9.61	10.00	22.50°	9.97	19.87°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/4/19

KGS

Field Instrument Calibration Log

Date: 9/5/19 **Weather:** 70's

Project/Site Name: Deers **Instrument:** YSI 650XL

Calibrated By: VBA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1435	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.437	1.413	19.20°	1.420	19.50°	±10 µS/cm	N
pH (7)	2/21	7.26	7.00	19.40°	7.03	19.47°	± 0.3 Ph *	N
pH (4)	3/21	4.15	4.00	19.37°	4.09	19.68°	± 0.3 Ph *	N
pH (10)	2/21	9.62	10.00	19.31°	10.00	19.79°	± 0.3 Ph *	N
ORP (240 mv)	10/19	263.1	240.0	19.18°	247.1	19.39°	±10 mv	N
Dissolved Oxygen (%)	N/A	87.1%	100.0%	19.07°	87.6%	19.21°	-	N
Dissolved Oxygen (mg/L)	N/A	9.47	10.00	19.14°	9.77	19.02°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/5/19

KGS

Field Instrument Calibration Log

Date: 9/6/19 **Weather:** 60's

Project/Site Name: Dvers **Instrument:** YSI 650XL

Calibrated By: VA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.427	1.413	17.97°	1.410	18.11°	±10 µS/cm	N
pH (7)	2/21	7.19	7.00	17.86°	7.08	18.14°	± 0.3 Ph *	N
pH (4)	3/21	4.18	4.00	17.93°	4.09	18.21°	± 0.3 Ph *	N
pH (10)	2/21	9.70	10.00	17.61°	9.97	18.09°	± 0.3 Ph *	N
ORP (240 mv)	10/19	259.7	240.0	17.69°	241.6	18.11°	±10 mv	N
Dissolved Oxygen (%)	N/A	81.6%	100.0%	17.30°	96.2%	18.00°	-	N
Dissolved Oxygen (mg/L)	N/A	9.47	10.00	17.01°	9.90	18.09	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/6/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devers

Instrument: ~~LaMotte~~ YSI 650XL

Calibrated By: RBH

Serial Number: 18B100186

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
9/3/19	0.00	0.00	9.93	10.00	0.07	10.11	N
9/4/19	0.17	0.00	10.40	10.00	0.13	9.70	N
9/5/19	0.09	0.00	10.30	10.00	0.09	9.92	N
9/6/19	0.11	0.00	10.40	10.00	0.11	9.97	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: RBH

Date: 9/6/19

KGS

Field Instrument Calibration Log

Date: ~~9/9~~ 9/10/19 **Weather:** 70's

Project/Site Name: Deas **Instrument:** YSI 650XL

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 625		Cal. Temp. (°C)	PM Post Cal. Check Time 1300	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.382	1.413	17.99	1.420	16.92°	±10 µS/cm	N
pH (7)	2/21	7.26	7.00	18.32°	7.01	17.31°	± 0.3 Ph *	N
pH (4)	3/21	4.21	4.00	18.13°	4.03	17.40°	± 0.3 Ph *	N
pH (10)	2/21	9.70	10.00	18.26°	10.00	17.37°	± 0.3 Ph *	N
ORP (240 mv)	10/19	230.1	240.0	18.32°	240.0	17.56°	±10 mv	N
Dissolved Oxygen (%)	N/A	92.6%	100.0%	18.21°	103.2%	17.29°	-	N
Dissolved Oxygen (mg/L)	N/A	9.60	10.00	18.00°	9.92	17.40°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/10/19

KGS

Field Instrument Calibration Log

Date: 9/11/19 **Weather:** 80's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm[c])	3/20	1.472	1.413	18.47°	1.420	17.97°	±10 µS/cm	N
pH (7)	2/21	7.19	7.00	18.49°	7.11	18.09°	± 0.3 Ph *	N
pH (4)	3/21	4.19	4.00	18.56°	4.03	18.11°	± 0.3 Ph *	N
pH (10)	2/21	10.20	10.00	18.63°	10.02	18.21°	± 0.3 Ph *	N
ORP (240 mv)	10/19	227.1	240.0	18.51°	237.7	18.09°	±10 mv	N
Dissolved Oxygen (%)	N/A	82.6%	100.0%	18.20°	109.7%	18.01°	-	N
Dissolved Oxygen (mg/L)	N/A	9.42	10.00	18.11°	9.90	17.92°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/11/19

KGS

Field Instrument Calibration Log

Date: 9/12/19 **Weather:** 70's Rain

Project/Site Name: Davis **Instrument:** YSI 650 XL

Calibrated By: VA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 610		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.429	1.413	19.03°	1.413	17.92°	±10 µS/cm	N
pH (7)	2/21	7.23	7.00	19.15°	7.02	17.81°	± 0.3 Ph *	N
pH (4)	3/21	4.18	4.00	19.01°	4.01	17.77°	± 0.3 Ph *	N
pH (10)	2/21	10.21	10.00	18.97°	10.09	17.83°	± 0.3 Ph *	N
ORP (240 mv)	10/19	253.7	240.0	18.91°	243.1	17.90°	±10 mv	N
Dissolved Oxygen (%)	N/A	91.1%	100.0%	18.78°	96.7%	17.47°	-	N
Dissolved Oxygen (mg/L)	N/A	9.60	10.00	18.69°	9.90	17.20°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/12/19

KGS

Field Instrument Calibration Log

Date: 9/13/19 **Weather:** 60's

Project/Site Name: Devers **Instrument:** YSI 650 XL

Calibrated By: KW **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 610		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.439	1.413	16.97°	1.403	17.92°	±10 µS/cm	N
pH (7)	2/21	7.37	7.09	16.82°	7.11	17.91°	± 0.3 Ph *	N
pH (4)	3/21	4.26	4.09	16.80°	4.02	18.10°	± 0.3 Ph *	N
pH (10)	2/21	10.15	10.09	16.92°	10.23	18.09°	± 0.3 Ph *	N
ORP (240 mv)	10/19	259.7	240.0	16.80°	231.9	18.21°	±10 mv	N
Dissolved Oxygen (%)	N/A	122.2%	100.0%	16.39°	91.60%	18.00°	-	N
Dissolved Oxygen (mg/L)	N/A	9.42	10.09	16.42°	9.80	18.03°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/13/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devers

Instrument: LaMotte 2020WE

Calibrated By: VGA

Serial Number: 15083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
9/10/19	0.25	0.00	9.70	10.00	0.03	10.26	N
9/11/19	0.11	0.00	10.15	10.00	0.02	10.11	N
9/12/19	0.27	0.00	9.97	10.00	0.09	9.97	N
9/13/19	0.40	0.00	10.53	10.00	0.11	9.79	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 9/13/19

KGS

Field Instrument Calibration Log

Date: 9/16/19 **Weather:** 60's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: VGA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.479	1.413	15.92°	1.407	17.22°	±10 µS/cm	N
pH (7)	2/21	7.23	7.00	16.21°	7.00	17.31°	± 0.3 Ph *	N
pH (4)	3/21	4.39	4.00	16.18°	4.07	17.46°	± 0.3 Ph *	N
pH (10)	2/21	10.27	10.00	16.09	10.02	17.38°	± 0.3 Ph *	N
ORP (240 mv)	10/19	227.6	240.0	16.23°	241.7	17.33°	±10 mv	N
Dissolved Oxygen (%)	N/A	91.1%	100.0%	15.87°	91.6%	16.97°	-	N
Dissolved Oxygen (mg/L)	N/A	9.47	10.00	15.80°	9.81	16.81°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: _____ **Date:** 9/16/19

KGS

Field Instrument Calibration Log

Date: 9/17/19 **Weather:** 70's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: VM **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.437	1.413	16.03°	1.413	17.40°	±10 µS/cm	N
pH (7)	BH 2/21	7.20	7.00	16.11°	7.11	17.49°	± 0.3 Ph *	N
pH (4)	3/21	4.47	4.00	16.03°	4.11	17.61°	± 0.3 Ph *	N
pH (10)	2/21	10.19	10.00	16.27°	10.02	17.50°	± 0.3 Ph *	N
ORP (240 mv)	10/19	231.1	240.0	16.18°	231.7	17.59°	±10 mv	N
Dissolved Oxygen (%)	N/A	129.7%	100.0%	15.97°	92.6%	17.40°	-	N
Dissolved Oxygen (mg/L)	N/A	10.40	10.00	15.41°	9.90	17.29°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/17/19

KGS

Field Instrument Calibration Log

Date: 09/18/19 MM **Weather:** 40°F

Project/Site Name: PFAS RI - Devens MA **Instrument:** YSI 650 XL

Calibrated By: Melissa Miller **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 0725		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/20	1421	1413	15.97	1410	17.47	±10 µS/cm	N
pH (7)	2/21	7.13	7.00	15.90	6.96	17.51	± 0.3 Ph *	N
pH (4)	3/21	4.05	4.00	15.93	3.99	17.32	± 0.3 Ph *	N
pH (10)	2/21	10.08	10.0	15.95	9.89	17.29	± 0.3 Ph *	N
ORP (240 mv)	10/19	232.7	240.0	15.89	235.3	17.20	±10 mv	N
Dissolved Oxygen (%)	NA	101%	100%	15.39	91.6	17.13	-	N
Dissolved Oxygen (mg/L)	NA	10.20	10.00	15.39	9.92	17.13	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	NA	—	760	15.39	760	17.13	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 09/19/19 MM

KGS

Field Instrument Calibration Log

Date: 09/20/19 **Weather:** 38°F

Project/Site Name: PFAS RI - Devens, MA **Instrument:** YSI 650 XL

Calibrated By: Melissa **Serial Number:** 11B100185

Parameters	Solution Expiration Date	AM Calibration Time 0700		Cal. Temp. (°C)	PM Post Cal. Check Time 1300	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/20	1410	1413	15.90	1420	[redacted] 18.9	±10 µS/cm	N
pH (7)	2/21	6.98	7.0	15.84	6.83	19.13	± 0.3 Ph *	N
pH (4)	3/21	3.99	4.0	15.86	3.91	19.20	± 0.3 Ph *	N
pH (10)	2/21	10.02	10.0	15.80	9.87	19.27	± 0.3 Ph *	N
ORP (240 mv)	10/19	233.5	240.0	15.79	245	19.35	±10 mv	
Dissolved Oxygen (%)	NA	108.9	100%	15.30	92.5	20.15	-	Y
Dissolved Oxygen (mg/L)	NA	10.10	10.00	15.30	9.50	20.15	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	NA	—	760	15.30	760	[redacted] 20.15	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 09/20/19

Turbidity Instrument Calibration Log

Project/Site Name: Deers

Instrument: Hach 2100Q

Calibrated By: KA

Serial Number: 5083 - 5014

	Date	AM Calibration				PM Post Calibration Check		Variance Noted
		Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
KA	9/16/19	0.27	0.00	9.73	10.00	0.02	10.11	N
	9/17/19	0.19	0.00	10.15	10.00	0.03	10.03	N
MM	9/18/19	0.18	0.00	10.10	10.0	0.02	10.01	N
	9/20/19	0.10	0.00	9.98	10.00	0.07	10.4	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature]

Date: 09/18/19 - 09/20/19

KGS

Field Instrument Calibration Log

Date: 9/24/19 **Weather:** 80's

Project/Site Name: Dams **Instrument:** YSI 650XL

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 610		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.459	1.413	23.70°	1.420	19.27°	±10 µS/cm	N
pH (7)	2/21	7.31	7.00	23.41°	7.00	20.11°	± 0.3 Ph *	N
pH (4)	3/21	4.11	4.00	23.69°	4.03	19.71°	± 0.3 Ph *	N
pH (10)	2/21	9.67	10.00	23.58°	9.90	19.68°	± 0.3 Ph *	N
ORP (240 mv)	10/19	221.7	240.0	23.59°	242.2	19.57°	±10 mv	N
Dissolved Oxygen (%)	N/A	83.7%	100.0%	23.20°	102.6%	19.70°	-	N
Dissolved Oxygen (mg/L)	N/A	9.90	10.00	23.17°	9.90	19.49°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: _____ **Date:** 9/24/19

KGS

Field Instrument Calibration Log

Date: 9/25/19 **Weather:** 70's

Project/Site Name: Pevas **Instrument:** YSI 650XL

Calibrated By: KBA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.471	1.413	21.70°	1.403	18.79°	±10 µS/cm	N
pH (7)	2/21	7.27	7.00	21.77°	7.11	18.69°	± 0.3 Ph *	N
pH (4)	3/21	4.11	4.00	21.69°	4.03	18.47°	± 0.3 Ph *	N
pH (10)	2/21	10.47	10.00	21.73°	10.00	18.61°	± 0.3 Ph *	N
ORP (240 mv)	10/19	238.6	240.0	21.68°	241.1	18.50°	±10 mv	N
Dissolved Oxygen (%)	N/A	96.1%	100.0%	21.30°	102.2%	18.21°	-	N
Dissolved Oxygen (mg/L)	N/A	10.11	10.00	21.18°	10.30	18.40°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	769	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/25/19

KGS

Field Instrument Calibration Log

Date: 9/26/19 **Weather:** 70's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.380	1.413	22.60°	1.419	19.20°	±10 µS/cm	N
pH (7)	2/21	6.86	7.00	22.70°	7.11	19.38°	± 0.3 Ph *	N
pH (4)	3/21	3.72	4.00	22.50°	4.20	19.27°	± 0.3 Ph *	N
pH (10)	2/21	9.70	10.00	22.49°	10.03	19.09°	± 0.3 Ph *	N
ORP (240 mv)	10/19	229.7	240.0	22.47°	238.7	19.18°	±10 mv	N
Dissolved Oxygen (%)	N/A	131.6	100.0%	22.20°	111.1%	19.20°	-	N
Dissolved Oxygen (mg/L)	N/A	9.37	10.00	22.17°	9.90	19.03°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	769	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/26/19

KGS

Field Instrument Calibration Log

Date: 9/27/19 **Weather:** 70's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: VA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1200	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.497	1.413	20.19°	1.420	18.60°	±10 µS/cm	N
pH (7)	2/21	7.30	7.00	20.39°	7.03	18.57°	± 0.3 Ph *	N
pH (4)	3/21	4.26	4.00	20.68°	4.01	18.59°	± 0.3 Ph *	N
pH (10)	2/21	9.78	10.00	20.57°	9.90	18.63°	± 0.3 Ph *	N
ORP (240 mv)	10/19	261.7	240.0	20.49°	247.7	18.70°	±10 mv	N
Dissolved Oxygen (%)	N/A	79.9%	90.0%	20.19°	91.6%	18.73°	-	N
Dissolved Oxygen (mg/L)	N/A	9.80	10.09	20.21°	9.91	18.39°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/27/19

Turbidity Instrument Calibration Log

Project/Site Name: Davis

Instrument: LaMotte 2020we

Calibrated By: VBL

Serial Number: 5083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
9/24/19	0.13	0.00	10.27	10.00	0.02	9.70	N
9/25/19	0.11	0.00	9.70	10.00	0.03	10.11	N
9/26/19	0.20	0.00	10.15	10.00	0.09	10.00	N
9/27/19	0.39	0.00	9.79	10.00	0.20	10.18	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 9/27/19

KGS

Field Instrument Calibration Log

Date: 9/30/19 **Weather:** 60's

Project/Site Name: Davis **Instrument:** YSI 650XL

Calibrated By: MBA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 645		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.437	1.413	22.20°	1.409	19.77°	±10 µS/cm	N
pH (7)	2/21	7.21	7.00	22.30°	7.11	18.69°	± 0.3 Ph *	N
pH (4)	3/21	4.23	4.00	22.18°	4.11	18.73°	± 0.3 Ph *	N
pH (10)	2/21	10.19	10.00	22.19°	10.01	18.69°	± 0.3 Ph *	N
ORP (240 mv)	10/19	231.7	240.0	22.36°	242.9	18.51°	±10 mv	N
Dissolved Oxygen (%)	N/A	111.1%	100.0%	21.97°	109.7%	18.30°	-	N
Dissolved Oxygen (mg/L)	N/A	10.27	10.00	21.93°	9.79	18.01°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 9/30/19

KGS

Field Instrument Calibration Log

Date: 10/1/19 **Weather:** 70's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: KA **Serial Number:** 11B600186

Parameters	Solution Expiration Date	AM Calibration Time 605		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.392	1.413	18.61°	1.406	19.60°	±10 µS/cm	N
pH (7)	2/21	6.72	7.00	18.87°	7.11	19.47°	± 0.3 Ph *	N
pH (4)	3/21	3.68	4.00	18.79°	4.02	19.53°	± 0.3 Ph *	N
pH (10)	2/21	9.77	10.00	18.83°	9.91	19.42°	± 0.3 Ph *	N
ORP (240 mv)	10/19	229.6	240.0	18.91°	232.6	19.60°	±10 mv	N
Dissolved Oxygen (%)	N/A	81.6%	100.0%	18.62°	91.1%	19.57°	-	N
Dissolved Oxygen (mg/L)	N/A	9.80	10.00	18.58°	9.89	19.41°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/1/19

KGS

Field Instrument Calibration Log

Date: 10/2/19 **Weather:** 70's

Project/Site Name: Davis **Instrument:** YSI 650 MP

Calibrated By: MA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.468	1.413	20.32°	1.410	21.70°	±10 µS/cm	N
pH (7)	2/21	6.80	7.00	20.47°	7.11	21.47°	± 0.3 Ph *	N
pH (4)	3/21	4.37	4.00	20.42°	4.01	21.60°	± 0.3 Ph *	N
pH (10)	2/21	10.50	10.00	20.38°	10.10	21.40°	± 0.3 Ph *	N
ORP (240 mv)	10/19	229.7	240.0	20.32°	240.7	21.38°	±10 mv	N
Dissolved Oxygen (%)	N/A	82.6%	100.0%	20.19°	96.1%	21.19°	-	N
Dissolved Oxygen (mg/L)	N/A	10.39	10.00	20.09°	10.11	21.40°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/2/19

KGS

Field Instrument Calibration Log

Date: 10/3/19

Weather: 60's

Project/Site Name: Dewa'

Instrument: YSI 650XL

Calibrated By: VGR

Serial Number: 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 630		Cal. Temp. (°C)	PM Post Cal. Check Time 1330	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.493	1.413	20.15	1.419	18.79°	±10 µS/cm	N
pH (7)	2/21	7.26	7.00	20.14	7.01	18.81°	± 0.3 Ph *	N
pH (4)	3/21	4.03	4.00	20.10	4.00	18.77°	± 0.3 Ph *	N
pH (10)	2/21	9.97	10.00	20.37	10.16	18.69°	± 0.3 Ph *	N
ORP (240 mv)	10/19	256.1	240.0	20.16	241.7	18.77°	±10 mv	N
Dissolved Oxygen (%)	N/A	91.6%	100.0%	20.01	91.6%	18.37°	-	N
Dissolved Oxygen (mg/L)	N/A	10.00	10.00	19.79	9.90	18.61°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

* Ph Unit with Ph 7 Buffer

(Mark Noted Variences on Field Forms)

Signature: [signature]

Date: 10/3/19

Turbidity Instrument Calibration Log

Project/Site Name: Davis

Instrument: Hach 2020we

Calibrated By: MA

Serial Number: 5083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
9/30/19	0.32	0.00	9.90	10.00	0.07	10.00	N
10/1/19	0.47	0.00	9.63	10.00	0.11	10.11	N
10/2/19	0.27	0.00	10.16	10.00	0.19	9.90	N
10/3/19	0.19	0.00	10.21	~~10.00~~ 10.00	0.17	10.11	N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature]

Date: 10/3/19

KGS

Field Instrument Calibration Log

Date: 6/7/19 **Weather:** 70's

Project/Site Name: Devars **Instrument:** YSI 650 XL

Calibrated By: VBA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1200	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.501	1.413	22.39°	1.412	21.60°	±10 µS/cm	N
pH (7)	2/21	7.39	7.00	22.46°	7.03	21.73°	± 0.3 Ph *	N
pH (4)	3/21	4.50	4.00	22.51°	4.06	21.89°	± 0.3 Ph *	N
pH (10)	2/21	10.19	10.00	22.39°	9.97	21.77°	± 0.3 Ph *	N
ORP (240 mv)	10/19	223.7	240.0	22.61°	241.7	21.60°	±10 mv	N
Dissolved Oxygen (%)	N/A	106.1%	100.0%	22.91°	96.1%	21.07°	-	N
Dissolved Oxygen (mg/L)	N/A	10.49	10.00	22.11°	9.97	21.30°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 6/7/19

KGS

Field Instrument Calibration Log

Date: 10/8/19 **Weather:** 55°F Overcast

Project/Site Name: Devens, MA **Instrument:** YSI 650 XL

Calibrated By: Melissa Miller **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 0645		Cal. Temp. (°C)	PM Post Cal. Check Time 1450	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm*)	3/20	1427	1,413	20.10	1410	19.98	±10 µS/cm	N
pH (7)	2/21	7.13	7.00	20.15	6.98	19.90	± 0.3 Ph *	N
pH (4)	3/21	4.18	4.00	20.14	3.99	19.92	± 0.3 Ph *	N
pH (10)	2/21	10.15	10.00	20.20	9.81	19.95	± 0.3 Ph *	N
ORP (240 mv)	10/19	235.7	240.0	20.17	243.7	19.89	±10 mv	N
Dissolved Oxygen (%)	NA	105.7	100.0	20.05	98.9	19.93	-	N
Dissolved Oxygen (mg/L)	NA	10.34	10.00	20.05	9.95	19.93	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	760	—	—	—	—	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 10/8/19

KGS

Field Instrument Calibration Log

Date: 10/9/19 **Weather:** 50's

Project/Site Name: Dover **Instrument:** YSI 650 XL

Calibrated By: KKA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 650		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.503	1.413	19.71°	1.411	17.97°	±10 µS/cm	N
pH (7)	2/21	7.47	7.00	19.87°	7.27	17.83°	± 0.3 Ph *	N
pH (4)	3/21	4.60	4.00	19.97°	4.11	17.64°	± 0.3 Ph *	N
pH (10)	2/21	9.39	10.00	19.71°	9.92	17.70°	± 0.3 Ph *	N
ORP (240 mv)	10/19	263.1	240.0	19.61°	231.9	17.78°	±10 mv	N
Dissolved Oxygen (%)	N/A	132.1%	100.0%	19.50°	89.7%	17.46°	-	N
Dissolved Oxygen (mg/L)	N/A	10.49	10.00	19.57°	9.60	17.63°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/9/19

KGS

Field Instrument Calibration Log

Date: 10/10/19 **Weather:** 50's

Project/Site Name: Devers **Instrument:** YSI 650x2

Calibrated By: LGA **Serial Number:** 17B100186

Parameters	Solution Expiration Date	AM Calibration Time 645		Cal. Temp. (°C)	PM Post Cal. Check Time 1500	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.378	1.413	17.21°	1.420	16.97°	±10 µS/cm	N
pH (7)	2/21	6.90	7.00	17.39°	6.91	17.03°	± 0.3 Ph *	N
pH (4)	3/21	3.51	4.00	17.31°	4.03	17.02°	± 0.3 Ph *	N
pH (10)	2/21	10.32	10.00	17.19°	10.11	17.11°	± 0.3 Ph *	N
ORP (240 mv)	10/19	221.6	240.0	17.24°	242.6	17.24°	±10 mv	N
Dissolved Oxygen (%)	N/A	97.6%	100.0%	17.02°	103.1%	16.97°	-	N
Dissolved Oxygen (mg/L)	N/A	9.42	10.00	16.90°	9.90	16.80°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: _____ **Date:** 10/10/19

Turbidity Instrument Calibration Log

Project/Site Name: Davis

Instrument: Lamotte 2020we

Calibrated By: VLA / MM

Serial Number: ~~5014-50~~ 5083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
10/7/19	0.47	0.00	10.47	10.00	0.13	9.78	N
10/8/19	0.37	0.00	10.32	10.00	0.17	9.83	N
10/9/19	0.22	0.00	10.87	10.00	0.20	10.11	N
10/10/19	0.30	0.00	10.72	10.00	0.11	9.70	N
~~10/11/19~~	~~0.49~~	~~0.00~~	~~10.70~~	~~10.00~~		VLA	

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature] 10/8/19

Date: 10/10/19

KGS

Field Instrument Calibration Log

Date: 10/14/19 **Weather:** 50's

Project/Site Name: Dover 32 **Instrument:** YSI 650XL

Calibrated By: N/A **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 645		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.497	1.413	18.56	1.420	19.47	±10 µS/cm	N
pH (7)	2/21	6.69	7.00	18.48	7.03	19.37	± 0.3 Ph *	N
pH (4)	3/21	4.56	4.00	18.45	4.11	19.46	± 0.3 Ph *	N
pH (10)	2/21	9.70	10.00	18.55	9.79	19.49	± 0.3 Ph *	N
ORP (240 mv)	5/20	221.6	240.0	18.00	241.7	19.58	±10 mv	N
Dissolved Oxygen (%)	N/A	127.0	100.0%	17.00	91.6%	19.02	-	N
Dissolved Oxygen (mg/L)	N/A	9.11	10.00	16.74	9.79	18.99	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/14/19

KGS

Field Instrument Calibration Log

Date: 10/15/19

Weather: 50's

Project/Site Name: Dover

Instrument: YSI 650XL

Calibrated By: [illegible]

Serial Number: ~~[illegible]~~ 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 720		Cal. Temp. (°C)	PM Post Cal. Check Time 1300	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.437	1.413	18.47°	1.413	17.91	±10 µS/cm	N
pH (7)	2/21	7.11	7.00	18.39°	7.07	17.67	± 0.3 Ph *	N
pH (4)	3/21	4.09	4.00	18.41°	4.11	17.69	± 0.3 Ph *	N
pH (10)	2/21	10.29	10.00	18.47°	10.09	17.80	± 0.3 Ph *	N
ORP (240 mv)	5/20	256.7	240.0	18.69°	231.1	17.77	±10 mv	N
Dissolved Oxygen (%)	N/A	121.1%	100.0%	18.21°	91.7%	16.97	-	N
Dissolved Oxygen (mg/L)	N/A	9.47	10.00	17.97°	10.17	17.30	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

* Ph Unit with Ph 7 Buffer

(Mark Noted Variences on Field Forms)

Signature: [signature]

Date: 10/15/19

KGS

Field Instrument Calibration Log

Date: 10/18/19 **Weather:** 50's

Project/Site Name: Davis **Instrument:** YSI 650 XL

Calibrated By: VW **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 715		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.497	1.413	17.97	1.410	16.27°	±10 µS/cm	N
pH (7)	2/21	7.29	7.00	17.97	7.11	16.39°	± 0.3 Ph *	N
pH (4)	3/21	4.36	4.00	18.11	4.20	16.29°	± 0.3 Ph *	N
pH (10)	2/21	10.18	10.00	18.03	10.07	16.33°	± 0.3 Ph *	N
ORP (240 mv)	5/20	230.1	240.0	18.10	243.3	16.57°	±10 mv	N
Dissolved Oxygen (%)	N/A	121.6%	100.0%	18.00	91.7%	16.31°	-	N
Dissolved Oxygen (mg/L)	N/A	9.58	10.00	17.67	9.92	16.27	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	~	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: A **Date:** 10/18/19

Turbidity Instrument Calibration Log

Project/Site Name: Delong **Instrument:** # LaMotte 2020WE

Calibrated By: VBA **Serial Number:** 5983-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
10/14/19	0.23	0.00	10.59	10.00	0.09	10.11	N
10/15/19	0.39	0.00	10.12	10.00	0.15	10.09	N
10/18/19	0.59	0.00	10.03	10.00	0.30	10.41	N
					Post Calibration Criteria		
					-	± 0.5	

Notes: Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 10/18/19

KGS

Field Instrument Calibration Log

Date: 10/21/19 **Weather:** 50's

Project/Site Name: Devers **Instrument:** YSI 650XL

Calibrated By: VA **Serial Number:** 11B100186

Parameters	Solution Expiration Date	AM Calibration Time 700		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.439	1.413	19.70°	1.407	18.79°	±10 µS/cm	N
pH (7)	2/21	6.80	7.00	19.47°	7.19	18.72°	± 0.3 Ph *	N
pH (4)	3/21	3.72	4.00	19.42°	3.87	18.64°	± 0.3 Ph *	N
pH (10)	2/21	10.18	10.00	19.50°	10.11	18.73°	± 0.3 Ph *	N
ORP (240 mv)	5/20	230.2	240.0	19.40°	232.6	18.69°	±10 mv	N
Dissolved Oxygen (%)	N/A	87.1%	100.0%	19.20°	91.7%	18.40°	-	N
Dissolved Oxygen (mg/L)	N/A	9.60	10.00	19.13°	9.80	18.31°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/21/19

KGS

Field Instrument Calibration Log

Date: 10/23/19 **Weather:** 50's Rain

Project/Site Name: Devon **Instrument:** YSI 650xl

Calibrated By: KW **Serial Number:** 11B100986

Parameters	Solution Expiration Date	AM Calibration Time 600		Cal. Temp. (°C)	PM Post Cal. Check Time 1450	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.452	1.413	18.79°	1.412	18.14°	±10 µS/cm	N
pH (7)	2/21	7.39	7.00	19.02°	7.11	17.97°	± 0.3 Ph *	N
pH (4)	3/21	3.92	4.00	19.15°	4.00	17.82°	± 0.3 Ph *	N
pH (10)	2/21	10.18	10.00	19.21°	10.11	18.00°	± 0.3 Ph *	N
ORP (240 mv)	5/20	247.6	240.0	19.19°	247.2	17.99°	±10 mv	N
Dissolved Oxygen (%)	— N/A	138.7%	100.0%	19.01°	87.1%	18.01°	-	N
Dissolved Oxygen (mg/L)	— N/A	9.62	10.09	18.88°	10.20	17.47°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	— N/A	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/23/19

KGS

Field Instrument Calibration Log

Date: 10/24/19 **Weather:** 50's

Project/Site Name: Devas **Instrument:** YSI 650XL

Calibrated By: VM **Serial Number:** 18B100186

Parameters	Solution Expiration Date	AM Calibration Time 650		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	3/20	1.371	1.413	19.18°	1.410	18.11°	±10 µS/cm	N
pH (7)	2/21	6.82	7.00	19.30°	7.11	18.27°	± 0.3 Ph *	N
pH (4)	3/21	4.02	4.00	19.27°	4.11	18.19°	± 0.3 Ph *	N
pH (10)	2/21	9.62	10.00	19.28°	10.01	18.31°	± 0.3 Ph *	N
ORP (240 mv)	5/20	247.1	240.0	19.40°	241.7	18.27°	±10 mv	N
Dissolved Oxygen (%)	NA	81.7%	100.0%	19.17°	92.2%	18.07°	-	N
Dissolved Oxygen (mg/L)	NA	9.47	10.00	19.17°	9.89	18.01°	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	NA	—	760	—	760	—	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/24/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devas

Instrument: ~~AS~~ Lamotte 2020WE

Calibrated By: VM

Serial Number: 5083-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
10/21/19	0.27	0.00	9.72	10.00	0.30	10.20	N
10/23/19	0.20	0.00	9.80	10.00	0.19	10.03	N
10/24/19	0.11	0.00	10.39	10.00	0.07	10.15	N
10/25/19	0.03	0.00	10.11	10.00	0.11	10.03	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature]

Date: 10/25/19

KGS

Field Instrument Calibration Log

Date: 10/4/19 **Weather:** Cloudy slight prec. 49-59°F

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Kristen Esher **Serial Number:** 18L100445

Parameters	Solution Expiration Date	AM Calibration Time 0645		Cal. Temp. (°C)	PM Post Cal. Check Time 1410	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.433	1.413	19.5	1.390	18.9	±10 µS/cm	~~N~~ Y
pH (7)	10/2020	7.14	7.00	18.8	6.80	18.3	± 0.3 Ph *	N
pH (4)	7/2020	4.86	4.00	19.3	4.21	18.5	± 0.3 Ph *	N
pH (10)	2/2020	9.81	10.00	18.9	10.04	18.5	± 0.3 Ph *	N
ORP (240 mv)	1/2023	244.4	240.0	19.4	231.3	18.8	±10 mv	N
Dissolved Oxygen (%)	—	98.5	98.5	19.5	99.6	18.2	-	—
Dissolved Oxygen (mg/L)	—	9.09	9.08	19.5	9.53	18.2	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	752.3	752.3	19.5	758.8	18.2	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 10/4/19

KGS

Field Instrument Calibration Log

Date: 8/26/19 **Weather:** Clear, cool, 75° F

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Kristen Esser **Serial Number:** 18G100145

Parameters	Solution Expiration Date	AM Calibration Time 0705		Cal. Temp. (°C)	PM Post Cal. Check Time 1436	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	~~0.77~~ 1.402 (KE)	~~7.04~~ 1.411 (KE)	~~16.6~~ 16.1 (KE)	1.385	22.8	±10 µS/cm	N
pH (7)	10/2020	6.77	7.04	16.6	7.02	21.7	± 0.3 Ph *	N
pH (4)	3/2021	4.14	4.01	16.7	4.21	~~22.3~~ ~~21.8~~ (KE)	± 0.3 Ph *	N
pH (10)	2/2021	10.07	10.08	16.6	10.07	21.0	± 0.3 Ph *	N
ORP (240 mv)	10/2019	251.8	~~240.5~~	16.1	240.2	21.7	±10 mv	N
Dissolved Oxygen (%)	—	97.8	100.0	13.3	103.8	20.8	-	—
Dissolved Oxygen (mg/L)	—	10.48	10.47	13.6	8.88	21.5	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	—	763.8	763.8	13.3	761.7	20.8	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Kristen Esser **Date:** 8/26/19

KGS

Field Instrument Calibration Log

Date: 8/27/19 **Weather:** Partly Cloudy, 51-75°F

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Kristen Exner **Serial Number:** 18G100145

Parameters	Solution Expiration Date	AM Calibration Time 0715		Cal. Temp. (°C)	PM Post Cal. Check Time 1530	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.349	1.413	16.8	1.388	23.9	±10 µS/cm	N
pH (7)	10/2020	6.99	7.03	17.5	7.01	23.6	± 0.3 Ph *	N
pH (4)	3/2021	4.28	4.05	17.2	4.00	23.8	± 0.3 Ph *	N
pH (10)	2/2021	10.15	10.09	17.3	10.02	23.1	± 0.3 Ph *	N
ORP (240 mv)	10/2019	237.6	239.6	17.0	234.1	22.9	±10 mv	N
Dissolved Oxygen (%)	—	115.2	99.9	17.0	99.4	23.1	-	N
Dissolved Oxygen (mg/L)	—	9.66	9.67	17.0	8.67	23.2	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	—	759.4	759.4	17.0	755.6	23.1	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Kristen Exner **Date:** 8/27/19

KGS

Field Instrument Calibration Log

Date: 8/28/19 **Weather:** Partly cloudy, chance of PM showers 62-78°F

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Kristen Ecker **Serial Number:** 18G10G145

Parameters	Solution Expiration Date	AM Calibration Time 0716		Cal. Temp. (°C)	PM Post Cal. Check Time 1440	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.374	1.413	20.8	1.867	22.3	±10 µS/cm	N
pH (7)	10/2020	6.82	7.00	20.8	7.01	22.9	± 0.3 Ph *	N
pH (4)	3/2021	4.20	4.00	20.7	4.00	23.0	± 0.3 Ph *	N
pH (10)	2/2021	9.97	10.00	20.8	10.02	23.1	± 0.3 Ph *	N
ORP (240 mv)	10/2019	235.2	240.1	20.8	239.7	22.2	±10 mv	N
Dissolved Oxygen (%)	—	100	100	20.7	99.9	22.1	-	N
Dissolved Oxygen (mg/L)	—	8.93	8.92	20.7	8.74	22.2	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	755.7	755.7	20.7	757.6	757.6	-	N

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/28/19

KGS

Field Instrument Calibration Log

Date: 8/29/19 **Weather:** Partly cloudy 66-82°F

Project/Site Name: Devens PFAS RI **Instrument:** YSI Pro DSS

Calibrated By: Kristen Escher **Serial Number:** 18A100145

Parameters	Solution Expiration Date	AM Calibration Time 0730		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm[c])		1.589	1.413	20.1	1.434	25.9	±10 µS/cm	N
pH (7)		6.70	~~7.0~~ 7.00	20.2	7.00	26.2	± 0.3 Ph *	N
pH (4)		4.34	4.00	20.1	~~4~~ 4.01	~~25.0~~	± 0.3 Ph *	N
pH (10)		9.72	10.00	20.2	10.01	24.9	± 0.3 Ph *	N
ORP (240 mv)		242.4	240.0	20.1	234.4	25.0	±10 mv	N
Dissolved Oxygen (%)	—	98.9	98.9	20.2	98.9	26.2	-	—
Dissolved Oxygen (mg/L)	—	8.97	8.97	20.2	8.57	26.3	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	751.6	751.6	20.2	751.3	26.2	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 8/29/19

Turbidity Instrument Calibration Log

Project/Site Name: Devens PFAS RI **Instrument:** La Motte 2020we

Calibrated By: Kristen Exner **Serial Number:** 1828-0412

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
8/26/19	0.08	0.01	7.94	10.80	0.02	7.82	KE 8/26 Y
8/27/19	0.05	0.00	7.94	7.17	0.00	7.70	Y
8/28/19	1.15	0.02	7.39	8.54	0.03	8.37	N
8/29/19	0.01	0.00	7.91	7.57	0.01	8.06	Y N

Post Calibration Criteria	
-	± 0.5

Notes: Mark Noted Variences on Field Forms

Signature: [signature] **Date:** 8/29/19

KGS

Field Instrument Calibration Log

Date: 10/4/19

Project/Site Name: Devens PFAS RI

Calibrated By: Kristen Esher

Weather: Cloudy slight prec. 49-59°F

Instrument: YSI Pro DSS

Serial Number: 18L100445

Parameters	Solution Expiration Date	AM Calibration Time 0645		Cal. Temp. (°C)	PM Post Cal. Check Time 1410	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1.413 µS/cm°)	11/2019	1.433	1.413	19.5	1.390	18.9	±10 µS/cm	N
pH (7)	10/2020	7.14	7.00	18.8	6.90	18.3	± 0.3 Ph *	N
pH (4)	7/2020	4.86	4.00	19.3	4.21	18.5	± 0.3 Ph *	N
pH (10)	2/2020	9.81	10.00	18.9	10.04	18.5	± 0.3 Ph *	N
ORP (240 mv)	1/2023	244.4	240.0	19.4	231.3	18.8	±10 mv	N
Dissolved Oxygen (%)	—	98.5	98.5	19.5	99.6	18.2	-	—
Dissolved Oxygen (mg/L)	—	9.09	9.08	19.5	9.53	18.2	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	752.3	752.3	19.5	758.8	18.2	-	—

Notes:

* Ph Unit with Ph 7 Buffer

(Mark Noted Variences on Field Forms)

Signature: [signature]

Date: 10/4/19

Turbidity Instrument Calibration Log

Project/Site Name: Devens PFAS RI

Instrument: LaMotte 2020we

Calibrated By: Kristen Escher

Serial Number: 1828-0412

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
9/26/19	0.01	0.00	10.13	10.06	0.01	9.98	N
9/27/19	0.00	0.00	9.11	9.69	0.00	9.57	N
9/30/19	1.60	0.00	10.96	8.49	0.01	8.67	N
10/1/19	1.56	0.01	10.90	8.55	0.01	8.25	N
10/2/19	1.49	0.00	8.88	9.37	0.00	9.85	N
10/3/19	1.38	0.00	8.75	9.67	0.00	9.86	N
10/4/19	1.47	0.02	9.18	9.53	0.02	9.32	N

Post Calibration Criteria	
-	±0.5

Notes: Mark Noted Variences on Field Forms

Signature: Kristen Escher

Date:

APPENDIX D SOIL BORING LOGS

AOC 20

KOMAN Government Solutions, LLC
SOIL BORING LOG

QC'd 4/7/2020 LBW

Project: Devens PFAS Soil Borings	Boring No.: 205B-19-01
Project No.: 10820011-533	Drilling Co.: TDS
Address: AOC-20 -21	Driller: Jay Jimenville
Logger: Don Melcher	Drilling Method: Geoprobe (Direct Push)
Date: 10/18/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15'	Static Water: NA

Core Section	Recovery (ft)	Interval (ft)	PID (ppm)	GEOLOGIC LOG	REMARKS
0-5'	36" (3')	0-9"	NA SW	dry, dark brown, fine to medium SAND, some coarse Gravel, trace Organics	Soil sample @ 0-0.5' collected 0855
		9-36"	NA SW	dry, light brown, medium to coarse SAND, some fine to coarse Gravel	Soil sample @ 0.5-3' collected 0900
5-10'	38"	0-9"	NA SP	dry, light grayish brown, fine to medium SAND, trace fine Gravel	Soil sample @ 3-7' collected 0905
		9-38"	NA SW	dry, light brown, medium to coarse SAND, some fine to coarse Gravel	
5-15'	32"	0-12"	NA SP	dry, light ~~grayish~~ brown (LBW), fine to medium SAND, trace fine Gravel	Soil sample @ 7-15' collected 0910
		12-17"	SP NA	dry, light grayish brown, fine SAND, trace Silt	
		17-32"	NA SW	dry, light grayish brown, medium to coarse SAND, some fine to coarse Gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 205B-19-02 Page 1 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/22/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 60ft. bgs	Static Water: 54 ft. bgs

QCd 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.4/5.0	0-0.5'	SP	Dry, brown, poorly graded, fine SAND, trace rounded gravel	205B-19-02-0-0.5 (DK) @ 1115
		0.5-4'	SW	Dry, tan, well graded, coarse SAND, ~~some~~ (DK) little subangular gravel	205B-19-02-0.5-4 @ 1120
		4-5'	SP	Dry, tan, poorly graded, medium SAND	
5-10'	2.5/5.0	5-10'	SP	Dry, tan, poorly graded, fine to medium SAND, trace subangular gravel	205B-19-02-4-7 @1125 205B-19-02-7-15 @1130
10-15'	2.4/5.0	10-11'	SP	Same as 5-10' bgs	
		11-15'	SW	Dry, tan, well graded, coarse SAND, little subangular gravel	
15-20'	3.0/5.0	15-20'	SP	Dry, brown to tan, poorly graded, fine to medium SAND, little subangular gravel	

Notes:

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SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 20SB-19-02	Page 2 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 20	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/22/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 60 ft. bgs	Static Water: 54 ft. bgs	

QC'd 4/7/2020 [signature]

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
20-25'	2.3/5.0	20-25'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	
25-30'	2.4/5.0	25-30'	SP	Dry, tan, poorly graded, fine SAND	
30-35'	2.7/5.0	30-35'	SP	Dry, tan, poorly graded, fine SAND, little medium sand	
35-40'	3.0/5.0	35-40'	SP	Dry, tan, poorly graded, fine SAND	

Notes:

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SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 20SB-19-02	Page 3 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address:	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/22/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 60 ft. bgs	Static Water: 54 ft. bgs	

QCid 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
40-45'	3.1/5.0	40-45'	SP	Dry, tan, poorly graded, fine SAND, trace silt	
45-50'	4.2/5.0 (LBW)	45-48'	SM	Dry, tan, fine silty SAND	
		~~45-50'~~ (DF)			
		48-50'	SP	Dry, tan, poorly graded, fine SAND	
50-55'	3.1/5.0	50-54' (LBW)	SP	to moist Dry, tan, poorly graded, fine SAND	20SB-19-02-52-54 @1430
		54-55'	SP	wet, tan, poorly graded, fine SAND	
55-60'	3.7/5.0	55-60'	SP	Wet, tan, poorly graded, fine to medium SAND	

Notes:

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SOIL BORING LOG

Project: Devens PFAS Soil Borings	Boring No.: 20 SB - 19-03
Project No.: 108200 11-533	Drilling Co.: TDS
Address: AOC-20, 21	Driller: Jay Jumonville
Logger: Don Melcher	Drilling Method: Direct Push
Date: 10/18/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 15'	Static Water: NA

QC'd 4/7/2020 LW

Core Section	Recovery (ft)	Interval (ft)	PID (ppm)	GEOLOGIC LOG	REMARKS
0-5'	32"	0-7"	NA SW	dry, dark brown, fine to medium SAND, some fine gravel, trace Organics	Sampled @ 1015 (0-0.5')
		7-32"	NA SW	dry, light grayish brown, medium to coarse SAND, some fine to coarse Gravel	Sample @ 1020 (0.5-3')
5-10'	36"	0-36"	NA SW	dry, light grayish brown, medium to coarse SAND, some fine to coarse Gravel	Sampled @ ~~1020~~ 1025 (5-7')
10-15'	44"	0-12"	NA SP	dry, ~~light~~ grayish brown, fine to medium SAND, trace silt	Sampled @ 1030 (10-15')
		12-44"	NA SW	dry, light grayish brown, medium to coarse SAND and fine to coarse Gravel	

Notes:

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SOIL BORING LOG

Project: Devens PFAS Soil Borings	Boring No.: 2058-19-04
Project No.: 108200 11-5-33	Drilling Co.: TDS
Address: AOC-20, 21	Driller: Jay Jumonville
Logger: Don Melcher	Drilling Method: Direct Push
Date: 10/18/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 15'	Static Water: NA

QC 4/7/2020 LCW

Core Section	Recovery (ft)	Interval (ft)	PID (ppm)	GEOLOGIC LOG	REMARKS
0-5'	32"	0-6"	NA SW	dry, dark brown, fine to medium SAND, some fine to coarse Gravel, trace organics	
		6-32"	NA SW	dry, light grayish brown, medium to coarse SAND, some fine to coarse Gravel	
5-10'	44"	0-12"	NA SP	dry, grayish brown, medium SAND, trace fine Gravel	
		12-24"	NA SW	dry, light grayish brown, medium to coarse SAND and fine to coarse Gravel	
10-15'	40"	0-12"	NA SP	dry, grayish brown, fine SAND, trace silt, trace fine Gravel	
		12-40"	NA SW	dry, light grayish brown, medium to coarse SAND and fine to coarse Gravel	

Notes:
Samples collected @ 0-0.5' interval (1135), 0.5-3.0' (1140), 3-7' (1145), 7-15' (1150), & 4-5' Duplicate (1155)

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS Soil Boring	Boring No.: 20SB-19-05
Project No.: 10820011-533	Drilling Co.: TDS
Address: AOC-20, 21	Driller: Jay Jumenville
Logger: Don Melcher	Drilling Method: Direct Push
Date: 10/18/19	Drilling Equip: Geoprobe 6.712 DT
Total Boring Depth: 15'	Static Water: NA

QC 18 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	PID (ppm)	GEOLOGIC LOG	REMARKS
0-5'	30"	0-5"	NA SP	dry, dark brown, fine to medium SAND, trace fine to coarse Gravel, trace Organics	
		5-30"	NA SW	dry, light yellowish brown, medium to coarse SAND, some fine to coarse Gravel, Iron-staining @ 5" transition	
5-10'	39"	0-10"	NA SP	dry, grayish brown, fine to medium SAND, trace fine Gravel	
		10-39"	NA SW	dry, light grayish brown, medium to coarse ~~Grave~~ SAND, some fine to coarse Gravel	
10-15'	33"	0-12"	NA SP	dry, grayish brown, fine to medium SAND, trace fine Gravel, trace Silt	
		12-33"	NA SW	dry, light yellowish brown, medium to coarse SAND and fine to coarse Gravel, Iron-staining @ 12" transition	

Notes:
Samples collected @ 1340 (0-0.5' interval), 1345 (0.5-3.0'), 1350 (3.0-7.0'), & 1355 (7.0-15.0')

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SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 20SB-19-06 Page 1 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/21/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 60' bgs	Static Water: 54' bgs

QC'd 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.7/5.0	0-5'	SW	Dry, brown to tan, well graded, medium SAND, some gravel (subangular), little coarse sand	20SB-19-06-0-0.5 @1215 20SB-19-06-0.5-3 @1220
5-10'	3.6/5.0	5-7'	SP	Dry, tan, poorly graded, fine SAND, little subangular gravel	20SB-19-06-3-7 @1225
		7-8'	SW	Dry, tan, well graded, coarse SAND	
		8-10'	SP	Dry, tan, poorly graded, fine SAND	20SB-19-06-7-15 @1230 → MS/MSD
10-15'	3.5/5.0	10-12'	SP	Dry, brown, poorly graded, fine to medium SAND, some subangular gravel	
		12-15'	SW	Dry, brown, well graded, coarse SAND, some subangular gravel	
15-20'	3.1/5.0	15-20'	SP	Dry, brown, poorly graded, fine SAND, some subangular GRAVEL, trace coarse sand	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: ~~205~~ B-19-06	Page 2 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 20	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/21/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 60' bgs	Static Water: 54' bgs	

QC'd 4/7/2020 CW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
20-25'	2.1/5.0	20-25'	SP	Dry, brown, poorly graded, fine to medium SAND, some subangular gravel	
25-30'	2.4/5.0	25-30'	SP	Dry, brown, poorly graded, fine to medium SAND, little subangular gravel	
30-35'	2.8/5.0	30-35'	SP	Dry, brown to tan, poorly graded, medium SAND, trace subangular gravel	
35-40'	1.0/5.0	35-40'	SP	Dry, tan, poorly graded, fine SAND, little subangular gravel	

Notes:

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 205B-19-06 Page 3 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/21/19 (OK)	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: ~~54' bgs~~ 60' bgs	Static Water: 54' bgs

QC'd 4/7/2020 LW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
40-45'	3.2/5.0	40-45'	SW GW	Dry, brown to tan, well graded, coarse SAND, some subrounded gravel, few medium sand	
45-50'	2.7/5.0	45-50'	SP	Dry, tan, poorly graded, fine SAND, little silt	
50-55'	2.9/5.0	50-52	SP	Dry, tan, poorly graded, fine SAND	205B-19-06-52-54 @ 1415
		52-54	SP	Moist, tan, poorly graded, fine to medium SAND, trace subrounded gravel	
		54-55'	SP	Same as 52-54' but wet	
55-60	2.1/5.0	55-60'	SP	Wet, tan, poorly graded, fine SAND	

Notes:

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 205B-19-07 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/22/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 ft. bgs	Static Water:

QCd 4/7/2020 GW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.7/5.0	0-1'	SP	Dry, brown, poorly graded, medium SAND, few rounded gravel	
		1-5'	SP	Dry, brown to tan, poorly graded, medium SAND, few subangular gravel, trace coarse sand	205B-19-07-0-0.5 @920 205B-19-07-0.5-3 @925
5-10'	3.0/5.0	5-6'	SP	Dry, brown, poorly graded, fine to medium SAND, little subangular gravel	
		6-10'	SW	Dry, tan, well graded, coarse SAND, little medium sand, trace subrounded gravel	205B-19-07-3-7 @930 A3-SB-DUP01-102219 @935
10-15'	4.1/5.0	10-12'	SP	Dry, tan, poorly graded, medium SAND, trace subrounded gravel	205B-19-07-7-15 @940
		12-15'	SW GW	Dry, tan, well graded, coarse SAND, ~~trace~~ some (PB) subrounded gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 20SB-19-08 Page 1 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/21/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 65' bgs	Static Water: 64' bgs

QC'd 4/7/2020 GW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.7/5.0	0-1'	SP	Dry, brown, poorly graded, fine SAND, little rounded gravel, roots/organics	
		1-5'	SP	Dry, brown, poorly graded, fine SAND, trace subangular gravel, trace medium sand	20SB-19-08-0-0.5 @825 20SB-19-08-0.5-3 @830
5-10'	3.0/5.0	5-8'	SP	Dry, tan, poorly graded, fine SAND, little subangular gravel, trace coarse sand	20SB-19-08-3-7@835
		8-10'	SW GW	Dry, tan, well graded, medium to coarse SAND, some subangular gravel	20SB-19-08-7-15 @840 A3-SB-DUP01-102119 @845
10-15'	3.3/5.0	10-15'	SW GW	Dry, tan to brown, well graded, medium to ~~coarse~~ coarse SAND, some subangular gravel	
15-20'	3.4/5.0	15-20'	SW GW	Dry, tan to brown, well graded, medium to coarse SAND and subangular GRAVEL	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 205B-19-08	Page 2 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	QC'd 4/7/2020 LGW
Address: AOC 20	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/21/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 65' bgs	Static Water: 64' bgs	

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
20-25'	2.8/5.0	20-25'	SP	Dry, tan, poorly graded, medium SAND, trace subangular gravel	
25-30'	2.1/5.0	25-30'	SP	Dry, tan, poorly graded, medium SAND, trace subangular gravel, trace fine sand	
30-35'	2.2/5.0	30-35'	SP	Same as 25-30' bgs	
35-40	0.5/5.0	35-40'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	

Notes:

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 20SB-19-08	Page 3 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 20	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/21/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 65' bgs	Static Water: 64' bgs	

QC'd 4/7/2020 (BW)

Core Section	Recovery (ft)	Interval (ft)	~~USCS~~ ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
40-45'	2.9/5.0	40-45'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	
45-50'	3.2/5.0	45-50'	SP	Dry, tan, poorly graded, fine SAND, little subrounded gravel, trace coarse sand	
50-55'	3.0/5.0	50-55'	SP	Dry, tan, poorly graded, medium SAND, trace subangular gravel	
55-60'	3.3/5.0	55-60'	SP	Same as 50-55' bgs	

Notes:

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 205B-19-08 Page 4 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 20	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/21/19	Drilling Equip: Geoprobe 7712DT
Total Boring Depth: 65' bgs	Static Water: 64' bgs

QC'd 4/7/2020 LMW

Core Section	Recovery (ft)	Interval (ft)	~~USCS PID (ppm)~~	GEOLOGIC LOG	REMARKS
60-65'	3.1/5.0	60-62 (W)	SP	Dry, tan to brown, poorly graded, medium SAND, trace subrounded gravel	205B-19-08-62-64 @1020
		(W) 62-64'	SP	Moist, tan, wet, poorly graded, medium SAND, trace fine sand	
		64-65'	SP	Wet brown, poorly graded, medium SAND, trace coarse sand, trace subrounded gravel	

Notes:

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AOC 21

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 215B-19-01 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 21	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 11/14/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 ft. bgs	Static Water: 12 ft. bgs

QC'd 4/9/2020 SW

Core Section	Recovery (ft)	Interval (ft)	~~USCS PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	4.2/5.0	~~0-1.5'~~ 0-2'	SW GW	Dry, Brown, well graded, coarse SAND and GRAVEL (subangular), organics/roots at surface	215B-19-01-0-0.5 @1050
		2-5'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	215B-19-01-0.5-3 @1055
5-10'	4.4/5.0	5-10'	SW	Dry, tan, well graded, medium and coarse SAND, few subangular gravel	215B-19-01-3-7 @1100 A3-SB-DUP01-111419 @1105 215B-19-01-7-10 @1110 MS/MSD
10-15'	3.8/5.0	10-12'	SP	Moist, ~~fe~~ brown, poorly graded, medium SAND, little subrounded gravel	
		12-15'	SP	wet, brown, poorly graded, medium SAND	215B-19-01-10-12 @1115

Notes: Drilled through plastic liner in ~~sludge~~ beds (~~liner~~ approx. 2 ft bgs)

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 215B-19-02 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 21	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 11/14/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 ft. bgs	Static Water: 13 ft. bgs

QCid 4/9/2020 [illegible]

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	3.6/5.0	0-1	SW	Dry, brown, well graded, medium SAND, trace subangular gravel, grass/roots at surface	
		1-3	SW	Dry, tan, well graded, coarse SAND, little subangular gravel	215B-19-02-0-0.5 @ 1220
		3-5	SM	Dry, tan, poorly graded, fine silty SAND	215B-19-02-0.5-3 @ 1225
5-10'	2.5/5.0	5-7	SP	Dry, tan, poorly graded, fine SAND, little subangular gravel	215B-19-02-3-7 @ 1230
		7-10	SW	Dry, tan, well graded, medium ~~and co~~ (DB) SAND, little subangular gravel	215B-19-02-7-11 @ 1235
10-15	3.0/5.0	10-13	SP	Moist, brown to tan, poorly graded, fine SAND, little subrounded gravel	
		13-15	SP	Wet, tan, poorly graded, fine SAND	

Notes: Drilled through (DB) ~~liner~~ liner in bed ≈ 2 ft. bgs

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 21SB-19-03 — Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC21	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 11/14/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 ft. bgs	Static Water: 13 ft. bgs

QC'd 4/9/2020 [illegible]

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	~~0-2~~ [illegible] 3.5/5.0	0-1' ~~0-2'~~ [illegible]	SP	Dry, brown, poorly graded, fine SAND, organics/roots at surface	21SB-19-03-0-0.5 @1400
		1-3'	SW	Dry, brown/gray, well graded, subrounded gravel, some medium sand	
		3-5'	SM	Dry, tan, poorly graded, fine silty SAND	21SB-19-03-0.5-3 @1405
5-10'	2.3/5.0	5-7	SM	Same as 3-5' bgs	21SB-19-03-3-7 @1410
		7-10	SW	Dry, tan, well graded, medium SAND, little subrounded gravel	21SB-19-03-7-11 @~~1420~~ [illegible] 1415
10-15'	3.3/5.0	10-13'	SP	Moist, brown, poorly graded, fine SAND, few subrounded gravel	A3-SB-DUP02-111419 @1420
		13-15'	SP	Wet, tan, poorly graded, fine and Medium SAND.	

Notes: Drilled through Plastic ~~Linner~~ [illegible] liner at 2 ft. bgs

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AOC 30

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 305B-19-01
Project No.: 1082	Drilling Co.: TDS
Address: AOC 30	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: DPT
Date: 10/14/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 65' bgs	Static Water: 60' bgs

QC'd 4/7/2020 LCW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.5/5.0	0-4'	SP	Dry, brown, poorly graded, fine SAND, trace subrounded gravel, grass/roots at surface (0' bgs)	305B-19-01-0-0.5 @1205
		4-5'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	305B-19-01-0.5-3 @1210 1210 (LS)
5-10'	2.5/5.0	5-10'	SP	Dry, tan, poorly graded, fine ~~SA~~ (SX) to medium SAND, trace subangular gravel, trace silt	305B-19-01-3-7 @~~1210~~ 1215 (DK)
10-15'	2.3/5.0	10-15'	SP	Dry, tan, poorly graded, fine SAND, little silt	305B-19-01-7-15 @1220 → MS/MSD
15-20'	2.6/5.0	15-20'	SP	Same as 10-15' bgs	
20-25'	2.4/5.0	20-25'	SM	Dry, tan, poorly graded, fine silty SAND, little medium sand	

Notes:

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KOMAN Government Solutions, LLC 293 Boston Post Road, Marlborough, MA

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 30SB-19-01
Project No.: 1082	Drilling Co.: TOS
Address: AOC 30	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: DPT
Date: 10/14/19	Drilling Equip: Geoprobe 7712DT
Total Boring Depth: 65' bgs	Static Water: 60' bgs

QC'd 4/2/2020 CSW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
25-30'	3.0/5.0	25-27'	ML	Dry, tan to brown, SILT, little fine sand	
		27-30'	SM	Dry, tan, poorly graded, fine silty SAND	
30-35'	2.8/5.0	30-33'	SM	Same as 27-30' bgs	
		33-35'	ML	Dry, tan, SILT, little fine sand	
35-40'	3.2/5.0	35-40'	SM	Dry, tan, fine silty SAND	
40-45'	3.3/5.0	40-45'	SM	Dry, tan, fine silty SAND	
45-50'	3.4/5.0	45-50'	SM	Dry, tan, fine silty SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 30SB-19-01
Project No.: 1082	Drilling Co.: TDS
Address: AOC 30	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: DPT
Date: 10/14/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 65' bgs	Static Water: 60' bgs

QC'd 4/2/2020 JM

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
50-55'	3.4/5.0	50-55'	SM	Dry to moist, tan to brown, fine silty SAND	
55-60'	3.0/5.0	55-60'	SM	Moist, tan to brown, fine silty SAND	30SB-19-01-58-60 @1325
60-65'	4.6/5.0	60-65'	SP	wet, brown, poorly graded fine SAND, little medium-coarse sand	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 30SB-19-02
Project No.: 1082	Drilling Co.: TDS
Address: AOC 30	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: DPT
Date: 10/14/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 feet bgs	Static Water:

QC'd 4/7/2020 SW

Core Section	Recovery (ft)	Interval (ft)	~~PID~~ ~~(ppm)~~ USCS	GEOLOGIC LOG	REMARKS
0-5'	4.3/5.0	0-0.5'		Asphalt	30SB-19-02-0-0.5 @1035
		0.5-1.5'	SP	Dry, gray to tan, poorly graded, fine SAND, some subangular gravel	30SB-19-02-0.5-3 @1040
		1.5-5'	SP	Dry, brown, poorly graded, fine to medium SAND, ~~little~~ trace fine subrounded gravel.	
5-10'	4.5/5.0	5-10'	SP	Dry, tan, poorly graded, fine SAND, little subrounded gravel	30SB-19-02-3-7 @1045
10-15'	4.5/5.0	10-15'	SP	Dry, tan, poorly graded, fine to medium SAND, trace subrounded gravel	30SB-19-02-7-15 @1050 A3-SB-DUP-101419 @1055

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 305B-19-03
Project No.: 1082	Drilling Co.: TDS
Address: AOC 30	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: DPT
Date: 10/14/19	Drilling Equip: Geoprobe 6712DT,
Total Boring Depth: 15 ft. bgs	Static Water:

QC'd 4/7/2020 CW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	4.3/5.0	0-0.5'		0-0.5' Asphalt	305B-19-03-0-0.5 @ 935
		0.5-3' ~~0-5~~ (DX)	SP	0.5-3' Dry, dark brown, poorly graded, fine SAND, trace subangular gravel	
		3-5'	SP	3-5' Dry, tan, poorly graded, fine to medium SAND, trace subangular gravel	305B-19-03-0.5-3 @ 940
5-10' ~~5~~ (DX)	4.2/5.0	5-10' ~~5-10~~ (DX)	SP	5-10' Dry tan, poorly graded, fine to medium SAND	305B-19-03-3-7 @ 945
10-15'	4.1/5.0	10-13'	SP	Dry, tan, poorly graded, fine SAND	305B-19-03-7-15 @ 950
		13-15'	SW	Dry, tan, well graded, coarse SAND, little medium ~~SAND~~ (W) sand, trace subrounded gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 305B-19-04	Page 1 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 30	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/15/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 70 ft. bgs	Static Water: 6 ft. bgs	

QC'd 4/7/2020 GW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	4.1/5.0	0-0.5'	—	Concrete	
		0.5-3'	SW	Dry, tan, well graded, medium SAND, little coarse sand	~~305B~~ OK 305B-19-04-0-0.5 @910
		3-5'	SP	Dry, tan, poorly graded, fine SAND, little medium sand	
5-10'	3.8/5.0	5-8'	SP	Same as 3-5' bgs	305B-19-04-0.5-3 @915
		8-10'	SW	Dry, tan, well graded, medium and coarse SAND	A3-SB-DUP01-101519 @920 305B-19-04-3-7 @925
10-15'	4.0/5.0	10-12'	SP	Dry, tan, poorly graded, fine SAND	305B-19-04-7-15 @930
		12-15'	SW	Dry, tan, well graded, medium and coarse SAND, trace subrounded gravel	
15-20'	3.0/5.0	15-20'	SP	Dry, tan, poorly graded, fine SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 30SB-19-04	Page 2 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	QC'd 4/7/2020
Address: AOC 30	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/15/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 70 ft. bgs	Static Water: 69 ft. bgs	

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
20-25'	3.6/5.0	20-25'	SP	Dry, tan, poorly graded, fine SAND, trace subrounded gravel	
25-30'	3.2/5.0	25-30'	SP	Dry, tan, poorly graded, fine SAND	
30-35'	3.5/5.0	30-35	SP	Dry, tan, poorly graded, fine SAND, trace rounded gravel	
35-40'	3.0/5.0	35-40	SP-SM	Dry, tan, poorly graded, fine SAND, some fine silty sand	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 305B-19-04 Page 3 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 30	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/15/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 70 ft. bgs	Static Water: 69 ft. bgs

QC'd 4/7/2020 LBG

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
40-45'	2.9/5.0	40-45'	SP	Dry, tan, poorly graded, fine SAND	
45-50'	2.5/5.0	45-48'	SP	Dry, tan, poorly graded, fine SAND	
		48-50'	SM	Dry, tan, poorly graded, fine silty SAND	
50-55'	3.1/5.0	50-55'	SM	Dry, tan, poorly graded, fine silty SAND	
55-60'	3.2/5.0	55-60'	SP	Dry tan, poorly graded, fine SAND, little silt	

Notes:

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SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 305B-19-04	Page 4 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	QC'd 4/7/2020 LGW
Address: AOC 30	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/15/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 70 ft. bgs	Static Water: 69 ft. bgs	

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
60-65'	3.1/5.0	60-65	SM	Dry ~~to Moist~~ OK, tan, poorly graded, fine silty SAND	
65-70'	3.3/5.0	65-67	SM	Dry, tan, poorly graded, fine silty SAND	305B-19-04-67-69 @1440
		67-69	SM	Moist, tan, poorly graded, fine silty SAND	
		69-70	SM	Wet tan, poorly graded, fine silty SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 305B-19-05 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 30	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/14/19	Drilling Equip: Geoprobe 7712DT
Total Boring Depth: 15 ft. bgs	Static Water:

QC'd 4/7/2020 JRW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	4.0/5.0	0-0.5'	—	Asphalt	
		0.5-5'	SP	Dry, brown to tan, poorly graded, fine to medium SAND, little subrounded gravel	305B-19-05-0-0.5 @ 1425 305B-19-05-0.5-3 @ 1430
5-10'	4.0/5.0	5-7'	SW	Dry, brown, well graded, medium to coarse SAND, little subangular gravel	305B-19-05-3-7 @1435
		7-10'	SP	Dry, tan, poorly graded, fine to medium SAND, trace subrounded gravel	305B-19-05-7-15 @1440
10-15'	3.7/5.0	10-11'	SP	Same as 7-10' bgs	
		11-15'	SW	Dry, tan, well graded, coarse SAND, little medium sand, trace subrounded gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 305B-19-06	Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 30	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/15/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 15 ft. bgs	Static Water:	

QC'd 4/7/2020 CDW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	3.8/5.0	0-0.5'	SP	Dry, dark brown, poorly graded, fine sand, little subangular gravel, grass/roots at surface (topsoil)	
		0.5-5'	SW	Dry, tan, well graded, medium SAND, little coarse sand, trace rounded gravel	305B-19-06-0-0.5 @805 305B-19-06-0.5-3 @810
5-10'	3.9/5.0	5-10'	SP	Dry, tan, poorly graded, fine to medium SAND, trace coarse sand	305B-19-06-5-7 @815 305B-19-06-7-15 @820
10-15'	3.7/5.0	10-15'	SP	Dry, tan-orange tint, poorly graded medium SAND, trace subrounded gravel	

Notes:

KOMAN Government Solutions, LLC 293 Boston Post Road, Marlborough, MA

AOC 31

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-01	Page 1 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 31	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/16/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 20 ft. bgs	Static Water: 6.7 ft. bgs	

QC'd 4/7/2020 LAW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID~~ (ppm)	GEOLOGIC LOG	REMARKS
		0-3" LAW	—	Concrete	
0-5'	3.0/5.0 LAW 5.0	3"-5'	SP	Dry, brown, poorly graded, fine to medium SAND, trace subangular gravel	315B-19-01-0-0.5 @955 315B-19-01-0.5-3 @1000
5-10'	2.9/5.0	5-10'	SP	Dry, tan, poorly graded, fine to medium SAND, little subangular gravel, trace coarse sand	315B-19-01-3-7 @1005 315B-19-01-7-15 @1010 ↳ MS/MSD
10-15'	3.1/5.0	10-11'	SP	Dry, dark brown, poorly graded, fine SAND	
		11-15'	SW	Dry, tan, well graded, medium SAND, little coarse sand, little subangular gravel	
15-20'	2.5/5.0	15-20'	SP	Dry, tan, poorly graded, fine SAND, some subrounded gravel, trace coarse sand	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-01	Page 2 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 31	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/16/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 70 ft. bgs	Static Water: 67 ft. bgs	

QC'd 4/7/2020 (SW)

Core Section	Recovery (ft)	Interval (ft)	PID (ppm)	GEOLOGIC LOG	REMARKS
20-25'	2.6/5.0	20-22'	SP	Dry, brown, poorly graded, fine SAND, trace subrounded gravel	
		22-25'	SW	Dry, tan, well graded, medium SAND, little subrounded gravel	
25-30'	2.0/5.0	25-30'	SW	Dry, tan/brown, well graded, medium SAND, little subangular gravel, trace coarse sand	
30-35'	2.7/5.0	30-35'	SP	Dry, brown, ~~poorly~~ well (SP) graded, medium SAND, little subangular gravel	
35-40'	3.0/5.0	35-40'	SW	Dry, tan, well graded, medium to coarse SAND, trace subangular gravel	

Notes:

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KOMAN Government Solutions, LLC 293 Boston Post Road, Marlborough, MA

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-01	Page 3 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 31	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/16/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 70 ft. bgs	Static Water: 67 ft. bgs	

QC'd 4/7/2020 [signature]

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
40-45'	0	–		No recovery	
45-50'	2.8/5.0	45-50'	SW	Dry, tan, well graded, medium to coarse SAND, some subangular gravel	
50-55'	3.1/5.0	50-55'	SW	Dry, tan, well graded, medium to coarse SAND, some subangular gravel	
55-60'	3.3/5.0	55-60'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-01	Page 4 of 4
Project No.: 1082	Drilling Co.: Technical Drilling Services	QC'd 4/7/2020 LBW
Address: AOC 31	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/16/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 70 ft. bgs	Static Water: 67 ft. bgs	

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
60-65'	2.8/5.0	60-65'	SP	Dry to moist, tan, poorly graded, fine SAND, few rounded gravel	
65-70'	3.5/5.0	65-67'	SP	Moist, tan, poorly graded, fine SAND, trace subrounded gravel	315B-19-01-65-67 @ 1240
		67-70'	SP	Wet, tan, poorly graded, fine to medium SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-02 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 31	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/17/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 Ft. bgs	Static Water:

QC'd 4/7/2020

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	3.1/5.0	0-2"	—	Asphalt	315B-19-02-0-0.5 @820
		2"-3'	SP	Dry, brown, poorly graded, medium SAND, trace subangular gravel	
		3-5'	SP	Dry, brown to tan, poorly graded, fine SAND, trace medium sand	315B-19-02-0.5-3 @825
5-10'	3.5/5.0	5-10'	SP	Dry, tan, poorly graded, fine to medium SAND, little subangular gravel	315B-19-02-3-7 @830 ~~DUP~~ AS-SB-DUP01-101719 @835
10-15'	2.7/5.0	10-12'	SP	Dry, brown, poorly graded, fine SAND, trace subangular gravel	315B-19-02-7-15 @840
		12-15'	SP	Dry, tan, poorly graded, medium SAND, trace subrounded gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-03 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 31	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/17/19	Drilling Equip: Geoprobe 7712DT
Total Boring Depth: 15 ft. bgs	Static Water:

QCd 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	~~PID (ppm)~~ USCS	GEOLOGIC LOG	REMARKS
0-5'	3.4/5.0	0-0.5'	SP	Dry, tan, poorly graded, fine SAND, trace subrounded gravel, little asphalt chuncks	
		0.5-5'	SP	Dry, brown, poorly graded, fine to medium SAND, little subangular gravel	315B-19-03-0-0.5 @930 315B-19-03-0.5-5 @935
5-10'	3.8/5.0	5-6'	SW	Dry, tan, well graded, medium SAND, trace subangular gravel	315B-19-03-3-7 @940
		6-10'	SP	Dry, tan, poorly graded, fine to medium SAND, trace subangular gravel	315B-19-03-7-15 @945
10-15'	4.0/5.0	10-13'	SP	Dry, brown, poorly graded, fine SAND	
		13-15'	SW	Dry, tan, well graded, medium SAND, trace coarse sand	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-04	Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services	QC'd 4/7/2020 [illegible]
Address: AOC 31	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/16/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 15 ft. bgs	Static Water:	

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.9/5.0	0-0.5	—	Asphalt/concrete	315B-19-04-0-0.5 @ 1420
		0.5-5'	SP	Dry, brown to tan, poorly graded, fine to medium SAND, little subangular gravel	315B-19-04-0.5-3 @ 1425
5-10'	3.1/5.0	5-6'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	315B-19-04-3-7 @ 1430
		6-10'	SW	Dry, tan, well graded, medium to coarse SAND, trace subangular gravel	315B-19-04-7-15 @ 1435
10-15'	3.1/5.0	10-12'	SP	Dry, tan, poorly graded, fine SAND, trace angular gravel	
		12-15'	SW	Dry, tan, well graded, medium SAND, little coarse sand, trace subangular gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-05 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 31	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/17/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 ft. bgs	Static Water:

QCd 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	~~0-1~~ DK ~~3.2/5.0~~	0-1'	SW	Dry, brown, well graded, medium to coarse SAND, trace asphalt chunks	
	3.2/5.0	1-5'	SP	Dry, tan, poorly graded, fine SAND, trace subangular gravel	~~315B~~ DK 315B-19-05-0-0.5 @1220 315B-19-05-0.5-3 @1225
5-10'	3.1/5.0	5-7'	SW	Dry, tan, well graded, coarse SAND, little subrounded gravel	315B-19-05-3-7 @1230
		7-10'	SP	Dry, tan, poorly graded, fine SAND, little subangular gravel	315B-19-05-7-15 @1235
10-15'	3.3/5.0	10-15'	SP	Dry, tan, poorly graded, fine to medium SAND, little subangular gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 315B-19-06 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 31	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/16/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 10 ft. bgs	Static Water:

QC'd 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	3.0/5.0	0-5'	SP	Dry, brown, poorly graded, fine to medium SAND, trace subangular gravel	315B-19-06-0-5 @ 1325
5-10'	2.9/5.0	5-10'	SP	Dry, tan, poorly graded, fine to medium SAND, little coarse sand, trace subangular gravel	315B-19-06-5-7 @ 1330

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 31SB-19-07 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 31	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/16/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 10 Ft. bgs	Static Water:

QC'd 4/7/2020 (DW)

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	3.3/4.0	0-0.5'	—	Concrete	31-concrete-OCT19 @840
		0.5-5'	SP	Dry, brown, poorly graded, medium SAND, trace subangular gravel	31SB-19-07-0-1 @845
5-10'	3.0/4.0	5-10'	SP	Dry, tan, poorly graded, fine to medium SAND, trace subrounded gravel	31SB-19-07-5-7 @850 A3-SB-DUP01-101619 @855

Notes:

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AOC 50

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 505B-19-01 Page 1 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/24/19	Drilling Equip: Vac Master 4000 to 10' bgs / Geoprobe 6712DT after
Total Boring Depth: 50 ft. bgs	Static Water: 46 ft. bgs

QC'd 4/7/2020 CSW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	N/A	0-0.5'	SP	Dry, dark brown, poorly graded, fine SAND, trace rounded gravel, some organics	505B-19-01-0-0.5 @830
		0.5-5'	SP	Dry, dark brown, poorly graded, fine SAND, trace subrounded gravel	505B-19-01-0.5-3 @835
5-10'	N/A	5-10'	SW	Dry, dark brown, well graded, medium SAND, few coarse sand, trace subangular gravel	505B-19-01-3-7 @840 505B-19-01-7-15 @1115
10-15'	3.0/5.0	10-13'	SP	Dry, dark brown, poorly graded, fine SAND, trace subrounded gravel	
		13-15'	SP	Dry, tan, poorly graded, medium SAND, little coarse sand	
15-20'	3.5/5.0	15-18'	SP	Dry, dark brown, poorly graded, fine SAND	
		18-20'	SP	Dry, tan, poorly graded, fine SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: SOSB-19-01 Page 2 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/24/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 50 ft. bgs	Static Water: 46 ft. bgs

QC'd 4/7/2020 [signature]

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
20-25'	2.7/5.0	20-25'	SP	Dry, tan, poorly graded, fine SAND, little silt	
25-30'	3.0/5.0	25-30'	SM	Dry, tan, poorly graded, fine silty SAND	
30-35'	2.5/5.0	30-35'	SM	Dry, tan, poorly graded, fine silty SAND	
35-40'	3.2/5.0	35-38'	SM	Dry, tan, poorly graded, fine silty SAND	
		38-39' (DE) ~~38-39'~~	ML	Dry, ~~tan~~ brown, SILT, little fine sand	
		39-40'	SP	Dry, tan, poorly graded, fine sand	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 505B-19-01	Page 3 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services	QC'd 4/7/2020
Address: AOC 50	Driller: Jay Jumonville	
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/24/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 50 ft. bgs	Static Water: 46 ft. bgs	

Core Section	Recovery (ft)	Interval (ft)	~~PID (ppm)~~ USCS	GEOLOGIC LOG	REMARKS
40-45'	2.8/5.0	40-44'	SP	Dry, tan, poorly graded, fine SAND	
		44-45'	SM	Moist, tan, poorly graded, fine silty SAND	
45-50'	3.9/5.0	45-46'	SM	Same as 44-45' bgs	505B-19-01-44-46 @1240
		46-50'	SM	Wet, brown/tan, poorly graded, fine silty SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: SOSB-19-02 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/24/19	Drilling Equip: Vac Master 4000 to 10' bgs Geoprobe 6712DT after
Total Boring Depth: 15 ft. bgs	Static Water:

QC 9/7/2020

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
~~0-0~~ 0-5'	N/A	0-0.5'	SP	Dry, dark brown, poorly graded, fine sand, some organics/roots, trace subangular gravel	SOSB-19-02-0-0.5 @930
		0.5-5'	SP	Dry, tan, poorly graded, fine SAND, little medium sand	SOSB-19-02-0.5-5 @935
5-10'	N/A	5-10'	SP	Dry, tan, poorly graded, fine SAND	SOSB-19-02-5-7 @940
					SOSB-19-02-7-15 @~~915~~ DK 1340
10-15'	2.5/5.0	10-15'	SP	Dry, tan to ~~brown~~ brown, poorly graded fine SAND, few coarse sand	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: SOSB-19-03	Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services	
Address: AOC 50	Driller: Jay Jumonville	QC'd 4/7/2020 SAG
Logger: Dave Kortjohn	Drilling Method: Direct Push	
Date: 10/23/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 15 ft. bgs	Static Water:	

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.5/5.0	0-0.5'	–	Asphalt	SOSB-19-03-0-0.5 @910
		0.5-3'	SP	Dry, tan, poorly graded, fine SAND, trace subrounded gravel, little coarse sand	SOSB-19-03-0.5-3 @915
		3-5'	SP	Dry, tan, poorly graded, fine SAND, trace subrounded gravel	
5-10'	3.3/5.0	5-6'	SP	Same as 3-5' bgs	SOSB-19-03-3-7 @920
		6-9'	SW	Dry, tan, well graded, coarse SAND, little medium sand, trace subrounded gravel	SOSB-19-03-7-15 @925
		9-10'	SP	Dry, tan, poorly graded, fine SAND	
10-15'	3.4/5.0	10-15'	SP	Dry, tan, poorly graded, medium SAND, some fine sand	A3-SB-DUP01-102319 @930

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 505B-19-04 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/23/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 ft. bgs	Static Water:

QC'd 4/2/20 DK

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	3.2/5.0	0-0.5'	—	Asphalt/concrete	505B-19-04-0-0.5 @1100
		0.5-3'	SP	Dry, tan, poorly graded, fine SAND, few subrounded gravel	505B-19-04-0.5-3 @1105
		3-5'	SP	Dry, dark brown to brown, poorly graded, fine SAND	
5-10'	3.8/5.0	5-8'	SP	Dry, tan, poorly graded, fine SAND, trace subrounded gravel	505B-19-04-3-7 @1110 → MS/MSD
		8-10'	SP	Dry, tan, (UNW) poorly graded, medium SAND, trace coarse sand, trace subrounded gravel	505B-19-04-7-15 @1115
10-15'	4.0/5.0	10-11'	SP	Dry, brown, poorly graded, fine SAND	
		11-13'	SW	Dry, tan, well graded, coarse SAND, some subrounded gravel	
		13-15'	SP	Dry, tan, poorly graded, fine SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI		Boring No.: 505B-19-05	Page 1 of 3
Project No.: 1082		Drilling Co.: Technical Drilling Services	
Address: AOC 50		Driller: Jay Jumonville	
Logger: Dave Kortjohn		Drilling Method: Direct Push	
Date: 10/23/19		Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 60 ft. bgs		Static Water: 53 ft. bgs	

QC'd 4/2/2020

Core Section	Recovery (ft)	Interval (ft)	VSCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	3.6/5.0	0-0.5'	–	Asphalt	505B-19-05-0-0.5 @1230
		0.5-1.5'	SW	Dry, brown, well graded, medium SAND, little coarse sand, trace subrounded gravel	
		1.5-5'	SP	Dry, ~~orange~~ orange/tan to tan, poorly graded, fine SAND, trace subangular gravel	505B-19-05-0.5-3 @1235
5-10'	3.2/5.0	5-9'	SW	Dry, tan, well graded, coarse SAND, little medium sand, trace subangular gravel	505B-19-05-3-7 @1240
		9-10'	SP	Dry, tan, poorly graded, fine SAND	A3-SB-DVP02-102519 @ ~~1245~~ 1250 (DUP) ↓ 505B-19-05-7-15 @1245
10-15'	3.0/5.0	10-13'	SW	Dry, brown to tan, well graded, coarse SAND, little medium sand, little subangular gravel	
		13-15'	SP	Dry, tan, poorly graded, fine SAND	
15-20'	3.1/5.0	15-20'	SP	Dry, brown, poorly graded, fine SAND, trace subangular gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 505B-19-05 Page 2 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/23/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 60 ft. bgs	Static Water: 53 ft. bgs

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
20-25'	3.4/5.0	20-25'	SP	Dry, tan, poorly graded, fine SAND, ~~little~~ trace silt	
25-30'	3.6/5.0	25-30'	SM	poorly graded Dry, tan, fine silty SAND	
30-35'	3.8/5.0	30-35'	SM	Dry/Moist, tan, poorly graded, fine silty SAND	
35-40'	3.7/5.0	35-40'	SM	Dry/Moist, tan, poorly graded, fine silty SAND	

Notes:

KOMAN Government Solutions, LLC 293 Boston Post Road. Marlborough, MA

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: SOSB-19-05 Page 3 of 3
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/23/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 60 ft. bgs	Static Water: 53 ft bgs

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
40-45'	4.0/5.0	40-45'	SM	Dry, tan, poorly graded, fine silty SAND	
45-50'	4.0/5.0	45-50'	SM	Dry/Moist, tan/brown poorly graded, fine silty SAND	
50-55'	4.0/5.0	50-53'	SM	Moist, brown, poorly graded, fine silty SAND	SOSB-19-05-51-53 @1350
		53-55'	SM	Wet, brown, poorly graded, fine silty SAND	
55-60'	3.8/5.0	55-60'	SP	Wet, brown, poorly graded, fine SAND	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Downs PFAS SB, Area 3	Boring No.: SOSB-19-06
Project No.: 01082-0011-533	Drilling Co.: TNS
Address: AOC 50	Driller: Jay Jumonville
Logger: Chris Vignola	Drilling Method: Geoprobe (Direct Push)
Date: 10/28/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 65'	Static Water: N/A

QC'd 4/7/2020 LBW

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~ Symbol	GEOLOGIC LOG	REMARKS
0-5'	39"	0-7"	SP	Dry, dark brown, fine to medium sand, (poorly graded) trace organics	0-0.5 ~ 0820
		7-39"	SP	Dry, tan, poorly graded fine to medium sand, trace sub-angular, fine gravel	0.5-3 ~ 0825
5-10'	37"	0-13"	SP	Dry, brown, poorly graded fine to medium sand	3-7 ~ 0830
		13-37"	SP	Dry, tan, poorly graded medium to coarse sand, trace sub-rounded fine gravel	7-15 ~ 0835
10-15'	37"	0-13"	SP	Dry, brown, poorly graded, fine to medium sand	
		13-31"	SP	Dry, tan, poorly graded medium to coarse sand with few sub angular fine gravel	
		31-37"	SP SW	Dry, tan, well graded coarse sand with some sub-angular fine gravel	
15-20'	46"	0-26"	SP	Dry, brown, poorly graded, fine to medium sand with few, sub-rounded fine gravel.	
		26-46"	SP	Dry, tan, poorly graded, medium to coarse sand with little, sub-angular fine gravel	
20-25'	27"	0-27"	SP	Dry, tan, poorly graded, medium to coarse sand with trace, sub rounded fine gravel	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS SB, Area 3	Boring No.: SOSB-19-06
Project No.: 0082-0011-533	Drilling Co.: TAS
Address: Area 50	Driller: Jay Jamville
Logger: Chris Vigneault	Drilling Method: Geoprobe (Direct Push)
Date: 10/28/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 65'	Static Water: N/A

QC'd 4/21/2020

Core Section	Recovery (ft)	Interval (ft)	~~PID (ppm)~~ USCS symbols	GEOLOGIC LOG	REMARKS
25-30'	31"	0-31"	SP	Dry, tan, poorly graded, medium to coarse sand with trace, sub rounded, fine gravel	
30-35'	35"	0-35"	SP	Dry, tan, poorly graded, fine to medium sand with trace, sub rounded, fine gravel, trace coarse sand	
35-40'	34"	0-34"	SP	Dry, tan, poorly graded, fine to medium sand with trace, sub-rounded fine gravel, few coarse sand	
40-45'	36"	0-36"	SP	Dry, tan, poorly graded, fine to medium sand, trace sub-rounded, fine gravel, trace coarse sand	
45-50'	26"	0-16"	SP	Dry, tan, poorly graded, fine to medium sand	
		16-26"	SP	Dry, light tan, poorly graded, fine to medium sand	

Notes:

KOMAN Government Solutions, LLC 293 Boston Post Road, Marlborough, MA

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Deans PFAS SB, Area 3	Boring No.: SOSB-19-06
Project No.: 01082-0011-533	Drilling Co.: TDS
Address: AOC 50	Driller: Jay Jumonville
Logger: Chris Vigneau	Drilling Method: Geoprobe (Direct Push)
Date: 10/28/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 65'	Static Water: N/A

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~ symbols	GEOLOGIC LOG	REMARKS
50-55'	33"	0-33"	SP	Dry, tan, poorly graded, fine to medium sand	
55-60'	39"	0-26"	SP	Dry, tan, poorly graded, fine to medium sand, small pockets of coarse sand	
		26-39"	SM	Dry tan, poorly graded, fine sand with few silt	
60-65'	43"	0-24"	SM	Moist, poorly graded, fine sand with few silt	Water table @ 62'
		62' ~ water table			60-62' ~ 1125

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 505B-19-07 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/25/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15 ft. bgs	Static Water:

QCd 4/7/2020 GWF

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	2.7/5.0 (GW)	0-1'	SP	Dry, dark brown, ~~f~~ poorly graded, fine SAND, few organics/roots (GW)	505B-19-07-0-0.5 @ 840
		1-5'	SP	Dry, tan, poorly graded, fine SAND, cobble @ 3' bgs	505B-19-07-0.5-3 @ 845
5-10'	3.8/5.0	5-8'	SP	Dry, tan, poorly graded, medium SAND, little fine sand	505B-19-07-3-7 (GW) @ 850
		8-10'	SW	Dry, tan, well graded, coarse SAND, little subangular gravel	505B-19-07-7-15 @ 855 A3-SB-DUP01-102519 @ 900
10-15'	3.0/5.0	10-12'	SP	Dry, light brown, poorly graded, fine SAND	
		12-15'	SW	Dry, tan, well graded, coarse SAND, some subrounded gravel	

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: SOSB-19-08 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: Dave Kortjohn	Drilling Method: Direct Push
Date: 10/25/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 15 ft. bgs	Static Water:

4/7/2020

Core Section	Recovery (ft)	Interval (ft)	USCS ~~PID (ppm)~~	GEOLOGIC LOG	REMARKS
0-5'	4.2/5.0	0-1'	SP	Dry, dark brown, poorly graded, fine SAND, little organics/roots	SOSB-19-08-0-0.5 @1015
		1-2'	SP	Dry, tan, poorly graded fine SAND, trace subangular gravel	
		2-5'	SW	Dry, tan, well graded, coarse SAND, little medium sand, little subrounded gravel	SOSB-19-08-0.5-3 @1020
5-10'	4.0/5.0	5-8'	SW	Dry, tan, well graded, medium SAND, trace subangular gravel	SOSB-19-08-3-7 @1025 → MS/MSD
		8-10'	SW	Dry, tan, well graded, coarse SAND, some subrounded gravel	SOSB-19-08-7-15 @1030
10-15'	4.3/5.0	10-12'	SW	Dry, tan, well graded, medium SAND, trace subrounded gravel	
		12-15'	SW GW	Dry, tan, well graded, coarse SAND and subrounded GRAVEL	

Notes:

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS Soil Borings	Boring No.: 50SB-19-09
Project No.: 02082-0011-5333	Drilling Co.: TDS
Address: AOC 50 -	Driller: Jay Jumonville
Logger: Kristen Esser	Drilling Method: DPT
Date: 10/31/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 10'	Static Water: NA

QC'd 4/7/2020 KSW

Core Section	Recovery ~~(ft)~~ in	Interval ~~(ft)~~ in	USCS ~~PID (ppm)~~ sym	GEOLOGIC LOG	REMARKS
0-5'	32	0-18	SM-~~SW~~	0-18': Dark brown to black poorly graded fine-med SAND with some SILT and some organics	
		18-28	SM-~~SW~~	18-28': Dark brown to black poorly graded med. SAND, dry, few SILT, some organics	
		28-32	SW	28-32': light brown well graded med-coarse SAND, dry	
5-10'	26	0-5	SW	0-5': light brown well graded med-coarse SAND, dry	
		5-26	SW	5-26': ~~Red~~ saturated tan well graded med-coarse SAND	Water table @ 7' bgs

Notes: Water table @ 7', sample intervals are 0-0.5, 0.5-3, 3-5', 5-7'

PID 0.5-3 misplaced @ 5-7'

KGS
KOMAN Government Solutions, LLC 293 Boston Post Road, Marlborough, MA

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Queens PFAS Soil Borings	Boring No.: SOSB-19-10
Project No.: 02082-0011-533	Drilling Co.: TDS
Address: AOC 50-	Driller: Jay Jumonville
Logger: Kristen Euler	Drilling Method: DPT
Date: 10/31/19	Drilling Equip: Geoprobe 6712 DT
Total Boring Depth: 10'	Static Water: NA

QCd 4/7/2020 [initials]

Core Section	Recovery (ft) in	Interval (ft) in	USCS ~~PID~~ (ppm) Sym.	GEOLOGIC LOG	REMARKS
0-5'	32	0-26	SM	0-26: dark brown - black poorly graded dry fine-med SAND with little SILT	
		26-32	SP	26-32: Brown poorly graded med. SAND dry with some organics	
5'-10'	29	0-5	SP	0-5: tan-brown poorly graded med. SAND dry	(E)
		5-19	SP	5-19: tan-grey poorly graded med SAND dry	
		19-29	SW	19-29: tan-grey well graded med-coarse SAND saturated/moist trace Sub angular gravel (GW)	

Notes: Water @ 7' bgs, intervals for sampling 0-0.5, 0.5-3, 3-5, 5-7

Field dup @ 3-5

KGS

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KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: SOSB-19-11 Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services
Address: AOC 50	Driller: Jay Jumonville
Logger: ~~Dave Kortjohn~~ Kristen Estee	Drilling Method: Direct Push
Date: 11/25/19	Drilling Equip: Geoprobe 6712DT
Total Boring Depth: 15'	Static Water: NA

QC'd 4/7/2020 GMS

Core Section	Recovery ~~(ft)~~ in	Interval ~~(ft)~~ in	USCS ~~PID~~ (ppm) Sym.	GEOLOGIC LOG	REMARKS
0-5	37	0-11	SM	0-11: Top soil - dry dark brown fine sand	SILT, some
		11-24	SP	11-24: dry poorly graded tan fine-med. SAND fine cobble @ 24"	
		24-37	SW-GW	24-37: well graded tan med-coarse SAND dry some GRAVEL sub-angular	
5-10	46	0-23	SW	0-23: well graded light tan med-coarse SAND dry with few gravel	
		23-46	SP	23-46: dry poorly graded light tan fine-med SAND	
10-15	40	0-40	SP	0-40: Dry poorly graded light tan fine-med SAND	

Notes: Samples @ 0-0.5, 0.5-3, 3-7, 7-15
7-15 is MS/MSD

KOMAN Government Solutions, LLC 293 Boston Post Road, Marlborough, MA

KOMAN Government Solutions, LLC
SOIL BORING LOG

Project: Devens PFAS RI	Boring No.: 505B-19-~~12~~ 12	Page 1 of 1
Project No.: 1082	Drilling Co.: Technical Drilling Services	QC'd 4/7/2020
Address: AOC 50	Driller: Jay Jumonville	
Logger: ~~Dave Kortjohn~~ Kristen Esser	Drilling Method: Direct Push	
Date: 11/18/19	Drilling Equip: Geoprobe 6712DT	
Total Boring Depth: 15'	Static Water: 52'	

Core Section	Recovery ~~(ft)~~ in	Interval ~~(ft)~~ in	VOCs ~~PID~~ (ppm)	GEOLOGIC LOG	REMARKS
0-5	~~40~~ 46	0-5.5 ~~5-25~~ 5.5-25 25-~~40~~ 46	SM-0 SP SW	0-5.5: topsoil, ~~SILT~~ with some fine ~~SAND~~ SAND dry dark brown 5.5-25: dry tan fine-med. SAND, poorly graded 25-~~40~~ 46: dry well graded light tan med-coarse SAND with trace SUB round gravel	
5-10	40	0-40	SW	0-40: dry light tan well graded med-coarse SAND trace SUB. angular gravel	
10-15	40	0-40	SW	0-40: dry light brown to light tan well graded med-coarse SAND trace angular gravel	

Notes:

KOMAN Government Solutions, LLC 293 Boston Post Road, Marlborough, MA

APPENDIX E SURFACE WATER AND SEDIMENT FIELD SHEETS

Area 3 Surface Water and Sediment Sampling Field Sheets

AOC 20 Unnamed
Wetland

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: PFAS-RI Devens, MA
Location: Area 3
Sample Location ID: UP-19-01

Date/Time: 10/17/19 1145
Sampler: Melissa Miller

KGS

Surface Water/Leachate Seep Information

Shorline

Type of SW: ( ) Stream ( ) River ( ) Seep x Pond

Water Depth: 6"	Dissolved Oxygen (mg/L): 9.22
Velocity of Water: Standing H_2O	ORP (mV): 131.4
Temperature (C): 10.75	Specific Conductance (µS/cm): —
pH (STD): 6.84	Turbidity (NTU): 7.13

Sample Observations:
( ) Odor none
( ) Color Clear
( ) Other
Sample Direct Dip

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938 AB
Lamotte	2020WE	1828-0412

Sediment/Leachate Seep Sediment Information

Sample Depth = 6" bgs

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor slight smell
( ) Color Grey
( ) Other
Sample collected via Stainless steel Hand Cover & Homoginized

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
UP-19-01-SW-OCT19	UP-19-01	1145	SW	2	none	PFAS
UP-19-01-SE-OCT19	|	1145	SE	1	|	PFAS
UP-19-01-SE-OCT19	|	1145	SE	1	|	TOC
UP-19-01-SE-OCT19	X	1145	SE	1	X	Grain Size

Comments: SE = Sediment SW = Surface H_2O
Sample location 12 ft North from ID Stake

Enco: Small & Large trees line the shore of the Pond
lily Pads & a Beaver Dam Present
42.5695913, -71.6140248 gmap.

AOC 21
Unnamed
Stream

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

Project: PFAS RI
Location: Area 3
Sample Location ID: US-19-01

Date/Time: 10/18/2019 1145
Sampler: Seiler + Hazebrouck

Surface Water/Leachate Seep Information → no SW sample collected

Type of SW: ( ) Stream ( ) River ( ) Seep

Water Depth:	Dissolved Oxygen (mg/L):
Velocity of Water:	ORP (mV):
Temperature (C):	Specific Conductance (µS/cm):
pH (STD):	Turbidity (NTU):

Sample Observations:

( ) Odor
( ) Color
( ) Other

Field Testing Equipment:

Make	Model	Serial #
NA		
NA		

Sediment/Leachate Seep Sediment Information

Sample Depth 0-6"

Sediment Type: (X) Organic ( ) Gravel ( ) Clay (X) Silt ( ) Sand (X) Other fine sand

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:

( ) Odor none
( ) Color brown/dark brown
( ) Other

Sample collected with decon. stainless steel spoon

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
US-19-01_SE-Oct19	US-19-01	1145	Sed.	1	none	PFAS
US-19-01_SE-Oct19	US-19-01	1145	Sed.	1	none	TOC
US-19-01_SE-Oct 19	US-19-01	1145	Sed.	1	none	Grain Size

Comments: Stake is 10' S of sampling location
Creek bed was dry at time of sampling, only Sediment was collected on 10/18

42.5671102 x -71.608341

Airfield Wetland

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

Project: PFAS RI
Location: Area 3
Sample Location ID: AFW-19-01

Date/Time: 10/18/2019 1000
Sampler: Seiler + Hazebrouck

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream ( ) River ( ) Seep (x) wetland

Water Depth: 1-2 inches	Dissolved Oxygen (mg/L): 3.23
Velocity of Water: stagnant	ORP (mV): 166.8
Temperature (C): 8.37	Specific Conductance (µS/cm): 93
pH (STD): 4.73	Turbidity (NTU): 759 AU

Sample Observations:
( ) Odor none
( ) Color gray
( ) Other
Direct dip sample

Field Testing Equipment:

	Make	Model	Serial #
	YSI	560 MDS	0J1938AB
	Lamotte	2020 we	1828-0412

Sediment/Leachate Seep Sediment Information

Sample Depth: 0-6"

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt ( ) Sand (X) Other Pine Sand

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor none
( ) Color dark brown/black
( ) Other
Sample collected with decon. stainless steel spoon

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
AFW-19-01_SW-Oct19	AFW-19-01	1000	SW	2	none	PFAS
AFW-19-01_SE-Oct19	AFW-19-01	1000	Sed.	1	none	PFAS
AFW-19-01_SE-Oct19	AFW-19-01	1000	Sed.	1	none	TOC
AFW-19-01_SE-Oct19	AFW-19-01	1000	Sed.	1	none	Grain Size

Comments: Stake is 20' NW of sample location
Trees along shoreline, woody brush within water

42.570138 x -71.6065536

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: PFAS RI
Location: Area 3
Sample Location ID: AFW-19-02

Date/Time: 10/18/2019 0900
Sampler: Seiler + Hazebrouck

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream ( ) River ( ) Seep (X) wetland

Water Depth: 3-4 inches	Dissolved Oxygen (mg/L): 3.54
Velocity of Water: stagnant	ORP (mV): 185.3
Temperature (C): 8.91	Specific Conductance (µS/cm): 143
pH (STD): 3.57	Turbidity (NTU): 10.94

Sample Observations:
( ) Odor none
( ) Color clear
( ) Other
Direct Dip Sample

Field Testing Equipment:

	Make	Model	Serial #
( ) Odor none	YSI	560MDS	0J1938AB
( ) Color clear	LaMotte	2020we	1828-0412
( ) Other			

Sediment/Leachate Seep Sediment Information

Sample Depth 0-6"

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt ( ) Sand (X) Other fine sand

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor none
( ) Color dark brown/black
( ) Other
Sample collected with decon. stainless steel spoon

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
AFW-19-02_SW-Oct19	AFW-19-02	0900	SW	2	none	PFAS
AFW-19-02_SE-Oct19	AFW-19-02	0900	Sed.	1	none	PFAS
AFW-19-02_SE-Oct19	AFW-19-02	0900	Sed.	1	none	TOC
AFW-19-02_SE-Oct19	AFW-19-02	0900	Sed.	1	none	Grain Size

Comments: * readjusted points due to access
stake is 10' NW of sample location
Trees along shoreline, woody brush within water

42.571408 x -71.0084668

Nashua River

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: PFAS RI - Devens, MA
Location: Area 3
Sample Location ID: NR-19-01

Date/Time: 10/17/19 1020
Sampler: Melissa Miller

Surface Water/Leachate Seep Information Before Dam

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 8"	Dissolved Oxygen (mg/L): 9.37
Velocity of Water: Steady/Slow	ORP (mV): 159.1
Temperature (C): 10.79	Specific Conductance (µS/cm): 337
pH (STD): 6.0	Turbidity (NTU): 10.33

Sample Observations:
( ) Odor None
( ) Color Clear
( ) Other
Sample by Direct DIP

Field Testing Equipment:

	Make	Model	Serial #
	YSI	650 MDS	06J1938AB
	Lamotte	2020we	1328-0412

Sediment/Leachate Seep Sediment Information Sample Depth 6"

Sediment Type: (X) Organic ( ) Gravel ( ) Clay (X) Silt ( ) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor No
( ) Color Grey/Brown
( ) Other

Sample collected via Stainless Steel Hand Corer & Homogenized

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-01-SW-0019	NR-19-01	1020	SW	2	none	PFAS
NR-19-01-SE-0019	NR-19-01	1020	SE	1		PFAS
NR-19-01-SE-0019	NR-19-01	1020	SE	1		TOC
NR-19-01-SE-0019	NR-19-01	1020	SE	1	↓	Grain

Comments: SE = Sediment, SW = Surface Water
Sample location 12ft Towards the Eastbank of the Nashua River from ID stake.
ECO: Small trees & shrubs & cattails line the West Bank of the Nashua River

42.552234, -71.6197537 (google MAPS)

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

PFAS RI

Project: Devens, MA
Location: Area 3
Sample Location ID: NR-19-02

Date/Time: 10/16/19
Sampler: Melissa Miller

Surface Water/Leachate Seep Information West Bank

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 8"	Dissolved Oxygen (mg/L): 10.24
Velocity of Water: Steady Flow	ORP (mV): 105.4
Temperature (C): 11.34	Specific Conductance (µS/cm): 473
pH (STD): 6.82	Turbidity (NTU): 1.8

Sample Observations:
( ) Odor none
( ) Color clear
( ) Other
Sample Direct DIP

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938 AB

Sediment/Leachate Seep Sediment Information Sample Depth 6" BGS

Sediment Type: (X) Organic ( ) Gravel ( ) Clay (X) Silt ( ) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor none
( ) Color Dark Grey
( ) Other
Sample Collected via Stainless Steel Hand Corer & Homogenized

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-02-SW-OCT19	NR-19-02	1245	SW	2	none	PFAS
NR-19-02-SE-OCT19		1245	SE	1		PFAS
NR-19-02-SE-OCT19		1245	SE	1		TOC
NR-19-02-SE-OCT19		1245	SE	1		Grain Size
AB-SW-DUP-101619		1250	SW	2		PFAS
AB-SE-DUP-101619		1250	SE	1		PFAS
AB-SE-DUP-101619		1250	SE	1		TOC
AB-SE-DUP-101619	✓	1250	SE	1	✓	Grain Size

Comments: SE = Sediment SW = Surface H_2O
Sample Location 8ft towards East bank of ID staff

ECO: Large & Small trees line the shore/Bank of the River

42.5629948, -71.6107814

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: PFAS RI
Location: Area 3
Sample Location ID: NR-19-03

Date/Time: 10/16/19 1130
Sampler: Melissa Miller

Surface Water/Leachate Seep Information west bank

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 8"	Dissolved Oxygen (mg/L): 10.12
Velocity of Water: Steady Flow	ORP (mV): 104.9
Temperature (C): 11.5	Specific Conductance (µS/cm): 479.
pH (STD): 6.83	Turbidity (NTU): 1.0

Sample Observations:
( ) Odor none
( ) Color Clear
( ) Other
Sample Direct DIP

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938AB

Sediment/Leachate Seep Sediment Information Sample Depth: 6" bgs

Sediment Type: (X) Organic ( ) Gravel ( ) Clay (X) Silt ( ) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor none
( ) Color Brown
( ) Other
Sample collected via stainless steel hand corer & homogenized

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-03-SW-OCT19	NR-1903	1130	SW	2	none	PFAS
NR-19-03-SE-OCT19	↓	1130	SE	1	↓	PFAS
NR-19-03-SE-OCT19	↓	1130	SE	1	↓	TOC
NR-19-03-SE-OCT19	X	1130	SE	1	X	Grain Size

Comments: SE=Sediment, SW=surface H_2O
Sample Location. 12FT SE of ID stake

ECO: Large & small trees line the shore

42.56387 79, -71.609 2686 gmaps

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: PFAS RI
Location: Area 3
Sample Location ID: NR-19-04

Date/Time: 10/16/19 1030
Sampler: Melissa Miller

Surface Water/Leachate Seep Information West bank

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 8"	Dissolved Oxygen (mg/L): 9.98
Velocity of Water: Steady Flow	ORP (mV): 108.1
Temperature (C): 10.70	Specific Conductance (µS/cm): 479
pH (STD): 6.47	Turbidity (NTU): 2.2

Sample Observations:
( ) Odor None
( ) Color Clear
( ) Other
Sample Direct Dip

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MPS	06J1938AB

Sediment/Leachate Seep Sediment Information Sample Depth 6" bgs

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____
Type of Sample Collected: ( ) Discrete ( ) Composite
Sample Observations:
( ) Odor none
( ) Color Grey/Black
( ) Other
Sample collected via stainless steel Hand Dover & Homogenize

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-04-SW-OCT19	NR-19-04	1030	SW	2	None	PFAS
NR-19-04-SE-OCT19	↓	1030	SE	1	↓	PFAS
NR-19-04-SE-OCT19	↓	1030	SE	1	↓	TOC
NR-19-04-SE-OCT19	X	1030	SE	1	X	Grain Size

Comments:
Sample location 8ft towards the bank.
SE=Sediment
SW=Surface H2O

Eco: Small trees/shrubs, Plants & Large trees line the Shoreline

42.5654225, -71.6086473

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: PFAS RI ⊙
Location: Area 3
Sample Location ID: NR-19-05

Date/Time: 10/16/19 0930
Sampler: Melissa Miller

Surface Water/Leachate Seep Information West Bank

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 7.5 FT	Dissolved Oxygen (mg/L): 9.72
Velocity of Water: Steady Flow	ORP (mV): 147.2
Temperature (C): 10.16	Specific Conductance (µS/cm): 494
pH (STD): 6.03	Turbidity (NTU): 1.3

Sample Observations:
( ) Odor none
( ) Color clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938 AB

Sample collected by Direct Dip

Sediment/Leachate Seep Sediment Information Sample Depth 6" bgs

Sediment Type: (X) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor none
( ) Color Grey/Black
( ) Other

Sample Collected by Stainless Steel Hand Corer & Homoginized

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-05-SW-OCT19	NR-19-05	0930	SW	2	none	PFAS
NR-19-05-SE-OCT19	|	0930	SE	1	|	PFAS
NR-19-05-SE-OCT19	|	0930	SE	1	|	TOC
NR-19-05-SE-OCT19	X	0930	SE	1	X	Grain Size

Comments: SE = Sediment SW = Surface H2O
Sample location 10 ft NE of ID stake

ECO: Trees and small shrubs / plants line the west bank

42.5671448, -71.6081300 (ID Stake) Gmaps

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

PFAS RT

Project: Devens, MA
Location: Area 3
Sample Location ID: NR-19-06

Date/Time: 10/15/19 1300
Sampler: Melissa Miller

KGS

Surface Water/Leachate Seep Information (West Bank)

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 8"	Dissolved Oxygen (mg/L): 9.35
Velocity of Water: Steady flow / slow	ORP (mV): 128.1
Temperature (C): 11.71	Specific Conductance (µS/cm): 609
pH (STD): 6.83	Turbidity (NTU): 1.2

Sample Observations:

( ) Odor none
( ) Color clear
( ) Other
Direct DIO Sample.

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938 AB

Sediment/Leachate Seep Sediment Information 6" bgs

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay ( ) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:

( ) Odor none
( ) Color Brown / Black
( ) Other
sample w/ a stainless steel Hand Cover & Homogenized

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-06-SW-OCT19	NR-19-06	1300	SW	2	none	PFAS
NR-19-06-SE-OCT19	↓	1300	SE	1	↓	PFAS
NR-19-06-SE-OCT19	↓	1300	SE	1	↓	TOC
NR-19-06-SE-OCT19	X	1300	SE	1	X	Grain size

Comments: Sample location 10 FT SE of TD Stake
SE = Sediment
SW = Surface H_2O

ECO: Trees & Shrubs line the west bank

42.5685740, -71.6115984 (Gmaps)

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens, MA PFAS RI
Location: Area 3
Sample Location ID: NR-19-07
Date/Time: 10/15/19 1155
Sampler: Melissa Miller

Surface Water/Leachate Seep Information West Bank

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 8"	Dissolved Oxygen (mg/L): 9.84
Velocity of Water: Steady flow	ORP (mV): 102.9
Temperature (C): 11.70	Specific Conductance (µS/cm): 494
pH (STD): 6.94	Turbidity (NTU): 1.5

Sample Observations:
( ) Odor None
( ) Color Clear
( ) Other
Direct DIP

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938AB

Sediment/Leachate Seep Sediment Information 0.5' bgs

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____
Type of Sample Collected: (X) Discrete ( ) Composite
Sample Observations:
( ) Odor None
( ) Color Dark Grey
( ) Other
Stainless steel Hand corer & Homogenized

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-07-SW-OCT19	NR-19-07	1155	SW	2	none	PFAS
NR-19-07-SE-OCT19	|	1155	SE	1	|	PFAS
NR-19-07-SE-OCT19	|	1155	SE	1	|	TOC
NR-19-07-SE-OCT19	X	1155	SE	1	none	Grain size

Comments: SE = Sediment Sample location 7 RT from ED state (East)
SW = Surface H_2O
ECO: Trees and shrubs line the River Bank

42.5698960, -71.6120098 (Gmaps)

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: PFAS RI, Devens, MA
Location: Area 3
Sample Location ID: NR-19-08

Date/Time: 10/15/19 1010
Sampler: Melissa Miller

Surface Water/Leachate Seep Information Eastburn

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: .61 ft	Dissolved Oxygen (mg/L): 9.22
Velocity of Water: Steady flow	ORP (mV): 87.6
Temperature (C): 10.42	Specific Conductance (µS/cm): 440
pH (STD): 6.95	Turbidity (NTU): 1.0

Sample Observations:
( ) Odor none
( ) Color Clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938AB

Sediment/Leachate Seep Sediment Information Sample Depth, 6" bgs

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor none
( ) Color Grey
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-08-SW-OCT19	NR-19-08	1010	SW	2	none	PFAS
NR-19-08-SE-OCT19		1010	SE	1		PFAS
NR-19-08-SE-OCT19		1010	SE	1		TOC
NR-19-08-SE-OCT19		1010	SE	1	X	Grain size

Comments: SE= Sample Collected via Hand Corer Stainless Steel & Homogenized
SW= Sample Collected by Direct Dip
SE=Sediment
SW=Surface H2O
Sample collected 8 ft from ID STAKE

ECO. Trees & Small Shrubs line the east Bank

42.5719878, -71.6125164 (gmaps)

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

PFAS RI

Project: Devens, MA

Location: Area 3

Sample Location ID: NR-19-09

Date/Time: 10/15/19 0920

Sampler: Melissa Miller

Surface Water/Leachate Seep Information East bank

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: .6' ft	Dissolved Oxygen (mg/L): 8.26
Velocity of Water: Steady Flow	ORP (mV): 83.0
Temperature (C): 10.02	Specific Conductance (µS/cm): 439
pH (STD): 6.73	Turbidity (NTU): 1 NTU

Sample Observations:

( ) Odor none

( ) Color Clear

( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650MDS	06J1938 AB

Sediment/Leachate Seep Sediment Information Sample Depth: 0.5' bgs

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete (X) Composite

Sample Observations:

( ) Odor none

( ) Color Grey / Black

( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-09-SW-0919	0920	NR-19-09	SW	2	none	PFAS
NR-19-09-SE-0919	0920	"	SE	1	"	PFAS
NR-19-09-SE-0919	0920	"	SE	1	"	TOC
NR-19-09-SE-0919	0920	"	SE	1	"	Grain Size

Comments: SE = Sampled via stainless steel Hand Cover & Homogenized
SW = Sample Direct Dip.
Sample Location 5ft from ID stake.

ECO: Trees & shrubs line the east bank

42.5729238, -71.6143028 - (gmaps)

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

PFAS RI
Project: Devens, MA
Location: ~~NR-19~~ Area 3
Sample Location ID: NR-19-10

Date/Time: 10/15/19 0825
Sampler: Melissa Miller

KGS

Surface Water/Leachate Seep Information

East Bank

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: .6' Approx	Dissolved Oxygen (mg/L): 9.64
Velocity of Water: Steady flow	ORP (mV): 149.1
Temperature (C): 10.91	Specific Conductance (µS/cm): 436
pH (STD): 5.79	Turbidity (NTU): 5.0

Sample Observations:
( ) Odor none
( ) Color Clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938AB

Sediment/Leachate Seep Sediment Information

Sample Depth .5' bgs

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt ( ) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete (X) Composite

Sample Observations:
( ) Odor n
( ) Color Grey/Brown
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-10-SW-OCT19	NR-19-10	0825	SW	2	none	PFAS
NR-19-10-SE-OCT19		0825	SE	1		PFAS
NR-19-10-SE-OCT19		0825	SE	1		TOC
NR-19-10-SE-OCT19	X	0825	SE	1	X	Grain Size

Comments:
SE Sample collected via Grab from Stainless Steel Hand Corer & Homoginized
SW = Sample collected by Direct Dip
SE = Sediment
Eco: Trees & Ferns line the East Bank, Beaver marks on trees.
SW = Surface H_2O

42.5750183, -71.6140366 gmaps
mple location 8 ft from ID Stake (West)

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

Project: Devens, MA PFAS RI **Date/Time:** 10/14/19 1244

Location: Area 3 **Sampler:** Melissa Miller

Sample Location ID: NR-19-11

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 1ft Approx	Dissolved Oxygen (mg/L): 9.61
Velocity of Water: Steady flow	ORP (mV): 106.0
Temperature (C): 11.91	Specific Conductance (µS/cm): 407.0
pH (STD): 6.53	Turbidity (NTU): 0.5

Sample Observations:

( ) Odor none

( ) Color clear

( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MPS	06J198AB

Sediment/Leachate Seep Sediment Information Depth .6'

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: ( ) Discrete (X) Composite

Sample Observations:

( ) Odor

( ) Color Grey / Brown

( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-11-SW-OCT19	NR-19-11	1245	SW	2	none	PFAS
NR-19-11-SE-OCT19		1245	SE	1		PFAS
NR-19-11-SE-Oct19		1245	SE	1		TOC
NR-19-11-SE-OCT19		1245	SE	1		Grain Size
A3-SW-Dup-101419		1250	SW	2		PFAS
A3-SE-Dup-101419		1250	SE	1		PFAS
A3-SE-Dup-101419		1250	SE	1		TOC
A3-SE-Dup-101419	X	1250	SE	1	X	Grain Size

Comments: Sample grabbed - stainless steel Hand corer & Homogenized

Direct Dip = SW

Sample Location - 10 ft N of ID stake.

SW = Surface H_2O

SE = Sediment

Eco: Trees, shrubs along the Bank

42.5570480, -71.6125932

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens PFAS RI
Location: Area 3
Sample Location ID: NR-19-12

Date/Time: 10/14/19 1100
Sampler: Melissa Miller

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 3 ft ~	Dissolved Oxygen (mg/L): 9.92
Velocity of Water: Steady flow	ORP (mV): 100.5
Temperature (C): 11.22	Specific Conductance (µS/cm): 414
pH (STD): 6.62	Turbidity (NTU): 0.6

Sample Observations: SW
( ) Odor none
( ) Color clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MPS	06J1938AB

Sediment/Leachate Seep Sediment Information Sampling Depth 6"

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt ( ) Sand ( ) Other _____

Type of Sample Collected: ( ) Discrete (X) Composite

Sample Observations:
( ) Odor none
( ) Color Black
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-12-SW-OCT19	NR-19-12	1100	SW	2	none	PFAS
NR-19-12-SE-OCT19	"	1100	SE	1	"	PFAS
NR-19-12-SE-OCT19	"	1100	SE	1	"	TOC
NR-19-12-SE-OCT19	"	1100	SE	1	"	Grain Size

Comments: Sample collected 5ft North of ID Stake. East Bank, trees and grass present.

Samples collected by Stainless Steel Hand Auger & Homogenize

42.577748, -71.609839

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens, MA PFAS RI **Date/Time:** 10/14/19 0930
Location: Area 3 **Sampler:** [redacted] Melissa Miller
Sample Location ID: NR-19-13

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: 1.5 ft ≈	Dissolved Oxygen (mg/L): 9.74
Velocity of Water: Steady flow	ORP (mV): 117.9
Temperature (C): 11.03	Specific Conductance (µS/cm): 432
pH (STD): 5.80	Turbidity (NTU): 4.9

Sample Observations: SW
( ) Odor none
( ) Color Clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	06J1938AB

Sediment/Leachate Seep Sediment Information

sample depth = 6"

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt (X) Sand ( ) Other ____

Type of Sample Collected: ( ) Discrete (X) Composite

Sample Observations:
( ) Odor no.
( ) Color Black
( ) Other
Homoginized Sample

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-19-13-SW-OCT19	NR-19-13	0930	SW	2	none	PFAS
NR-19-13-SE-OCT19	"	0930	SE	1	none	PFAS
NR-19-13-SE-OCT19	"	0930	SE	1	none	TOC
NR-19-13-SE-OCT19	"	0930	SE	1	none	Grain Size

Comments: by a culvert, 4 feet NE of EP stake SW = Surface Water
River, East Bank, trees & shrubs line the banks SE = Sediment

42.5784140, -71.6093709

Sample collected w/ Stainless steel Hand cover & Homoginized

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens PFAS RI
Location: ~~NR 19-14 Background~~ (DF)
Area 3
Sample Location ID: NR-19-14
Date/Time: 12/18/19/900
Sampler: Kevin Anderson

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: ≈3 ft.	Dissolved Oxygen (mg/L): 12.22
Velocity of Water: N/A	ORP (mV): 188.8
Temperature (C): 0.80°C	Specific Conductance (µS/cm): 0.256
pH (STD): 6.31	Turbidity (NTU): 13.2

Sample Observations:
( ) Odor None
( ) Color ~~Brown~~ (DK) Clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650 MDS	16100387
LaMotte	2020we	3590-3513

Sediment/Leachate Seep Sediment Information

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____
Type of Sample Collected: (X) Discrete ( ) Composite
Sample Observations:
( ) Odor None
( ) Color Brown
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NR-SW-19-14-DEC19	NR-19-14	1030	SW	2	none	PFAS 537
NR-SED-19-14-DEC19	NR-19-14	1105	SED	2	none	PFAS/TOC
NR-SED-19-14-DEC19	NR-19-14	1300	SED	1 bag	none	Grainsize

Comments:
→ Collected on 12/20/19 by Dave Kortjohn

Background Surface Water and Sediment Sampling

Squannacook River

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

Project: Devens PFAS RI
Location: Background
Sample Location ID: SR-19-01

Date/Time: 12/18/19 / 1130
Sampler: Kevin Anderson

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth: ≈ 3.5ft	Dissolved Oxygen (mg/L): 12.85
Velocity of Water: N/A	ORP (mV): 171.0
Temperature (C): 0.59	Specific Conductance (µS/cm): 0.125
pH (STD): 5.92	Turbidity (NTU): 2.72

Sample Observations:

( ) Odor None
( ) Color Clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI 650 MDS		11G100387
La Motte	2020we	3590-3513

Sediment/Leachate Seep Sediment Information

Sediment Type: ( ) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:

( ) Odor None
( ) Color Brown
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
SR-SW-19-01-DEC19	SR-19-01	1230	SW	2	None	PFAS
BK-SW-DUP-121819	SR-19-01	1235	SW	2	None	PFAS
SR-SED-19-01-DEC19	SR-19-01	1245	SED	2	None	PFAS/TOC
BK-SED-DUP-121819	SR-19-01	1250	SED	2	None	PFAS/TOC
SR-SED-19-01-DEC19	SR-19-01	1200	SED	1 bag	None	Grain Size

Comments:

→ Collected on 12/20/19 by Dave Kortjohn

Bower's Brook

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens RI SW/SED
Location:
Sample Location ID: BB-20-01
Date/Time: 5/20/2020 0800
Sampler: KA

Surface Water/Leachate Seep Information

Type of SW: (X) Stream ( ) River ( ) Seep

Water Depth: ~18-24"	Dissolved Oxygen (mg/L): 4.78
Velocity of Water: ~0 m/s	ORP (mV): 91.4
Temperature (C): 13.47	Specific Conductance (µS/cm): 299
pH (STD): 7.00	Turbidity (NTU): 6.27

Sample Observations:
(X) Odor Light brown tint (no odor)
(X) Color
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	556MPS	05619411AD

Sediment/Leachate Seep Sediment Information

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt (X) Sand ( ) Other _____
Type of Sample Collected: (X) Discrete ( ) Composite
Sample Observations:
(X) Odor Organic decomposition odor
(X) Color Brown - dark brown
(X) Other Heavy organic concentration

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
~~BB-20-01~~	—	—	—	—	—	—
BB-SW-20-01-MAY20	BB-20-01	0820	SW	6	NA	PFAS M537
BB-SED-20-01-MAY20	BB-20-01	0825	SED	6	NA	PFAS M537
BB-SED-20-01-MAY20	BB-20-01	0825	SED	3	NA	TOC
BB-SED-20-01-MAY20	BB-20-01	0825	SED	1 (bag)	NA	Grain Size

Comments: MS/MSD collected at location for PFAS (SW), PFAS (SED), TOC (SED)

Flannigan's Pond

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens RI SW/SED
Location: _____
Sample Location ID: FP-20-01

Date/Time: 5/20/2020 1100
Sampler: KA

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream ( ) River (X) Seep (Lake)

Water Depth: ~30"	Dissolved Oxygen (mg/L): 7.48
Velocity of Water: 0 ft/s	ORP (mV): -13.9
Temperature (C): 19.41	Specific Conductance (µS/cm): 172
pH (STD): 7.08	Turbidity (NTU): 2.14

Sample Observations:

( ) Odor None
( ) Color Light brown tint
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	556 MPS	05G1941AD

Sediment/Leachate Seep Sediment Information

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:

(X) Odor Strong organic decomposition
(X) Color Dark brown
(X) Other Heavy organic concentration, little sand

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
FP-SW-20-01-May20	FP-20-01	1100	SW	2	—	PFAS M537
FP-SED-20-01-May20	FP-20-01	1110	SED	2	—	PFAS M537
FP-SED-20-01-May20	FP-20-01	1110	SED	1	—	TOC
FP-SED-20-01-May20	FP-20-01	1110	SED	1 bag	—	Grain Size

Comments:

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens RI SW/SED
Location:
Sample Location ID: FP-20-02

Date/Time: 5/20/2020 1000
Sampler: KA

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream ( ) River (X) Seep (Lake)

Water Depth: ~ 24"	Dissolved Oxygen (mg/L): 6.97
Velocity of Water: ~0 m/s	ORP (mV): -25.2
Temperature (C): 20.52	Specific Conductance (µS/cm): 186
pH (STD): 7.14	Turbidity (NTU): 4.33

Sample Observations:
( ) Odor none
( ) Color clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	556 MPS	05619414D

Sediment/Leachate Seep Sediment Information

Sediment Type: (X) Organic ( ) Gravel ( ) Clay ( ) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor slight organic decomposition odor
( ) Color Gray/dark gray sand w/ dark brown organics
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
FP-SW-20-02-MAY20	FP-20-02	1015	SW	2	—	PFAS MS37
BK-SW-DUP-052020	FP-20-02	1020	SW	2	—	PFAS MS37 (DUP)
FP-SED-20-02-may20	FP-20-02	1030	SED	2	—	PFAS MS37
BK-SED-DUP-052020	FP-20-02	1035	SED	2	—	PFAS MS37 (DUP)
FP-SED-20-02-may20	FP-20-02	1030	SED	1	—	TOC
BK-SED-DUP-052020	FP-20-02	1035	SED	1	—	TOC (DUP)
FP-SED-20-02-may20	FP-20-02	1030	SED	1 (bag)	—	Grain Size

Comments: FD collected for PFAS(SW), PFAS(SED), TOC(SED)

Nashua River

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

Project: Devens PFAS RI

Location: NRBK-19-01

Sample Location ID: ~~NRBK-19-01-DEC19~~ NRBK-SW-19-01-DEC19

Date/Time: 12/20/19 / 1100

Sampler: Dave Kostyohn

NRBK-SED-19-01-DEC19

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth:	Dissolved Oxygen (mg/L): 18.77
Velocity of Water:	ORP (mV): 147.8
Temperature (C): -0.10°	Specific Conductance (µS/cm): 0.290
pH (STD): 5.77	Turbidity (NTU): 3.68

Sample Observations:

(X) Odor None

(X) Color Clear

( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	6050MDS	11G100387

Sediment/Leachate Seep Sediment Information

Sediment Type: (X) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:

(X) Odor None

(X) Color dark brown

( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NRBK-SW-19-01-DEC19		1100	SW	2	none	PFAS M537
NRBK-SED-19-01-DEC19		1110	SED	1	none	PFAS M537
NRBK-SED-19-01-DEC19		1110	SED	1	none	TOC
NRBK-SED-19-01-DEC19		1110	SED	1	none	Grain Size

Comments:

KOMAN Government Solutions, LLC
Surface Water and Sediment Sampling Log

Project: Devens PFAS RI
Location: NRBK-19-02
Sample Location ID: NRBK-SW-19-02-DEC19
NRBK-SED-19-02-DEC19

Date/Time: 12/20/19 / 0930
Sampler: Dave Kristjann

Surface Water/Leachate Seep Information

Type of SW: ( ) Stream (X) River ( ) Seep

Water Depth:	Dissolved Oxygen (mg/L): 18.19
Velocity of Water:	ORP (mV): 195.3
Temperature (C): −0.02°	Specific Conductance (µS/cm): 0.295
pH (STD): 5.660	Turbidity (NTU): 2.23

Sample Observations:
(X) Odor None
(X) Color clear
( ) Other

Field Testing Equipment:

Make	Model	Serial #
YSI	650MDS	11G100387

Sediment/Leachate Seep Sediment Information

Sediment Type: (X) Organic ( ) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor None
( ) Color dark brown
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
NRBK-SW-19-02-DEC19		0930	SW	~~2~~ 10	none	PFAS M537 MS/MSD
NRBK-SED-19-02-DEC19		0945	SED	1	none	PFAS M537
NRBK-SED-19-02-DEC19		0945	SED	1	none	TOC
NRBK-SED-19-02-DEC19		0945	SED	1	none	Grain size

Comments:

Willow's Brook

KOMAN Government Solutions, LLC

Surface Water and Sediment Sampling Log

Project: Devens PFAS RI
Location: Background
Sample Location ID: WAB-19-01

Date/Time: 12/18/19 / 1315
Sampler: Dave Kortjohn

Surface Water/Leachate Seep Information

Type of SW: (X) Stream ( ) River ( ) Seep

Water Depth: ≈ 1.5 FT	Dissolved Oxygen (mg/L): 11.47
Velocity of Water: N/A	ORP (mV): 156.2
Temperature (C): 0.71	Specific Conductance (µS/cm): 0.260
pH (STD): 5.94	Turbidity (NTU): 2.95

Sample Observations:
( ) Odor None
( ) Color Clear
( ) Other

Field Testing Equipment:

	Make	Model	Serial #
	YSI	650 MDS	11G100387
	LaMotte	2020we	3590-3513

Sediment/Leachate Seep Sediment Information

Sediment Type: ( ) Organic (X) Gravel ( ) Clay (X) Silt (X) Sand ( ) Other _____

Type of Sample Collected: (X) Discrete ( ) Composite

Sample Observations:
( ) Odor None
( ) Color Brown
( ) Other

Samples Collected

Sample ID	Sample Location	Time	Matrix	# of Bottles	Preservative	Analysis
WAB-SW-19-01-DEC19	WAB-19-01	1310	SW	2	None	PFAS
WAB-SED-19-01-DEC19	WAB-19-01	1350	SED	4 (MS/MSD)	None	PFAS/TOC
WAB-SED-19-01-DEC19	WAB-19-01	1130	SED	1 ziplock	None	Grain Size

Comments:
→ Collected on 12/20/19 by DK

Calibration Field Sheets

KGS

Field Instrument Calibration Log

Date: 10/14/19 **Weather:** 50°F Partial clouds

Project/Site Name: Devens, MA **Instrument:** YSI 650 MDS

Calibrated By: Melissa Miller **Serial Number:** 06J1938 AB

Parameters	Solution Expiration Date	AM Calibration Time 725		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/20	1347	1413	16.60	1410	19.79	±10 µS/cm	N
pH (7)	2/2021	7.10	7.00	17.30	6.98	19.85	± 0.3 Ph *	N
pH (4)	3/21	3.83	4.00	17.40	3.89	19.82	± 0.3 Ph *	N
pH (10)	12/31/19	9.93	10.00	16.61	9.92	19.69	± 0.3 Ph *	N
ORP (240 mv)	5/2020	240.8	240.0	17.11	235.1	19.78	±10 mv	N
Dissolved Oxygen (%)	NA	101.7	100.0	16.41	99.8	18.71	-	N
Dissolved Oxygen (mg/L)	NA	9.96	9.98	16.41	9.96	18.71	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	NA	—	760	16.41	—	—	-	NA

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 10/14/19

Field Instrument Calibration Log

Date: 10/15/19 **Weather:** 42°F cool / Partial clouds

Project/Site Name: Devens, MA **Instrument:** YSI 650 MDS

Calibrated By: Melissa Miller **Serial Number:** 06J1938 AB

Parameters	Solution Expiration Date	AM Calibration Time 0635		Cal. Temp. (°C)	PM Post Cal. Check Time 1400	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/20	1409	1413	18.31	1410	17.36	±10 µS/cm	N
pH (7)	2/21	6.92	7.00	18.26	7.06	17.42	± 0.3 Ph *	N
pH (4)	3/21	4.09	4.00	18.33	3.98	17.39	± 0.3 Ph *	N
pH (10)	12/31/19	9.97	10.0	18.41	10.05	17.47	± 0.3 Ph *	N
ORP (240 mv)	5/20	232.1	240.0	18.50	233.1	17.50	±10 mv	N
Dissolved Oxygen (%)	NA	102.5	100.0	16.21	99.1	16.50	-	N
Dissolved Oxygen (mg/L)	NA	10.08	9.82	16.21	9.68	16.50	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	760	—	—	16.21	—	—	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa A. Miller **Date:** 10/15/19

KGS

Field Instrument Calibration Log

Date: 10/16/19 **Weather:** 32°F Cool Chance of Rain

Project/Site Name: Devens, MA **Instrument:** YSI 650 MDS

Calibrated By: Melissa Miller **Serial Number:** 06J1938 AB

Parameters	Solution Expiration Date	AM Calibration Time 0645		Cal. Temp. (°C)	PM Post Cal. Check Time 1430	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/20	1363	1413	16.48	1407	16.22	±10 µS/cm	N
pH (7)	2/21	7.06	7.00	16.32	6.98	16.27	± 0.3 Ph *	N
pH (4)	3/21	4.09	4.00	16.29	3.94	16.30	± 0.3 Ph *	N
pH (10)	12/19	9.99	10.0	16.41	9.89	16.34	± 0.3 Ph *	N
ORP (240 mv)	5/20	242.1	240.0	16.55	237.9	16.38	±10 mv	N
Dissolved Oxygen (%)	NA	100.0	100.0	17.28	102.1	14.47	-	N
Dissolved Oxygen (mg/L)	NA	9.61	9.61	17.28	10.0	14.47	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	760	—	—	17.28	760	~~14.47~~	-	NA

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 10/16/19

Turbidity Instrument Calibration Log

Project/Site Name: Devens, MA PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Melissa Miller **Serial Number:** 06J1938 AB

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 126 NTU	Post-Cal 126 NTU	0 NTU	126 NTU	
10/14/19	-2.7	0.0	133.6	126.0	0.3	118.7	N
10/15/19	1.4	0.0	122.1	124.0	1.0	119.1	N
10/16/19	-0.9	0.0	100.9	126.0	2.7	115.3	N
10/17/19	Not calibrating switched to Lamotte						

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 12.6

Signature: Melissa Miller **Date:** 10/17/19

KGS

Field Instrument Calibration Log

Date: 10/17/19 **Weather:** 58°F Windy/Cool

Project/Site Name: PFAS RI - Devens, MA **Instrument:** YSI 650 MDS

Calibrated By: Melissa Miller **Serial Number:** 06J1938 AB

Parameters	Solution Expiration Date	AM Calibration Time 0720		Cal. Temp. (°C)	PM Post Cal. Check Time 1525	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/20	1,405	1413	17.78	1420	16.50	±10 µS/cm	N
pH (7)	2/21	6.93	7.00	17.70	6.91	16.43	± 0.3 Ph *	N
pH (4)	3/21	~~4.05~~ 4.00	~~4.00~~ 4.00	17.77	3.97	16.41	± 0.3 Ph *	N
pH (10)	12/19	9.99	10.00	17.53	9.89	16.38	± 0.3 Ph *	N
ORP (240 mv)	5/20	~~235.1~~ 235	~~240~~ 240	~~17.79~~ 17.79	247	16.48	±10 mv	N
Dissolved Oxygen (%)	—	99.6	100.0	17.22	104.9	14.22	-	Y
Dissolved Oxygen (mg/L)	—	9.59	9.62	17.22	10.75	14.22	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	760	—	—	17.22	760	—	-	

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Melissa Miller **Date:** 10/17/19

KGS

Field Instrument Calibration Log

Date: 10/18/2019 **Weather:** some clouds, dry, ≈ 40-55°F

Project/Site Name: Devens MA - PFAS RI **Instrument:** YSI 556 MDS

Calibrated By: Seiler **Serial Number:** 06J1938 AB

Parameters	Solution Expiration Date	AM Calibration Time 0640		Cal. Temp. (°C)	PM Post Cal. Check Time 1250	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/2020	1432	1413	16.70	1393 → 1413 ~~10.10 → 10.02~~	17.06	±10 µS/cm	Yes ~~no~~
pH (7)	2/2021	7.04	7.00	16.67	6.96 → 7.00	16.83	± 0.3 Ph *	no
pH (4)	3/2021	4.01	4.00	16.87	3.99 → 4.00	16.53	± 0.3 Ph *	no
pH (10)	12/31/2019	10.11	10.02	16.69	10.10 → 10.02	16.87	± 0.3 Ph *	no
ORP (240 mv)	5/2020	239.5	239.9	16.56	240.9 → 240.0	17.11	±10 mv	no
Dissolved Oxygen (%)	—	112.5	100.0	14.52	97.1% → 100.0%	17.52	-	—
Dissolved Oxygen (mg/L)	—	11.45	10.19	14.52	9.28 → 9.56	17.52	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	yes
Barometric Pressure (mmHg)	760	—	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: Brad Seiler **Date:** 10/18/2019

KGS

Turbidity Instrument Calibration Log

Project/Site Name: PFAS RI – Devens, MA

Instrument: Lamotte 2020we

Calibrated By: Melissa Miller

Serial Number: 1828-0412

	AM Calibration				PM Post Calibration Check		
Date	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	Variance Noted
MM 10/17/19	0.0	0.0	9.15	10.0	0.25	9.59	N
10/18/19	0.29	0.23	5.20	7.51	1.82	9.10	yes

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature]
Erich Eilo

Date: 10/17/19
10/18/2019

KGS

Field Instrument Calibration Log

Date: 12/18/19 **Weather:** 30°F, cloudy

Project/Site Name: Devens PFAS RI **Instrument:** YSI 650 MDS

Calibrated By: Dave Kortjohn **Serial Number:** 16100387

Parameters	Solution Expiration Date	AM Calibration Time 730		Cal. Temp. (°C)	PM Post Cal. Check Time 1455	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/2020	1.458	1.413	15.89	1.420	16.10	±10 µS/cm	N
pH (7)	2/2021	7.69	7.00	15.72	7.12	15.95	± 0.3 Ph *	N
pH (4)	2/2021	4.05	3.99	15.87	4.02	15.99	± 0.3 Ph *	N
pH (10)	2/2021	10.51	10.07	15.71	10.21	16.03	± 0.3 Ph *	N
ORP (240 mv)	5/2020	214.4 ~~2.14~~ OK	240.0	15.91	241.2	16.13	±10 mv	N
Dissolved Oxygen (%)	—	89.7	100.0	14.16	OK ~~99.3~~ 105.6	14.82	-	Y
Dissolved Oxygen (mg/L)	—	9.22	10.27	14.16	OK ~~10.~~ 12.89	14.82	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	Y
Barometric Pressure (mmHg)	—	760	—	—	760	—	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

nature: [signature] **Date:** 12/18/19

KGS

Field Instrument Calibration Log

Date: 12/20/19 **Weather:** Clear, 13-27°F

Project/Site Name: Devens PFAS RI **Instrument:** 1050 MDS

Calibrated By: Kristen Esser **Serial Number:** 116100387

Parameters	Solution Expiration Date	AM Calibration Time 0745		Cal. Temp. (°C)	PM Post Cal. Check Time 1345	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	3/2020	1.411	1.413	9.80	1.386	11.61	±10 µS/cm	N
pH (7)	2/2021	6.34	7.00	9.29	6.94	11.02	± 0.3 Ph *	N
pH (4)	3/2021	4.45	4.00	9.57	4.17	11.36	± 0.3 Ph *	N
pH (10)	2/2021	11.38	10.00	9.64	9.98	11.23	± 0.3 Ph *	N
ORP (240 mv)	5/2020	245.6	240.1	9.50	244.5	11.14	±10 mv	N
Dissolved Oxygen (%)	—	75.0	100.0	9.67	97.8	8.83	-	—
Dissolved Oxygen (mg/L)	—	11.45	9.56	9.67	11.34	8.83	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	—	760.0	760.0	9.70	760.0	8.83	-	—

Notes:

*** Ph Unit with Ph 7 Buffer**

(Mark Noted Variences on Field Forms)

Signature: [signature] **Date:** 12/20/19

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens PFAS RI **Instrument:** LaMotte 2020we

Calibrated By: Dave Kortjohn **Serial Number:** 3590 - 3513

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
12/18/19	0.00	0.00	9.60	10.00	0.00	9.95	N
12/20/19	0.95	0.01	9.81	10.00	0.01	10.28	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: _____ **Date:** _____

KGS

Field Instrument Calibration Log

Date: 5/20/20 **Weather:** 50's

Project/Site Name: Dever **Instrument:** ~~05 6194 1AD~~ YSI 556MPS

Calibrated By: MM **Serial Number:** 05619411AD

Parameters	Solution Expiration Date	AM Calibration Time 700		Cal. Temp. (°C)	PM Post Cal. Check Time 1200	Post Cal. Check Temp (°C)	Post Cal. Check Criteria	Varience Noted (Y/N)
Specific Conductivity (1,413 µS/cm°)	10/20	1.372	1.413	18.30	1.420	18.97	±10 µS/cm	N
pH (7)	2/21	6.90	7.00	18.43	7.01	18.81	± 0.3 Ph *	N
pH (4)	10/21	3.77	4.00	18.40	4.00	18.77	± 0.3 Ph *	N
pH (10)	10/21	9.78	10.00	18.29	10.18	18.68	± 0.3 Ph *	N
ORP (240 mv)	5/20	257.9	240.0	17.89	246.1	18.59	±10 mv	N
Dissolved Oxygen (%)	N/A	91.6%	100.0%	17.11	94.1%	18.77	-	N
Dissolved Oxygen (mg/L)	N/A	9.77	10.00	17.03	9.89	18.54	± 0.5 mg/L < 0.5 mg/L for 0 mg/L solution, no negative value	N
Barometric Pressure (mmHg)	N/A	—	760	—	760	—	-	N

Notes: (Mark Noted Variences on Field Forms)

* Ph Unit with Ph 7 Buffer

Signature: [signature] **Date:** 5/20/20

KGS

Turbidity Instrument Calibration Log

Project/Site Name: Devens

Instrument: LaMotte 2020WE

Calibrated By: [illegible]

Serial Number: 5088-5014

Date	AM Calibration				PM Post Calibration Check		Variance Noted
	Pre-Cal 0 NTU	Post-Cal 0 NTU	Pre-Cal 10 NTU	Post-Cal 10 NTU	0 NTU	10 NTU	
5/20/20	0.31	0.00	10.34	10.00	0.12	10.13	N

Notes: Mark Noted Variences on Field Forms

Post Calibration Criteria	
-	± 0.5

Signature: [signature]

Date: 5/20/20

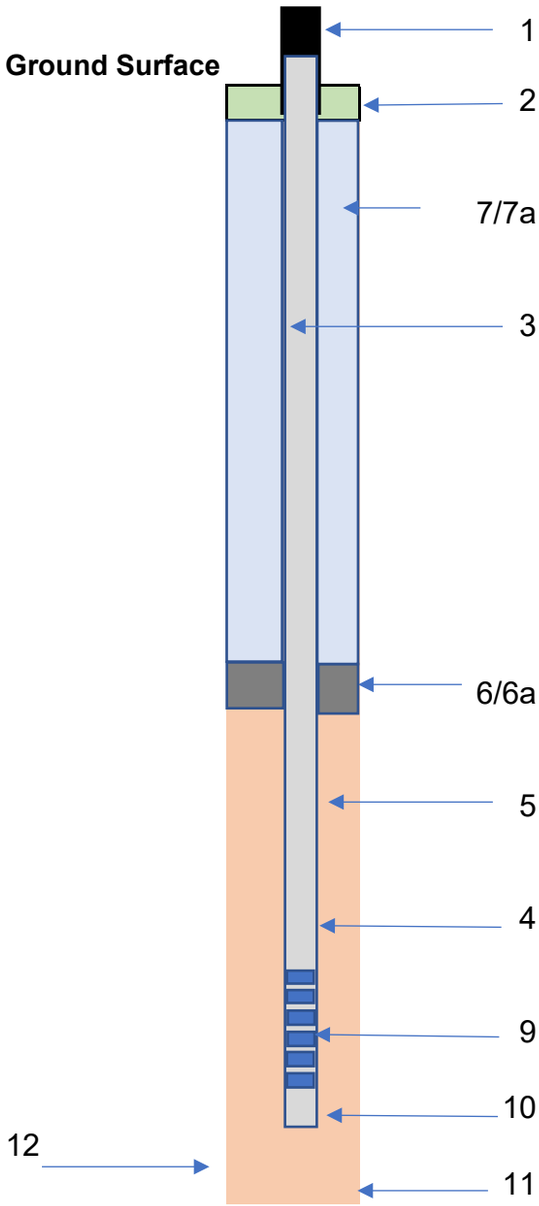
APPENDIX F PIEZOMETER CONSTRUCTION LOGS

AOC 30

KGS	Project: PFAS RI	Piezometer Identification: 30PZ-19-01
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In woods ~440 feet west of western edge of
Drilling Company: Technical Drilling Services	training parking lot/former Moore Army Airfield
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 7/17/2019	Well Construction Date: 7/17/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 30VP-19-01
Ground Elevation (ft NAVD88): 221.30	Top of PVC Elevation (ft NAVD88): 224.63
Easting (State Plane NAD83 [FT]): 626817.1	Northing (State Plane NAD83 [FT]): 3035431.2



1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	0.5 feet
3. Diameter/Type of well casing:	1 inch PVC shcedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 Bags
Top/Bottom of Pack:	16-28 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-16 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	18-28 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	28 feet bgs
12. Diameter of borehole:	4 inches

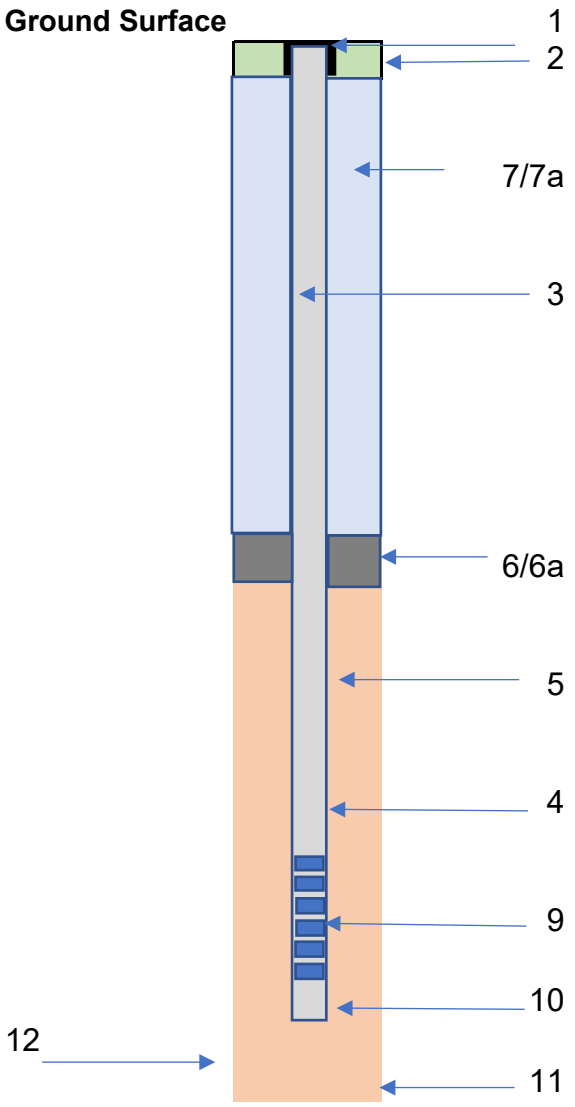
Comments:

2' x 2' concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 30PZ-19-02
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In open field, ~44 feet south of southeastern
Drilling Company: Technical Drilling Services	corner of radio tower fence. Former Moore Army Airfield.
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 7/15/2019	Well Construction Date: 7/15/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: N/A
Ground Elevation (ft NAVD88): 267.45	Top of PVC Elevation (ft NAVD88): 267.12
Easting (State Plane NAD83 [FT]): 626870.2	Northing (State Plane NAD83 [FT]): 3034956.6



1. Well Protection Type:	Flushmount Road Box
2. Concrete Pad Depth:	0.5 feet
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 bags
Top/Bottom of Pack:	68-80 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-68 feet bgs
7. Backfill Mixture Used:	Bentonite Chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	70-80 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	80 feet bgs
12. Diameter of borehole:	4 inches

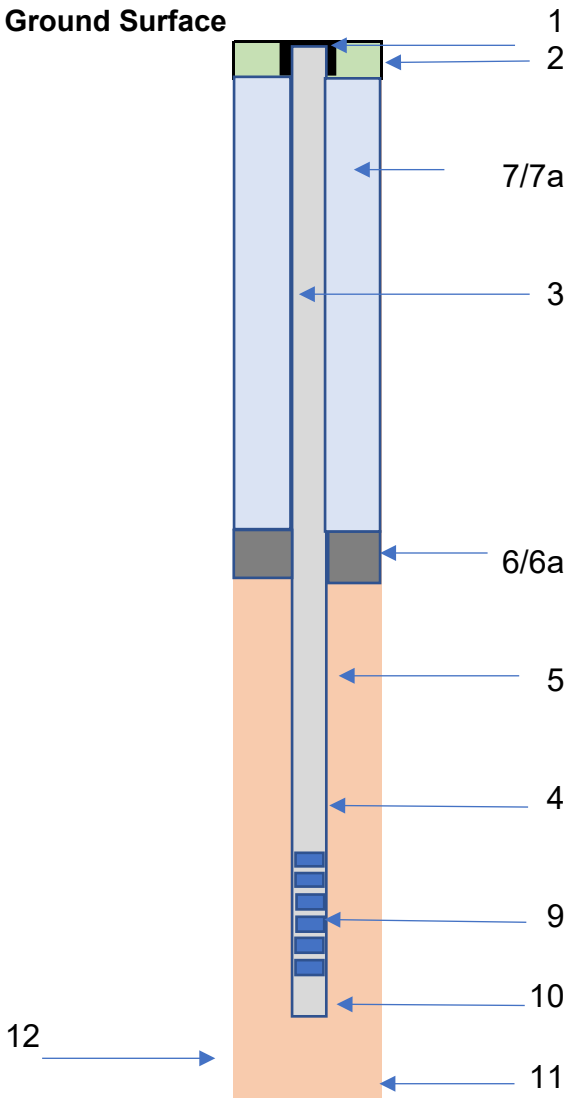
Comments:

2' x 2' concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 30PZ-19-03
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In grass ~ 6 feet north of former western drum
Drilling Company: Technical Drilling Services	storage pad, former Moore Army Airfield.
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 7/12/2019	Well Construction Date: 7/12/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Dave Kortjohn (Jacobs)	Associated Vertical Profile: 30VP-19-03
Ground Elevation (ft NAVD88): 268.04	Top of PVC Elevation (ft NAVD88): 267.90
Easting (State Plane NAD83 [FT]): 626448.8	Northing (State Plane NAD83 [FT]): 3035148.1



1. Well Protection Type:	Flushmount Road Box
2. Concrete Pad Depth:	4 inches
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	25-lbs
Top/Bottom of Pack:	67-80 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	1-67 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	70-80 feet bgs
10. Sump Length:	2 inches
11. Bottom of Boring:	80 feet bgs
12. Diameter of borehole:	3.75 inches

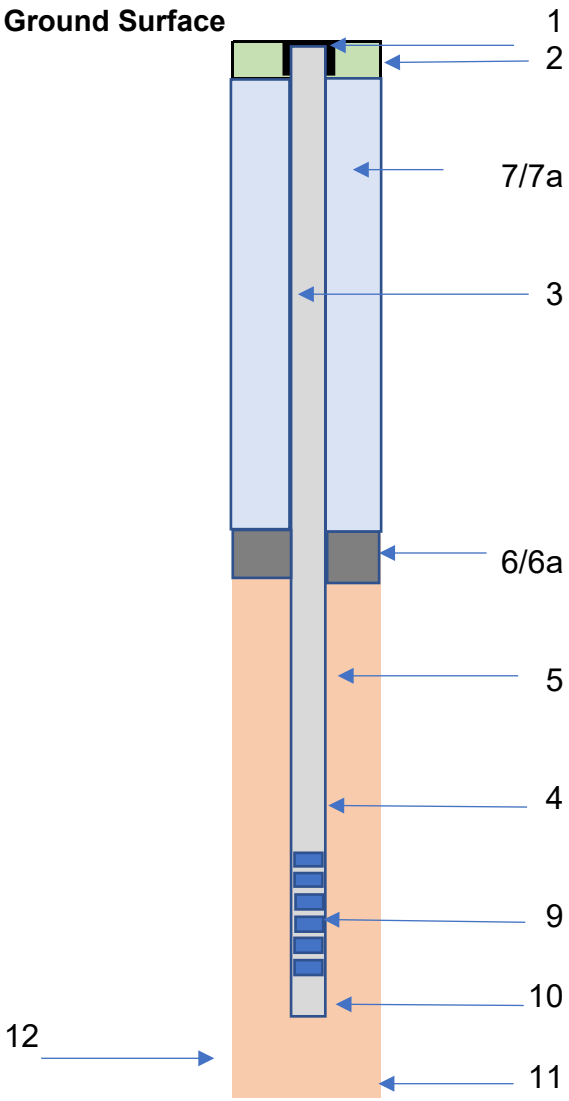
Comments:

2' x 2' concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 30PZ-19-04
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In grass ~3 feet west of northwestern
Drilling Company: Technical Drilling Services	taxiway turn, former Moore Army Airfield.
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 7/24/2019	Well Construction Date: 7/24/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Dave Kortjohn (Jacobs)	Associated Vertical Profile: 30VP-19-04
Ground Elevation (ft NAVD88): 266.90	Top of PVC Elevation (ft NAVD88): 266.80
Easting (State Plane NAD83 [FT]): 626262.8	Northing (State Plane NAD83 [FT]): 3034929.9



1. Well Protection Type:	Flushmount Road Box
2. Concrete Pad Depth:	6 inches
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	50-lbs
Top/Bottom of Pack:	65-77 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-65 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	67-77 feet bgs
10. Sump Length:	2 inches
11. Bottom of Boring:	77 feet bgs
12. Diameter of borehole:	2.25 inches

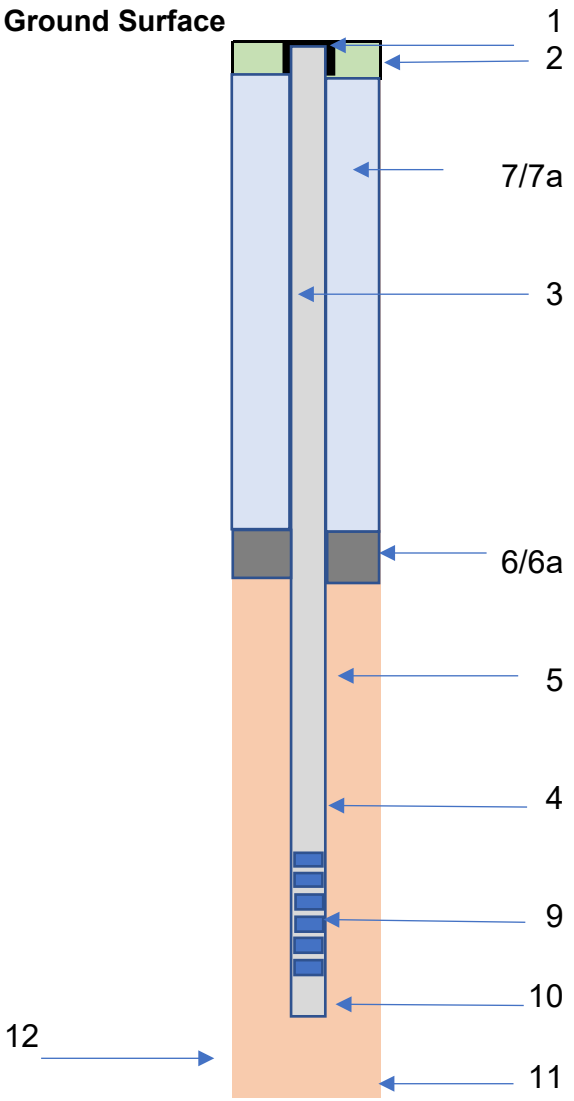
Comments:

2' x 2' concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 30PZ-19-05
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: Located in northwest portion of the
Drilling Company: Technical Drilling Services	motorcycle training parking lot, former Moore Army
Drilling Method and Equipment: Direct Push	Airfield.
Drilling Date(s): 7/17/2019	Well Construction Date: 7/17/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 30VP-19-05
Ground Elevation (ft NAVD88): 224.1	Top of PVC Elevation (ft NAVD88): 223.77
Easting (State Plane NAD83 [FT]): 627375.5	Northing (State Plane NAD83 [FT]): 3035471.4



1. Well Protection Type:	Flushmount Road Box
2. Concrete Pad Depth:	6 inches
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 Bags
Top/Bottom of Pack:	18-30 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-18 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	20-30 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	30 feet bgs
12. Diameter of borehole:	4 inches

Comments:

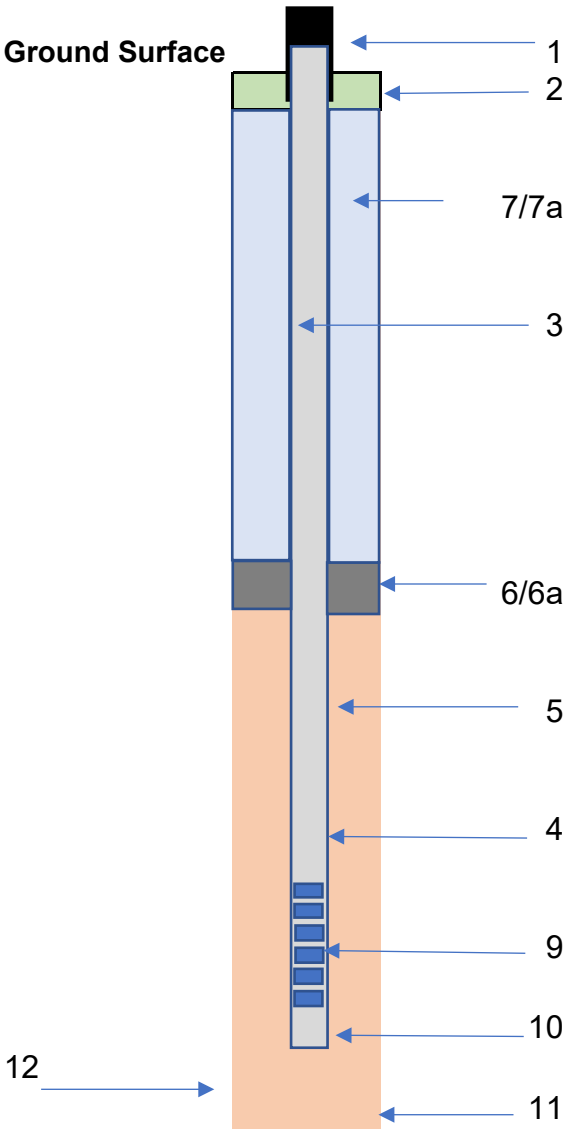
2' x 2' concrete pad

AOC 31

KGS	Project: PFAS RI	Piezometer Identification: 31PZ-19-01
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In grass along west perimeter road, west of
Drilling Company: Technical Drilling Services	runway, former Moore Army Airfield.
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 8/9/2019	Well Construction Date: 8/9/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Dave Kortjohn (Jacobs)	Associated Vertical Profile: 31VP-19-04
Ground Elevation (ft NAVD88): 266.66	Top of PVC Elevation (ft NAVD88): 269.38
Easting (State Plane NAD83 [FT]): 626075.50	Northing (State Plane NAD83 [FT]): 3034166.00



1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	6 inches
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	50 lbs
Top/Bottom of Pack:	65-77 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0-65 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	67-77 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	77 feet bgs
12. Diameter of borehole:	2.25 inches

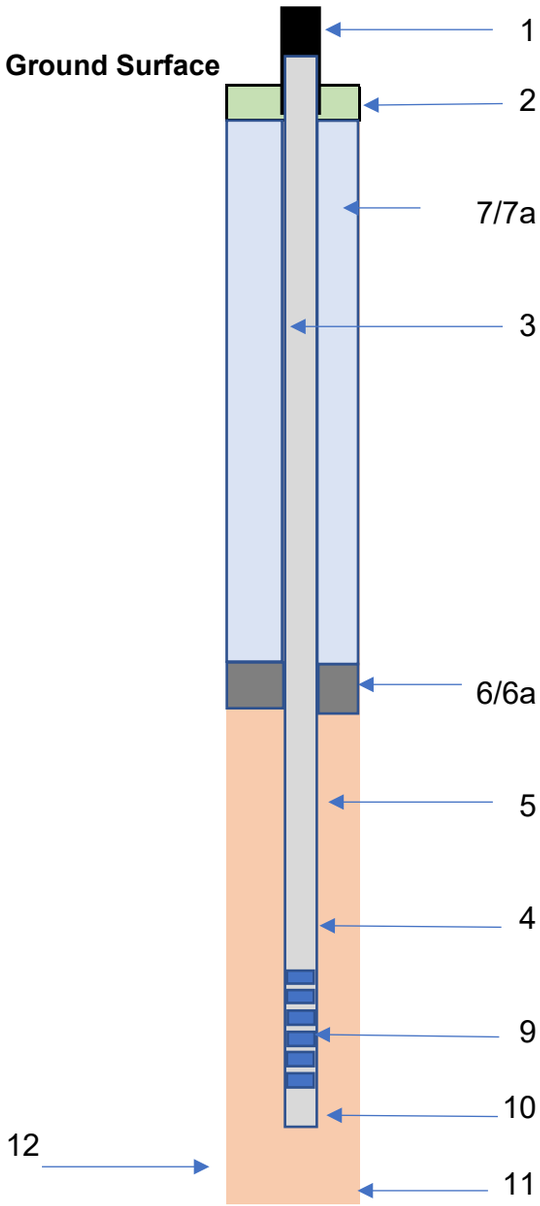
Comments:

2' x 2' concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 31PZ-19-02D
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In woods ~570 feet west of western edge of
Drilling Company: Technical Drilling Services	airfield, ~44 ft east of the west bank of the Nashua
Drilling Method and Equipment: Direct Push	River, Former Moore Army Airfield
Drilling Date(s): 10/1/2019	Well Construction Date: 10/1/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 31VP-19-07
Ground Elevation (ft NAVD88): 206.31	Top of PVC Elevation (ft NAVD88): 209.48
Easting (State Plane NAD83 [FT]): 625372.87	Northing (State Plane NAD83 [FT]): 3033989.36



1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	0.5 feet
3. Diameter/Type of well casing:	1 inch PVC shcedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	1 Bag
Top/Bottom of Pack:	63-70 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-63 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	5 feet
9. Screen interval:	65-70 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	70 feet bgs
12. Diameter of borehole:	4 inches

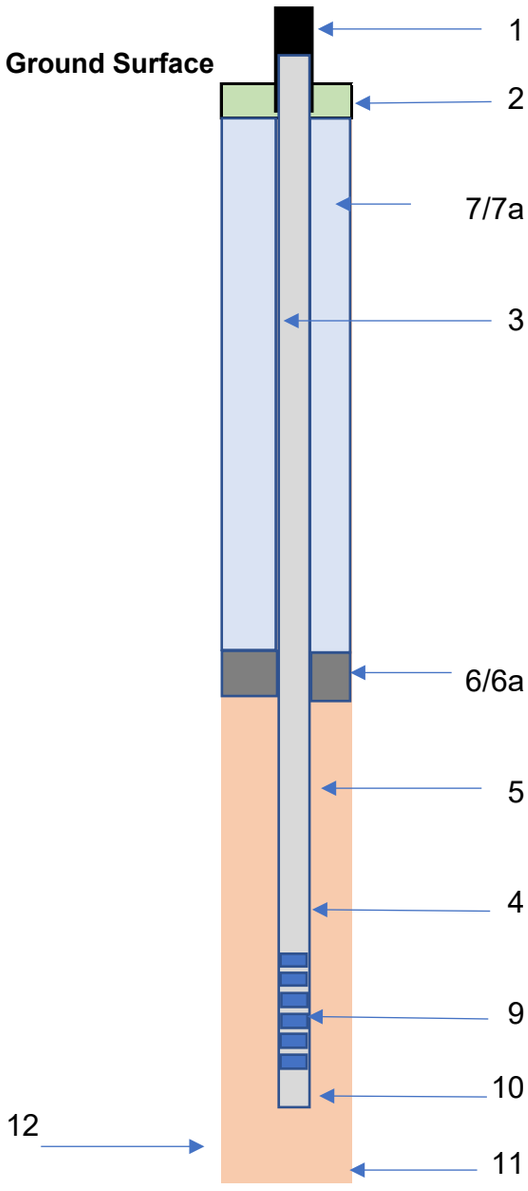
Comments:

concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 31PZ-19-02S
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In woods ~570 feet west of western edge of
Drilling Company: Technical Drilling Services	airfield, ~44 ft east of the west bank of the Nashua
Drilling Method and Equipment: Direct Push	River, Former Moore Army Airfield
Drilling Date(s): 10/1/2019	Well Construction Date: 10/1/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 31VP-19-07
Ground Elevation (ft NAVD88): 206.29	Top of PVC Elevation (ft NAVD88): 209.44
Easting (State Plane NAD83 [FT]): 625374.19	Northing (State Plane NAD83 [FT]): 3033989.86



1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	0.5 feet
3. Diameter/Type of well casing:	1 inch PVC shcedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#1
Quanity Used:	1 Bag
Top/Bottom of Pack:	6-13 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-6 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	5 feet
9. Screen interval:	8-13 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	13 feet bgs
12. Diameter of borehole:	4 inches

Comments:

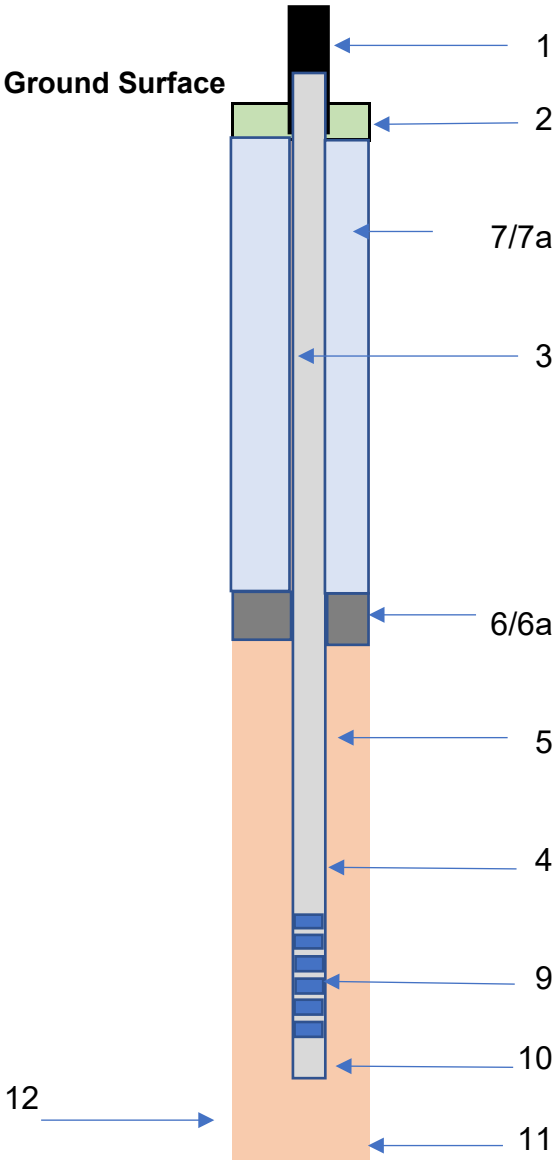
concrete pad

AOC 50

KGS	Project: PFAS RI	Piezometer Identification: 50PZ-19-01
	Project Number: 1082	

WELL CONSTRUCTION DIAGRAM

Client: USACE	Location: In open grass field, ~88 feet east of Bldg.
Drilling Company: Technical Drilling Services	3822, Former Moore Army Airfield.
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 7/22/19	Well Construction Date: 7/22/19
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Dave Kortjohn (Jacobs)	Associated Vertical Profile: 50VP-19-04
Ground Elevation (ft NAVD88): 249.78	Top of PVC Elevation (ft NAVD88): 252.02
Easting (State Plane NAD83 [FT]): 627821.1	Northing (State Plane NAD83 [FT]): 3034978.4



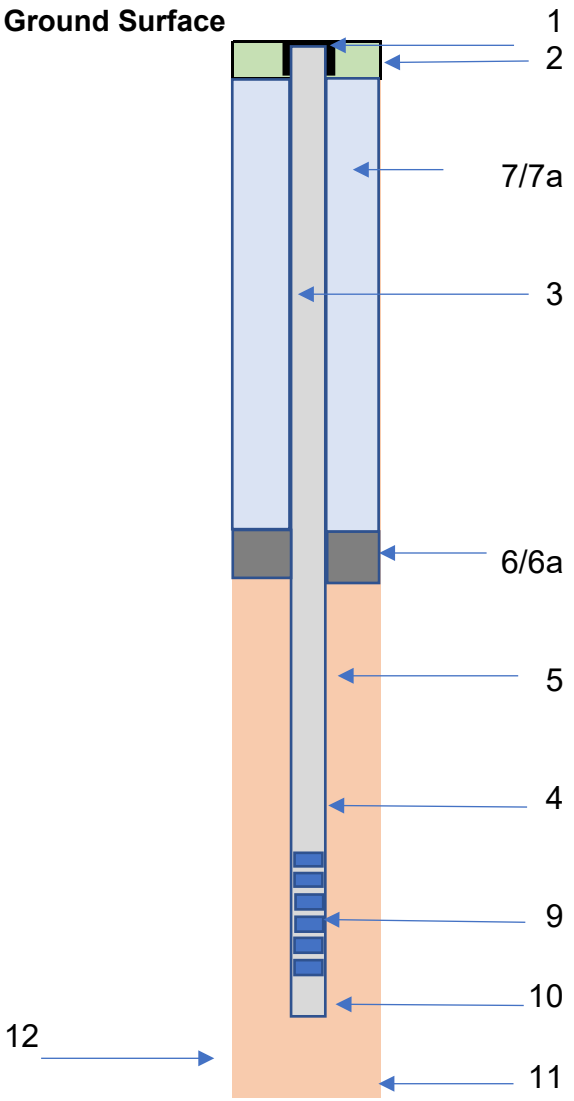
1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	6 inches
3. Diameter/Type of well casing:	1 inch PVC shcedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	50 lbs.
Top/Bottom of Pack:	41-53 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0- 41 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	43-53 feet bgs
10. Sump Length:	2 inches
11. Bottom of Boring:	53 feet bgs
12. Diameter of borehole:	2.25 inches

Comments: **2x2 ft. concrete pad**

KGS	Project: PFAS RI	Piezometer Identification: 50PZ-19-02
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: South of former Fire Station garage bay
Drilling Company: Technical Drilling Services	door in asphalt, Former Moore Army Airfield.
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 7/3/2019	Well Construction Date: 7/3/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 50VP-19-06
Ground Elevation (ft NAVD88): 265.21	Top of PVC Elevation (ft NAVD88): 264.94
Easting (State Plane NAD83 [FT]): 627345.5	Northing (State Plane NAD83 [FT]): 3034648.6



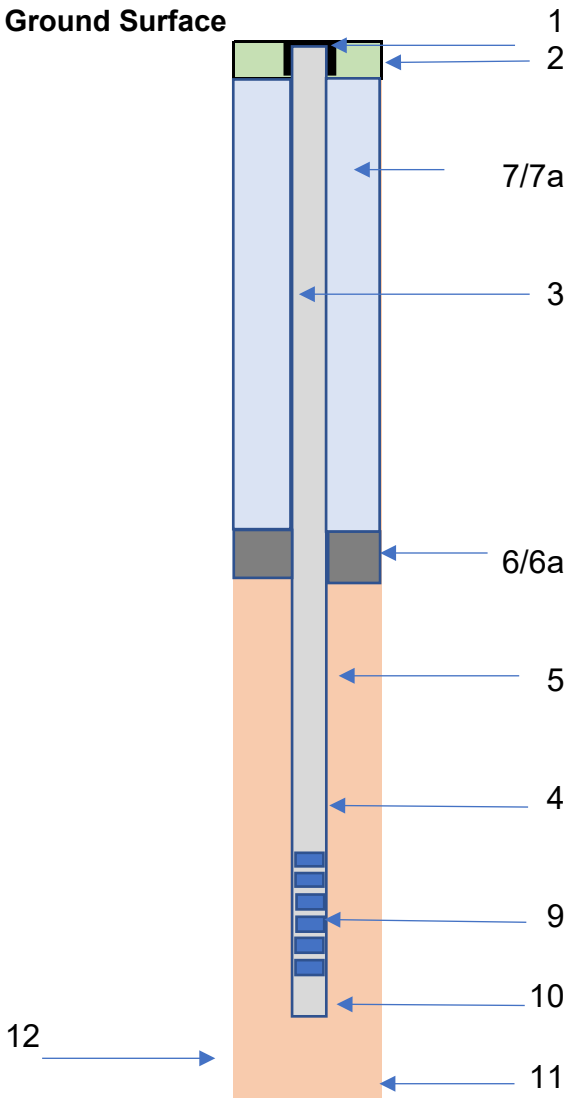
1. Well Protection Type:	Flushmount Road Box
2. Concrete Pad Depth:	6 inches
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 bags
Top/Bottom of Pack:	55-67 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-55 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	57-67 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	67 feet bgs
12. Diameter of borehole:	3 inches

Comments:

KGS	Project: PFAS RI	Piezometer Identification: 50PZ-19-03
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In grass area on the eastern edge of airfield, ~15 ft
Drilling Company: Technical Drilling Services	west of perimeter road, ~200 ft east of the eastern runway,
Drilling Method and Equipment: Direct Push	Former Moore Army Airfield.
Drilling Date(s): 8/23/2019	Well Construction Date: 8/23/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 50VP-19-09
Ground Elevation (ft NAVD88): 255.61	Top of PVC Elevation (ft NAVD88): 258.40
Easting (State Plane NAD83 [FT]): 628849.20	Northing (State Plane NAD83 [FT]): 3033897.40



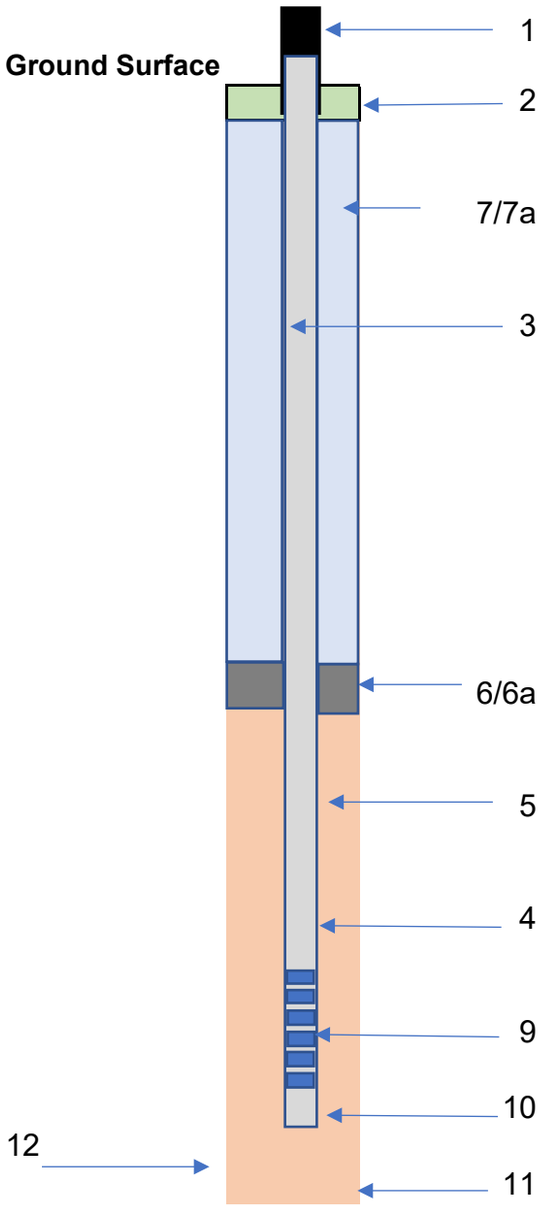
1. Well Protection Type:	Flushmount Road Box
2. Concrete Pad Depth:	6 inches
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 bags
Top/Bottom of Pack:	38-50 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-38 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	40-50 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	50 feet bgs
12. Diameter of borehole:	4 inches

Comments: **2 x 2 concrete pad**

KGS	Project: PFAS RI	Piezometer Identification: 50PZ-19-04
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In the central grass area of Former Moore
Drilling Company: Technical Drilling Services	Army Airfield, ~586 ft from the intersection of the
Drilling Method and Equipment: Direct Push	main and eastern runway.
Drilling Date(s): 8/16/2019	Well Construction Date: 8/16/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 50VP-19-10
Ground Elevation (ft NAVD88): 256.99	Top of PVC Elevation (ft NAVD88): 260.37
Easting (State Plane NAD83 [FT]): 628182.7	Northing (State Plane NAD83 [FT]): 3033509.9



1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	0.5 feet
3. Diameter/Type of well casing:	1 inch PVC shcedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 Bags
Top/Bottom of Pack:	43-53 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-43 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	45-55 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	55 feet bgs
12. Diameter of borehole:	4 inches

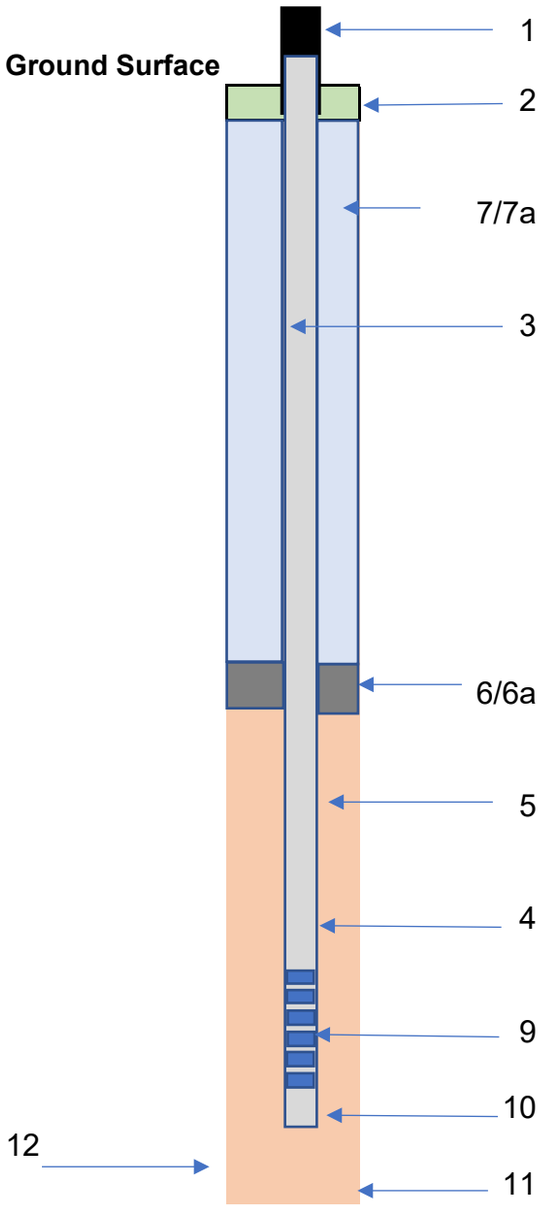
Comments:

2' x 2' concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 50PZ-19-05
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In northern grass area of the auction yard,
Drilling Company: Technical Drilling Services	~75 ft southwest of perimeter fence.
Drilling Method and Equipment: Direct Push	Former Moore Army Airfield.
Drilling Date(s): 8/29/2019	Well Construction Date: 8/29/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Melissa Miller	Associated Vertical Profile: 50VP-19-11
Ground Elevation (ft NAVD88): 256.16	Top of PVC Elevation (ft NAVD88): 256.51
Easting (State Plane NAD83 [FT]): 629266.5	Northing (State Plane NAD83 [FT]): 3032501.4



1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	0.5 feet
3. Diameter/Type of well casing:	1 inch PVC shcedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2.5 Bags
Top/Bottom of Pack:	37-49 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0-37 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	39-49 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	49 feet bgs
12. Diameter of borehole:	4 inches

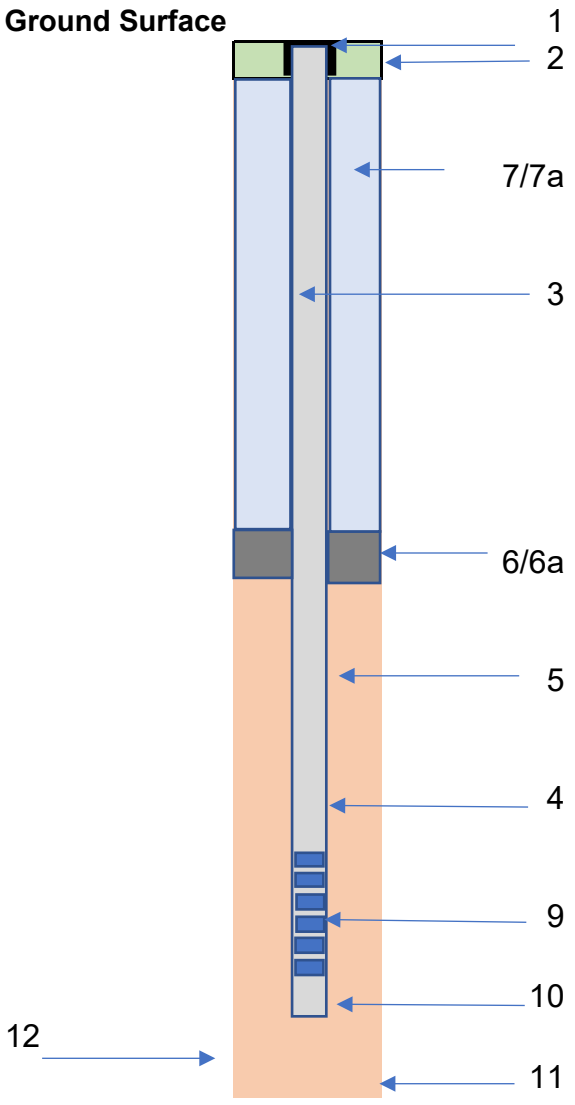
Comments:

2' x 2' concrete pad

KGS	Project: PFAS RI	Piezometer Identification: 50PZ-19-06
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In grass area, ~101 ft southwest of the southeastern
Drilling Company: Technical Drilling Services	corner of the southern runway. Former Moore Army Airifeld.
Drilling Method and Equipment: Direct Push	
Drilling Date(s): 08/14/2019	Well Construction Date: 08/14/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: Kevin Anderson	Associated Vertical Profile: 50VP-19-12
Ground Elevation (ft NAVD88): 256.03	Top of PVC Elevation (ft NAVD88): 255.54
Easting (State Plane NAD83 [FT]): 628574.60	Northing (State Plane NAD83 [FT]): 3031601.90



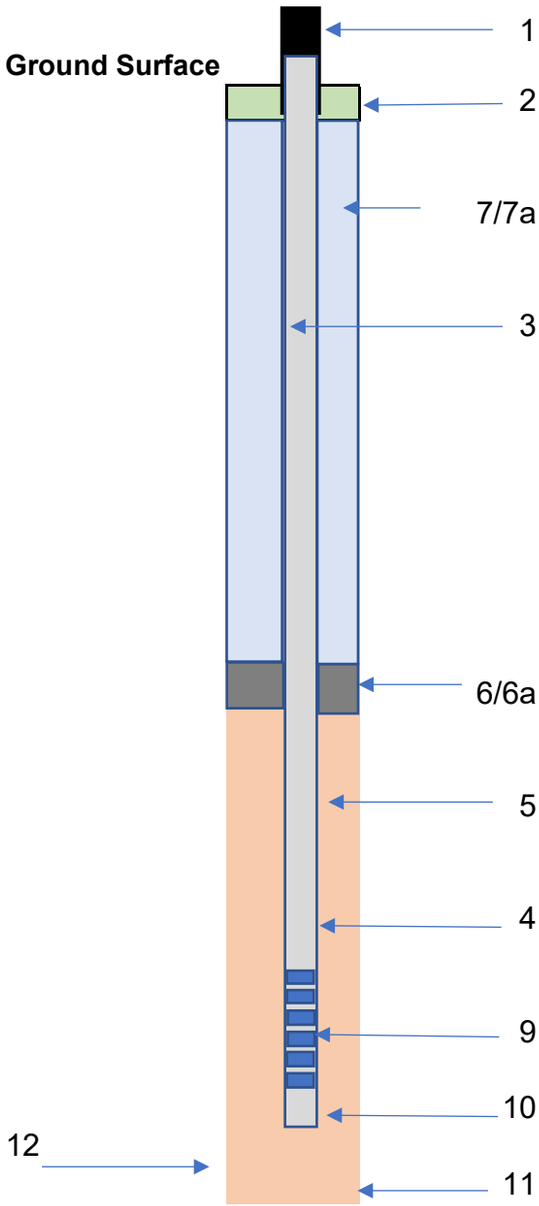
1. Well Protection Type:	Flushmount Road Box
2. Concrete Pad Depth:	6 inches
3. Diameter/Type of well casing:	1 inch/PVC schedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 bags
Top/Bottom of Pack:	51-63 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0.5-51 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	53-63 feet bgs
10. Sump Length:	N/A
11. Bottom of Boring:	63 feet bgs
12. Diameter of borehole:	3 inches

Comments: **2 x 2 concrete pad**

KGS	Project: PFAS RI	Piezometer Identification: 50PZ-19-07
	Project Number: 1082	

PIEZOMETER CONSTRUCTION DIAGRAM

Client: USACE	Location: In grass area, ~227 ft SW of the NW corner
Drilling Company: Technical Drilling Services	of the main runway. Former Moore Army Airfield.
Drilling Method and Equipment: Direct Push	Former Moore Army Airfield.
Drilling Date(s): 8/22/2019	Well Construction Date: 8/22/2019
Potable Water Used: (Y/N) Source: N	Drums of IDW: N/A
KGS Field Personnel: David Kortjohn (Jacobs)	Associated Vertical Profile: 50VP-19-13
Ground Elevation (ft NAVD88): 267.03	Top of PVC Elevation (ft NAVD88): 270.11
Easting (State Plane NAD83 [FT]): 625891.4	Northing (State Plane NAD83 [FT]): 3034626.9



1. Well Protection Type:	Steel Stickup
2. Concrete Pad Depth:	0.5 feet
3. Diameter/Type of well casing:	1 inch PVC shcedule 40
4. Type/Screen Slot:	Schedule 40 PVC/0.010 inch
5. Type of Filter Sand:	#2
Quanity Used:	2 Bags
Top/Bottom of Pack:	62-74 feet bgs
6. Type of Seal:	Bentonite chips
6a.Top/Bottom of Seal:	0-62 feet bgs
7. Backfill Mixture Used:	Bentonite chips
7a. Placement Method:	Gravity
8. Screen length:	10 feet
9. Screen interval:	64-74 feet bgs
10. Sump Length:	2 inches
11. Bottom of Boring:	74 feet bgs
12. Diameter of borehole:	2.25 inches

Comments:

2' x 2' concrete pad

APPENDIX G GRAIN SIZE RESULTS

AOC 20

Unnamed

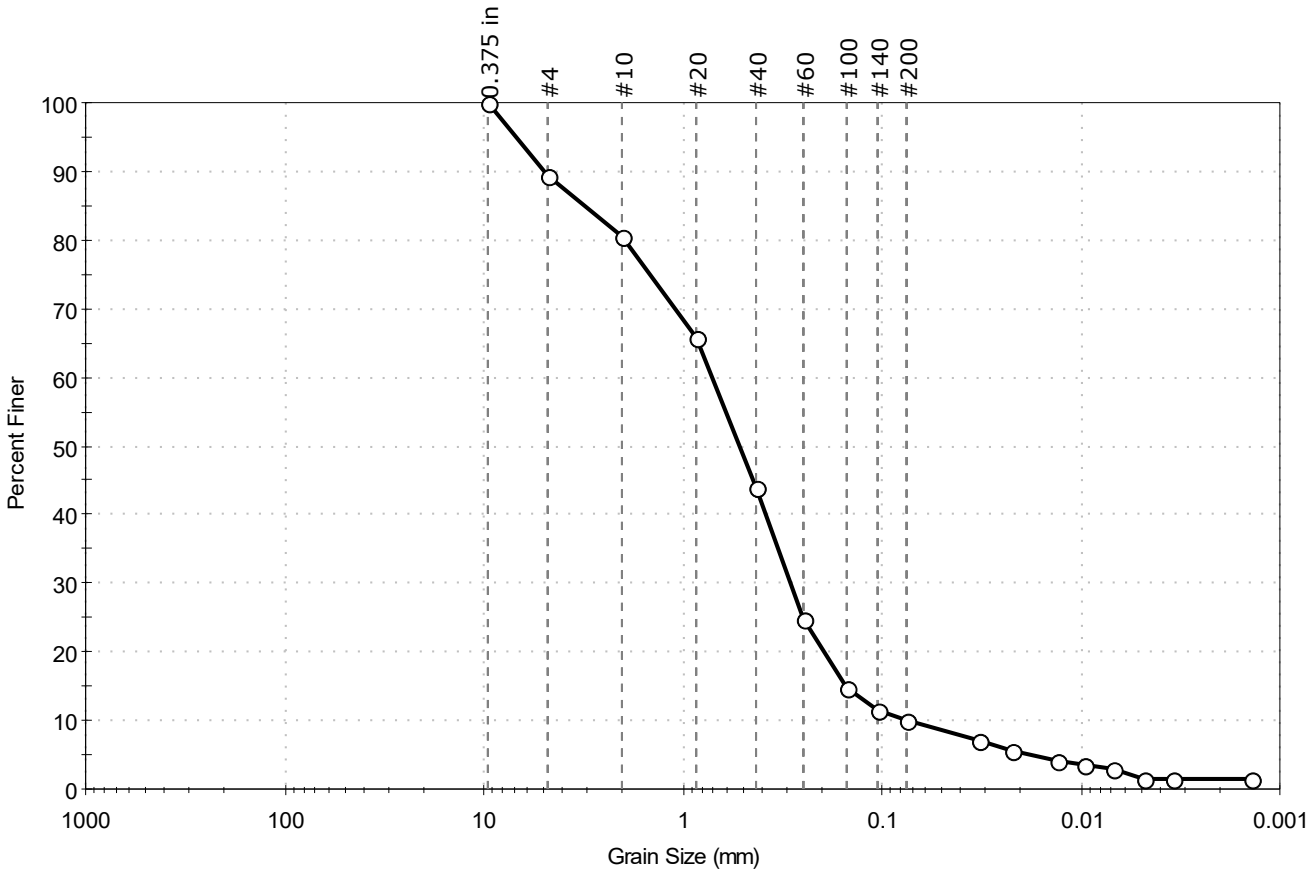
Wetland

Sediment Grain

Size Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	UP-19-01-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529919		
Test Comment:	---				
Visual Description:	Moist, very dark brown sand with silt				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	10.7	79.4	9.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	89		
#10	2.00	80		
#20	0.85	66		
#40	0.42	44		
#60	0.25	25		
#100	0.15	15		
#140	0.11	12		
#200	0.075	9.9		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0322	7		
---	0.0225	6		
---	0.0133	4		
---	0.0095	4		
---	0.0068	3		
---	0.0048	1		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 3.1283 mm	D_{30} = 0.2883 mm
D_{60} = 0.7087 mm	D_{15} = 0.1522 mm
D_{50} = 0.5159 mm	D_{10} = 0.0760 mm
C_u = 9.325	C_c = 1.543

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

AOC 21

Unnamed

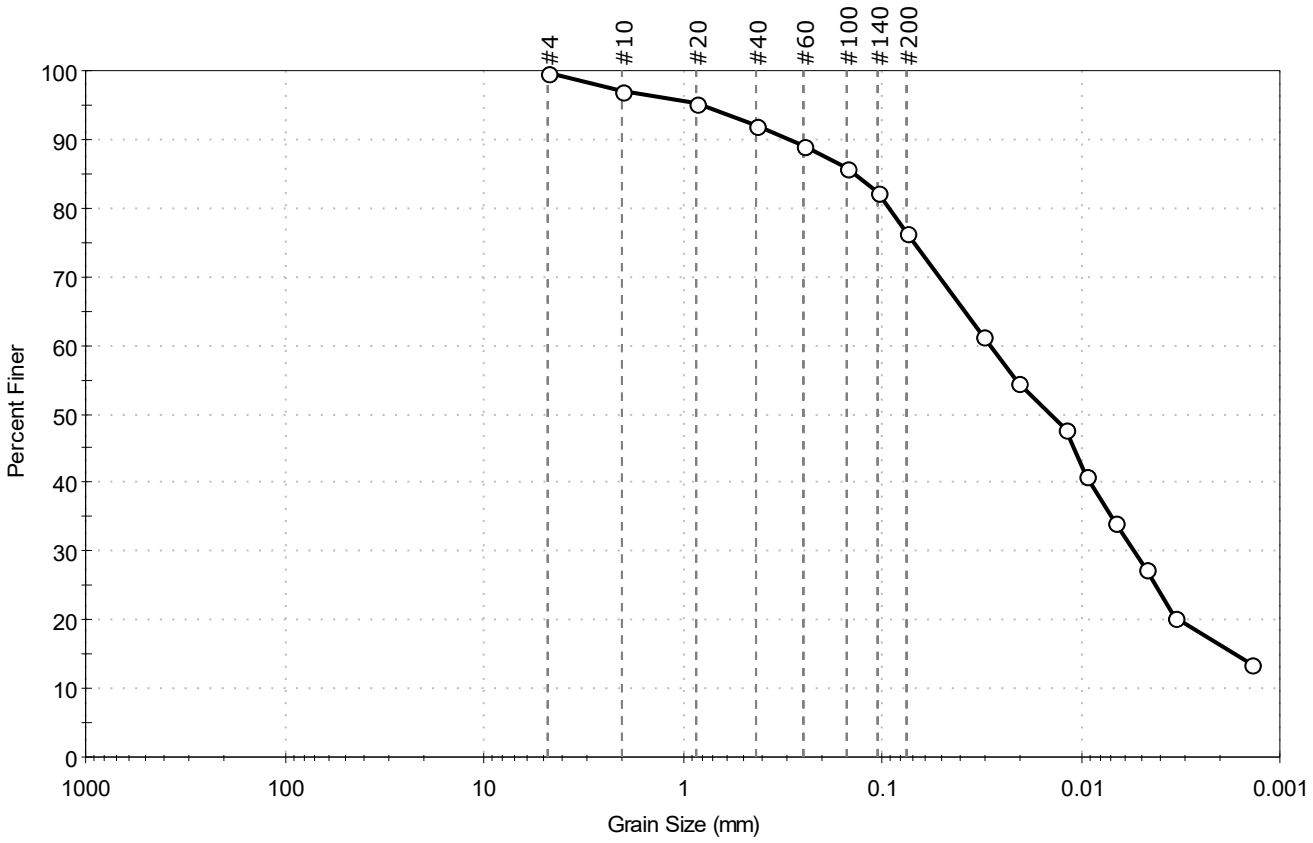
Stream

Sediment Grain

Size Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	US-19-01_SE_OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529922		
Test Comment:	---				
Visual Description:	Moist, dark brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.4	23.3	76.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	97		
#20	0.85	95		
#40	0.42	92		
#60	0.25	89		
#100	0.15	86		
#140	0.11	82		
#200	0.075	76		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0312	61		
---	0.0208	55		
---	0.0120	48		
---	0.0094	41		
---	0.0067	34		
---	0.0048	27		
---	0.0034	20		
---	0.0014	14		

Coefficients

D_{85} = 0.1389 mm D_{30} = 0.0054 mm
D_{60} = 0.0286 mm D_{15} = 0.0017 mm
D_{50} = 0.0143 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

Airfield

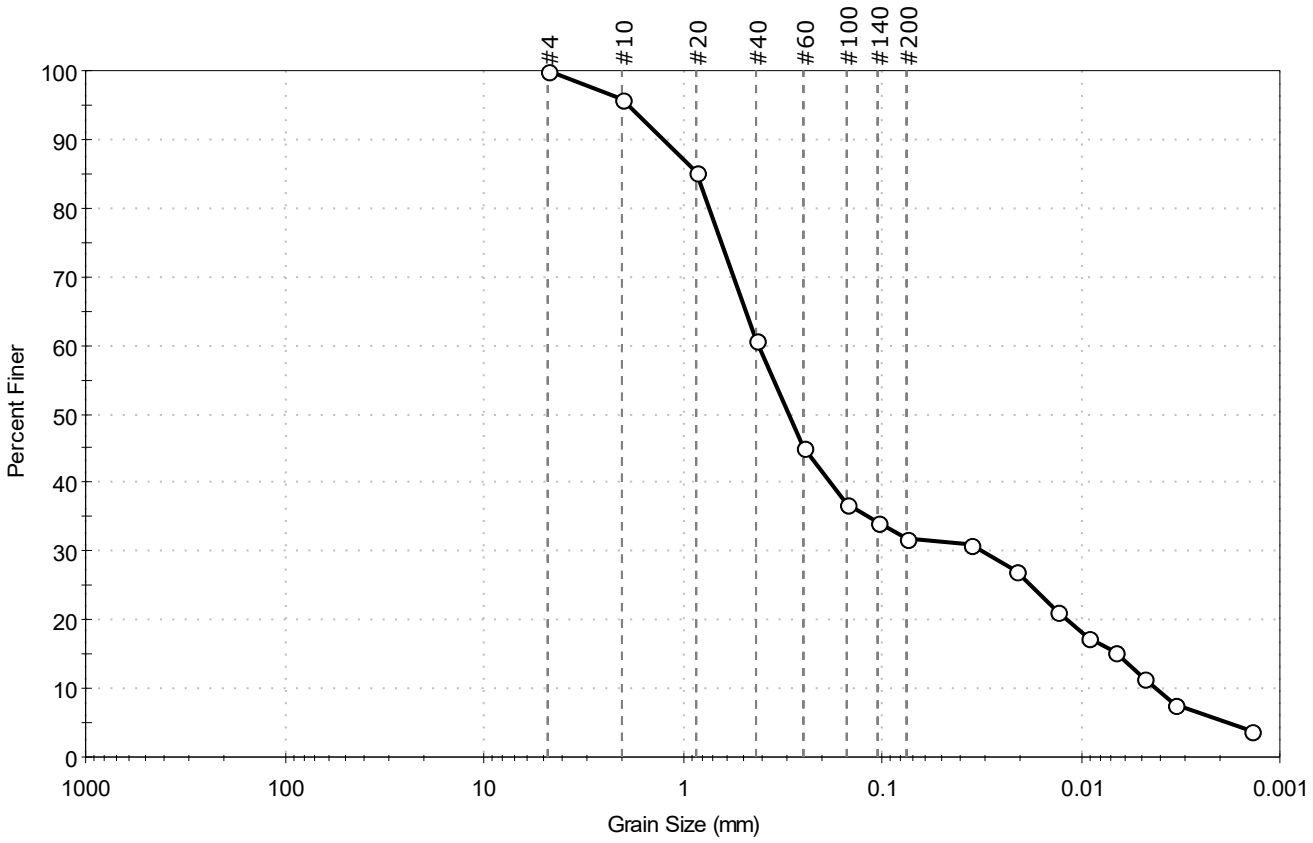
Wetland

Sediment Grain

Size Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AFW-19-01-SE_OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529921		
Test Comment:	---				
Visual Description:	Moist, very dark brown silty sand				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.2	68.1	31.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	96		
#20	0.85	85		
#40	0.42	61		
#60	0.25	45		
#100	0.15	37		
#140	0.11	34		
#200	0.075	32		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0357	31		
---	0.0214	27		
---	0.0132	21		
---	0.0091	17		
---	0.0067	15		
---	0.0048	12		
---	0.0034	8		
---	0.0014	4		

Coefficients

D_{85} =0.8446 mm	D_{30} =0.0316 mm
D_{60} =0.4130 mm	D_{15} =0.0064 mm
D_{50} =0.2953 mm	D_{10} =0.0042 mm
C_u =98.333	C_c =0.576

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

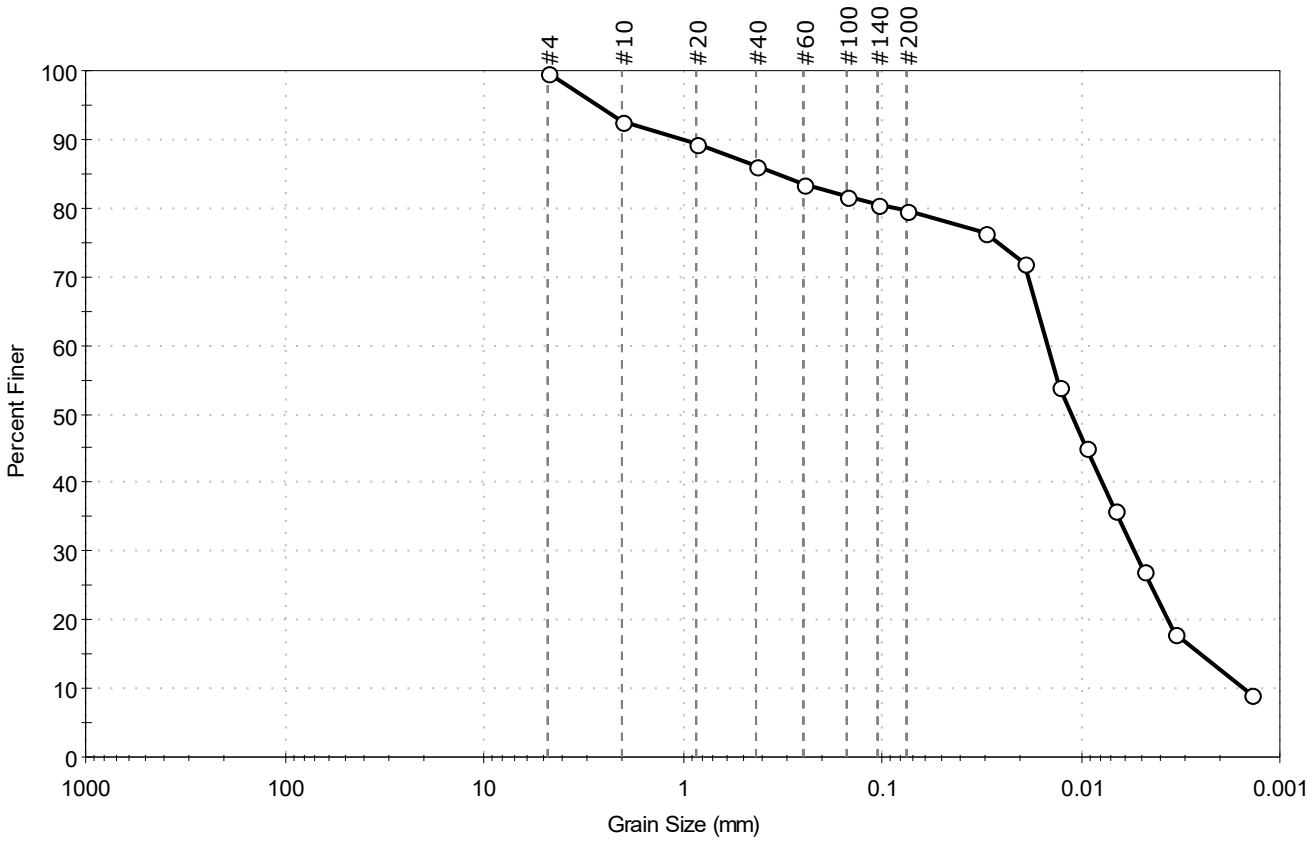
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	AFW-19-02-SE_OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529920		
Test Comment:	---				
Visual Description:	Moist, very dark brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.4	19.9	79.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	93		
#20	0.85	89		
#40	0.42	86		
#60	0.25	83		
#100	0.15	82		
#140	0.11	81		
#200	0.075	80		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0302	77		
---	0.0192	72		
---	0.0129	54		
---	0.0095	45		
---	0.0068	36		
---	0.0048	27		
---	0.0034	18		
---	0.0014	9		

Coefficients

D_{85} =0.3431 mm	D_{30} =0.0054 mm
D_{60} =0.0148 mm	D_{15} =0.0025 mm
D_{50} =0.0113 mm	D_{10} =0.0016 mm
C_u =9.250	C_c =1.231

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

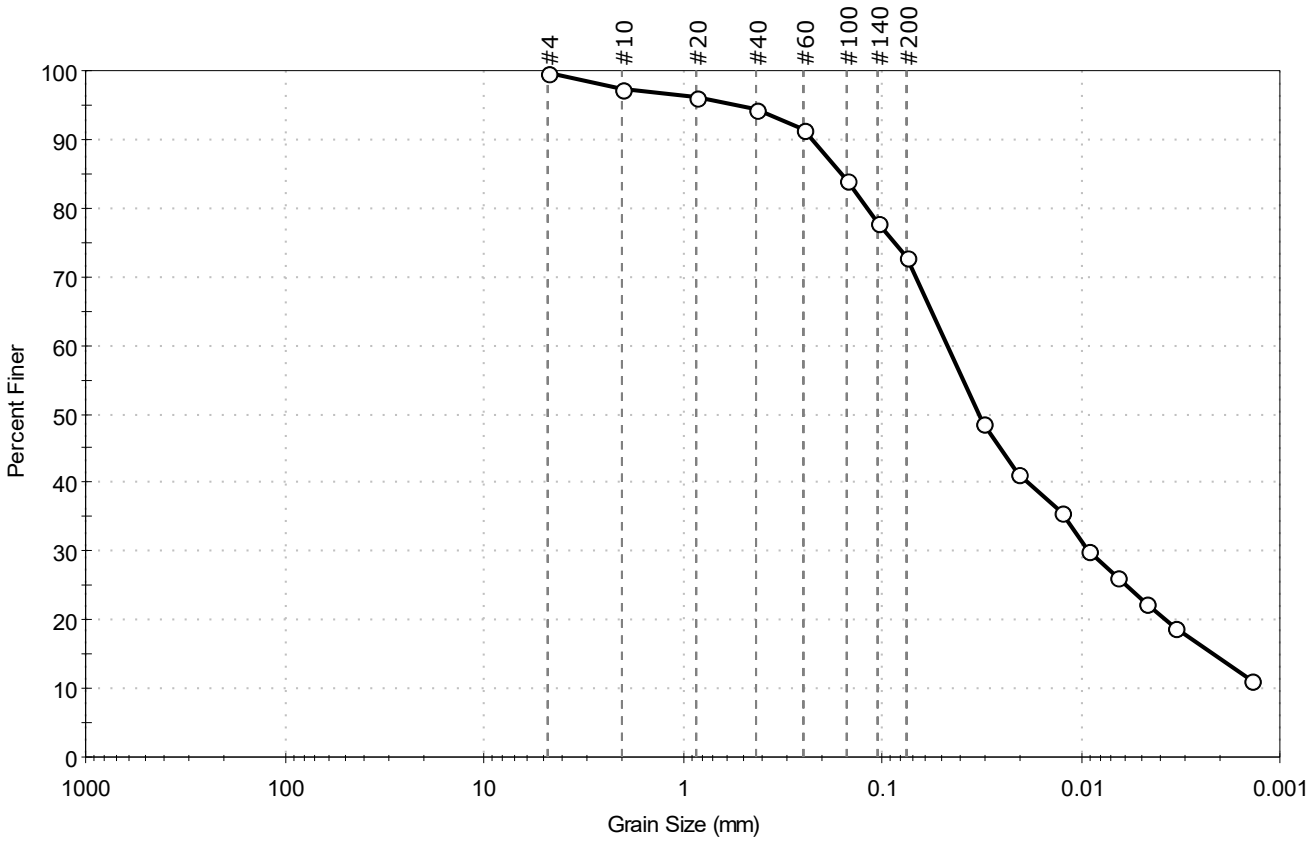
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Nashua River
Sediment Grain
Size Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-01-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529918		
Test Comment:	---				
Visual Description:	Moist, very dark brown silt with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.2	26.9	72.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	97		
#20	0.85	96		
#40	0.42	94		
#60	0.25	92		
#100	0.15	84		
#140	0.11	78		
#200	0.075	73		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0308	49		
---	0.0206	41		
---	0.0127	36		
---	0.0093	30		
---	0.0066	26		
---	0.0047	23		
---	0.0033	19		
---	0.0014	11		

Coefficients

D_{85} = 0.1606 mm	D_{30} = 0.0092 mm
D_{60} = 0.0466 mm	D_{15} = 0.0022 mm
D_{50} = 0.0322 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

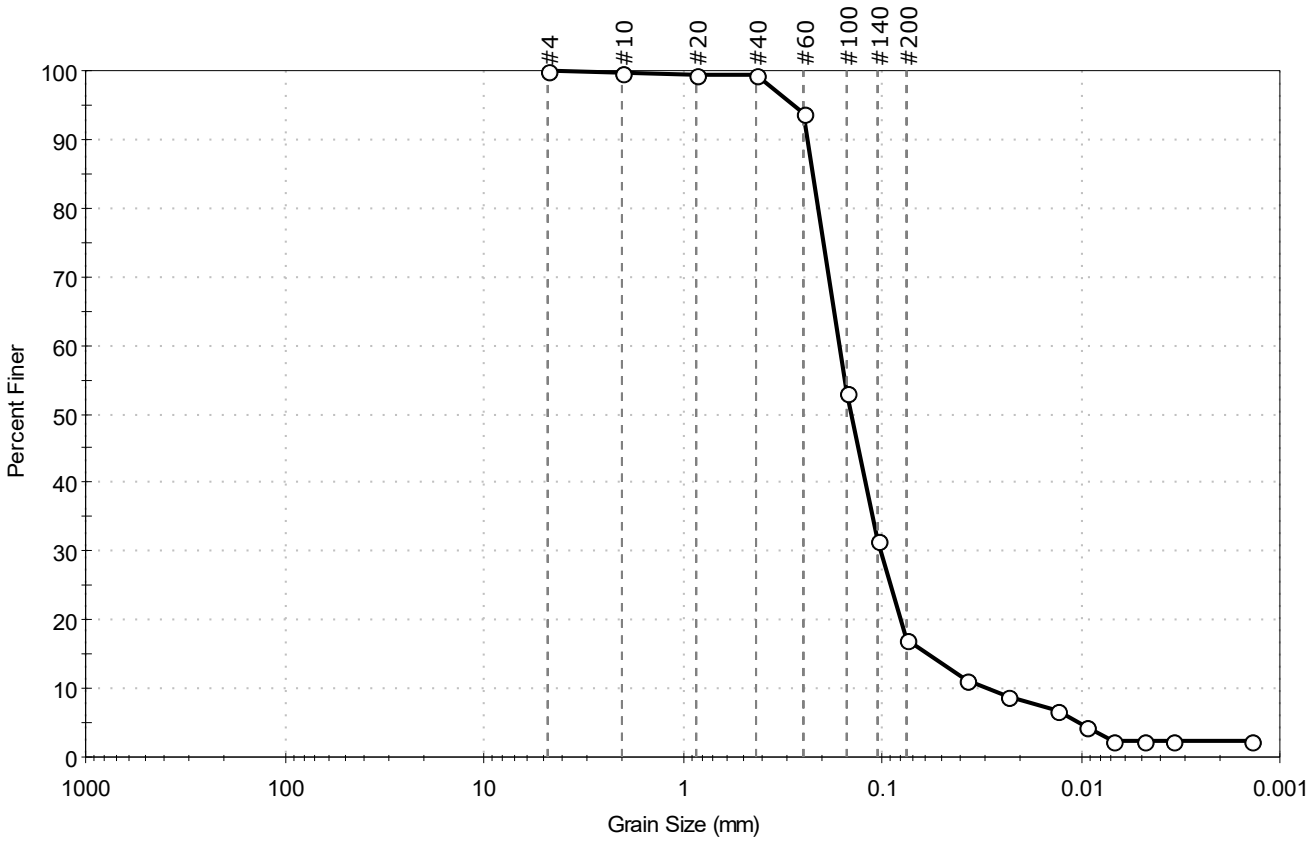
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-02-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5	Test Id:	529917		
Test Comment:	---				
Visual Description:	Moist, very dark gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.1	82.7	17.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	94		
#100	0.15	53		
#140	0.11	32		
#200	0.075	17		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0376	11		
---	0.0233	9		
---	0.0132	7		
---	0.0094	4		
---	0.0069	2		
---	0.0048	2		
---	0.0034	2		
---	0.0014	2		

Coefficients

D_{85} = 0.2237 mm	D_{30} = 0.1020 mm
D_{60} = 0.1636 mm	D_{15} = 0.0583 mm
D_{50} = 0.1428 mm	D_{10} = 0.0295 mm
C_u = 5.546	C_c = 2.156

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

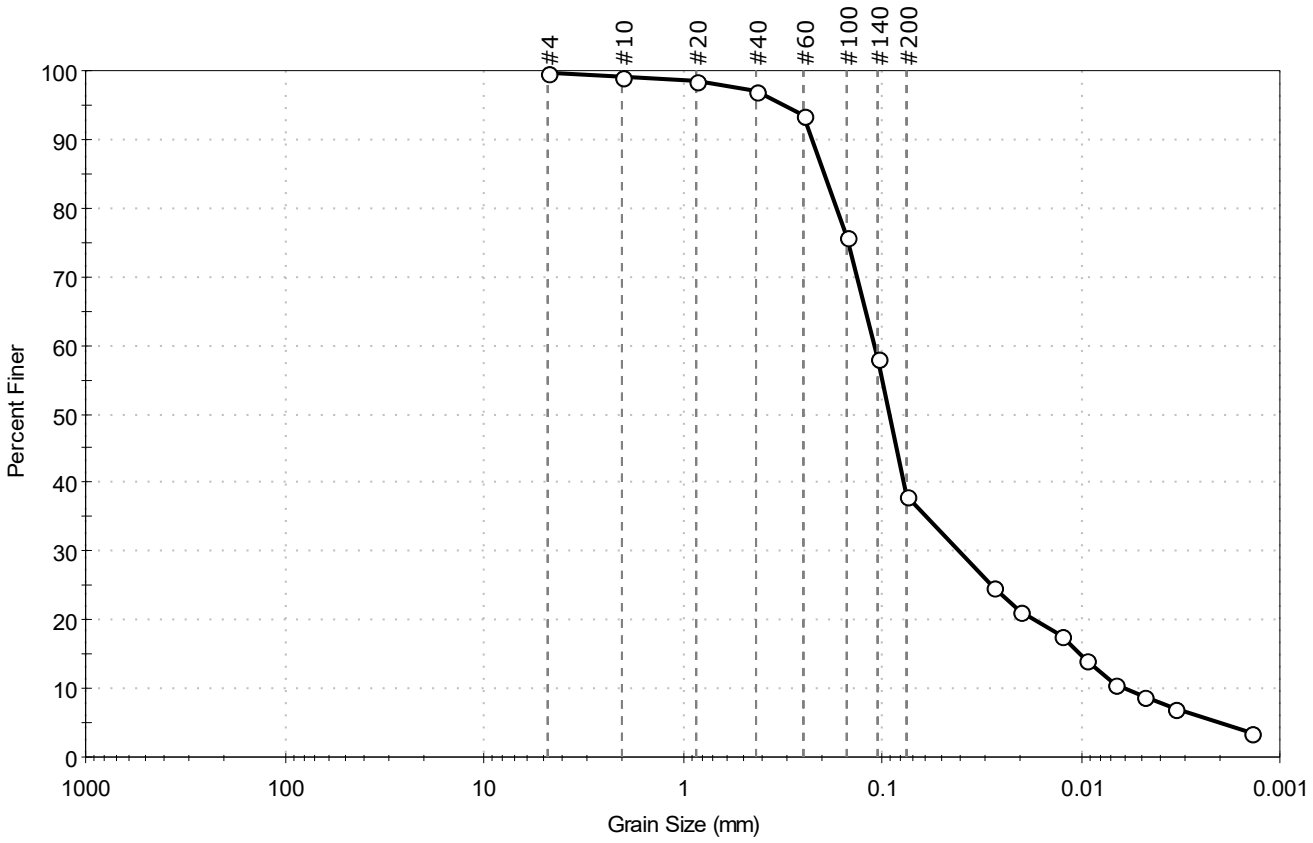
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-03-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5	Test Id:	529916		
Test Comment:	---				
Visual Description:	Moist, very dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.2	61.6	38.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	98		
#40	0.42	97		
#60	0.25	93		
#100	0.15	76		
#140	0.11	58		
#200	0.075	38		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0276	25		
---	0.0204	21		
---	0.0126	18		
---	0.0095	14		
---	0.0067	11		
---	0.0048	9		
---	0.0034	7		
---	0.0014	4		

Coefficients

D_{85} =0.1953 mm	D_{30} =0.0409 mm
D_{60} =0.1102 mm	D_{15} =0.0102 mm
D_{50} =0.0922 mm	D_{10} =0.0060 mm
C_u =18.367	C_c =2.530

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

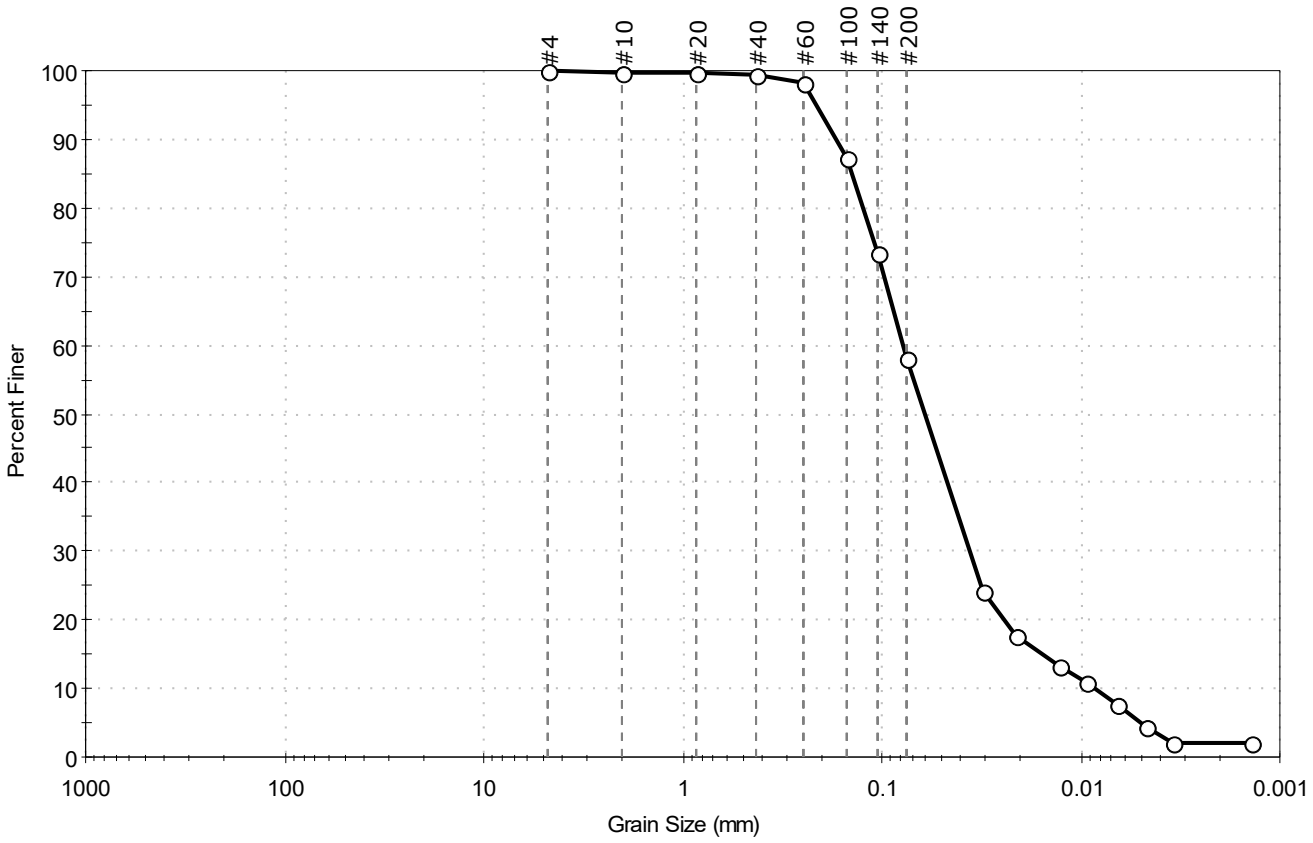
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-04-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529915		
Test Comment:	---				
Visual Description:	Moist, dark brown sandy silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	41.8	58.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	98		
#100	0.15	87		
#140	0.11	73		
#200	0.075	58		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0307	24		
---	0.0211	18		
---	0.0129	13		
---	0.0093	11		
---	0.0066	8		
---	0.0047	4		
---	0.0034	2		
---	0.0014	2		

Coefficients

D_{85} =0.1415 mm	D_{30} =0.0357 mm
D_{60} =0.0781 mm	D_{15} =0.0156 mm
D_{50} =0.0604 mm	D_{10} =0.0084 mm
C_u =9.298	C_c =1.943

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

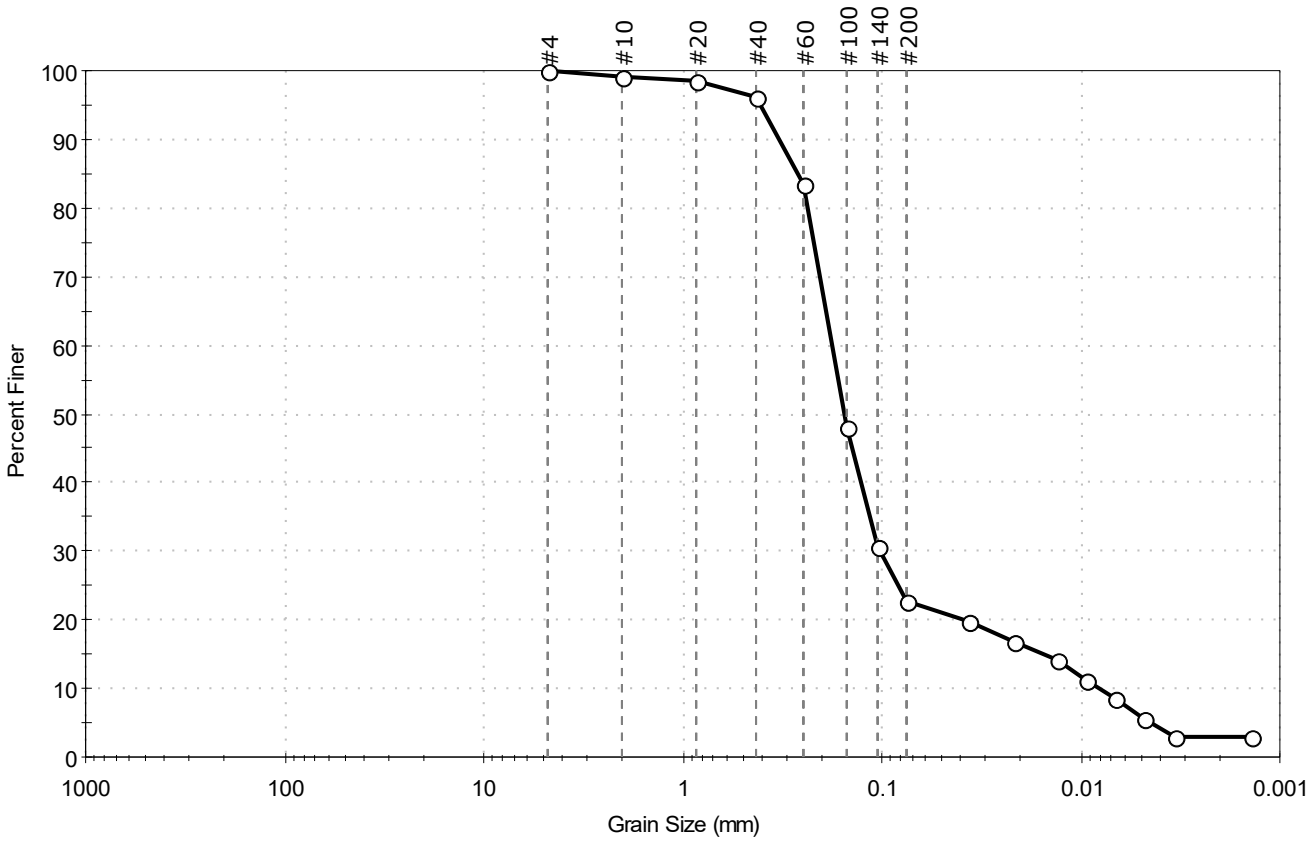
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-05-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529914		
Test Comment:	---				
Visual Description:	Moist, olive brown silty sand				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	77.4	22.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	98		
#40	0.42	96		
#60	0.25	84		
#100	0.15	48		
#140	0.11	31		
#200	0.075	23		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0365	20		
---	0.0215	17		
---	0.0130	14		
---	0.0094	11		
---	0.0067	8		
---	0.0048	6		
---	0.0034	3		
---	0.0014	3		

Coefficients

D_{85} =0.2659 mm	D_{30} =0.1028 mm
D_{60} =0.1782 mm	D_{15} =0.0154 mm
D_{50} =0.1544 mm	D_{10} =0.0081 mm
C_u =22.000	C_c =7.321

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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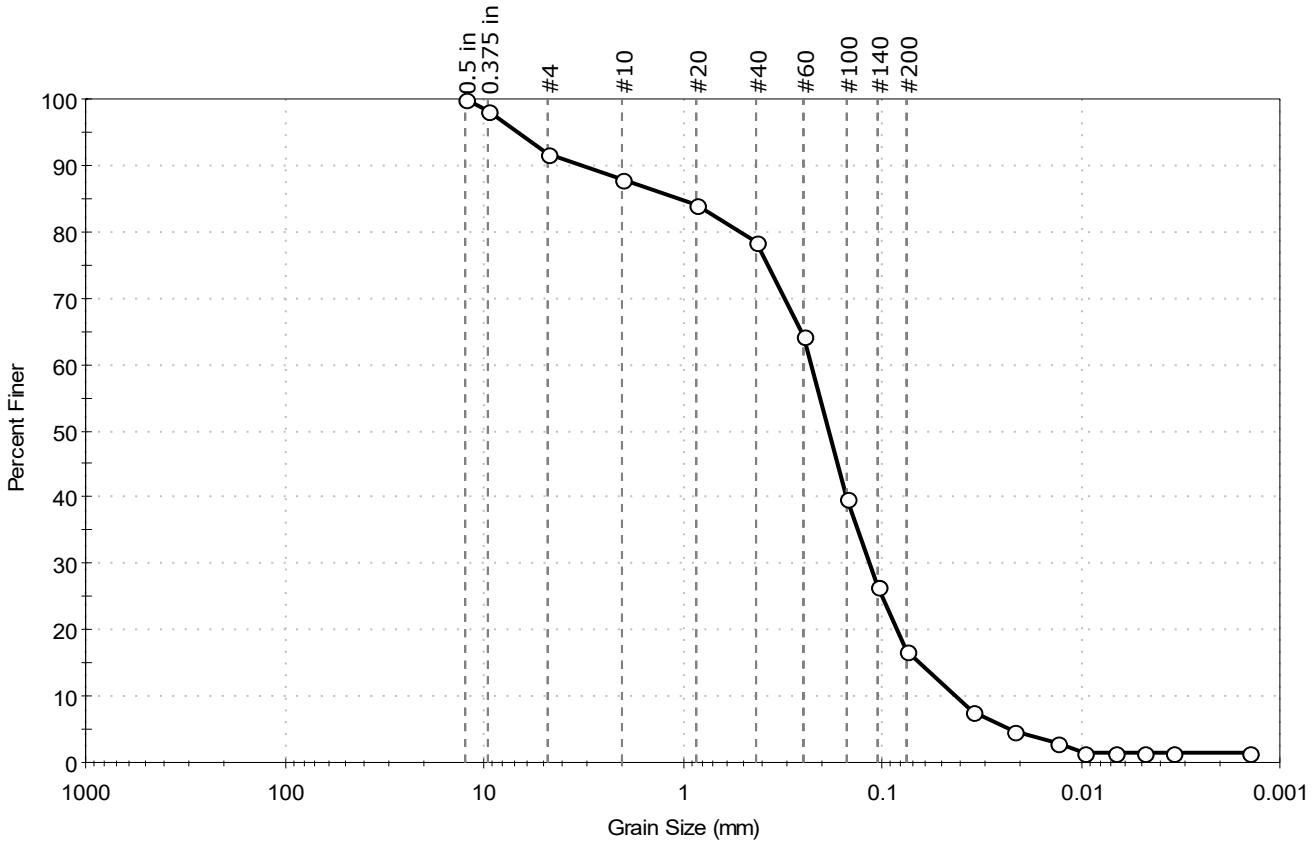
Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-06-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529913		
Test Comment:	---				
Visual Description:	Moist, dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	8.2	75.0	16.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	98		
#4	4.75	92		
#10	2.00	88		
#20	0.85	84		
#40	0.42	78		
#60	0.25	64		
#100	0.15	40		
#140	0.11	26		
#200	0.075	17		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0352	8		
---	0.0218	5		
---	0.0132	3		
---	0.0097	2		
---	0.0067	2		
---	0.0049	2		
---	0.0034	2		
---	0.0014	2		

Coefficients

D_{85} = 1.0450 mm	D_{30} = 0.1163 mm
D_{60} = 0.2290 mm	D_{15} = 0.0646 mm
D_{50} = 0.1860 mm	D_{10} = 0.0427 mm
C_u = 5.363	C_c = 1.383

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

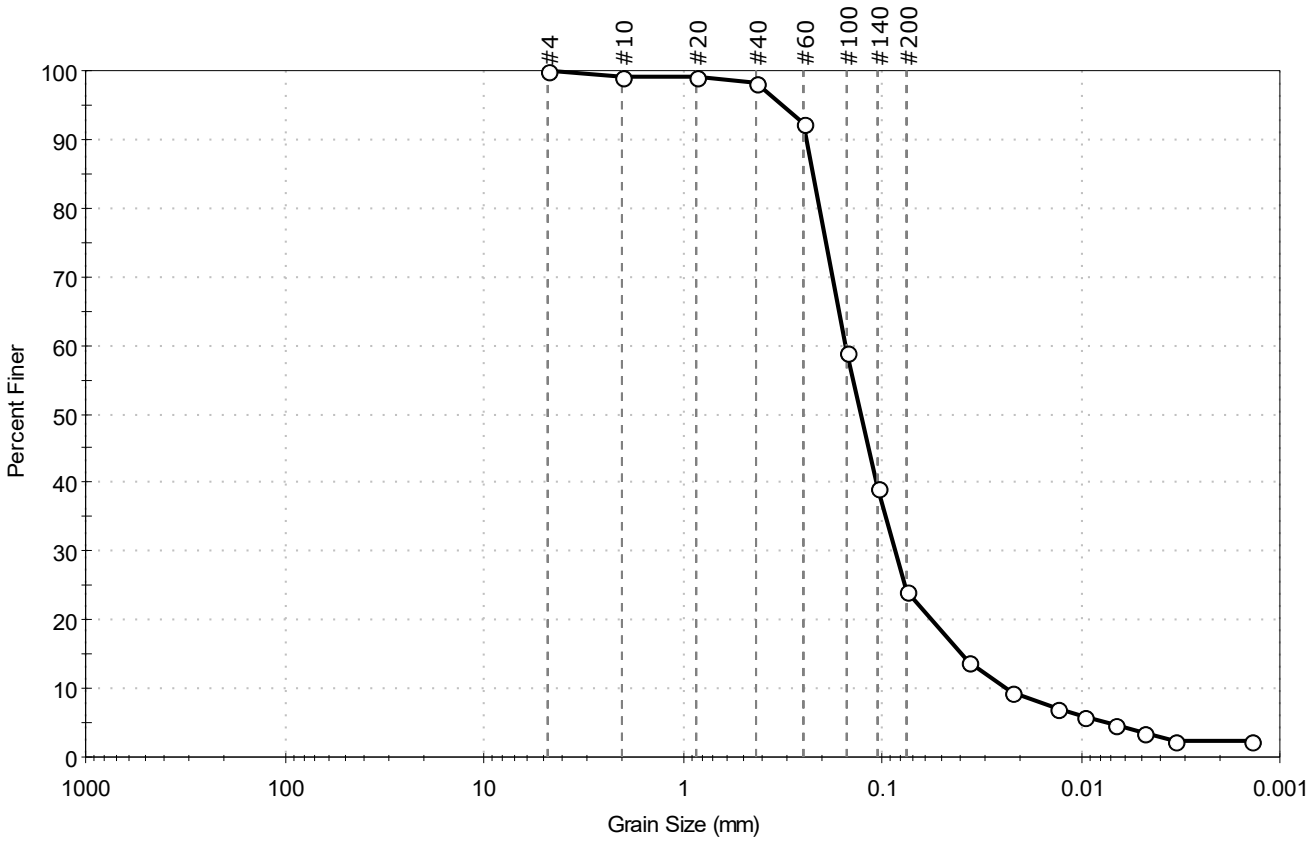
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-07-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-05'	Test Id:	529912		
Test Comment:	---				
Visual Description:	Moist, very dark gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.1	75.8	24.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	98		
#60	0.25	92		
#100	0.15	59		
#140	0.11	39		
#200	0.075	24		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0365	14		
---	0.0221	9		
---	0.0131	7		
---	0.0097	6		
---	0.0068	5		
---	0.0048	3		
---	0.0034	2		
---	0.0014	2		

Coefficients

D_{85} = 0.2232 mm D_{30} = 0.0859 mm
D_{60} = 0.1521 mm D_{15} = 0.0393 mm
D_{50} = 0.1281 mm D_{10} = 0.0238 mm
C_u = 6.391 C_c = 2.038

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

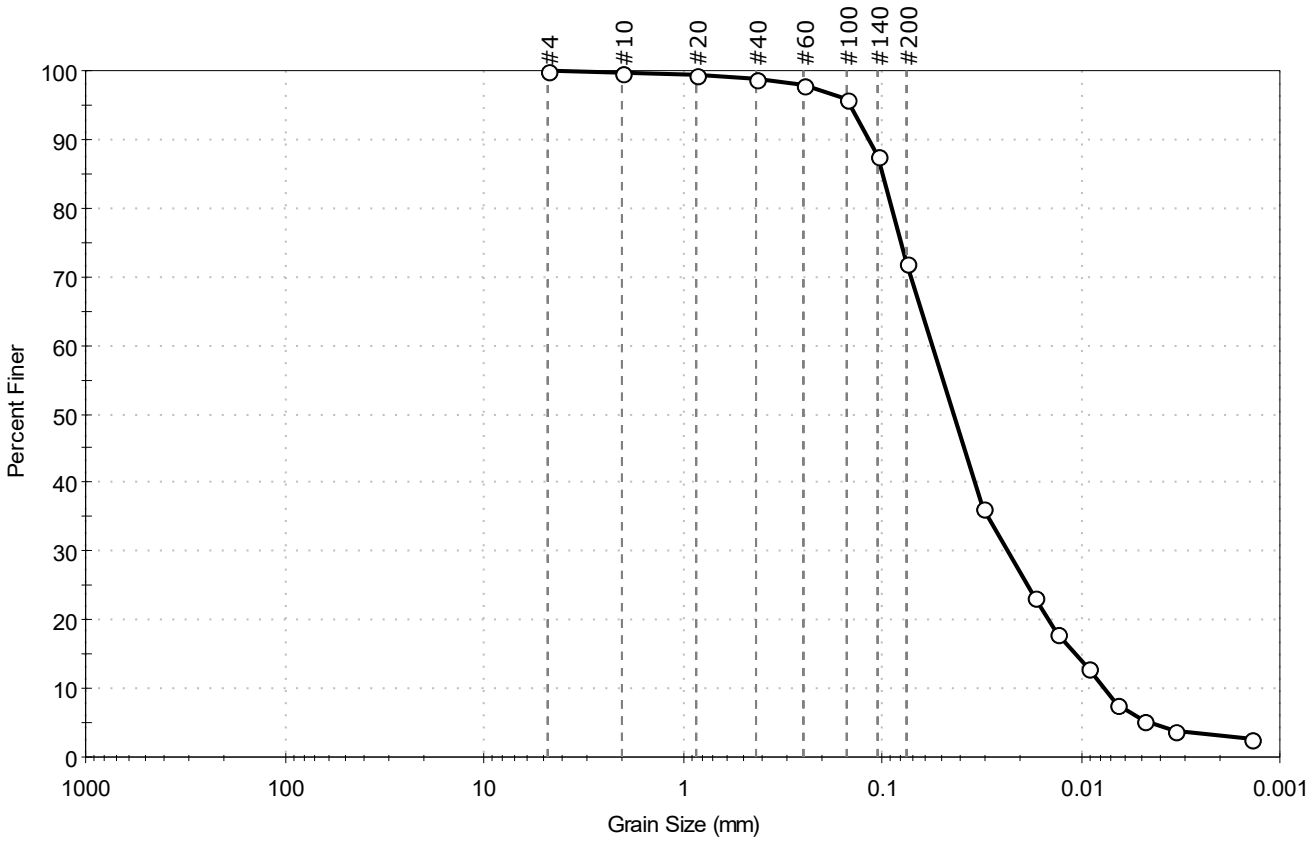
Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-08-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529911		
Test Comment:	---				
Visual Description:	Moist, olive brown silt with sand				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	28.1	71.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	98		
#100	0.15	96		
#140	0.11	88		
#200	0.075	72		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0312	36		
---	0.0172	23		
---	0.0130	18		
---	0.0093	13		
---	0.0066	8		
---	0.0048	5		
---	0.0034	4		
---	0.0014	3		

Coefficients

D_{85} = 0.1001 mm
D_{30} = 0.0235 mm
D_{60} = 0.0560 mm
D_{15} = 0.0106 mm
D_{50} = 0.0438 mm
D_{10} = 0.0077 mm
C_u = 7.273
C_c = 1.281

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

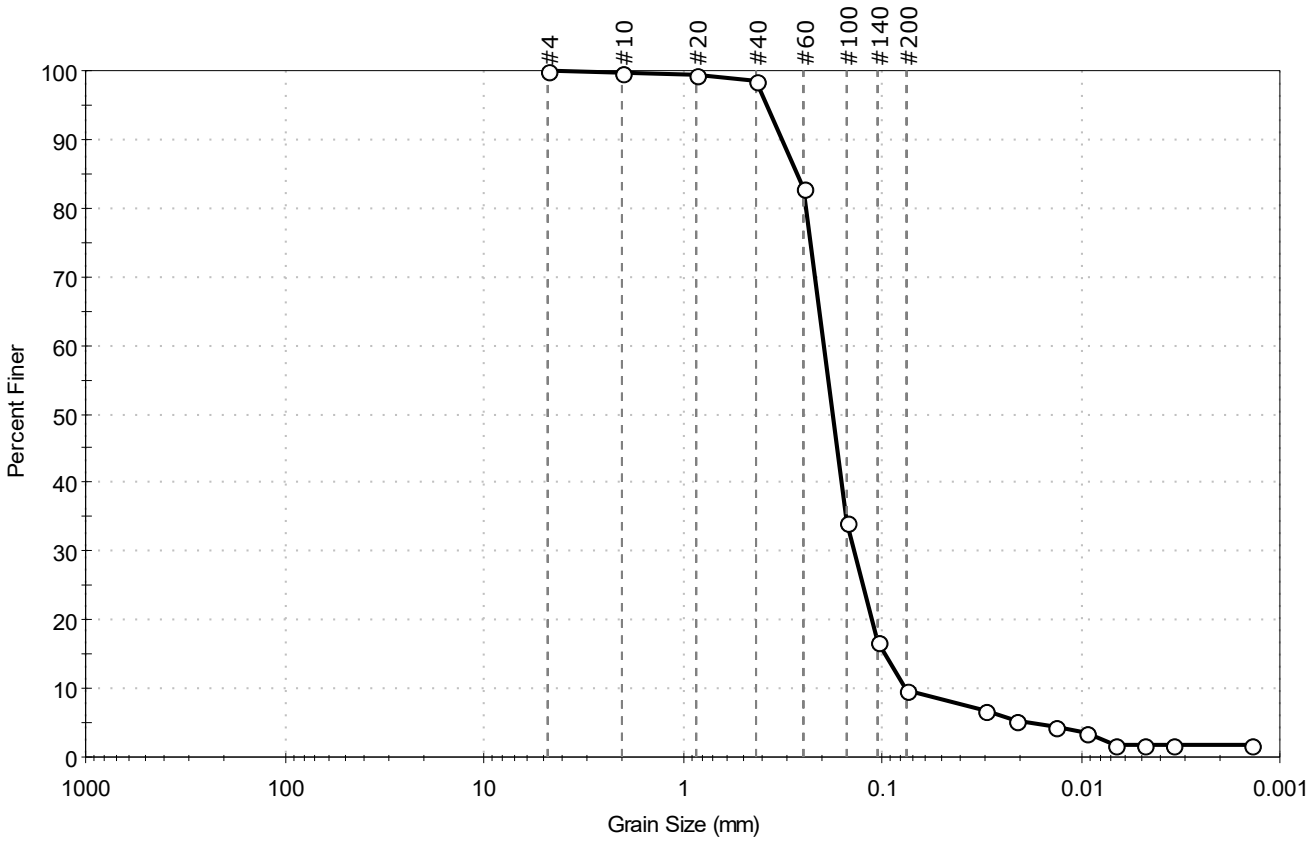
Sample/Test Description

Sand/Gravel Particle Shape : ---
Sand/Gravel Hardness : ---
Dispersion Device : Apparatus A - Mech Mixer
Dispersion Period : 1 minute
Est. Specific Gravity : 2.65
Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-09-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529910		
Test Comment:	---				
Visual Description:	Moist, very dark brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.1	90.3	9.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	83		
#100	0.15	34		
#140	0.11	17		
#200	0.075	9.6		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0306	7		
---	0.0213	5		
---	0.0133	4		
---	0.0094	3		
---	0.0067	2		
---	0.0048	2		
---	0.0034	2		
---	0.0014	2		

Coefficients

D_{85} = 0.2681 mm	D_{30} = 0.1381 mm
D_{60} = 0.1966 mm	D_{15} = 0.0972 mm
D_{50} = 0.1771 mm	D_{10} = 0.0763 mm
C_u = 2.577	C_c = 1.271

Classification

ASTM N/A

AASHTO Fine Sand (A-3 (1))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

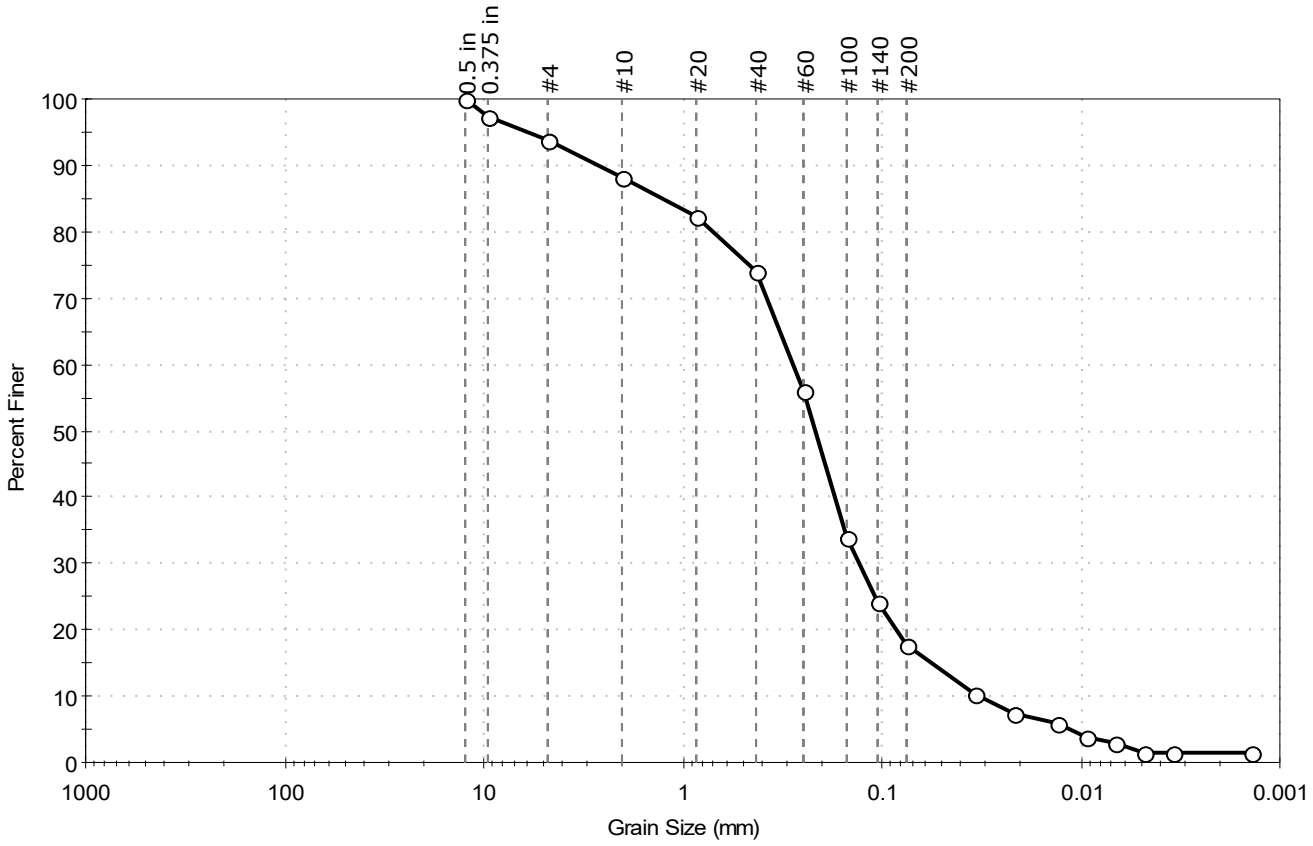
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-10-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529909		
Test Comment:	---				
Visual Description:	Moist, dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.1	76.1	17.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	94		
#10	2.00	88		
#20	0.85	82		
#40	0.42	74		
#60	0.25	56		
#100	0.15	34		
#140	0.11	24		
#200	0.075	18		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0338	10		
---	0.0216	7		
---	0.0132	6		
---	0.0095	4		
---	0.0068	3		
---	0.0048	1		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 1.2461 mm	D_{30} = 0.1302 mm
D_{60} = 0.2807 mm	D_{15} = 0.0553 mm
D_{50} = 0.2171 mm	D_{10} = 0.0315 mm
C_u = 8.911	C_c = 1.917

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

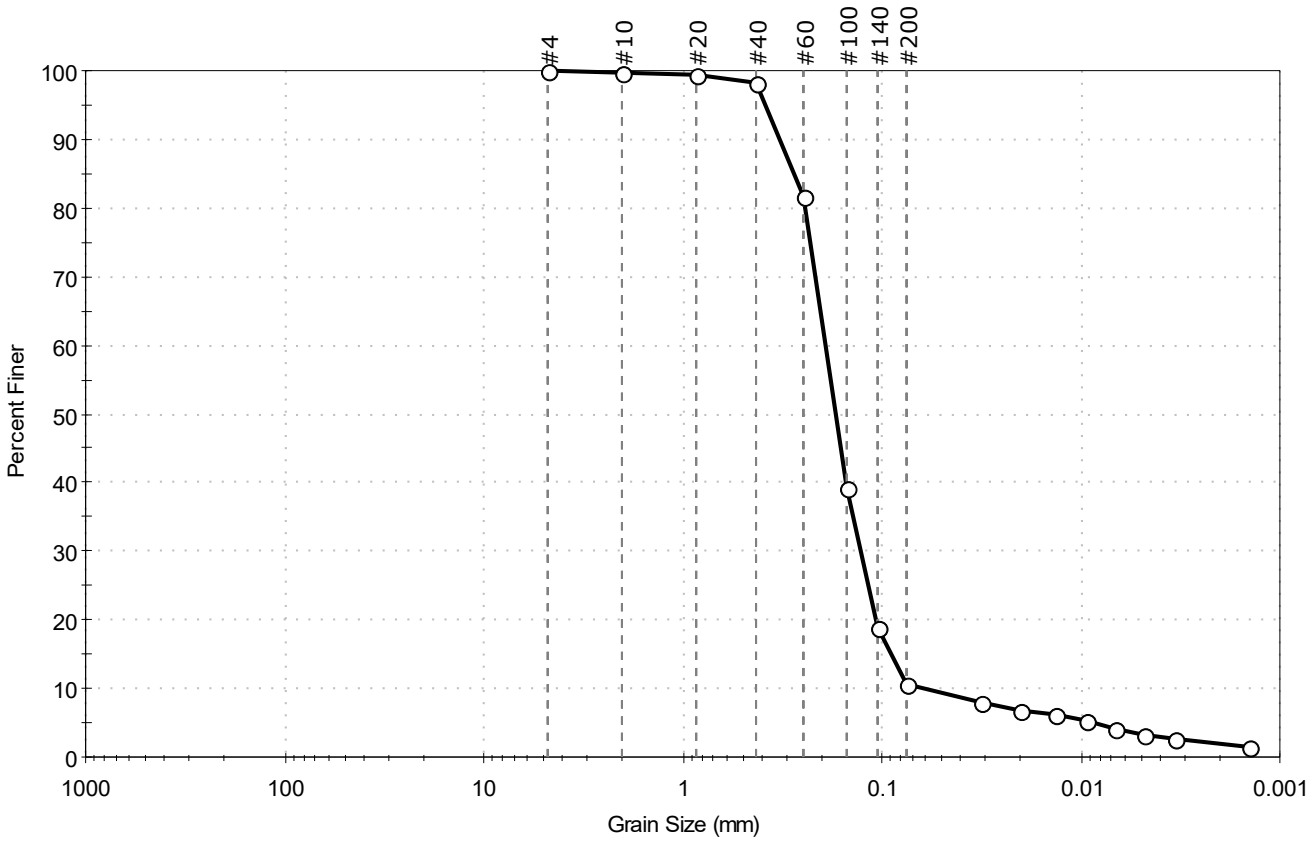
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-11-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529908		
Test Comment:	---				
Visual Description:	Moist, dark grayish brown sand with silt				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	89.4	10.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	82		
#100	0.15	39		
#140	0.11	19		
#200	0.075	11		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0319	8		
---	0.0201	7		
---	0.0136	6		
---	0.0094	5		
---	0.0068	4		
---	0.0048	3		
---	0.0034	3		
---	0.0014	1		

Coefficients

D_{85} = 0.2784 mm	D_{30} = 0.1282 mm
D_{60} = 0.1925 mm	D_{15} = 0.0903 mm
D_{50} = 0.1707 mm	D_{10} = 0.0608 mm
C_u = 3.166	C_c = 1.404

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

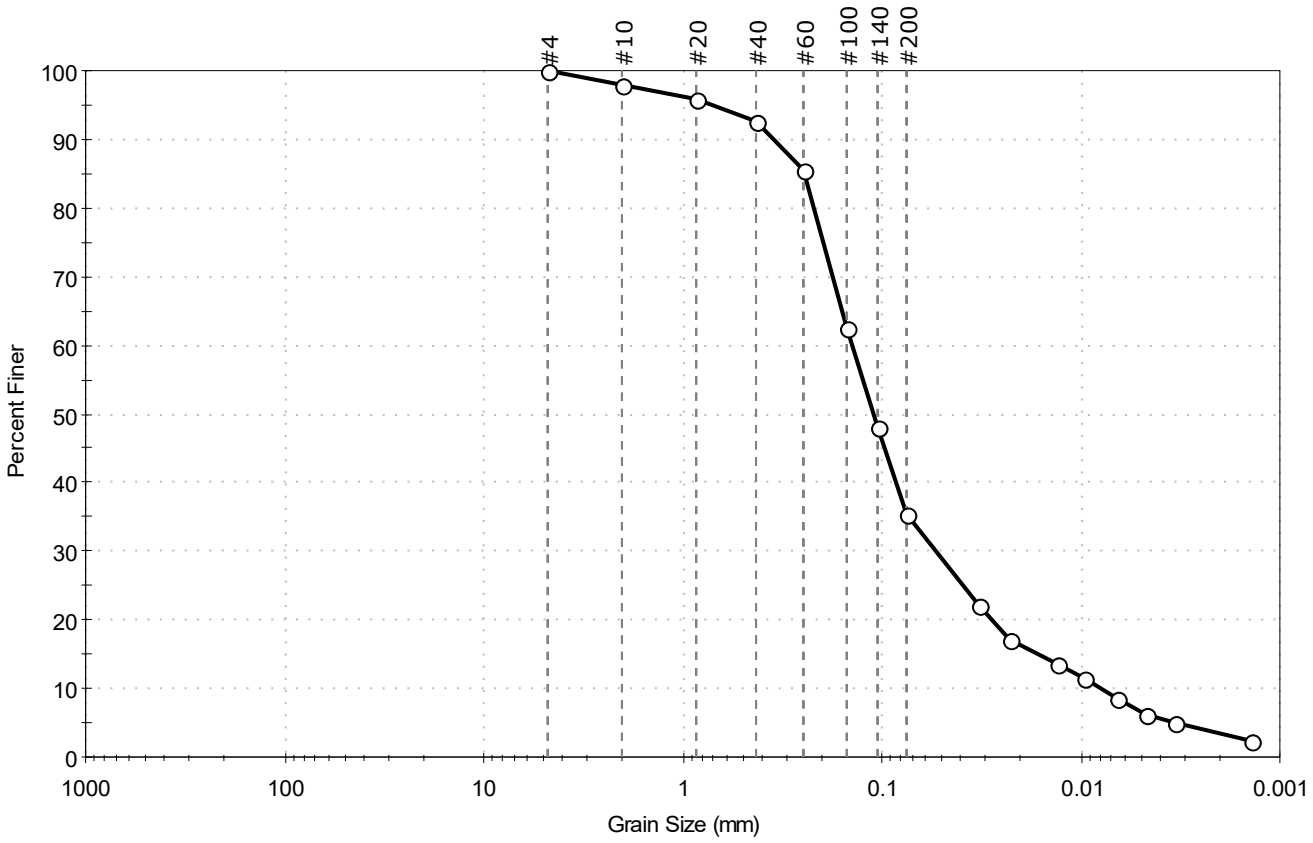
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-12-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529907		
Test Comment:	---				
Visual Description:	Moist, very dark grayish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	64.5	35.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	98		
#20	0.85	96		
#40	0.42	93		
#60	0.25	86		
#100	0.15	63		
#140	0.11	48		
#200	0.075	35		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0328	22		
---	0.0228	17		
---	0.0130	13		
---	0.0096	12		
---	0.0066	9		
---	0.0047	6		
---	0.0034	5		
---	0.0014	2		

Coefficients

D_{85} =0.2464 mm	D_{30} =0.0536 mm
D_{60} =0.1407 mm	D_{15} =0.0166 mm
D_{50} =0.1109 mm	D_{10} =0.0078 mm
C_u =18.038	C_c =2.618

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

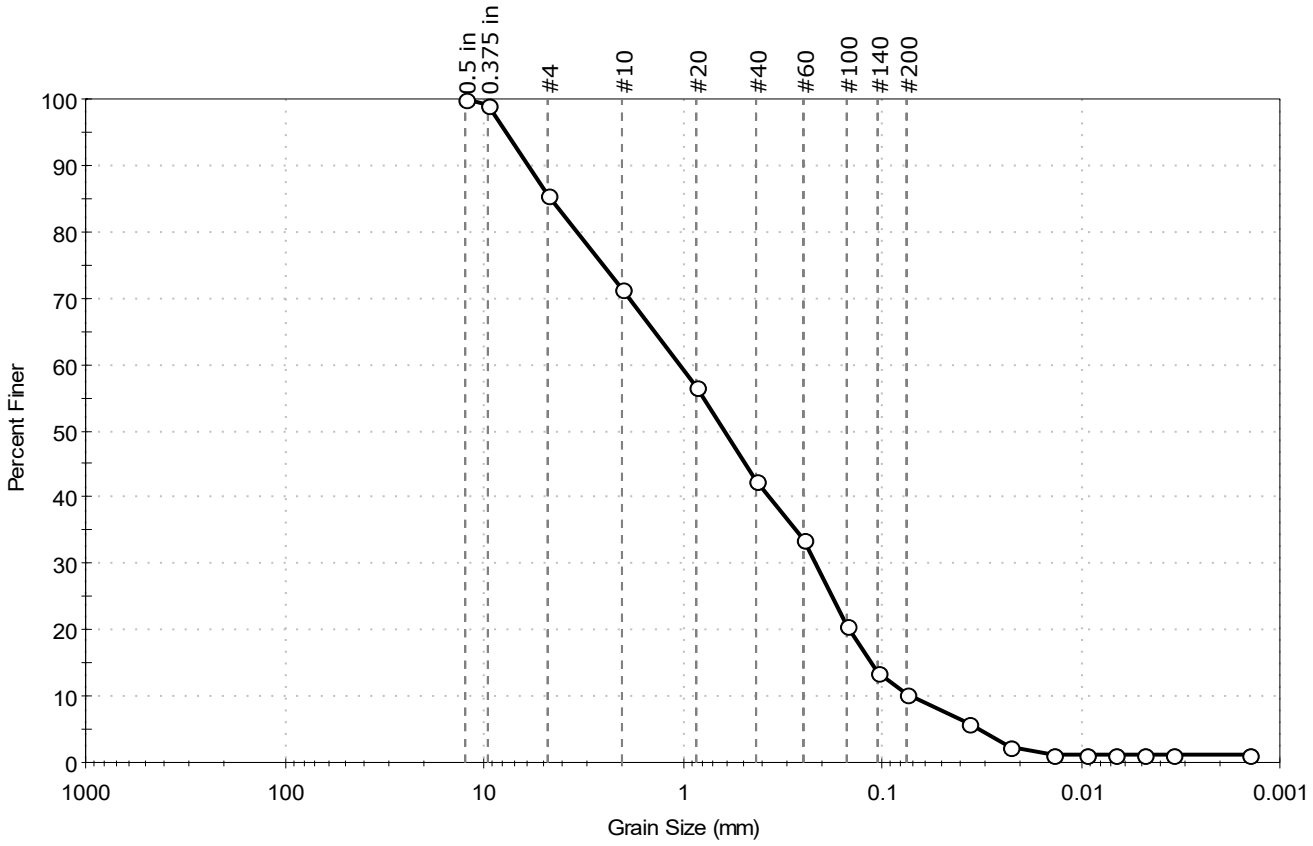
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-19-13-SE-OCT19	Test Date:	11/27/19	Checked By:	bfs
Depth :	0-0.5'	Test Id:	529906		
Test Comment:	---				
Visual Description:	Moist, olive brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	14.5	75.1	10.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	86		
#10	2.00	71		
#20	0.85	57		
#40	0.42	42		
#60	0.25	34		
#100	0.15	21		
#140	0.11	14		
#200	0.075	10		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0368	6		
---	0.0226	2		
---	0.0138	1		
---	0.0094	1		
---	0.0068	1		
---	0.0048	1		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 4.6014 mm	D_{30} = 0.2164 mm
D_{60} = 1.0368 mm	D_{15} = 0.1141 mm
D_{50} = 0.6150 mm	D_{10} = 0.0703 mm
C_u = 14.748	C_c = 0.642

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

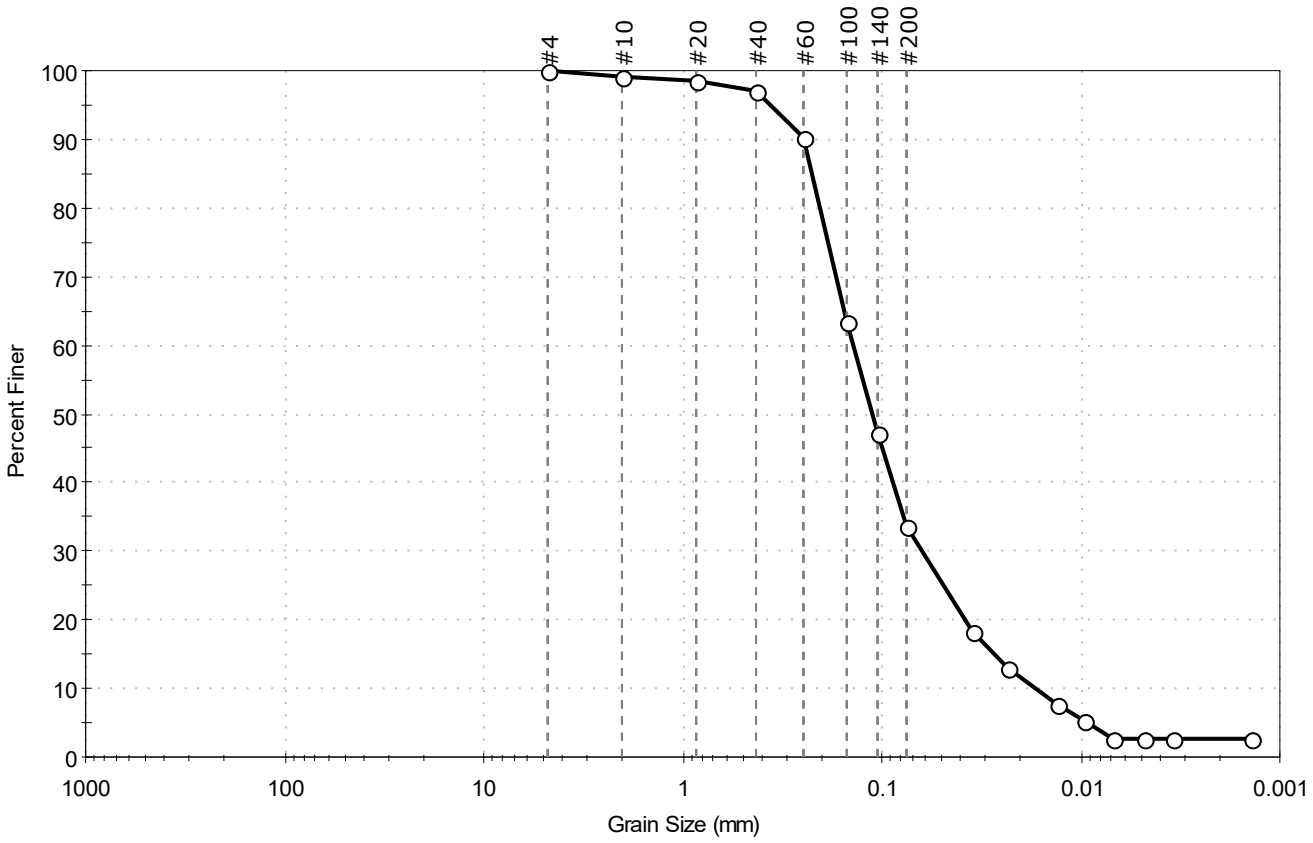
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NR-SED-19-14-DEC19	Test Date:	03/04/20	Checked By:	jsc
Depth :	0-0.5 ft	Test Id:	546010		
Test Comment:	---				
Visual Description:	Moist, dark gray silty sand				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	66.3	33.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	97		
#60	0.25	90		
#100	0.15	63		
#140	0.11	47		
#200	0.075	34		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0350	18		
---	0.0234	13		
---	0.0131	8		
---	0.0096	5		
---	0.0069	3		
---	0.0049	3		
---	0.0034	3		
---	0.0014	3		

Coefficients

D_{85} =0.2260 mm	D_{30} =0.0627 mm
D_{60} =0.1394 mm	D_{15} =0.0274 mm
D_{50} =0.1128 mm	D_{10} =0.0168 mm
C_u =8.298	C_c =1.679

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

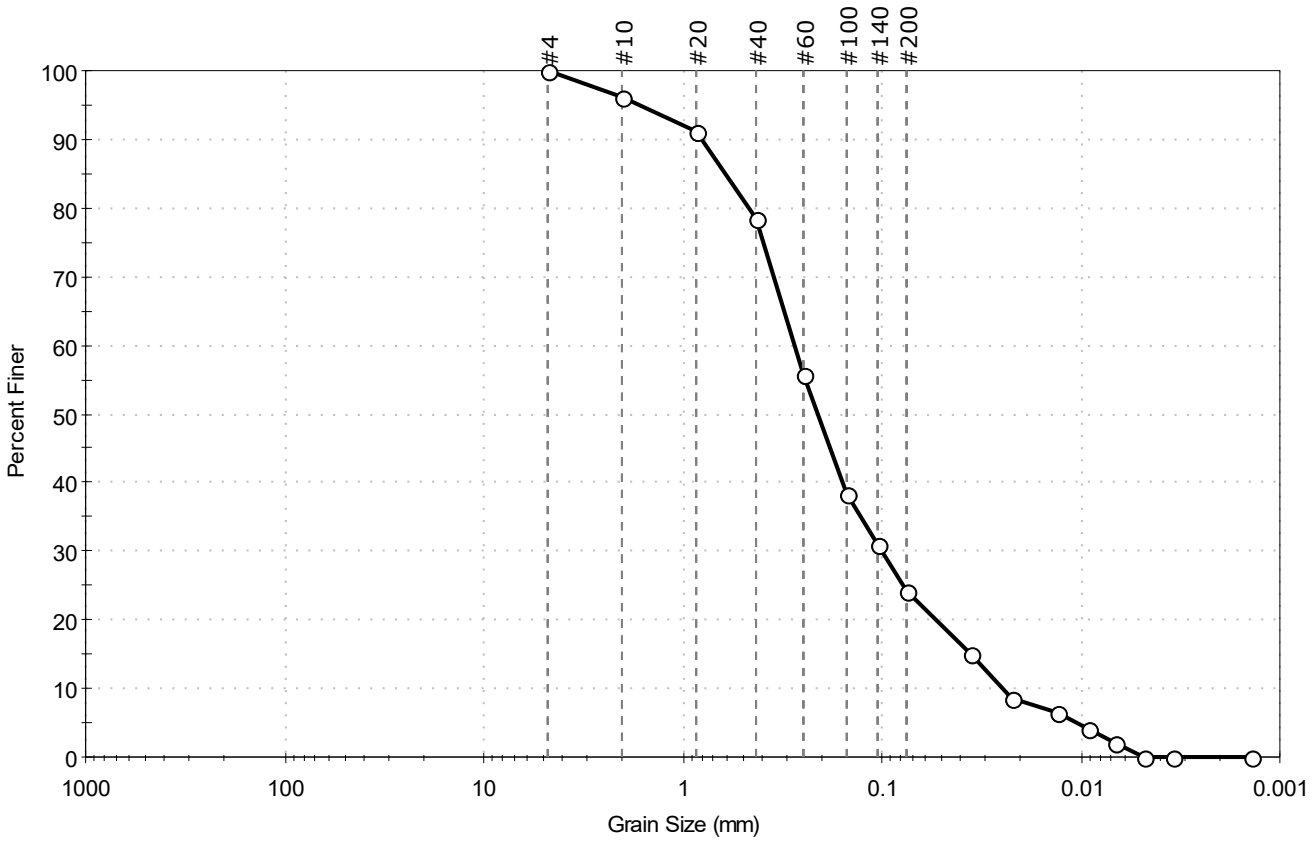
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NRBK-SED-19-01-DEC19	Test Date:	03/04/20	Checked By:	jsc
Depth :	0-0.5 ft	Test Id:	546007		
Test Comment:	---				
Visual Description:	Moist, dark gray silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	75.6	24.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	96		
#20	0.85	91		
#40	0.42	78		
#60	0.25	56		
#100	0.15	38		
#140	0.11	31		
#200	0.075	24		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0360	15		
---	0.0222	9		
---	0.0132	6		
---	0.0093	4		
---	0.0068	2		
---	0.0049	0		
---	0.0034	0		
---	0.0014	0		

Coefficients

D_{85} =0.6104 mm	D_{30} =0.1013 mm
D_{60} =0.2755 mm	D_{15} =0.0363 mm
D_{50} =0.2106 mm	D_{10} =0.0248 mm
C_u =11.109	C_c =1.502

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

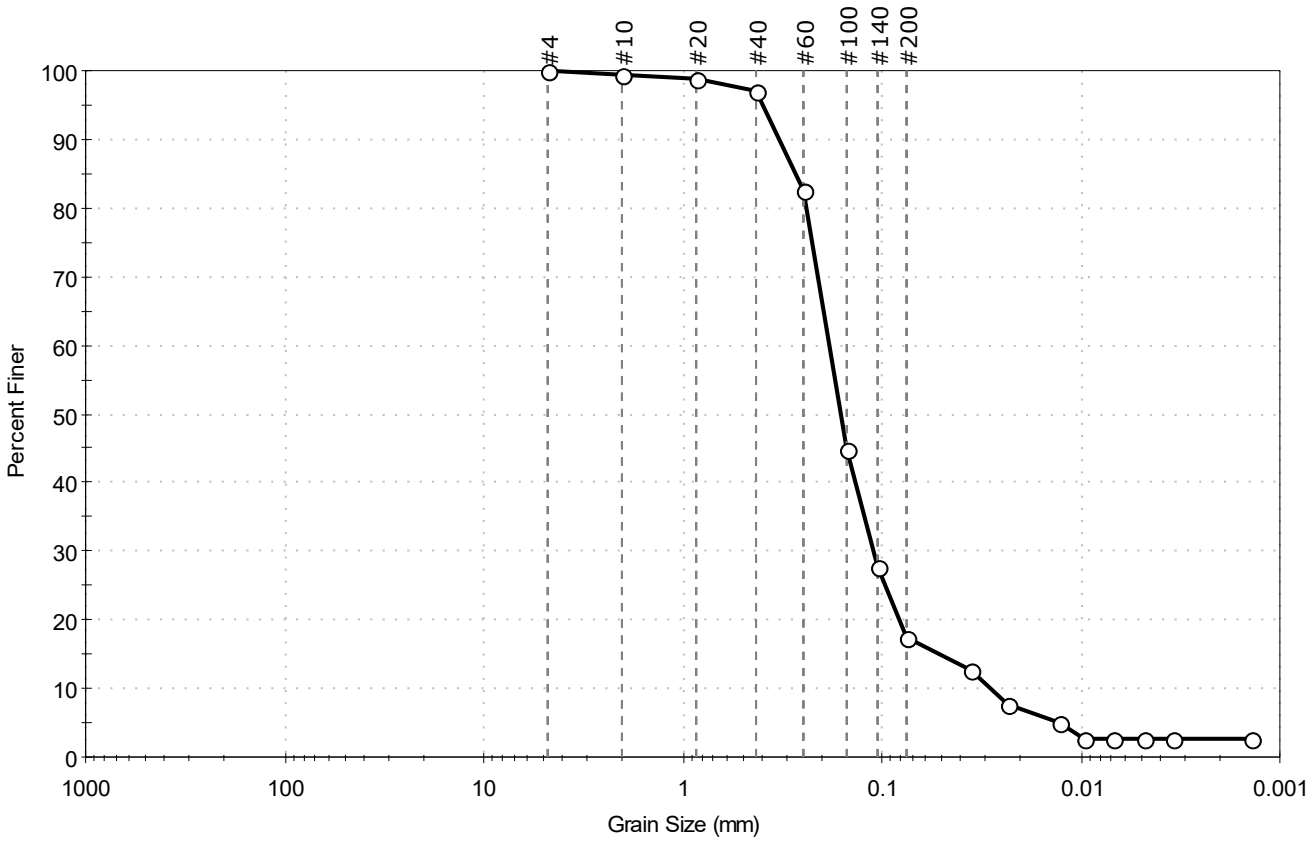
Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	NRBK-SED-19-02-DEC19	Test Date:	03/04/20	Checked By:	jsc
Depth :	0-0.5 ft	Test Id:	546006		
Test Comment:	---				
Visual Description:	Moist dark gray silty sand				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.1	82.5	17.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	99		
#40	0.42	97		
#60	0.25	83		
#100	0.15	45		
#140	0.11	28		
#200	0.075	17		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0362	13		
---	0.0233	8		
---	0.0127	5		
---	0.0096	3		
---	0.0068	3		
---	0.0048	3		
---	0.0034	3		
---	0.0014	3		

Coefficients

D_{85} =0.2733 mm	D_{30} =0.1112 mm
D_{60} =0.1843 mm	D_{15} =0.0522 mm
D_{50} =0.1610 mm	D_{10} =0.0289 mm
C_u =6.377	C_c =2.322

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Balch Pond

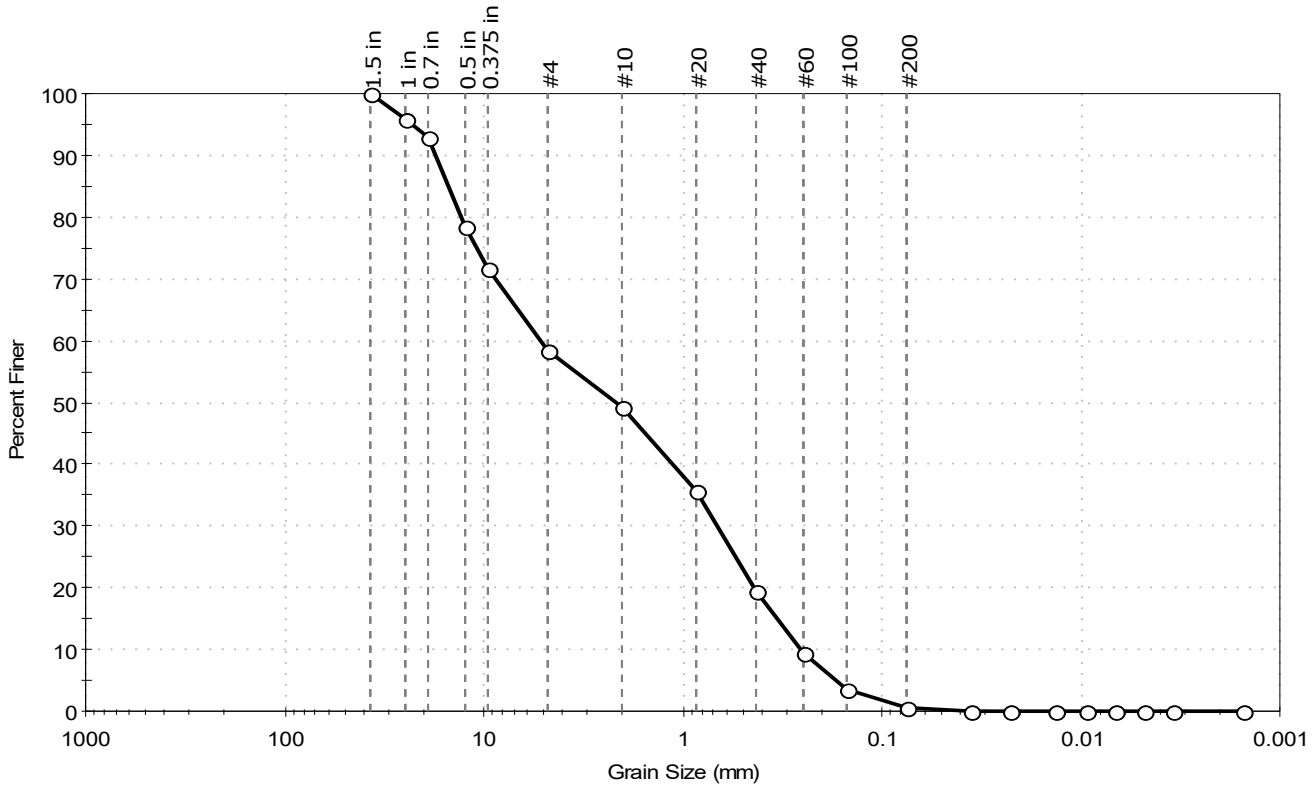
River Sediment

Grain Size

Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	Devens PFAS Remedial Investigation				
Location:	Devens, MA			Project No:	GTX-309411
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	BP-SED-18-01-DEC18	Test Date:	02/02/19	Checked By:	emm
Depth :	0-0.5'	Test Id:	489879		
Test Comment:	---				
Visual Description:	Moist, dark gray sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	41.7	57.7	0.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	96		
0.7 in	19.00	93		
0.5 in	12.50	78		
0.375 in	9.50	72		
#4	4.75	58		
#10	2.00	49		
#20	0.85	36		
#40	0.42	19		
#60	0.25	9		
#100	0.15	4		
#200	0.075	0.6		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0359	0		
---	0.0230	0		
---	0.0134	0		
---	0.0095	0		
---	0.0068	0		
---	0.0048	0		
---	0.0034	0		
---	0.0015	0		

Coefficients

D_{85} = 15.1105 mm	D_{30} = 0.6642 mm
D_{60} = 5.1755 mm	D_{15} = 0.3355 mm
D_{50} = 2.1264 mm	D_{10} = 0.2580 mm
C_u = 20.060	C_c = 0.330

Classification

ASTM — Poorly graded SAND with Gravel (SP)

AASHTO — Stone Fragments, Gravel and Sand (A-1-a (1))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Squannacook

River Sediment

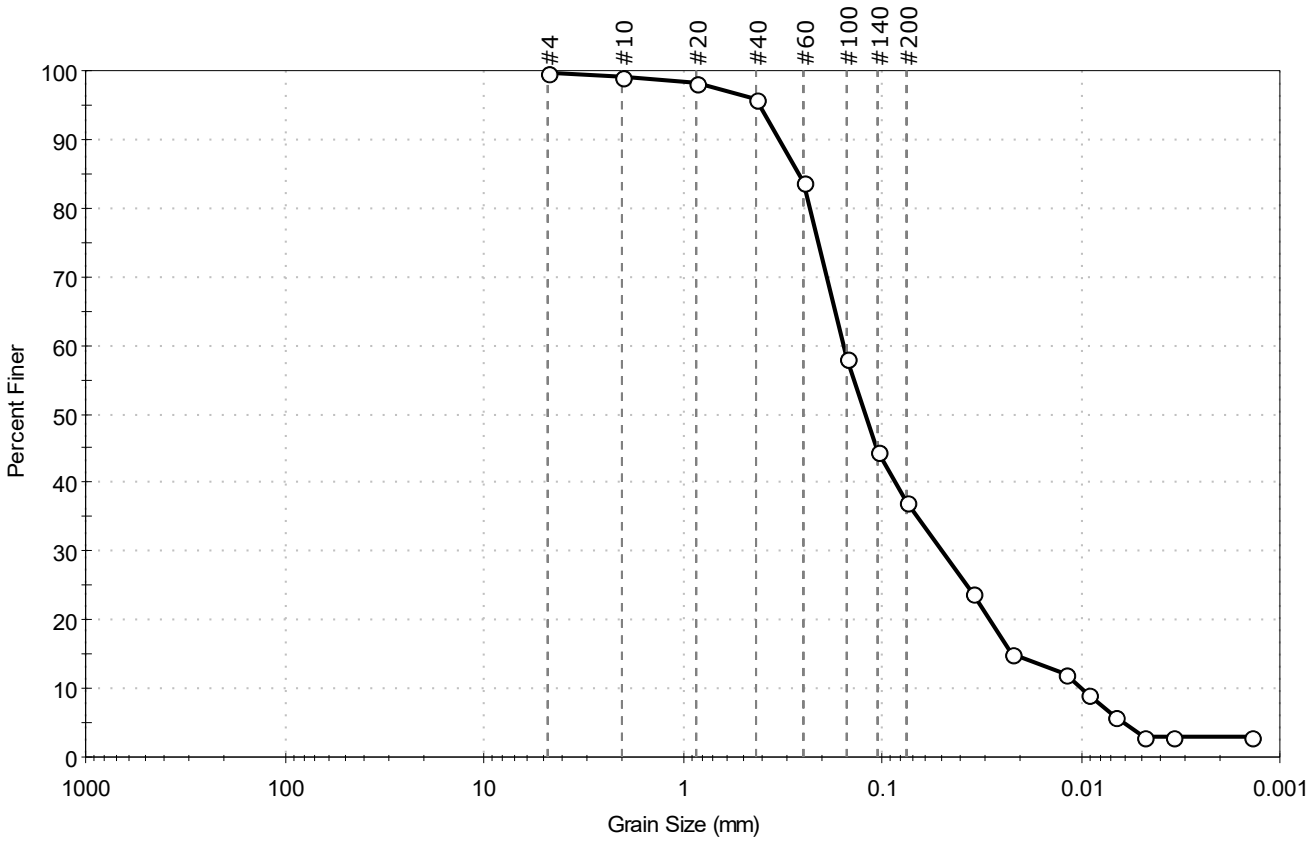
Grain Size

Graphs

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	SR-SED-19-01-DEC19	Test Date:	03/04/20	Checked By:	jsc
Depth :	0-0.5 ft	Test Id:	546009		
Test Comment:	---				
Visual Description:	Moist, dark gray silty sand				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.1	62.7	37.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	99		
#20	0.85	98		
#40	0.42	96		
#60	0.25	84		
#100	0.15	58		
#140	0.11	44		
#200	0.075	37		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0349	24		
---	0.0224	15		
---	0.0120	12		
---	0.0092	9		
---	0.0067	6		
---	0.0048	3		
---	0.0034	3		
---	0.0014	3		

Coefficients

D_{85} =0.2624 mm	D_{30} =0.0494 mm
D_{60} =0.1556 mm	D_{15} =0.0224 mm
D_{50} =0.1220 mm	D_{10} =0.0100 mm
C_u =15.560	C_c =1.568

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

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Willow's

Brook

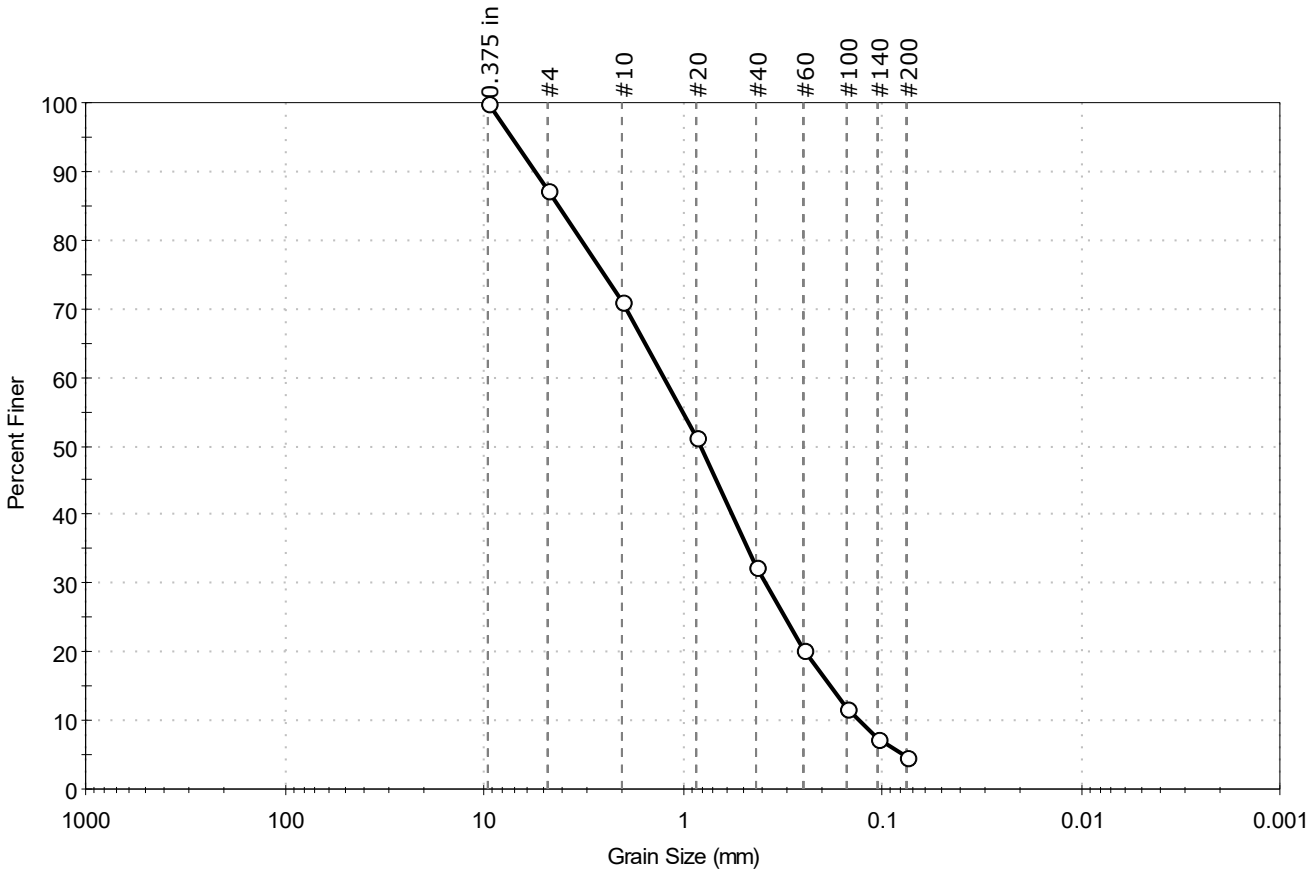
Sediment

Grain Size

Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	WAB-SED-19-01-DEC19	Test Date:	03/04/20	Checked By:	jsc
Depth :	0-0.5 ft	Test Id:	546008		
Test Comment:	---				
Visual Description:	Moist, very dark grayish brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	12.8	82.5	4.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	87		
#10	2.00	71		
#20	0.85	51		
#40	0.42	32		
#60	0.25	20		
#100	0.15	12		
#140	0.11	7		
#200	0.075	4.7		

Coefficients

D_{85} = 4.2146 mm
D_{30} = 0.3830 mm
D_{60} = 1.2348 mm
D_{15} = 0.1816 mm
D_{50} = 0.8097 mm
D_{10} = 0.1295 mm
C_u = 9.535
C_c = 0.917

Classification

ASTM: Poorly graded SAND (SP)

AASHTO: Stone Fragments, Gravel and Sand (A-1-b (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Bower's

Brook

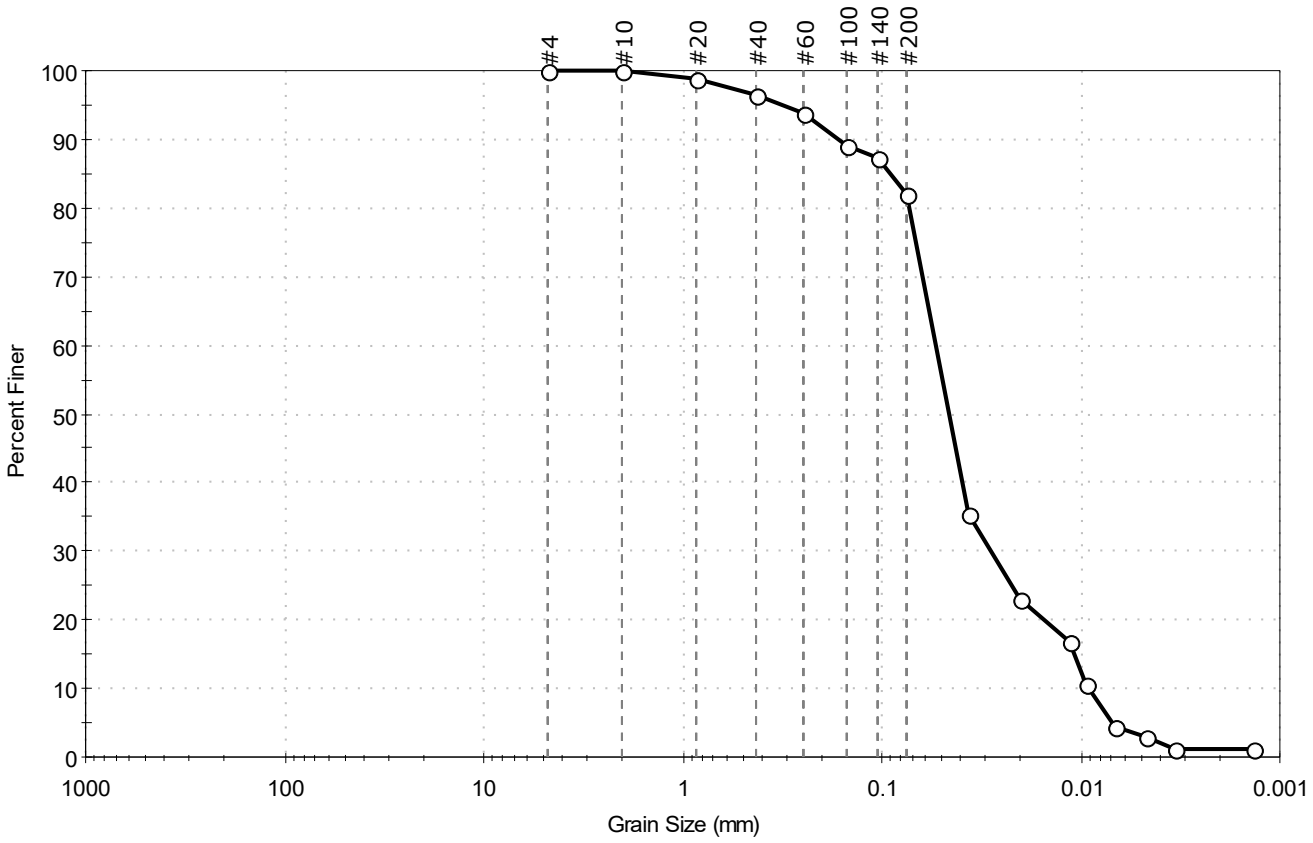
Sediment

Grain Size

Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	BB-SED-20-01-MAY20	Test Date:	08/28/20	Checked By:	bfs
Depth :	---	Test Id:	572436		
Test Comment:	---				
Visual Description:	Moist, very dark brown silt with sand				
Sample Comment:	Sample contains organics and removed one unrepresentitive 1.5 inch rock				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	18.1	81.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	97		
#60	0.25	94		
#100	0.15	89		
#140	0.11	87		
#200	0.075	82		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0368	35		
---	0.0203	23		
---	0.0114	17		
---	0.0094	11		
---	0.0067	4		
---	0.0048	3		
---	0.0034	1		
---	0.0014	1		

Coefficients

D_{85} = 0.0916 mm	D_{30} = 0.0284 mm
D_{60} = 0.0536 mm	D_{15} = 0.0108 mm
D_{50} = 0.0460 mm	D_{10} = 0.0091 mm
C_u = 5.890	C_c = 1.654

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

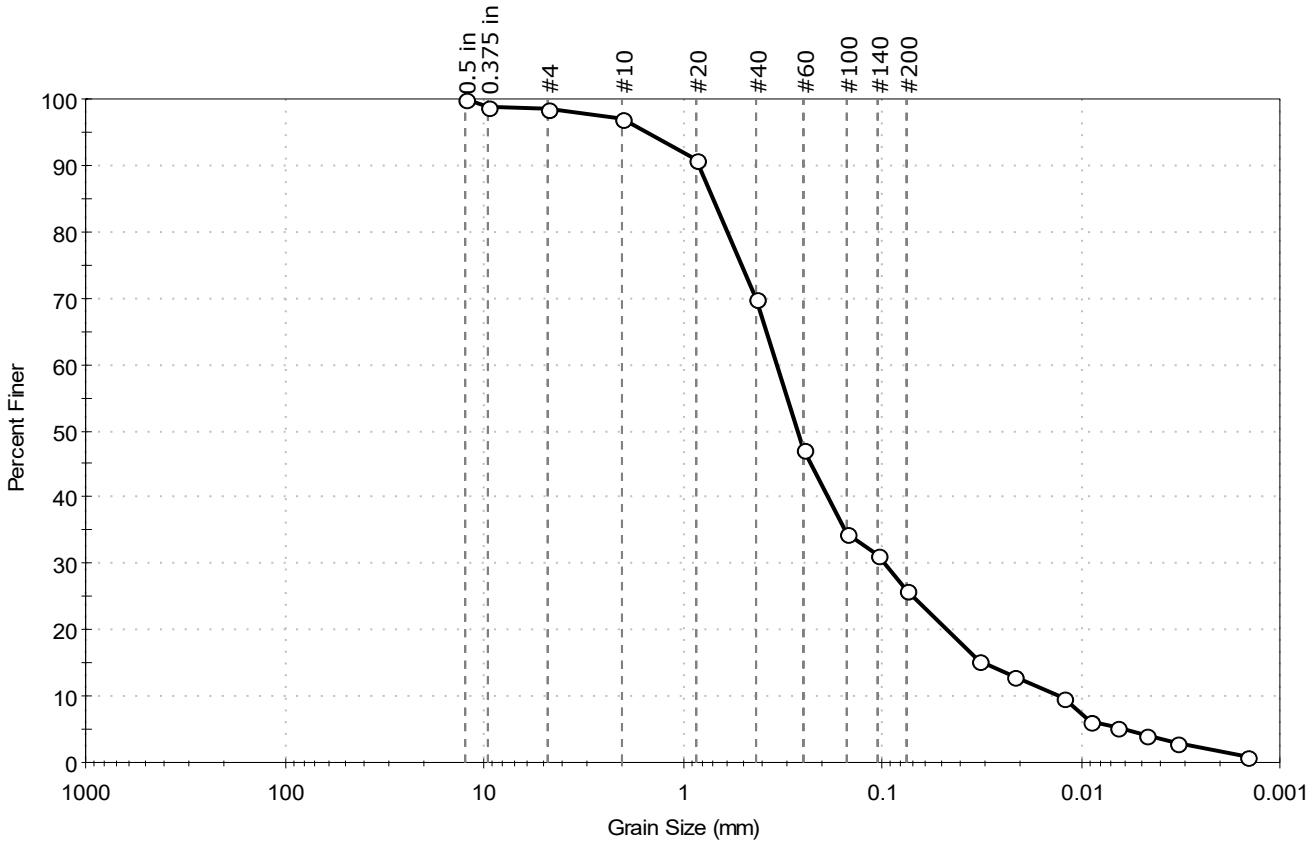
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

Flannagan's Pond Sediment Grain Size Graphs

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	FP-SED-20-01-MAY20	Test Date:	08/28/20	Checked By:	bfs
Depth :	---	Test Id:	572438		
Test Comment:	---				
Visual Description:	Moist, dark brown silty sand				
Sample Comment:	Sample contains organics				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.5	72.7	25.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	99		
#10	2.00	97		
#20	0.85	91		
#40	0.42	70		
#60	0.25	47		
#100	0.15	35		
#140	0.11	31		
#200	0.075	26		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0325	15		
---	0.0218	13		
---	0.0123	10		
---	0.0089	6		
---	0.0065	5		
---	0.0047	4		
---	0.0033	3		
---	0.0015	1		

Coefficients

D_{85} = 0.6983 mm	D_{30} = 0.0980 mm
D_{60} = 0.3367 mm	D_{15} = 0.0304 mm
D_{50} = 0.2670 mm	D_{10} = 0.0133 mm
C_u = 25.316	C_c = 2.145

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

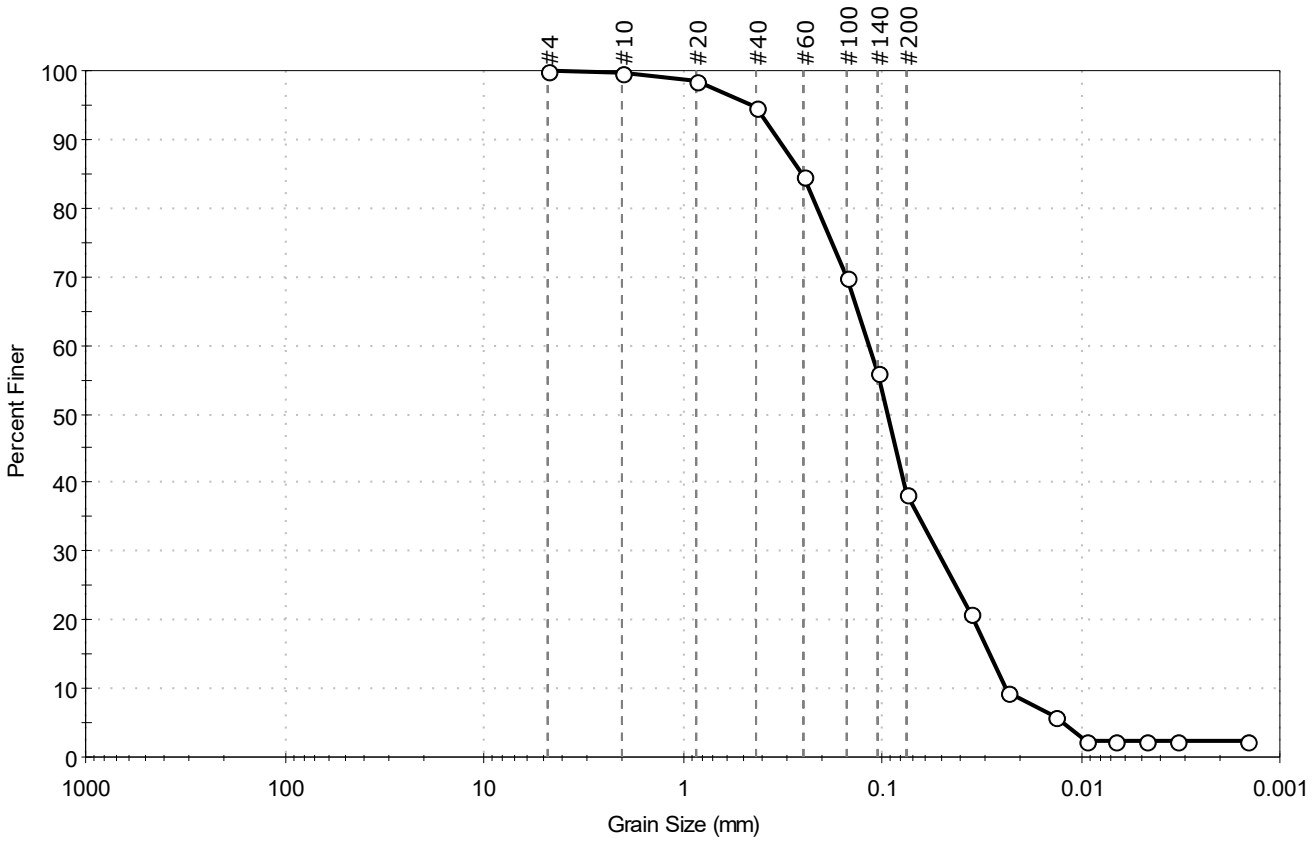
Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

GeoTesting EXPRESS

Client:	KOMAN Government Solutions, LLC				
Project:	PFAS Remedial Investigation				
Location:				Project No:	GTX-310909
Boring ID:	---	Sample Type:	bag	Tested By:	ckg
Sample ID:	FP-SED-20-02-MAY20	Test Date:	08/28/20	Checked By:	bfs
Depth :	---	Test Id:	572437		
Test Comment:	---				
Visual Description:	Moist, brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	61.6	38.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	95		
#60	0.25	85		
#100	0.15	70		
#140	0.11	56		
#200	0.075	38		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0356	21		
---	0.0233	9		
---	0.0134	6		
---	0.0095	2		
---	0.0067	2		
---	0.0048	2		
---	0.0033	2		
---	0.0015	2		

Coefficients

D_{85} = 0.2559 mm	D_{30} = 0.0524 mm
D_{60} = 0.1171 mm	D_{15} = 0.0286 mm
D_{50} = 0.0942 mm	D_{10} = 0.0237 mm
C_u = 4.941	C_c = 0.989

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #200 Sieve

APPENDIX H ANALYTICAL RESULTS

H-1

PFAS in Groundwater at Existing Monitoring Wells

AOC 20

Existing Monitoring Well Results

PFAS in Groundwater at Monitoring Well Locations
AOC 20

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
MW-01A	18	33	218.71	193.21	6/15/2017	N	143	205	209	33	110		43	13	6.2					3.9					
	18	33	218.71	193.21	4/30/2019	N	18.3	37.7	46.3	3.3	15	< 1.9	5.4	14	< 1.9	< 39	< 19	< 19	< 19	< 1.9	< 1.9	8.6	< 3.9	< 3.9	< 1.9
MW-02A	18	33	223.65	198.15	6/2/2017	N	103	180	193	68	35		8.8	60	8.4					13					
	18	33	223.65	198.15	4/30/2019	N	250	649	897	110	140	1.1	30	360	7.6	< 38	< 19	< 19	< 19	48	< 1.9	200	< 3.8	< 3.8	< 1.9
MW-04	7	22	214.72	200.22	6/2/2017	N	157	214	229	75	82		22	26	8.6					15					
	7	22	214.72	200.22	4/30/2019	N	168	218	250	130	38	3.7	20	15	11	< 38	< 19	< 19	< 19	6.6	< 1.9	26	< 3.8	< 3.8	< 1.9
MW-06	14	29	231.71	210.21	5/6/2019	N	0	0	0	< 3.8	< 1.9	< 1.9	< 1.9	< 1.9	< 1.9	< 38	< 19	< 19	< 19	< 1.9	< 1.9	< 1.9	< 3.8	< 3.8	< 1.9
MW-07	20.5	35.5	241.20	213.20	4/30/2019	N	0	0	0	< 3.7	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 37	< 18	< 18	< 18	< 1.8	< 1.8	< 1.8	< 3.7	< 3.7	< 1.8
	20.5	35.5	241.20	213.20	4/30/2019	FD	0	0	0	< 3.7	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 37	< 18	< 18	< 18	< 1.8	< 1.8	< 1.8	< 3.7	< 3.7	< 1.8
MW-WC1A	6.45	17.95	209.69	197.49	5/6/2019	N	11.5	15.7	18.3	4.9	6.6	< 2	1.7	2.5	< 2	< 39	< 20	< 20	< 20	0.79	< 2	1.8	< 3.9	< 3.9	< 2
MW-WC2	5.4	19.9	210.40	197.75	5/6/2019	N	38.0	51.7	78.2	< 3.9	38	< 2	12	1.7	< 2	< 39	< 20	< 20	< 20	0.5	< 2	26	< 3.9	< 3.9	< 2
PZ-1	70	75	272.10	199.60	5/7/2019	N	244	317	354	150	94	5.9	23	26	18	< 38	< 19	< 19	< 19	9.7	< 1.9	27	< 3.8	< 3.8	< 1.9
PZ-2	95	100	272.10	174.60	5/7/2019	N	173	212	255	130	43	3.6	18	12	5.1	< 38	< 19	< 19	< 19	11	< 1.9	32	< 3.8	< 3.8	< 1.9
PZ-5	25	30	224.30	196.80	4/30/2019	N	142	194	245	95	47	3	25	18	5.7	< 37	< 19	< 19	< 19	9.5	< 1.9	42	< 3.7	< 3.7	< 1.9
PZ-6	15	20	218.90	201.40	4/30/2019	N	38.0	48.9	55.3	28	10	0.74	5.3	3.1	1.8	< 37	< 18	< 18	< 18	< 1.8	< 1.8	6.4	< 3.7	< 3.7	< 1.8

Notes:
Results shown are displayed as parts per trillion (ppt).
bgs = below ground surface.
ft = feet.
EPA = U.S. Environmental Protection Agency.
LHA = Lifetime Health Advisory.
MassDEP = Massachusetts Department of Environmental Protection.
MassDEP GW-1 denotes sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).
NAVD88 = North American Vertical Datum 1988.
Result exceeds the EPA LHA (70 ppt) for either PFOA, PFOS, and/or the sum of PFOA+PFOS).
Result exceeds the MassDEP GW-1 (20 ppt) sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).

AOC 50

Existing Monitoring Well Results

PFAS in Groundwater at Monitoring Well Locations
AOC 50

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
G6M-01-01X	130	150	263.62	123.62	5/1/2019	N	64.0	129	141	50	14	< 1.9	2.4	63	< 1.9	< 39	< 19	< 19	< 19	3	< 1.9	8.4	< 3.9	< 3.9	< 1.9
G6M-02-01X	80	95	263.12	175.62	4/26/2019	N	427	841	923	330	97	< 1.9	13	400	1	< 38	< 19	< 19	< 19	23	< 1.9	58	< 3.8	1.2	< 1.9
	80	95	263.12	175.62	10/16/2019	N	450	865	949	330	120	< 1.8	14	400	0.95	< 36	< 18	< 18	< 18	23	< 1.8	61	< 3.6	< 3.6	< 1.8
	80	95	263.12	175.62	5/7/2020	N	430	845	924	330	100	< 1.8	14	400	0.96	< 36	< 18	< 18	< 18	24	< 1.8	55	< 3.6	< 3.6	< 1.8
G6M-02-06X	55	65	204.72	144.72	5/6/2019	N	70.0	155	166	52	18	< 1.9	3.7	81	0.55	< 39	< 19	< 19	< 19	2.3	< 1.9	8.9	< 3.9	< 3.9	< 1.9
G6M-02-07X	30	40	207.74	172.74	4/29/2019	N	64.0	137	153	40	24	1.7	7.1	61	3.3	< 38	< 19	< 19	< 19	4.3	< 1.9	12	< 3.8	< 3.8	< 1.9
G6M-02-08X	60	70	222.72	157.72	5/2/2019	N	50.0	166	184	26	24	< 2	5	110	0.96	< 40	< 20	< 20	< 20	3.7	< 2	14	< 4	< 4	< 2
G6M-02-09X	90	105	262.66	165.16	5/2/2019	N	3.90	34.9	36.2	1	2.9	< 1.7	< 1.7	31	< 1.7	< 34	< 17	< 17	< 17	1.3	< 1.7	< 1.7	< 3.4	< 3.4	< 1.7
G6M-02-13X	110	120	263.81	148.81	5/2/2019	N	54.0	120	132	42	12	< 1.8	2.4	64	< 1.8	< 37	< 18	< 18	< 18	2.8	< 1.8	8.4	< 3.7	< 3.7	< 1.8
G6M-03-11X	115	130	263.91	141.41	5/1/2019	N	38.0	94.0	101	28	10	< 1.9	2	54	< 1.9	< 38	< 19	< 19	< 19	< 1.9	< 1.9	6.9	< 3.8	< 3.8	< 1.9
	115	130	263.91	141.41	5/1/2019	FD	33.0	91.3	97.8	23	10	< 1.9	2.3	56	< 1.9	< 38	< 19	< 19	< 19	< 2	< 1.9	6.5	< 3.8	< 3.8	< 1.9
G6M-04-03X	85	95	264.78	174.78	4/26/2019	N	74.0	148	162	57	17	< 1.9	3.6	70	0.89	< 37	< 19	< 19	< 19	3	< 1.9	11	< 3.7	< 3.7	< 1.9
G6M-04-06X	95	105	262.2	162.2	5/1/2019	N	24.3	98.3	114	4.3	20	< 1.9	3	71	< 1.9	< 37	< 19	< 19	< 19	3.3	< 1.9	12	< 3.7	< 3.7	< 1.9
G6M-04-08X	80	90	203.2	118.2	4/30/2019	N	125	165	194	93	32	3.2	16	14	6.9	< 37	< 18	2.6	< 18	5.3	< 1.8	21	< 3.7	< 3.7	< 1.8
G6M-04-10X	52	62	222.46	165.46	4/29/2019	N	246	423	455	210	36	1.9	9.2	160	5.4	< 38	< 19	< 19	< 19	6	1	23	< 3.8	0.8	1.5
	52	62	222.46	165.46	4/29/2019	FD	235	399	428	200	35	0.82	9.1	150	4.2	< 39	< 20	< 20	< 20	6.2	< 2	23	< 3.9	< 3.9	< 2
G6M-04-11X	35	45	228.27	188.27	4/25/2019	N	94.0	182	194	78	16	< 1.9	3.2	83	1.4	< 38	< 19	< 19	< 19	2.4	< 1.9	10	< 3.8	< 3.8	< 1.9
G6M-04-13X	30	40	224.17	189.17	5/8/2019	N	1.00	10.8	10.8	< 3.8	1	< 1.9	< 1.9	9.8	< 1.9	< 38	< 19	< 19	< 19	< 1.9	< 1.9	< 1.9	< 3.8	< 3.8	< 1.9
G6M-04-14X	80	90	208.51	123.51	4/30/2019	N	96.0	222	263	57	39	1.9	10	110	3.9	< 37	< 19	< 19	< 19	5.7	11	17	1.3	4.9	1.6
G6M-13-02X	115	125	264.03	144.03	5/2/2019	N	410	846	929	300	110	< 1.8	15	420	1.4	< 36	< 18	< 18	< 18	20	< 1.8	63	< 3.6	< 3.6	< 1.8
G6M-13-03X	80	90	264.78	179.78	5/3/2019	N	349	722	774	280	69	< 1.7	11	360	1.5	< 34	< 17	< 17	< 17	13	< 1.7	39	< 3.4	< 3.4	< 1.7
G6M-13-05X	45	55	223.86	173.86	4/26/2019	N	570	1,060	1,200	410	160	< 2	24	470	1.1	< 39	< 20	< 20	< 20	44	< 2	93	< 3.9	< 3.9	< 2
	45	55	223.86	173.86	10/10/2019	N	580	1,240	1,380	400	180	< 1.8	27	630	0.98	< 37	< 18	< 18	< 18	52	< 1.8	94	< 3.7	< 3.7	< 1.8
	45	55	223.86	173.86	5/7/2020	N	510	1,190	1,340	310	200	< 1.9	27	650	1	< 38	< 19	< 19	< 19	53	< 1.9	100	< 3.8	< 3.8	< 1.9
G6M-18-01	116	126	264.58	143.58	10/14/2019	N	5,200	10,580	13,500	1200	4000	< 1.9	170	5200	7.9	9.8	8.2	< 19	< 19	160	< 1.9	2700	< 3.8	< 3.8	< 1.9
	116	126	264.58	143.58	5/7/2020	N	5,100	10,900	13,600	1500	3600	< 1.7	160	5600	8.7	18	7.1	< 17	< 17	110	< 1.7	2600	< 3.4	< 3.4	< 1.7
G6M-92-10X	9	19	222.4	208.4	4/26/2019	N	40.4	196	212	5.4	35	< 1.9	5.5	150	< 1.9	< 38	< 19	< 19	< 19	2.6	< 1.9	13	< 3.8	< 3.8	< 1.9
G6M-93-13X	9	19	222.9	208.9	4/29/2019	N	13.2	27.4	30.9	7.7	5.5	< 1.9	5.4	8	0.81	< 39	< 19	< 19	< 19	< 1.9	< 1.9	3.5	< 3.9	< 3.9	< 1.9
G6M-95-20X	18	23	222.51	202.01	4/26/2019	N	27.0	58.5	65.2	14	13	< 1.9	5.2	25	1.3	< 39	< 19	< 19	< 19	< 1.9	< 1.9	6.7	< 3.9	< 3.9	< 1.9
G6M-96-22A	40	50	216.3	171.3	5/6/2019	N	178	315	338	150	28	< 1.9	5.3	130	1.8	< 38	< 19	< 19	< 19	5.2	< 1.9	18	< 3.8	< 3.8	< 1.9
G6M-96-22B	65.5	70.5	216.4	148.4	5/6/2019	N	173	298	319	150	23	< 2	4.3	120	1.1	< 39	< 20	< 20	< 20	5.1	< 2	15	< 3.9	< 3.9	< 2
G6M-96-25A	9	18.7	223.28	209.43	4/25/2019	N	25.7	50.7	71.5	16	9.7	< 1.9	5.8	18	1.2	< 38	< 19	< 19	< 19	1.8	< 1.9	19	< 3.8	< 3.8	< 1.9
	9	18.7	223.28	209.43	4/25/2019	FD	27.0	51.1	73.8	16	11	< 1.8	5.8	17	1.3	< 36	< 18	< 18	< 18	1.7	< 1.8	21	< 3.6	< 3.6	< 1.8
G6M-96-25B	48	58	223.89	170.89	5/2/2019	N	107	163	176	100	7.2	< 1.9	3.1	53	< 1.9	< 38	< 19	< 19	< 19	2.4	< 1.9	10	< 3.8	< 3.8	< 1.9
G6M-96-26A	8	18	222.83	209.83	5/3/2019	N	11.0	33.1	42.6	< 3.8	11	0.94	3.1	17	1.1	< 38	< 19	< 19	< 19	2.3	< 1.9	6.4	< 3.8	< 3.8	0.78
G6M-96-26B	68	78	222.89	149.89	4/25/2019	N	0.0	2.70	2.70	< 3.9	< 2	< 2	< 2	2.7	< 2	< 39	< 20	< 20	< 20	< 2	< 2	< 2	< 3.9	< 3.9	< 2
G6M-97-09B	71.5	81.5	257.3	180.8	5/3/2019	N	5.97	24.7	35.1	0.97	5	0.45	6.8	8.9	2.6	< 35	< 18	< 18	< 18	1.8	0.6	7.3	< 3.5	< 3.5	0.66
G6P-97-05X	33	43	234.59	196.59	5/8/2019	N	1,140	3,900	4,890	520	620	< 1.9	160	2600	2.2	7.7	< 19	< 19	< 19	51	< 1.9	930	< 3.9	< 3.9	< 1.9
	33	43	234.59	196.59	10/15/2019	N	860	1,860	2,060	570	290	1.2	30	970	2.6	< 38	< 19	3	< 19	31	< 1.9	160	< 3.8	< 3.8	< 1.9
	33	43	234.59	196.59	10/15/2019	FD	860	1,790	1,980	570	290	0.93	29	900	2.6	< 37	< 18	2.6	< 18	32	< 1.8	150	< 3.7	< 3.7	< 1.8
	33	43	234.59	196.59	5/7/2020	N	1,540	2,270	2,410	1300	240	0.87	26	700	4.3	< 39	< 19	< 19	< 19	22	< 1.9	120	< 3.9	< 3.9	< 1.9
	33	43	234.59	196.59	5/7/2020	FD	1,540	2,270	2,410	1300	240	0.78	25	700	4.3	< 38	< 19	< 19	< 19	22	< 1.9	120	< 3.8	< 3.8	< 1.9
MW-6	125	135	263.59	133.59	5/8/2019	N	176	352	387	140	36	< 2	5.9	170	0.51	< 39	< 20	< 20	< 20	9.3	< 2	25	< 3.9	< 3.9	< 2
MW-7 (IT)	22	32	238.2*	211.2*	10/18/2019	N	1,350	2,710	3,010	1000	350	0.79	54	1300	3.9	13	< 20	< 20	< 20	34	< 2	250	< 3.9	< 3.9	< 2
XSA-12-96X	120	130	266.56	141.56	5/7/2019	N	182	477	547	97	85	< 1.9	14	280	0.6	< 38	< 19	< 19	< 19	17	< 1.9	53	< 3.8	< 3.8	< 1.9
	120	130	266.56	141.56	11/6/2019	N	188	451	512	110	78	< 1.9	12	250	0.68	< 38	< 19	< 19	< 19	16	< 1.9	45	< 3.8	< 3.8	< 1.9
	120	130	266.56	141.56	5/8/2020	N	199	493	559	120	79	< 1.9	13	280	0.63	< 38	< 19	< 19	< 19	17	< 1.9	49	< 3.8	< 3.8	< 1.9
XSA-12-98X	60	70	204.14	139.14	4/29/2019	N	78.0	166	190	41	37	1.2	7.3	77	2.2	< 39	< 19	< 19	< 19	4.9	< 1.9	19	< 3.9	< 3.9	< 1.9
	60	70	204.14	139.14	10/9/2019	N	41.0	110	123	20	21	< 1.9	3.7	65	< 1.9	< 39	< 19	< 19	< 19	3.4	< 1.9	10	< 3.9	< 3.9	< 1.9
	60	70	204.14	139.14	5/7/2020	N	80.0	142	164	52	28	1.4	10	47	3.3	< 36	< 18	< 18	< 18	5	< 1.8	17	< 3.6	< 3.6	< 1.8

Notes:
* Ground surface and mid-point elevation for MW-7 (IT) are estimated.
Results shown are displayed as parts per trillion (ppt).
bgs = below ground surface.
ft = feet.
EPA = U.S. Environmental Protection Agency.
LHA = Lifetime Health Advisory.
MassDEP = Massachusetts Department of Environmental Protection.
MassDEP GW-1 denotes sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).
NAVD88 = North American Vertical Datum 1988.
Result exceeds the EPA LHA (70 ppt) for either PFOA, PFOS, and/or the sum of PFOA+PFOS).
Result exceeds the MassDEP GW-1 (20 ppt) sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).

H-2

PFAS in Groundwater at Vertical Profile Locations

AOCs 20 and 21

Vertical Profile Results

PFAS in Groundwater at Vertical Profile Locations
AOC 20/21

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
20VP-19-01	17	21	218.82	199.82	7/30/2019	N	23.5	27.7	30.4	19	4.5	0.89	2	< 1.9	1.3	< 39	< 19	< 19	< 19	0.51	< 1.9	2.2	< 3.9	< 3.9	< 1.9
20VP-19-02	9	13	208.25	197.25	9/3/2019	N	73.0	95.3	119	62	11	6.5	7.9	3.9	4	< 39	< 19	< 19	< 19	0.79	< 1.9	23	< 3.9	< 3.9	< 1.9
	19	23	208.25	187.25	9/4/2019	N	57.4	69.6	75.8	49	8.4	1.2	4.9	4.1	2	< 38	< 19	< 19	< 19	1.3	< 1.9	4.9	< 3.8	< 3.8	< 1.9
	19	23	208.25	187.25	9/4/2019	FD	56.3	68.2	74.2	48	8.3	1.2	4.7	4.1	1.9	< 39	< 20	< 20	< 20	1.3	< 2	4.7	< 3.9	< 3.9	< 2
	29	33	208.25	177.25	9/4/2019	N	65.0	84.4	99.5	50	15	2.1	8.7	5.5	3.1	< 39	< 19	< 19	< 19	2.1	< 1.9	13	< 3.9	< 3.9	< 1.9
20VP-19-03	9	13	209.23	198.23	7/31/2019	N	31.4	41.9	51.2	9.4	22	< 1.9	5.6	4.9	< 1.9	< 38	< 19	< 19	< 19	2	< 1.9	7.3	< 3.8	< 3.8	< 1.9
	19	23	209.23	188.23	7/31/2019	N	17.5	23.4	33.9	2.5	15	< 1.9	3.6	2.3	< 1.9	< 39	< 19	< 19	< 19	1.3	< 1.9	9.2	< 3.9	< 3.9	< 1.9
	29	33	209.23	178.23	7/31/2019	N	58.3	78.2	120	6.3	52	< 1.9	17	2.9	< 1.9	< 38	< 19	< 19	< 19	0.69	< 1.9	41	< 3.8	< 3.8	< 1.9
	39	43	209.23	168.23	7/31/2019	N	81.0	117	162	13	68	< 1.9	22	13	0.64	< 39	< 19	< 19	< 19	2.2	< 1.9	43	< 3.9	< 3.9	< 1.9
	49	53	209.23	158.23	8/1/2019	N	74.4	99.8	144	7.4	67	< 1.9	20	4.7	0.67	< 38	< 19	< 19	< 19	0.82	< 1.9	43	< 3.8	< 3.8	< 1.9
	54	58	209.23	153.23	8/1/2019	N	110	161	204	44	66	1.2	20	26	4.1	< 39	< 19	< 19	< 19	3.9	< 1.9	39	< 3.9	< 3.9	< 1.9
20VP-19-04	19	23	225.1	204.1	7/22/2019	N	197	264	297	140	57	5.8	14	42	5.6	< 36	< 18	< 18	< 18	8.3	< 1.8	24	< 3.6	< 3.6	< 1.8
	29	33	225.1	194.1	7/22/2019	N	180	248	290	110	70	4.9	17	40	6.1	< 37	< 18	< 18	< 18	8.5	< 1.8	33	< 3.7	< 3.7	< 1.8
	39	43	225.1	184.1	7/23/2019	N	154	229	274	89	65	5.8	20	43	6	< 37	< 19	< 19	< 19	8.3	< 1.9	37	< 3.7	< 3.7	< 1.9
	49	53	225.1	174.1	7/23/2019	N	142	204	238	81	61	3.3	19	34	5.5	< 37	< 19	< 19	< 19	5.5	< 1.9	29	< 3.7	< 3.7	< 1.9
20VP-19-05	18	22	220.17	200.17	7/22/2019	N	19.3	28.5	35.2	8.3	11	1.7	5.9	< 1.9	1.6	< 37	< 19	< 19	< 19	< 1.9	< 1.9	6.7	< 3.7	< 3.7	< 1.9
20VP-19-06	63	67	270.07	205.07	8/2/2019	N	88.0	118	162	47	41	3.3	11	12	3.8	< 41	< 21	< 21	< 21	8.9	< 2.1	35	< 4.1	< 4.1	< 2.1
	73	77	270.07	195.07	8/2/2019	N	61.0	85.0	114	41	20	2.4	7.6	10	4	< 39	< 19	< 19	< 19	6.6	< 1.9	22	< 3.9	< 3.9	< 1.9
	83	87	270.07	185.07	8/5/2019	N	76.0	115	158	51	25	5.9	16	14	3	< 39	< 20	< 20	< 20	8.5	< 2	33	< 3.9	< 3.9	1.6
	93	97	270.07	175.07	8/5/2019	N	90.0	126	162	65	25	4.9	15	10	6	< 38	< 19	< 19	< 19	4.2	< 1.9	31	< 3.8	< 3.8	1.3
	103	107	270.07	165.07	8/5/2019	N	90.0	125	162	60	30	4.3	13	12	6	< 37	< 19	< 19	< 19	8.2	< 1.9	28	< 3.7	< 3.7	0.69
	113	117	270.07	155.07	8/6/2019	N	95.0	128	168	66	29	4	12	11	6.4	< 37	< 19	3.7	< 19	5.3	< 1.9	30	< 3.7	< 3.7	0.87
	123	127	270.07	145.07	8/6/2019	N	59.0	88.2	124	38	21	3.7	12	9.7	3.8	< 37	< 19	< 19	< 19	8.2	< 1.9	28	< 3.7	< 3.7	< 1.9
	133	137	270.07	135.07	8/6/2019	N	67.0	94.0	131	40	27	2.4	12	10	2.6	< 37	< 19	2.8	< 19	7.1	< 1.9	27	< 3.7	< 3.7	< 1.9
	143	147	270.07	125.07	8/7/2019	N	113	154	192	83	30	3.3	20	13	4.4	< 37	< 18	< 18	< 18	7.8	< 1.8	30	< 3.7	< 3.7	< 1.8
	152	156	270.07	116.07	8/8/2019	N	107	143	180	75	32	4.1	13	13	5.7	< 42	< 21	3.6	< 21	5.4	< 2.1	27	< 4.2	< 4.2	1.5
20VP-19-07	63	67	271.02	206.02	7/25/2019	N	93.0	119	163	70	23	0.83	11	9.2	4.6	< 38	< 19	< 19	< 19	9.5	< 1.9	35	< 3.8	< 3.8	< 1.9
	73	77	271.02	196.02	7/26/2019	N	112	158	201	72	40	5	24	14	2.6	< 37	< 19	< 19	< 19	5.9	1.9	35	< 3.7	0.85	< 1.9
	83	87	271.02	186.02	7/26/2019	N	173	220	252	130	43	6	14	11	16	< 38	< 19	< 19	< 19	7.8	< 1.9	24	< 3.8	< 3.8	< 1.9
	93	97	271.02	176.02	7/29/2019	N	201	259	307	160	41	5.2	30	15	8.2	< 40	< 20	< 20	< 20	10	< 2	38	< 4	< 4	< 2
	103	107	271.02	166.02	7/29/2019	N	146	195	228	110	36	4.2	22	15	7.4	< 52	< 26	< 26	< 26	6.7	< 2.6	27	< 5.2	< 5.2	< 2.6
	113	117	271.02	156.02	7/30/2019	N	141	180	220	110	31	5.1	18	11	4.8	< 38	< 19	< 19	< 19	8	< 1.9	32	< 3.8	< 3.8	< 1.9
	123	127	271.02	146.02	7/30/2019	N	149	187	238	120	29	5.7	16	11	5.1	< 57	< 28	< 28	< 28	9	4.1	35	< 5.7	2.3	1.2
	123	127	271.02	146.02	7/30/2019	FD	138	179	220	110	28	6.2	17	12	5.4	< 60	< 30	< 30	< 30	8.5	< 3	33	< 6	< 6	< 3
	133	137	271.02	136.02	7/31/2019	N	149	187	223	120	29	4.2	17	11	5.5	< 37	< 19	< 19	< 19	7	< 1.9	29	< 3.7	< 3.7	< 1.9
	143	147	271.02	126.02	8/1/2019	N	149	189	224	120	29	3.7	19	12	5.7	< 41	< 21	< 21	< 21	6.5	< 2.1	28	< 4.1	< 4.1	< 2.1
	153	157	271.02	116.02	8/1/2019	N	167	213	255	130	37	5.8	21	14	5.6	< 50	< 25	< 25	< 25	6.5	< 2.5	35	< 5	< 5	< 2.5
21VP-19-01	23	27	222.08	197.08	7/23/2019	N	153	190	231	110	43	4.6	14	12	6.3	< 38	< 19	< 19	< 19	12	< 1.9	29	< 3.8	< 3.8	< 1.9
	33	37	222.08	187.08	7/23/2019	N	256	304	341	160	96	1.9	16	19	11	< 38	< 19	< 19	< 19	12	< 1.9	25	< 3.8	< 3.8	< 1.9
	43	47	222.08	177.08	7/23/2019	N	214	243	284	190	24	4.9	9.5	5.8	8.5	< 37	< 18	< 18	< 18	14	< 1.8	27	< 3.7	< 3.7	< 1.8
	53	57	222.08	167.08	7/23/2019	N	105	139	182	49	56	2.8	13	15	3	< 38	< 19	< 19	< 19	12	< 1.9	31	< 3.8	< 3.8	< 1.9
	53	57	222.08	167.08	7/23/2019	FD	105	139	181	51	54	2.6	13	15	3.2	< 38	< 19	< 19	< 19	12	< 1.9	30	< 3.8	< 3.8	< 1.9
	63	67	222.08	157.08	7/23/2019	N	81.0	114	146	54	27	2.4	15	12	3.3	< 38	< 19	< 19	< 19	8	< 1.9	24	< 3.8	< 3.8	< 1.9
	73	77	222.08	147.08	7/23/2019	N	96.0	131	164	64	32	2.2	15	14	3.8	< 39	< 20	< 20	< 20	7.1	< 2	26	< 3.9	< 3.9	< 2
	83	87	222.08	137.08	7/24/2019	N	109	150	187	75	34	3.6	17	16	4.6	< 38	< 19	< 19	< 19	7.3	< 1.9	29	< 3.8	< 3.8	< 1.9
	91	95	222.08	129.08	7/24/2019	N	116	161	193	80	36	3.3	17	20	4.2	< 36	< 18	< 18	< 18	6	< 1.8	26	< 3.6	< 3.6	< 1.8
21VP-19-02	13	17	211.99	196.99	7/24/2019	N	54.0	61.4	65.6	38	16	< 1.8	3.3	4.1	< 1.8	< 36	< 18	< 18	< 18	2	< 1.8	2.2	< 3.6	< 3.6	< 1.8
	23	27	211.99	186.99	7/24/2019	N	161	202	227	120	41	1.7	13	18	8	< 37	< 18	< 18	< 18	7.3	< 1.8	18	< 3.7	< 3.7	< 1.8
	33	37	211.99	176.99	7/24/2019	N	100	137	163	73	27	3.1	13	15	5.4	< 37	< 18	< 18	< 18	5.2	< 1.8	21	< 3.7	< 3.7	< 1.8
	43	47	211.99	166.99	7/25/2019	N	101	136	162	72	29	3.3	12	15	4.7	< 37	< 19	< 19	< 19	4.8	< 1.9	21	< 3.7	< 3.7	< 1.9
	53	57	211.99	156.99	7/25/2019	N	111	153	181	79	32	3.2	15	18	5.5	< 37	< 19	< 19	< 19	6.5	< 1.9	22	< 3.7	< 3.7	< 1.9
	63	67	211.99	146.99	7/25/2019	N	120	164	193	86	34	3.5	15	19	6	< 38	< 19	< 19	< 19	6.2	< 1.9	23	< 3.8	< 3.8	< 1.9
	63	67	211.99	146.99	7/25/2019	FD	119	162	192	82	37	3.1	14	20	6	< 42	< 21	< 21	< 21	5.9	< 2.1	24	< 4.2	< 4.2	< 2.1
	73	77	211.99	136.99	7/25/2019	N	127	174	203	86	41	3.4	15	22	6.1	< 38	< 19	< 19	< 19	6.7	< 1.9	23	< 3.8	< 3.8	< 1.9
	83	87	211.99	126.99	7/26/2019	N	113	155	183	77	36	2.8	14	20	5.2	< 37	< 19	< 19	< 19	6.4	< 1.9	22	< 3.7	< 3.7	< 1.9
	93	97	211.99	116.99	7/26/2019	N	128	172	201	90	38	3.1	15	20	5.8	< 37	< 19	< 19	< 19	6.2	< 1.9	23	< 3.7	< 3.7	< 1.9

PFAS in Groundwater at Vertical Profile Locations
AOC 20/21

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
21VP-19-02	103	107	211.99	106.99	7/26/2019	N	114	160	189	76	38	2.7	15	22	5.8	< 37	< 19	< 19	< 19	5.7	< 1.9	24	< 3.7	< 3.7	< 1.9
	113	117	211.99	96.99	7/29/2019	N	149	200	231	100	49	4.4	16	22	9	< 42	< 21	< 21	< 21	6.7	< 2.1	24	< 4.2	< 4.2	< 2.1
	123	127	211.99	86.99	7/29/2019	N	159	214	246	100	59	3.4	16	27	8.2	< 38	< 19	3.2	< 19	6.5	< 1.9	23	< 3.8	< 3.8	< 1.9

Notes:
Results shown are displayed as parts per trillion (ppt).
bgs = below ground surface.
ft = feet.
EPA = U.S. Environmental Protection Agency.
LHA = Lifetime Health Advisory.
MassDEP = Massachusetts Department of Environmental Protection.
MassDEP GW-1 denotes sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).
NAVD88 = North American Vertical Datum 1988.
Result exceeds the EPA LHA (70 ppt) for either PFOA, PFOS, and/or the sum of PFOA+PFOS).
Result exceeds the MassDEP GW-1 (20 ppt) sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).

AOC 30

Vertical Profile Results

PFAS in Groundwater at Vertical Profile Locations
AOC 30

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
30VP-19-01	18	22	221.30	201.30	7/17/2019	N	14.2	29.4	33.2	11	3.2	< 1.9	1.2	14	< 1.9	< 37	< 19	< 19	< 19	0.76	< 1.9	3	< 3.7	< 3.7	< 1.9
	28	32	221.30	191.30	7/17/2019	N	127	215	227	110	17	< 1.9	6.5	80	1.2	< 38	< 19	< 19	< 19	2.4	< 1.9	9.9	< 3.8	< 3.8	< 1.9
30VP-19-02	18	22	221.88	201.88	7/18/2019	N	1.90	11.9	17.5	< 3.8	1.9	< 1.9	0.58	9.4	< 1.9	< 38	< 19	< 19	< 19	0.6	< 1.9	5	< 3.8	< 3.8	< 1.9
	28	32	221.88	191.88	7/19/2019	N	0.00	5.60	6.05	< 3.7	< 1.8	< 1.8	< 1.8	5.6	< 1.8	< 37	< 18	< 18	< 18	0.45	< 1.8	< 1.8	< 3.7	< 3.7	< 1.8
	28	32	221.88	191.88	7/19/2019	FD	0.00	5.60	6.08	< 3.9	< 2	< 2	< 2	5.6	< 2	< 39	< 20	< 20	< 20	0.48	< 2	< 2	< 3.9	< 3.9	< 2
	38	42	221.88	181.88	7/19/2019	N	66.0	110	118	56	10	< 1.8	3.9	40	< 1.8	< 37	< 18	< 18	< 18	1.8	< 1.8	5.8	< 3.7	< 3.7	< 1.8
30VP-19-03	73	77	268.04	193.04	7/8/2019	N	3,530	6,330	7,880	32	3500	< 2.1	300	2500	< 2.1	< 42	< 21	< 21	< 21	49	< 2.1	1500	< 4.2	< 4.2	< 2.1
	83	87	268.04	183.04	7/8/2019	N	58.0	251	274	44	14	< 2	11	180	1.7	< 40	< 20	< 20	< 20	2.7	< 2	21	< 4	< 4	< 2
	93	97	268.04	173.04	7/10/2019	N	194	683	769	120	74	< 1.9	17	470	1.7	< 38	< 19	< 19	< 19	8.8	< 1.9	77	< 3.8	< 3.8	< 1.9
	103	107	268.04	163.04	7/11/2019	N	347	594	621	300	47	< 1.8	22	220	4.6	< 36	< 18	< 18	< 18	3.8	< 1.8	24	< 3.6	< 3.6	< 1.8
	113	117	268.04	153.04	7/11/2019	N	232	465	490	180	52	< 1.9	20	210	2.7	< 38	< 19	< 19	< 19	3.3	< 1.9	22	< 3.8	< 3.8	< 1.9
30VP-19-04	73	77	266.90	191.90	7/9/2019	N	1.40	21.5	36.6	< 3.7	1.4	< 1.9	5.1	15	< 1.9	< 37	< 19	< 19	< 19	1.1	< 1.9	14	< 3.7	< 3.7	< 1.9
	73	77	266.90	191.90	7/9/2019	FD	1.40	21.5	36.7	< 3.9	1.4	< 1.9	5.1	15	< 1.9	< 39	< 19	< 19	< 19	1.2	< 1.9	14	< 3.9	< 3.9	< 1.9
	83	87	266.90	181.90	7/9/2019	N	0.730	22.4	29.2	< 4.2	0.73	< 2.1	1.7	20	< 2.1	< 42	< 21	< 21	< 21	0.72	< 2.1	6	< 4.2	< 4.2	< 2.1
	93	97	266.90	171.90	7/9/2019	N	0.00	0.00	5.20	< 8	< 4	< 4	< 4	< 5.7	< 4	< 80	< 40	< 40	< 40	< 4	< 4	5.2	< 8	< 8	< 4
	103	107	266.90	161.90	7/10/2019	N	0.00	28.6	58.5	< 3.8	< 1.9	< 1.9	9.6	19	< 1.9	< 38	< 19	< 19	< 19	1.9	< 1.9	28	< 3.8	< 3.8	< 1.9
	113	117	266.90	151.90	7/10/2019	N	39.0	210	383	16	23	< 2.1	11	160	< 2.1	< 42	< 21	< 21	< 21	23	< 2.1	150	< 4.2	< 4.2	< 2.1
	123	127	266.90	141.90	7/11/2019	N	250	515	596	130	120	< 2	23	240	1.9	< 41	< 20	< 20	< 20	9.5	< 2	72	< 4.1	< 4.1	< 2
	131	135	266.90	133.90	7/11/2019	N	370	645	740	200	170	< 2	23	250	2.2	< 40	< 20	< 20	< 20	11	< 2	84	< 4	< 4	< 2
30VP-19-05	20	24	224.10	202.10	7/16/2019	N	53.2	86.5	91.2	51	2.2	1.7	1.3	29	1.3	< 38	< 19	< 19	< 19	1.3	< 1.9	3.4	< 3.8	< 3.8	< 1.9
	30	34	224.10	192.10	7/16/2019	N	68.0	109	124	51	17	0.81	8.1	29	2.6	< 41	< 20	< 20	< 20	1.4	< 2	14	< 4.1	< 4.1	< 2
	40	44	224.10	182.10	7/16/2019	N	84.0	140	150	70	14	0.88	6.4	46	2.3	< 38	< 19	< 19	< 19	1.7	< 1.9	9	< 3.8	< 3.8	< 1.9
	45	49	224.10	177.10	7/16/2019	N	363	495	570	320	43	1.8	17	110	3.5	8.1	29	< 22	< 22	7.4	< 2.2	30	< 4.3	< 4.3	< 2.2
30VP-19-06	73	77	267.20	192.20	7/11/2019	N	980	1,360	1,490	870	110	2.1	63	310	7.7	< 37	56	< 19	< 19	7.1	< 1.9	69	< 3.7	< 3.7	< 1.9
	83	87	267.20	182.20	7/11/2019	N	1,930	2,420	2,600	1800	130	2.3	100	380	9	15	59	< 34	< 34	10	< 3.4	98	< 6.8	< 6.8	< 3.4

Notes:
Results shown are displayed as parts per trillion (ppt).
bgs = below ground surface.
ft = feet.
EPA = U.S. Environmental Protection Agency.
LHA = Lifetime Health Advisory.
MassDEP = Massachusetts Department of Environmental Protection.
MassDEP GW-1 denotes sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).
NAVD88 = North American Vertical Datum 1988.
Result exceeds the EPA LHA (70 ppt) for either PFOA, PFOS, and/or the sum of PFOA+PFOS).
Result exceeds the MassDEP GW-1 (20 ppt) sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).

AOC 31

Vertical Profile Results

PFAS in Groundwater at Vertical Profile Locations
AOC 31

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
31VP-19-01	63	67	267.34	202.34	9/3/2019	N	5,830	6,910	8,310	5100	730	2	77	1000	5.3	780	500	< 19	8.6	9.7	< 1.9	100	< 3.8	< 3.8	< 1.9
	73	77	267.34	192.34	9/3/2019	N	23.3	65.3	72.9	16	7.3	< 1.9	5	37	< 1.9	< 38	< 19	< 19	< 19	0.76	< 1.9	6.8	< 3.8	< 3.8	< 1.9
	83	87	267.34	182.34	9/3/2019	N	43.2	88.8	111	1.2	42	< 1.9	4.6	41	< 1.9	< 38	< 19	< 19	< 19	1.9	< 1.9	20	< 3.8	< 3.8	< 1.9
	93	97	267.34	172.34	9/3/2019	N	1,737	3,670	4,180	37	1700	< 1.9	130	1800	< 1.9	120	< 19	< 19	< 19	36	< 1.9	360	< 3.7	< 3.7	< 1.9
	103	107	267.34	162.34	9/4/2019	N	2,520	4,660	5,440	120	2400	< 1.9	140	2000	< 1.9	160	< 19	< 19	< 19	42	< 1.9	580	< 3.8	< 3.8	< 1.9
	113	117	267.34	152.34	9/4/2019	N	5,700	9,570	11,900	1800	3900	< 1.9	160	3700	6.8	550	5.8	< 19	< 19	73	< 1.9	1700	< 3.7	< 3.7	< 1.9
	123	127	267.34	142.34	9/4/2019	N	5,200	10,200	12,800	1100	4100	< 1.9	160	4800	6	51	16	< 19	< 19	190	< 1.9	2400	< 3.7	< 3.7	< 1.9
	133	137	267.34	132.34	9/5/2019	N	3,760	7,010	8,890	760	3000	< 2	150	3100	3.7	140	20	< 20	< 20	120	< 2	1600	< 4.1	< 4.1	< 2
	143	147	267.34	122.34	9/5/2019	N	400	780	884	280	120	< 1.9	19	360	0.83	< 38	3	< 19	< 19	29	< 1.9	72	< 3.8	< 3.8	< 1.9
	143	147	267.34	122.34	9/5/2019	FD	380	778	878	260	120	< 2.2	17	380	0.76	< 43	< 22	< 22	< 22	29	< 2.2	71	< 4.3	< 4.3	< 2.2
	153	157	267.34	112.34	9/16/2019	N	40.0	125	163	13	27	< 1.9	4.8	80	< 1.9	< 37	< 19	< 19	< 19	9.7	< 1.9	28	< 3.7	< 3.7	< 1.9
	163	167	267.34	102.34	9/17/2019	N	1,033	2,290	2,650	33	1000	< 2.4	54	1200	< 2.4	23	< 24	< 24	< 24	13	< 2.4	330	< 4.7	< 4.7	< 2.4
	173	177	267.34	92.34	9/19/2019	N	3,230	6,150	7,710	730	2500	0.71	120	2800	3.2	31	30	< 20	< 20	95	< 2	1400	< 4	< 4	< 2
	183	187	267.34	82.34	9/19/2019	N	5.50	14.8	19.5	1.7	3.8	< 1.9	0.59	8.7	< 1.9	< 37	< 19	< 19	< 19	0.85	< 1.9	3.2	< 3.7	< 3.7	0.7
	191.5	195.5	267.34	73.84	9/20/2019	N	261	481	616	91	170	0.55	18	200	1.2	10	12	< 19	< 19	3.3	< 1.9	110	< 3.7	< 3.7	< 1.9
31VP-19-04	69	73	266.66	195.66	8/5/2019	N	140	921	1,040	40	100	< 1.8	130	650	0.92	< 37	< 18	< 18	< 18	13	< 1.8	110	< 3.7	< 3.7	< 1.8
	79	83	266.66	185.66	8/5/2019	N	3.00	11.5	15.9	1.2	1.8	< 1.8	2.3	6.2	< 1.8	< 37	< 18	< 18	< 18	0.51	< 1.8	3.9	< 3.7	< 3.7	< 1.8
	89	93	266.66	175.66	8/5/2019	N	4.90	25.9	32.4	< 3.7	4.9	< 1.8	1	20	< 1.8	< 37	< 18	< 18	< 18	0.55	< 1.8	5.9	< 3.7	< 3.7	< 1.8
	99	103	266.66	165.66	8/6/2019	N	570	2,170	2,490	< 3.6	570	< 1.8	97	1500	< 1.8	< 36	< 18	< 18	< 18	13	< 1.8	310	< 3.6	< 3.6	< 1.8
	109	113	266.66	155.66	8/6/2019	N	540	3,380	4,040	< 3.7	540	< 1.8	240	2600	< 1.8	< 37	< 18	< 18	< 18	24	< 1.8	640	< 3.7	< 3.7	< 1.8
	109	113	266.66	155.66	8/6/2019	FD	476	2,890	3,470	16	460	< 1.8	210	2200	< 1.8	< 37	< 18	< 18	< 18	24	< 1.8	560	< 3.7	< 3.7	< 1.8
	119	123	266.66	145.66	8/7/2019	N	386	1,810	2,160	66	320	< 1.8	120	1300	< 1.8	< 37	< 18	< 18	< 18	23	< 1.8	330	< 3.7	< 3.7	< 1.8
	128	132	266.66	136.66	8/8/2019	N	285	1,150	1,410	65	220	< 1.9	93	770	0.7	< 37	< 19	< 19	< 19	19	< 1.9	240	< 3.7	< 3.7	< 1.9
31VP-19-05	4	8	206.26	200.26	9/4/2019	N	4.80	9.44	13.0	2.1	2.7	< 1.9	0.94	3.7	< 1.9	< 38	< 19	< 19	< 19	1.8	< 1.9	1.8	< 3.8	< 3.8	< 1.9
	14	18	206.26	190.26	9/5/2019	N	3.10	7.10	7.10	3.1	< 2	< 2	< 2	4	< 2	< 39	< 20	< 20	< 20	< 2	< 2	< 2	< 3.9	< 3.9	< 2
	24	28	206.26	180.26	9/5/2019	N	2.70	2.70	2.70	2.7	< 2	< 2	< 2	< 2	< 2	< 39	< 20	< 20	< 20	< 2	< 2	< 2	< 3.9	< 3.9	< 2
	33.5	37.5	206.26	170.76	9/5/2019	N	4.10	4.10	4.60	2.9	1.2	< 2	< 2	< 2	< 2	< 39	< 20	< 20	< 20	< 2	< 2	0.5	< 3.9	< 3.9	< 2
31VP-19-06	13	17	209.2	194.2	9/24/2019	N	830	1,470	1,790	290	540	< 1.8	39	600	0.66	44	7.9	< 18	< 18	19	< 1.8	250	< 3.7	< 3.7	< 1.8
	13	17	209.2	194.2	9/24/2019	FD	870	1,500	1,820	310	560	< 1.8	38	590	0.75	45	7.6	< 18	< 18	20	< 1.8	250	< 3.6	< 3.6	< 1.8
	23	27	209.2	184.2	9/24/2019	N	1,210	2,240	2,840	110	1100	< 1.8	68	960	< 1.8	38	< 18	< 18	< 18	37	< 1.8	530	< 3.7	< 3.7	< 1.8
	33	37	209.2	174.2	9/24/2019	N	1,047	1,950	2,500	97	950	< 1.9	58	840	< 1.9	32	< 19	< 19	< 19	36	< 1.9	490	< 3.7	< 3.7	< 1.9
	43	47	209.2	164.2	9/24/2019	N	114	204	242	38	76	< 1.8	5.4	85	< 1.8	< 36	< 18	< 18	< 18	2.7	< 1.8	35	< 3.6	< 3.6	< 1.8
	53	57	209.2	154.2	9/25/2019	N	23.5	37.5	40.1	18	5.5	< 1.8	< 1.8	14	< 1.8	< 37	< 18	< 18	< 18	< 1.8	< 1.8	2.6	< 3.7	< 3.7	< 1.8
	63	67	209.2	144.2	9/25/2019	N	174	335	425	34	140	< 1.9	11	150	< 1.9	< 37	< 19	< 19	< 19	6.7	< 1.9	83	< 3.7	< 3.7	< 1.9
	73	77	209.2	134.2	9/25/2019	N	117	224	275	36	81	< 1.8	6.5	100	< 1.8	< 37	< 18	< 18	< 18	3.6	< 1.8	48	< 3.7	< 3.7	< 1.8
	83	87	209.2	124.2	9/26/2019	N	143	261	318	50	93	< 1.8	8.3	110	< 1.8	< 37	< 18	< 18	< 18	3.7	< 1.8	53	< 3.7	< 3.7	< 1.8
31VP-19-07	8	12	206.31	196.31	9/26/2019	N	2.70	2.70	5.30	< 3.8	2.7	< 1.9	< 1.9	< 1.9	< 1.9	< 38	< 19	< 19	< 19	1.2	< 1.9	1.4	< 3.8	< 3.8	< 1.9
	18	22	206.31	186.31	9/27/2019	N	995	1,210	1,340	930	65	< 1.8	9	200	1.7	95	23	< 18	< 18	1.6	< 1.8	20	< 3.7	< 3.7	< 1.8
	28	32	206.31	176.31	9/27/2019	N	1,870	2,410	2,750	1700	170	< 1.8	28	510	2.8	210	40	< 18	< 18	7.4	< 1.8	79	< 3.6	< 3.6	< 1.8
	38	42	206.31	166.31	9/27/2019	N	646	1,280	1,600	86	560	< 1.9	42	590	0.74	47	< 19	< 19	< 19	18	< 1.9	260	< 3.7	< 3.7	< 1.9
	48	52	206.31	156.31	9/30/2019	N	392	821	1,050	62	330	< 1.9	28	400	1.1	26	< 19	< 19	< 19	12	< 1.9	190	< 3.7	< 3.7	< 1.9
	58	62	206.31	146.31	9/30/2019	N	110	155	183	76	34	2.4	13	23	6.6	< 37	< 19	2.8	< 19	4.5	< 1.9	21	< 3.7	< 3.7	< 1.9
	68	72	206.31	136.31	9/30/2019	N	114	167	197	75	39	2.8	14	30	6.5	< 37	< 19	2.9	< 19	4.6	< 1.9	22	< 3.7	< 3.7	< 1.9
	78	82	206.31	126.31	10/1/2019	N	141	203	230	100	41	2.6	11	41	7.5	< 36	< 18	< 18	< 18	4.1	< 1.8	23	< 3.6	< 3.6	< 1.8
	78	82	206.31	126.31	10/1/2019	FD	140	202	229	99	41	2.2	11	41	7.8	< 38	< 19	< 19	< 19	3.9	< 1.9	23	< 3.8	< 3.8	< 1.9
	88	92	206.31	116.31	10/1/2019	N	160	233	264	110	50	6.9	13	43	9.9	< 38	< 19	< 19	< 19	5.1	< 1.9	26	< 3.8	< 3.8	< 1.9
31VP-19-08	13	17	206.96	191.96	10/2/2019	N	349	649	856	89	260	0.9	27	270	1.7	41	< 19	< 19	< 19	16	< 1.9	150	< 3.7	< 3.7	< 1.9
	23	27	206.96	181.96	10/2/2019	N	91.0	169	195	49	42	1.7	8.8	64	3.3	< 39	< 19	< 19	< 19	5.2	< 1.9	21	< 3.9	< 3.9	< 1.9
	33	37	206.96	171.96	10/2/2019	N	106	163	190	67	39	2.4	13	35	6.5	< 37	< 19	< 19	< 19	5.5	< 1.9	22	< 3.7	< 3.7	< 1.9
	43	47	206.96	161.96	10/3/2019	N	104	159	188	65	39	2.4	12	35	5.5	< 37	< 19	2.8	< 19	5	< 1.9	21	< 3.7	< 3.7	< 1.9
	53	57	206.96	151.96	10/3/2019	N	116	166	199	77	39	2.5	14	27	6.5	< 37	< 18	3.8	< 18	5.7	< 1.8	23	< 3.7	< 3.7	< 1.8
	63	67	206.96	141.96	10/3/2019	N	125	172	207	85	40	2.8	16	21	7.6	< 37	< 18	4.4	< 18	7.1	< 1.8	23	< 3.7	< 3.7	< 1.8
	73	77	206.96	131.96	10/4/2019	N	125	172	204	83	42	3.2	16	20	7.9	< 37	< 19	4.3	< 19	4.9	< 1.9	23	< 3.7	< 3.7	< 1.9
	83	87	206.96	121.96	10/4/2019	N	128	178	210	88	40	3.2	16	24	7.1	< 37	< 19	3.6	< 19	5.2	< 1.9	23	< 3.7	< 3.7	< 1.9

Notes:
Results shown are displayed as parts per trillion (ppt).
bgs = below ground surface.
ft = feet.
EPA = U.S. Environmental Protection Agency.
LHA = Lifetime Health Advisory.
MassDEP = Massachusetts Department of Environmental Protection.
MassDEP GW-1 denotes sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).
NAVD88 = North American Vertical Datum 1988.
Result exceeds the EPA LHA (70 ppt) for either PFOA, PFOS, and/or the sum of PFOA+PFOS).
Result exceeds the MassDEP GW-1 (20 ppt) sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).

AOC 50

Vertical Profile Results

PFAS in Groundwater at Vertical Profile Locations
AOC 50

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
G6M-18-01	60	64	264.58	202.58	10/24/2018	N	9.76	70.2	77.1	1.04	8.72	< 1.87	4.67	55.8	< 1.87	< 37.3	< 18.7	< 18.7	< 18.7	1.01	< 1.87	5.84	< 3.73	< 3.73	< 1.87
	70	74	264.58	192.58	10/24/2018	N	0.778	31.2	36.6	< 3.65	0.778	< 1.83	2.92	27.5	< 1.83	< 36.5	< 18.3	< 18.3	< 18.3	0.624	< 1.83	4.81	< 3.65	< 3.65	< 1.83
	80	84	264.58	182.58	10/24/2018	N	24.3	65.5	90.6	1.58	22.7	< 2.23	6	35.2	< 2.23	< 44.6	< 22.3	< 22.3	< 22.3	2.16	< 2.23	23	< 4.46	< 4.46	< 2.23
	90	94	264.58	172.58	10/24/2018	N	2,700	6,010	6613	< 3.76	2700	< 1.88	48.7	3260	< 1.88	7.3	< 18.8	< 18.8	< 18.8	22.4	< 1.88	575	< 3.76	< 3.76	< 1.88
	100	104	264.58	162.58	10/24/2018	FD	3,040	5,430	5966	13.9	3030	< 1.86	139	2250	< 1.86	73.2	< 18.6	< 18.6	< 18.6	30	< 1.86	430	< 3.73	< 3.73	< 1.86
	100	104	264.58	162.58	10/24/2018	N	3,310	5,540	6096	15.3	3290	< 1.85	131	2100	< 1.85	76.3	< 18.5	< 18.5	< 18.5	29.4	< 1.85	454	< 3.69	< 3.69	< 1.85
	110	114	264.58	152.58	10/25/2018	N	4,660	8,590	9608	1380	3280	< 1.94	83.8	3840	2.46	154	< 19.4	< 19.4	< 19.4	33.2	< 1.94	834	< 3.88	< 3.88	< 1.94
G6M-18-02	64	68	266.64	200.64	10/22/2018	N	153	305	341	57.1	95.6	< 1.93	6.2	146	< 1.93	16.4	< 19.3	< 19.3	< 19.3	1.94	< 1.93	18.2	< 3.85	< 3.85	< 1.93
	74	78	266.64	190.64	10/22/2018	N	207	943	1,087	28.5	178	< 1.93	24.4	712	< 1.93	67	< 19.3	< 19.3	< 19.3	7.21	< 1.93	69.4	< 3.86	< 3.86	< 1.93
	84	88	266.64	180.64	10/22/2018	N	10,500	17,800	23,736	1180	9310	< 1.97	579	6690	2.61	1720	< 19.7	< 19.7	< 19.7	244	< 1.97	4010	< 3.94	< 3.94	< 1.97
	94	98	266.64	170.64	10/23/2018	N	6,800	11,900	15,111	480	6320	< 1.94	297	4820	2.65	834	< 19.4	< 19.4	< 19.4	117	< 1.94	2240	< 3.89	< 3.89	< 1.94
	104	108	266.64	160.64	10/23/2018	N	3,160	5,940	7,414	737	2420	< 1.94	172	2610	4.38	344	< 19.4	< 19.4	< 19.4	76.9	< 1.94	1050	< 3.89	< 3.89	< 1.94
	114	118	266.64	150.64	10/23/2018	FD	2,910	5,220	6,699	874	2040	< 1.95	163	2140	3.93	383	4.27	< 19.5	< 19.5	117	< 1.95	974	< 3.89	< 3.89	< 1.95
	114	118	266.64	150.64	10/23/2018	N	2,950	5,090	6,619	908	2040	0.497	163	1970	4.22	379	3.93	< 20	< 20	120	< 2	1030	< 4	< 4	< 2
	124	128	266.64	140.64	10/23/2018	N	2,520	4,790	5,856	806	1710	< 1.93	144	2130	4.13	244	< 19.3	< 19.3	< 19.3	65.6	< 1.93	752	< 3.85	< 3.85	< 1.93
50VP-19-01	9	13	218.90	207.90	8/28/2019	N	306	361	373	290	16	0.72	3.8	48	2.8	< 37	< 19	< 19	< 19	< 1.9	< 1.9	12	< 3.7	< 3.7	< 1.9
	19	23	218.90	197.90	8/28/2019	N	185	275	289	160	25	< 1.8	4.9	83	1.7	< 37	< 18	< 18	< 18	< 2.7	< 1.8	14	< 3.7	< 3.7	< 1.8
	29	33	218.90	187.90	8/28/2019	N	201	449	492	150	51	< 1.9	7.6	240	0.65	< 37	< 19	< 19	< 19	10	< 1.9	33	< 3.7	< 3.7	< 1.9
	39	43	218.90	177.90	8/28/2019	N	9.90	70.9	80.5	2.4	7.5	< 1.9	0.97	60	< 1.9	< 38	< 19	< 19	< 19	4.1	< 1.9	5.5	< 3.8	< 3.8	< 1.9
	49	53	218.90	167.90	8/29/2019	N	227	395	424	190	37	< 1.9	6.8	160	1.6	< 38	< 19	< 19	< 19	5.6	< 1.9	23	< 3.8	< 3.8	< 1.9
	59	63	218.90	157.90	8/29/2019	N	411	753	813	340	71	< 1.9	11	330	1.1	< 38	< 19	< 19	< 19	14	< 1.9	46	< 3.8	< 3.8	< 1.9
	69	72	218.90	148.40	8/29/2019	N	388	638	681	340	48	< 1.9	8.3	240	1.4	< 37	< 19	< 19	< 19	11	< 1.9	32	< 3.7	< 3.7	< 1.9
50VP-19-02	9	13	215.91	204.91	8/26/2019	N	7.40	104	109	1.1	6.3	< 1.9	1.2	95	< 1.9	< 37	< 19	< 19	< 19	3.4	< 1.9	1.6	< 3.7	< 3.7	< 1.9
	19	23	215.91	194.91	8/26/2019	N	0.800	82.8	89.2	< 3.7	0.8	< 1.9	< 1.9	82	< 1.9	< 37	< 19	< 19	< 19	5.6	< 1.9	0.82	< 3.7	< 3.7	< 1.9
	29	33	215.91	184.91	8/27/2019	N	0.550	80.6	83.7	< 3.8	0.55	< 1.9	< 1.9	80	< 1.9	< 38	< 19	< 19	< 19	3.1	< 1.9	< 1.9	< 3.8	< 3.8	< 1.9
	39	43	215.91	174.91	8/27/2019	N	0.00	58.0	60.5	< 3.7	< 1.8	< 1.8	< 1.8	58	< 1.8	< 37	< 18	< 18	< 18	2.5	< 1.8	< 1.8	< 3.7	< 3.7	< 1.8
	49	53	215.91	164.91	8/27/2019	N	107	295	341	64	43	< 1.9	7.7	180	< 1.9	< 37	< 19	< 19	< 19	6.2	< 1.9	40	< 3.7	< 3.7	< 1.9
	54	58	215.91	159.91	8/27/2019	N	114	321	358	73	41	< 1.7	6.5	200	0.45	< 34	< 17	< 17	< 17	8.4	< 1.7	29	< 3.4	< 3.4	< 1.7
50VP-19-03	14	18	220.54	204.54	8/23/2019	N	15.8	18.9	19.5	14	1.8	< 1.9	< 1.9	3.1	< 1.9	< 37	< 19	< 19	< 19	< 1.9	< 1.9	0.62	< 3.7	< 3.7	< 1.9
	24	28	220.54	194.54	8/23/2019	N	14.1	25.0	30.1	8.9	5.2	< 1.9	0.94	10	< 1.9	< 37	< 19	< 19	< 19	< 1.9	1.3	2.7	< 3.7	1.1	< 1.9
	34	38	220.54	184.54	8/23/2019	N	0.0	0.0	0.820	< 3.7	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 37	< 18	< 18	< 18	0.82	< 1.8	< 1.8	< 3.7	< 3.7	< 1.8
	44	48	220.54	174.54	8/23/2019	N	1.76	12.8	12.8	1.1	0.66	< 1.8	< 1.8	11	< 1.8	< 37	< 18	< 18	< 18	< 1.8	< 1.8	< 1.8	< 3.7	< 3.7	< 1.8
	54	56	220.54	165.54	8/26/2019	N	2.60	28.6	31.5	1.4	1.2	< 1.9	< 1.9	26	< 1.9	< 37	< 19	< 19	< 19	2	< 1.9	0.85	< 3.7	< 3.7	< 1.9
	9	13	220.54	209.54	8/26/2019	N	19.5	27.0	30.4	12	7.5	< 1.8	2.3	4.7	0.5	< 37	< 18	< 18	< 18	0.72	< 1.8	2.7	< 3.7	< 3.7	< 1.8
50VP-19-04	49	53	249.78	198.78	7/17/2019	N	18.0	154	205	< 3.8	18	< 1.9	6.2	130	< 1.9	< 38	< 19	< 19	< 19	20	< 1.9	31	< 3.8	< 3.8	< 1.9
	59	63	249.78	188.78	7/17/2019	N	278	564	632	180	98	< 1.9	15	270	0.94	< 37	< 19	< 19	< 19	14	< 1.9	54	< 3.7	< 3.7	< 1.9
	69	73	249.78	178.78	7/17/2019	N	400	807	886	290	110	< 1.8	15	390	1.5	< 37	< 18	< 18	< 18	22	< 1.8	57	< 3.7	< 3.7	< 1.8
	79	83	249.78	168.78	7/18/2019	N	162	321	355	120	42	< 1.9	8.2	150	1.2	< 37	< 19	< 19	< 19	7	< 1.9	27	< 3.7	< 3.7	< 1.9
	89	93	249.78	158.78	7/18/2019	N	93.0	229	252	63	30	< 1.9	5.9	130	< 1.9	< 37	< 19	< 19	< 19	6	< 1.9	17	< 3.7	< 3.7	< 1.9
50VP-19-05	63	67	263.89	198.89	10/18/2019	N	670	1,700	1,870	180	490	< 1.9	32	1000	1.4	13	< 19	< 19	< 19	22	< 1.9	130	< 3.9	< 3.9	< 1.9
	73	77	263.89	188.89	10/18/2019	N	88.0	152	166	70	18	< 1.8	4.1	59	1.1	< 37	< 18	< 18	< 18	2.9	< 1.8	11	< 3.7	< 3.7	< 1.8
	83	87	263.89	178.89	10/18/2019	N	6.10	13.8	14.3	2.6	3.5	< 1.9	< 1.9	7.7	< 1.9	< 38	< 19	< 19	< 19	0.46	< 1.9	< 1.9	< 3.8	< 3.8	< 1.9
	93	97	263.89	168.89	10/21/2019	N	13.5	23.0	24.3	8.1	5.4	< 2	0.73	8.8	< 2	< 40	< 20	< 20	< 20	1.3	< 2	< 3	< 4	< 4	< 2
	103	107	263.89	158.89	10/21/2019	N	490	696	802	330	160	< 1.8	16	190	< 1.8	14	< 18	< 18	< 18	26	< 1.8	66	< 3.6	< 3.6	< 1.8
50VP-19-06	63	67	265.21	200.21	7/1/2019	N	197	869	1,540	6.8	190	< 2	62	610	< 2	7.3	< 20	< 20	< 20	120	< 2	540	< 4.1	< 4.1	< 2
	73	77	265.21	190.21	7/1/2019	N	1,750	2,090	2,270	1600	150	0.49	30	310	1.5	48	< 19	< 19	< 19	42	< 1.9	87	< 3.9	< 3.9	< 1.9
	83	87	265.21	180.21	7/2/2019	N	240	437	550	160	80	< 2.6	17	180	< 2.6	14	< 26	< 26	< 26	24	< 2.6	75	< 5.2	< 5.2	< 2.6
	92	96	265.21	171.21	7/2/2019	N	1,070	1,420	1,570	950	120	0.57	35	310	2.5	25	3.7	< 21	< 21	32	< 2.1	89	< 4.1	< 4.1	< 2.1
50VP-19-07	63	67	264.55	199.55	10/7/2019	N	24.0	80.6	106	2	22	< 2	6.6	50	< 2	< 40	< 20	< 20	< 20	2.3	< 2	23	< 4	< 4	< 2
	73	77	264.55	189.55	10/7/2019	N	52.0	170	187	17	35	< 1.8	7.7	110	< 1.8	< 35	< 18	< 18	< 18	2.5	< 1.8	15	< 3.5	< 3.5	< 1.8
	83	87	264.55	179.55	10/7/2019	N	184	513	544	3.9	180	< 1.8	9.3	320	< 1.8	< 36	< 18	< 18	< 18	4.5	< 1.8	26	< 3.6	< 3.6	< 1.8
	93	97	264.55	169.55	10/8/2019	N	224	604	634	4.2	220	< 1.8	10	370	< 1.8	< 36	< 18	< 18	< 18	4	< 1.8	26	< 3.6	< 3.6	< 1.8
	103	107	264.55	159.55	10/8/2019	N	208	557	583	7.7	200	< 1.8	9	340	< 1.8	< 35	< 18	< 18	< 18	3.3	< 1.8	23	< 3.5	< 3.5	< 1.8
	113	117	264.55	149.55	10/9/2019	N	138	305	336	78	60	< 1.9	7	160	< 1.9	< 38	< 19	< 19	< 19	6.8	< 1.9	24	< 3.8	< 3.8	< 1.9
	123	127	264.55	139.55	10/9/2019	N	153	301	335	110	43	< 1.8	7.2	140	0.78	< 36	< 18	< 18	< 18	6.1	< 1.8	28	< 3.6	< 3.6	< 1.8
	133	137	264.55	129.55	10/10/2019	N	302	666	735	220	82	< 2	13	350	0.77	< 39	< 20	< 20	< 20	21	< 2	48	< 3.9	< 3.9	< 2
	143	147	264.55	119.55	10/10/2019	N	210	627	716	110	100	< 2.1	16	400	0.96	< 41	< 21	< 21	< 21	26	< 2.1	63	< 4.1	< 4.1	< 2.1
	153	157	264.55	109.55	10/14/2019	N	161	450	479	21	140	< 2.2	9.4	280	< 2.2	< 45	< 22	< 22	< 22	4	< 2.2	25	< 4.5	< 4.5	< 2.2
	160	164	264.55	102.55	10/15/2019	N	173	464	494	23	150	< 2.6	11	280	< 2.6	< 52	< 26	< 26	< 26	4.2	< 2.6	26	< 5.2	< 5.2	< 2.6

PFAS in Groundwater at Vertical Profile Locations
AOC 50

Location	Top of Sample (ft bgs)	Bottom of Sample (ft bgs)	Ground Surface Elevation (ft NAVD88)	Midpoint Sample Elevation (ft NAVD88)	Sample Date	Sample Type	EPA LHA	MassDEP GW-1	Total PFAS	PFOS	PFOA	PFDA	PFHPA	PFHXS	PFNA	62FTS	82FTS	NETFOSAA	NMEFOSAA	PFBS	PFDOA	PFHXA	PFTEA	PFTRIA	PFUNA
50VP-19-08	9	13	208.50	197.50	9/6/2019	N	5.90	9.30	11.8	2.5	3.4	< 1.9	1.1	2.3	< 1.9	< 38	< 19	< 19	< 19	0.92	< 1.9	1.6	< 3.8	< 3.8	< 1.9
	19	23	208.50	187.50	9/6/2019	N	158	202	242	120	38	3.5	18	15	7.4	< 37	< 19	2.7	< 19	5.8	< 1.9	32	< 3.7	< 3.7	< 1.9
	29	33	208.50	177.50	9/6/2019	N	155	200	235	120	35	3	19	15	8.3	< 39	< 19	< 19	< 19	5.9	< 1.9	29	< 3.9	< 3.9	< 1.9
	39	43	208.50	167.50	9/6/2019	N	135	181	216	93	42	3	19	16	7.7	< 38	< 19	< 19	< 19	6.1	< 1.9	29	< 3.8	< 3.8	< 1.9
	49	53	208.50	157.50	9/6/2019	N	135	180	225	98	37	3.2	17	17	7.3	< 38	< 19	3.7	< 19	18	< 1.9	24	< 3.8	< 3.8	< 1.9
	59	63	208.50	147.50	9/6/2019	N	130	174	207	96	34	3.5	17	16	7.1	< 38	< 19	3.3	< 19	5.4	< 1.9	25	< 3.8	< 3.8	< 1.9
	69	73	208.50	137.50	9/10/2019	N	125	169	202	87	38	3.1	17	16	7.8	< 61	< 30	< 30	< 30	6.1	< 3	27	< 6.1	< 6.1	< 3
	79	83	208.50	127.50	9/10/2019	N	140	189	224	91	49	2.9	19	18	9.5	< 44	< 22	< 22	< 22	6.5	< 2.2	28	< 4.4	< 4.4	< 2.2
50VP-19-09	53	57	255.61	200.61	8/16/2019	N	58.0	110	121	49	9	0.95	3.1	47	0.82	< 39	< 20	< 20	< 20	1.5	< 2	10	< 3.9	< 3.9	< 2
	63	67	255.61	190.61	8/19/2019	N	66.7	123	132	57	9.7	0.99	3.6	49	2.3	< 38	< 19	< 19	< 19	1.5	< 1.9	7.9	< 3.8	< 3.8	< 1.9
	73	77	255.61	180.61	8/19/2019	N	177	327	349	140	37	< 1.9	8.4	140	1.2	< 37	< 19	< 19	< 19	3	< 1.9	19	< 3.7	< 3.7	< 1.9
	83	87	255.61	170.61	8/19/2019	N	6.00	33.0	37.9	2.2	3.8	< 4	< 4	27	< 4	< 81	< 40	< 40	< 40	3.2	< 4	1.7	< 8.1	< 8.1	< 4
	103	107	255.61	150.61	8/21/2019	N	16.9	30.3	32.2	14	2.9	0.67	0.74	12	< 1.9	< 39	< 19	< 19	< 19	< 1.9	< 1.9	1.9	< 3.9	< 3.9	< 1.9
	43	47	255.61	210.61	8/23/2019	N	42.2	71.1	77.2	33	9.2	< 1.9	2.8	25	1.1	< 38	< 19	< 19	< 19	1.4	< 1.9	4.7	< 3.8	< 3.8	< 1.9
50VP-19-10	53	57	256.99	201.99	8/14/2019	N	1.50	13.0	17.0	< 3.8	1.5	< 1.9	1.8	9.7	< 1.9	< 38	< 19	< 19	< 19	0.71	< 1.9	3.3	< 3.8	< 3.8	< 1.9
	63	67	256.99	191.99	8/14/2019	N	0	8.80	10.6	< 3.7	< 1.9	< 1.9	< 1.9	8.8	< 1.9	< 37	< 19	< 19	< 19	0.59	< 1.9	1.2	< 3.7	< 3.7	< 1.9
	73	77	256.99	181.99	8/15/2019	N	0	3.60	3.60	< 3.9	< 2	< 2	< 2	3.6	< 2	< 39	< 20	< 20	< 20	< 2	< 2	< 2	< 3.9	< 3.9	< 2
50VP-19-11	43	47	256.16	211.16	8/23/2019	N	0.990	0.990	0.99	< 4.2	0.99	< 2.1	< 2.1	< 2.1	< 2.1	< 42	< 21	< 21	< 21	< 2.1	< 2.1	< 2.1	< 4.2	< 4.2	< 2.1
	53	57	256.16	201.16	8/26/2019	N	6.60	8.68	10.2	3.6	3	< 2	1.4	< 2	0.68	< 41	< 20	< 20	< 20	< 2	< 2	1.5	< 4.1	< 4.1	< 2
	63	67	256.16	191.16	8/26/2019	N	0.760	0.760	0.760	< 3.8	0.76	< 1.9	< 1.9	< 1.9	< 1.9	< 38	< 19	< 19	< 19	< 1.9	< 1.9	< 1.9	< 3.8	< 3.8	< 1.9
	73	77	256.16	181.16	8/26/2019	N	1.30	1.30	1.30	< 4.5	1.3	< 2.2	< 2.2	< 2.2	< 2.2	< 45	< 22	< 22	< 22	< 2.2	< 2.2	< 2.2	< 4.5	< 4.5	< 2.2
	83	87	256.16	171.16	8/27/2019	N	0.00	0.00	0	< 5.5	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 55	< 27	< 27	< 27	< 2.7	< 2.7	< 2.7	< 5.5	< 5.5	< 2.7
	93	97	256.16	161.16	8/27/2019	N	1.50	1.50	1.50	< 5.8	1.5	< 2.9	< 2.9	< 2.9	< 2.9	< 58	< 29	< 29	< 29	< 2.9	< 2.9	< 2.9	< 5.8	< 5.8	< 2.9
	103	107	256.16	151.16	8/28/2019	N	5.86	7.66	7.66	4.9	0.96	< 2	< 2	1.8	< 2	< 39	< 20	< 20	< 20	< 2	< 2	< 2	< 3.9	< 3.9	< 2
	111	115	256.16	143.16	8/28/2019	N	3.80	5.40	5.40	2.8	1	< 2	< 2	1.6	< 2	< 39	< 20	< 20	< 20	< 2	< 2	< 2	< 3.9	< 3.9	< 2
50VP-19-12	53	57	256.03	201.03	8/9/2019	N	4.60	17.8	30.1	< 3.9	4.6	< 2	9	4.2	< 2	< 39	< 20	< 20	< 20	1.5	< 2	9.9	0.89	< 3.9	< 2
	63	67	256.03	191.03	8/9/2019	N	3.90	10.9	16.5	< 3.7	3.9	< 1.9	2.9	4.1	< 1.9	< 37	< 19	< 19	< 19	1.3	< 1.9	4.3	< 3.7	< 3.7	< 1.9
	73	77	256.03	181.03	8/12/2019	N	4.40	10.9	14.3	1.3	3.1	< 2.1	1.9	4.6	< 2.1	< 41	< 21	< 21	< 21	1.1	< 2.1	2.3	< 4.1	< 4.1	< 2.1
	83	87	256.03	171.03	8/12/2019	N	4.60	26.3	30.6	2.7	1.9	< 1.8	7.7	14	< 1.8	< 37	< 18	< 18	< 18	0.7	< 1.8	3.6	< 3.7	< 3.7	< 1.8
	93	97	256.03	161.03	8/12/2019	N	5.10	14.0	17.5	2	3.1	< 1.8	2.8	6.1	< 1.8	< 36	< 18	< 18	< 18	0.47	< 1.8	3	< 3.6	< 3.6	< 1.8
50VP-19-13	69	73	267.03	196.03	8/12/2019	N	201	1,730	1,890	1	200	< 1.8	28	1500	< 1.8	< 37	< 18	< 18	< 18	7.6	< 1.8	150	< 3.7	< 3.7	< 1.8
	79	83	267.03	186.03	8/12/2019	N	131	896	966	1.1	130	< 1.8	15	750	< 1.8	< 37	< 18	< 18	< 18	4.7	< 1.8	65	< 3.7	< 3.7	< 1.8
	89	93	267.03	176.03	8/12/2019	N	12.4	26.6	30.0	7.4	5	< 1.9	2.2	12	< 1.9	< 38	< 19	< 19	< 19	0.47	< 1.9	2.9	< 3.8	< 3.8	< 1.9
	99	103	267.03	166.03	8/13/2019	N	1.70	9.00	12.6	< 3.7	1.7	< 1.9	2	5.3	< 1.9	< 37	< 19	< 19	< 19	< 1.9	< 1.9	3.6	< 3.7	< 3.7	< 1.9
	109	113	267.03	156.03	8/14/2019	N	75.3	113	145	66	9.3	1.2	3.3	32	1.1	< 37	< 18	< 18	< 18	2.5	< 1.8	28	< 3.7	< 3.7	1.5
	119	123	267.03	146.03	8/14/2019	N	660	1,560	1,870	310	350	< 1.8	66	830	1.9	< 36	< 18	< 18	< 18	60	< 1.8	250	< 3.6	< 3.6	< 1.8
	129	133	267.03	136.03	8/15/2019	N	73.0	225	650	26	47	< 1.9	12	140	< 1.9	< 38	< 19	< 19	< 19	65	< 1.9	360	< 3.8	< 3.8	< 1.9
	139	143	267.03	126.03	8/15/2019	N	380	1,010	1,260	230	150	< 1.9	33	600	1.3	< 38	< 19	< 19	< 19	42	< 1.9	200	< 3.8	< 3.8	< 1.9
	154	158	267.03	111.03	8/19/2019	N	990	2,180	2,660	440	550	< 1.9	87	1100	2.5	< 38	< 19	< 19	< 19	110	< 1.9	370	< 3.8	< 3.8	< 1.9
	164	168	267.03	101.03	8/20/2019	N	960	1,740	2,000	720	240	< 2	79	700	3.8	< 43	< 20	< 20	< 20	56	< 2	200	< 4	< 4	< 2
	174	178	267.03	91.03	8/20/2019	N	1,240	2,320	2,660	830	410	1.3	76	1000	3.8	< 44	< 22	< 22	< 22	64	< 2.2	270	< 4.4	< 4.4	0.93

Notes:
Results shown are displayed as parts per trillion (ppt).
bgs = below ground surface.
ft = feet.
EPA = U.S. Environmental Protection Agency.
LHA = Lifetime Health Advisory.
MassDEP = Massachusetts Department of Environmental Protection.
MassDEP GW-1 denotes sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).
NAVD88 = North American Vertical Datum 1988.
Result exceeds the EPA LHA (70 ppt) for either PFOA, PFOS, and/or the sum of PFOA+PFOS).
Result exceeds the MassDEP GW-1 (20 ppt) sum of 6 compounds (PFOS, PFOA, PFDA, PFHpA, PFHxS, PFNA).

H-3

PFAS in Soil

AOCs 20 and 21

Soil Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-01	20SB-19-01	20SB-19-01	20SB-19-01
	Field Sample ID	20SB-19-01-0-0.5	20SB-19-01-0.5-3	20SB-19-01-3-7	20SB-19-01-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/18/2019	10/18/2019	10/18/2019	10/18/2019
	SDG	320554781	320554781	320554781	320554781
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.00 U	2.00 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	0.980 U	0.980 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**4.50 J**	**0.800 J**	0.980 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**8.90**	**2.40**	**0.480 J**	**0.340 J**
Perfluorobutanesulfonic acid (PFBS)		0.180 U	0.180 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.350**	0.200 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		**1.30**	**0.200 J**	**0.110 J**	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.200 U	0.200 U	0.200 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.470**	**0.100 J**	**0.0730 J**	0.200 U
Perfluorohexanoic acid (PFHxA)		**0.170 J**	0.200 U	0.200 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	**0.110 J**	0.200 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**6.00 J**	**1.10**	**0.570 J**	**0.490 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.300**	0.200 U	0.200 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		**0.700**	0.300 U	0.290 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		**0.420**	0.200 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		**0.420**	0.200 U	0.200 U	0.200 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

Bolded results indicate detections of PFAS
Bolded and highlighted results indicate detections of PFAS above
Criteria = Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-02	20SB-19-02	20SB-19-02	20SB-19-02	20SB-19-02
	Field Sample ID	20SB-19-02-0-0.5	20SB-19-02-0.5-3	20SB-19-02-3-7	20SB-19-02-7-15	20SB-19-02-52-54
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	52.00 - 54.00
	Sampling Date	10/22/2019	10/22/2019	10/22/2019	10/22/2019	10/22/2019
	SDG	320556141	320556141	320556141	320556141	320556141
	Sample Type	Normal	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.00 U	2.20 U	2.20 U	2.30 U	2.10 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.10 U	1.10 U	1.20 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**0.570 J**	**0.330 J**	1.10 U	1.20 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**1.30 J**	**0.570 J**	**0.450 J**	1.20 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.180 U	0.200 U	0.200 U	0.210 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
Perfluorododecanoic acid (PFDoA)		**0.160 J**	0.220 U	0.220 U	0.230 U	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
Perfluorohexanoic acid (PFHxA)		0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
Perfluorononanoic acid (PFNA)	0.320	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**0.990 J**	0.550 U	**0.330 J**	0.580 U	0.520 U
Perfluorooctanoic acid (PFOA)	0.720	0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
Perfluorotetradecanoic acid (PFTA)		**0.110 J**	0.330 U	0.330 U	0.350 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.200 U	0.220 U	0.220 U	0.230 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		0.200 U	0.220 U	0.220 U	0.230 U	0.210 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-03	20SB-19-03	20SB-19-03	20SB-19-03
	Field Sample ID	20SB-19-03-0-0.5	20SB-19-03-0.5-3	20SB-19-03-3-7	20SB-19-03-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/18/2019	10/18/2019	10/18/2019	10/18/2019
	SDG	320554781	320554781	320554781	320554781
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.10 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.00 U	1.00 U	0.990 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**1.40 J**	**0.560 J**	1.00 U	0.990 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**3.90**	**0.620 J**	**0.300 J**	0.990 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	0.180 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.150 J**	0.210 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		**0.530**	**0.160 J**	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.210 U	0.210 U	0.200 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.150 J**	0.210 U	0.200 U	0.200 U
Perfluorohexanoic acid (PFHxA)		0.210 U	0.210 U	0.200 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.210 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**2.50**	**1.00**	**0.540 J**	**0.540 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.190 J**	0.210 U	0.200 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		**0.360 J**	0.310 U	0.300 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		**0.210 J**	0.210 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		**0.130 J**	0.210 U	0.200 U	0.200 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-04	20SB-19-04	20SB-19-04	20SB-19-04	20SB-19-04
	Field Sample ID	20SB-19-04-0-0.5	20SB-19-04-0.5-3	20SB-19-04-3-7	20SB-19-04-7-15	A3-SB-DUP01-101819
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00
	Sampling Date	10/18/2019	10/18/2019	10/18/2019	10/18/2019	10/18/2019
	SDG	320554781	320554781	320554781	320554781	320554781
	Sample Type	Normal	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		1.90 U	2.00 U	2.00 U	2.30 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		0.970 U	0.990 U	1.00 U	1.20 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**1.80 J**	**0.480 J**	1.00 U	1.20 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**1.80 J**	**0.990 J**	**0.310 J**	1.20 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.170 U	0.180 U	0.180 U	0.210 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.0950 J**	0.200 U	0.200 U	0.230 U	0.200 U
Perfluorododecanoic acid (PFDoA)		**0.480**	**0.110 J**	0.200 U	0.230 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.190 U	0.200 U	0.200 U	0.230 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.170 J**	**0.120 J**	**0.0670 J**	0.230 U	0.200 U
Perfluorohexanoic acid (PFHxA)		0.190 U	0.200 U	0.200 U	0.230 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	0.190 U	0.200 U	0.200 U	0.230 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**1.60**	**0.720 J**	**0.500 J**	**0.380 J**	**0.420 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.100 J**	0.200 U	0.200 U	0.230 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		**0.210 J**	0.300 U	0.300 U	0.350 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		**0.130 J**	0.200 U	0.200 U	0.230 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		**0.180 J**	0.200 U	0.200 U	0.230 U	0.200 U

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-05	20SB-19-05	20SB-19-05	20SB-19-05
	Field Sample ID	20SB-19-05-0-0.5	20SB-19-05-0.5-3	20SB-19-05-3-7	20SB-19-05-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/18/2019	10/18/2019	10/18/2019	10/18/2019
	SDG	320554781	320554781	320554781	320554781
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		1.90 U	2.00 U	2.10 U	2.10 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		0.970 U	1.00 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**0.590 J**	**0.360 J**	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**2.40**	**1.60 J**	**0.820 J**	**0.550 J**
Perfluorobutanesulfonic acid (PFBS)		0.170 U	0.180 U	0.190 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	**0.0860 J**	0.200 U	0.210 U	0.210 U
Perfluorododecanoic acid (PFDoA)		**0.160 J**	0.200 U	0.210 U	**0.140 J**
Perfluoroheptanoic acid (PFHpA)	0.500	0.190 U	0.200 U	0.210 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.100 J**	**0.110 J**	**0.0780 J**	0.210 U
Perfluorohexanoic acid (PFHxA)		0.190 U	0.200 U	0.210 U	0.210 U
Perfluorononanoic acid (PFNA)	0.320	0.190 U	0.200 U	0.210 U	0.210 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**1.60**	**0.970 J**	**0.510 J**	**0.450 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.110 J**	0.200 U	0.210 U	0.210 U
Perfluorotetradecanoic acid (PFTA)		**0.150 J**	**0.110 J**	0.310 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.190 U	0.200 U	0.210 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		0.190 U	0.200 U	0.210 U	0.210 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-06	20SB-19-06	20SB-19-06	20SB-19-06	20SB-19-06
	Field Sample ID	20SB-19-06-0-0.5	20SB-19-06-0.5-3	20SB-19-06-3-7	20SB-19-06-7-15	20SB-19-06-52-54
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	52.00 - 54.00
	Sampling Date	10/21/2019	10/21/2019	10/21/2019	10/21/2019	10/21/2019
	SDG	320556141	320556141	320556141	320556141	320556141
	Sample Type	Normal	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.00 U	2.00 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.10 U	1.00 U	0.980 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**0.510 J**	**0.430 J**	0.980 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**0.900 J**	**0.620 J**	**0.360 J**	1.00 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	0.180 U	0.180 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluorohexanoic acid (PFHxA)		0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**0.430 J**	**0.460 J**	**0.240 J**	**0.310 J**	**0.590 J**
Perfluorooctanoic acid (PFOA)	0.720	0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		0.320 U	0.300 U	0.290 U	0.300 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.200 U	0.200 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.200 U	0.200 U	0.200 U	0.200 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-07	20SB-19-07	20SB-19-07	20SB-19-07	20SB-19-07
	Field Sample ID	20SB-19-07-0-0.5	20SB-19-07-0.5-3	20SB-19-07-3-7	A3-SB-DUP01-102219	20SB-19-07-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/22/2019	10/22/2019	10/22/2019	10/22/2019	10/22/2019
	SDG	320556141	320556141	320556141	320556141	320556141
	Sample Type	Normal	Normal	Normal	Field Duplicate	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.40 U	2.30 U	2.20 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.20 U	1.20 U	1.10 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.20 U	1.20 U	1.10 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.20 U	1.20 U	**0.570 J**	**0.490 J**	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.220 U	0.210 U	0.200 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		**0.150 J**	0.230 U	0.220 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.240 U	0.230 U	**0.0890 J**	**0.0700 J**	**0.0670 J**
Perfluorohexanoic acid (PFHxA)		0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**0.400 J**	**0.280 J**	**0.380 J**	**0.340 J**	**0.310 J**
Perfluorooctanoic acid (PFOA)	0.720	0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		**0.140 J**	0.350 U	0.340 U	0.300 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.240 U	0.230 U	0.220 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.240 U	0.230 U	0.220 U	0.200 U	0.200 U

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	20SB-19-08	20SB-19-08	20SB-19-08	20SB-19-08	20SB-19-08	20SB-19-08
	Field Sample ID	20SB-19-08-0-0.5	20SB-19-08-0.5-3	20SB-19-08-3-7	20SB-19-08-7-15	A3-SB-DUP01-102119	20SB-19-08-62-64
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00	62.00 - 64.00
	Sampling Date	10/21/2019	10/21/2019	10/21/2019	10/21/2019	10/21/2019	10/21/2019
	SDG	320556141	320556141	320556141	320556141	320556141	320556141
	Sample Type	Normal	Normal	Normal	Normal	Field Duplicate	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.00 U	2.10 U	2.40 U	2.50 U	2.00 U	1.90 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.00 U	1.20 U	1.20 U	1.00 U	0.970 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**1.20 J**	1.00 U	1.20 U	1.20 U	1.00 U	0.970 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**3.00**	1.00 U	1.20 U	1.20 U	**0.370 J**	0.970 U
Perfluorobutanesulfonic acid (PFBS)		0.180 U	0.190 U	0.210 U	0.220 U	0.180 U	0.170 U
Perfluorodecanoic acid (PFDA)	0.300	**0.880**	0.210 U	0.240 U	0.250 U	0.200 U	0.190 U
Perfluorododecanoic acid (PFDoA)		**0.430**	0.210 U	0.240 U	0.250 U	0.200 U	0.190 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.200 U	0.210 U	**0.320 J**	0.250 U	0.200 U	0.190 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.230 J**	0.210 U	**0.400**	**0.130 J**	**0.130 J**	0.190 U
Perfluorohexanoic acid (PFHxA)		0.200 U	0.210 U	**0.210 J**	0.250 U	0.200 U	0.190 U
Perfluorononanoic acid (PFNA)	0.320	**0.170 J**	**0.290 J**	**0.190 J**	0.250 U	0.200 U	0.190 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**13.0**	**6.20**	**2.50**	**1.80**	**2.50**	0.480 U
Perfluorooctanoic acid (PFOA)	0.720	**0.270 J**	**0.160 J**	**1.80**	**0.300 J**	**0.340**	0.190 U
Perfluorotetradecanoic acid (PFTA)		**0.170 J**	0.310 U	0.350 U	0.370 U	0.310 U	0.290 U
Perfluorotridecanoic acid (PFTrDA)		0.200 U	0.210 U	0.240 U	0.250 U	0.200 U	0.190 U
Perfluoroundecanoic acid (PFUnA)		**0.260 J**	0.210 U	0.240 U	0.250 U	0.200 U	0.190 U

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 21, Waste Water Treatment Plant Sludge Drying Beds

	Location	21SB-19-01	21SB-19-01	21SB-19-01	21SB-19-01	21SB-19-01	21SB-19-01
	Field Sample ID	21SB-19-01-0-0.5	21SB-19-01-0.5-3	21SB-19-01-3-7	A3-SB-DUP01-111419	21SB-19-01-7-10	21SB-19-01-10-12
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	3.00 - 7.00	7.00 - 10.00	12.00 - 12.00
	Sampling Date	11/14/2019	11/14/2019	11/14/2019	11/14/2019	11/14/2019	11/14/2019
	SDG	320563431	320563431	320563431	320563431	320563431	320563431
	Sample Type	Normal	Normal	Normal	Field Duplicate	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.50 U	2.50 U	2.10 U	2.30 U	2.00 U	2.20 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.20 U	1.30 U	1.10 U	1.20 U	1.00 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**0.490 J**	**2.60**	1.10 U	1.20 U	1.00 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**0.540 J**	**0.970 J**	1.10 U	1.20 U	1.00 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.220 U	0.230 U	0.190 U	0.210 U	0.180 U	0.200 U
Perfluorodecanoic acid (PFDA)	0.300	**0.210 J**	**0.400**	0.210 U	0.230 U	0.200 U	0.220 U
Perfluorododecanoic acid (PFDoA)		**0.290 J**	0.250 U	0.210 U	0.230 U	0.200 U	0.220 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.250 U	**0.230 J**	0.210 U	0.230 U	0.200 U	0.220 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.560**	**0.370 J**	**0.280 J**	**0.280 J**	**0.0840 J**	0.220 U
Perfluorohexanoic acid (PFHxA)		0.250 U	**0.140 J**	0.210 U	**0.130 J**	0.200 U	0.220 U
Perfluorononanoic acid (PFNA)	0.320	0.250 U	**0.170 J**	0.210 U	0.230 U	0.200 U	0.220 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**5.80 J**	**19.0 J**	**5.20 J**	**7.10 J**	**0.350 J**	**0.950 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.130 J**	**1.90**	**2.20**	**2.10**	**0.380**	0.220 U
Perfluorotetradecanoic acid (PFTA)		0.370 U	0.380 U	0.320 U	0.350 U	0.310 U	0.330 U
Perfluorotridecanoic acid (PFTrDA)		0.250 U	0.250 U	0.210 U	0.230 U	0.200 U	0.220 U
Perfluoroundecanoic acid (PFUnA)		**0.140 J**	0.250 U	0.210 U	0.230 U	0.200 U	0.220 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 21, Waste Water Treatment Plant Sludge Drying Beds

	Location	21SB-19-02	21SB-19-02	21SB-19-02	21SB-19-02
	Field Sample ID	21SB-19-02-0-0.5	21SB-19-02-0.5-3	21SB-19-02-3-7	21SB-19-02-7-11
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 11.00
	Sampling Date	11/14/2019	11/14/2019	11/14/2019	11/14/2019
	SDG	320563431	320563431	320563431	320563431
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.50 U	2.20 U	2.20 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.20 U	1.10 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.20 U	**2.20**	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	1.20 U	**0.690 J**	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	0.220 U	0.200 U	0.200 U
Perfluorodecanoic acid (PFDA)	0.300	**0.290 J**	**0.290 J**	**0.120 J**	0.220 U
Perfluorododecanoic acid (PFDoA)		**0.200 J**	0.250 U	0.220 U	0.220 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.210 U	0.250 U	**0.150 J**	0.220 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.130 J**	**0.0960 J**	**0.160 J**	0.220 U
Perfluorohexanoic acid (PFHxA)		0.210 U	0.250 U	0.220 U	0.220 U
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.250 U	**0.110 J**	0.220 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**1.40 J**	**1.80 J**	**9.00 J**	**0.420 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.130 J**	0.250 U	**0.930**	**0.400**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.370 U	0.330 U	0.330 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.250 U	0.220 U	0.220 U
Perfluoroundecanoic acid (PFUnA)		**0.140 J**	0.250 U	0.220 U	0.220 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 21, Waste Water Treatment Plant Sludge Drying Beds

	Location	21SB-19-03	21SB-19-03	21SB-19-03	21SB-19-03	21SB-19-03
	Field Sample ID	21SB-19-03-0-0.5	21SB-19-03-0.5-3	21SB-19-03-3-7	21SB-19-03-7-11	A3-SB-DUP02-111419
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 11.00	7.00 - 11.00
	Sampling Date	11/14/2019	11/14/2019	11/14/2019	11/14/2019	11/14/2019
	SDG	320563431	320563431	320563431	320563431	320563431
	Sample Type	Normal	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.40 U	2.60 U	2.20 U	2.30 U	2.10 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.20 U	1.30 U	1.10 U	1.10 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.20 U	**2.50 J**	**8.50**	**0.630 J**	**0.890 J**
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.20 U	**4.60**	**1.80 J**	1.10 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.210 U	0.230 U	0.200 U	0.200 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	**0.140 J**	**0.270 J**	**0.460**	**0.150 J**	**0.190 J**
Perfluorododecanoic acid (PFDoA)		**0.250 J**	0.260 U	0.220 U	0.230 U	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.240 U	0.260 U	0.220 U	0.230 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.240 U	**0.210 J**	**0.120 J**	0.230 U	0.210 U
Perfluorohexanoic acid (PFHxA)		0.240 U	0.260 U	0.220 U	0.230 U	0.210 U
Perfluorononanoic acid (PFNA)	0.320	0.240 U	**0.160 J**	**0.260 J**	0.230 U	0.210 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**0.960 J**	**10.0 J**	**13.0 J**	**2.30 J**	**3.00 J**
Perfluorooctanoic acid (PFOA)	0.720	0.240 U	**0.370 J**	**0.410**	0.230 U	0.210 U
Perfluorotetradecanoic acid (PFTA)		0.360 U	0.390 U	0.330 U	0.340 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.240 U	0.260 U	0.220 U	0.230 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		**0.140 J**	0.260 U	0.220 U	0.230 U	0.210 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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AOC 30

Soil Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 30, Former Moore Army Air Field Drum Storage Area

	Location	30SB-19-01	30SB-19-01	30SB-19-01	30SB-19-01	30SB-19-01
	Field Sample ID	30SB-19-01-0-0.5	30SB-19-01-0.5-3	30SB-19-01-3-7	30SB-19-01-7-15	30SB-19-01-58-60
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	58.00 - 60.00
	Sampling Date	10/14/2019	10/14/2019	10/14/2019	10/14/2019	10/14/2019
	SDG	320554491	320554491	320554491	320554491	320554491
	Sample Type	Normal	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.10 U	2.00 U	2.00 U	2.20 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.00 U	1.00 U	1.00 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.00 U	1.00 U	1.00 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	1.00 U	1.00 U	1.00 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	0.180 U	0.180 U	**0.0830 J**	0.200 U
Perfluorodecanoic acid (PFDA)	0.300	0.210 U	**0.230 J**	0.200 U	0.200 U	0.220 U
Perfluorododecanoic acid (PFDoA)		**0.150 J**	0.210 U	0.200 U	0.200 U	0.220 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.110 J**	0.210 U	0.200 U	0.200 U	0.220 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**5.60**	**7.20**	**5.00**	**3.80**	**0.520**
Perfluorohexanoic acid (PFHxA)		**0.960**	**0.400**	0.200 U	**0.0920 J**	0.220 U
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.210 U	0.200 U	0.200 U	0.220 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**14.0**	**35.0**	1.00 U	1.00 U	0.550 U
Perfluorooctanoic acid (PFOA)	0.720	**0.930**	**1.50**	**2.20**	**1.00**	**0.120 J**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.310 U	0.300 U	0.300 U	0.330 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.210 U	0.200 U	0.200 U	0.220 U
Perfluoroundecanoic acid (PFUnA)		**0.120 J**	0.210 U	0.200 U	0.200 U	0.220 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 30, Former Moore Army Air Field Drum Storage Area

	Location	30SB-19-02	30SB-19-02	30SB-19-02	30SB-19-02	30SB-19-02
	Field Sample ID	30SB-19-02-0-0.5	30SB-19-02-0.5-3	30SB-19-02-3-7	30SB-19-02-7-15	A3-SB-DUP-101419
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00
	Sampling Date	10/14/2019	10/14/2019	10/14/2019	10/14/2019	10/14/2019
	SDG	320554491	320554491	320554491	320554491	320554491
	Sample Type	Normal	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		1.90 U	2.10 U	1.90 U	2.20 U	1.90 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		0.970 U	1.00 U	0.950 U	1.10 U	0.960 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		0.970 U	1.00 U	0.950 U	1.10 U	0.960 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		0.970 U	1.00 U	0.950 U	1.10 U	0.960 U
Perfluorobutanesulfonic acid (PFBS)		0.170 U	0.190 U	0.170 U	0.190 U	0.170 U
Perfluorodecanoic acid (PFDA)	0.300	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
Perfluorododecanoic acid (PFDoA)		0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
Perfluorohexanoic acid (PFHxA)		**0.270 J**	**0.320**	0.190 U	0.220 U	0.190 U
Perfluorononanoic acid (PFNA)	0.320	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
Perfluorooctanesulfonic acid (PFOS)	2.00	0.480 U	1.00 U	0.480 U	0.540 U	0.960 U
Perfluorooctanoic acid (PFOA)	0.720	0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
Perfluorotetradecanoic acid (PFTA)		0.290 U	0.310 U	0.290 U	0.320 U	0.290 U
Perfluorotridecanoic acid (PFTrDA)		0.190 U	0.210 U	0.190 U	0.220 U	0.190 U
Perfluoroundecanoic acid (PFUnA)		0.190 U	0.210 U	0.190 U	0.220 U	0.190 U

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 30, Former Moore Army Air Field Drum Storage Area

	Location	30SB-19-03	30SB-19-03	30SB-19-03	30SB-19-03
	Field Sample ID	30SB-19-03-0-0.5	30SB-19-03-0.5-3	30SB-19-03-3-7	30SB-19-03-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/14/2019	10/14/2019	10/14/2019	10/14/2019
	SDG	320554491	320554491	320554491	320554491
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.10 U	2.50 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.10 U	1.00 U	1.30 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.10 U	1.00 U	1.30 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.10 U	1.00 U	1.30 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	**0.0890 J**	0.230 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	0.210 U	0.210 U	0.250 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.210 U	0.210 U	0.250 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.210 U	0.210 U	0.250 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.0890 J**	**0.240 J**	**0.110 J**	0.200 U
Perfluorohexanoic acid (PFHxA)		0.210 U	**0.330**	**0.110 J**	0.200 U
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.210 U	0.250 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	1.10 U	0.510 U	1.30 U	0.500 U
Perfluorooctanoic acid (PFOA)	0.720	**0.160 J**	**0.150 J**	0.250 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		0.320 U	0.310 U	0.380 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.210 U	0.250 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.210 U	0.250 U	0.200 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 30, Former Moore Army Air Field Drum Storage Area

	Location	30SB-19-04	30SB-19-04	30SB-19-04	30SB-19-04	30SB-19-04	30SB-19-04
	Field Sample ID	30SB-19-04-0-0.5	30SB-19-04-0.5-3	A3-SB-DUP01-101519	30SB-19-04-3-7	30SB-19-04-7-15	30SB-19-04-67-69
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	67.00 - 69.00
	Sampling Date	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/15/2019
	SDG	320554481	320554481	320554481	320554481	320554481	320554481
	Sample Type	Normal	Normal	Field Duplicate	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.00 U	2.10 U	2.00 U	2.00 U	1.90 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		0.990 U	1.00 U	1.00 U	1.00 U	0.970 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		0.990 U	1.00 U	1.00 U	1.00 U	0.970 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		0.990 U	1.00 U	1.00 U	1.00 U	0.970 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.180 U	0.190 U	0.180 U	0.180 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.200 U	0.210 U	0.200 U	**0.0670 J**	0.290 U	**0.290 J**
Perfluorohexanoic acid (PFHxA)		0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.300 U
Perfluorononanoic acid (PFNA)	0.320	0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	0.490 U	**0.580 J**	**0.650 J**	**0.600 J**	**5.90**	0.500 U
Perfluorooctanoic acid (PFOA)	0.720	0.200 U	0.210 U	0.200 U	0.200 U	**0.110 J**	**0.900**
Perfluorotetradecanoic acid (PFTA)		0.300 U	0.310 U	0.300 U	0.300 U	0.290 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.200 U	0.210 U	0.200 U	0.200 U	0.190 U	0.200 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 30, Former Moore Army Air Field Drum Storage Area

	Location	30SB-19-05	30SB-19-05	30SB-19-05	30SB-19-05
	Field Sample ID	30SB-19-05-0-0.5	30SB-19-05-0.5-3	30SB-19-05-3-7	30SB-19-05-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/14/2019	10/14/2019	10/14/2019	10/14/2019
	SDG	320554491	320554491	320554491	320554491
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.00 U	2.00 U	2.00 U	2.10 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.00 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.00 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	1.00 U	1.00 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.180 U	0.180 U	0.180 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	0.200 U	0.200 U	0.200 U	0.210 U
Perfluorododecanoic acid (PFDoA)		0.200 U	0.200 U	0.200 U	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.200 U	0.200 U	0.200 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.180 J**	**0.270 J**	**1.10**	**2.20**
Perfluorohexanoic acid (PFHxA)		0.200 U	0.200 U	0.200 U	0.210 U
Perfluorononanoic acid (PFNA)	0.320	0.200 U	0.200 U	0.200 U	0.210 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**3.30**	1.00 U	**1.70**	**3.80**
Perfluorooctanoic acid (PFOA)	0.720	0.200 U	**0.100 J**	**1.70**	**5.70**
Perfluorotetradecanoic acid (PFTA)		0.300 U	0.300 U	0.300 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.200 U	0.200 U	0.200 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		0.200 U	0.200 U	0.200 U	0.210 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 30, Former Moore Army Air Field Drum Storage Area

Location		30SB-19-06	30SB-19-06	30SB-19-06	30SB-19-06
Field Sample ID		30SB-19-06-0-0.5	30SB-19-06-0.5-3	30SB-19-06-3-7	30SB-19-06-7-15
Sampling Depth		0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
Sampling Date		10/15/2019	10/15/2019	10/15/2019	10/15/2019
SDG		320554491	320554491	320554481	320554481
Sample Type		Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.20 U	2.00 U	2.10 U	2.10 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.10 U	0.980 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.10 U	0.980 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.10 U	0.980 U	1.00 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.200 U	0.180 U	0.190 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	0.220 U	0.200 U	**0.140 J**	0.210 U
Perfluorododecanoic acid (PFDoA)		0.220 U	0.200 U	0.210 U	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.220 U	0.200 U	0.210 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.300 J**	**0.110 J**	**0.850**	**0.980**
Perfluorohexanoic acid (PFHxA)		**0.160 J**	0.200 U	0.310 U	0.310 U
Perfluorononanoic acid (PFNA)	0.320	0.220 U	0.200 U	**0.330**	**0.200 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**1.60**	0.980 U	**100**	**54.0**
Perfluorooctanoic acid (PFOA)	0.720	**0.320 J**	**0.110 J**	**0.650**	**2.50**
Perfluorotetradecanoic acid (PFTA)		0.330 U	0.290 U	0.310 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.220 U	0.200 U	0.210 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		0.220 U	0.200 U	0.210 U	0.210 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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AOC 31

Soil/Concrete Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 31, Former Moore Army Air Field Fire Training Area

	Location	31SB-19-01	31SB-19-01	31SB-19-01	31SB-19-01	31SB-19-01
	Field Sample ID	31SB-19-01-0-0.5	31SB-19-01-0.5-3	31SB-19-01-3-7	31SB-19-01-7-15	31SB-19-01-65-67
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	65.00 - 67.00
	Sampling Date	10/16/2019	10/16/2019	10/16/2019	10/16/2019	10/16/2019
	SDG	320554481	320554481	320554481	320554481	320554481
	Sample Type	Normal	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		**5.10**	**1.90 J**	**1.30 J**	**3.30 J**	**4.00 J**
8:2 Fluorotelomer sulfonate (8:2 FTS)		**15.0**	**49.0**	**42.0 J**	**50.0 J**	**3.50**
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	0.980 U	0.970 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	**1.60 J**	**0.670 J**	**0.300 J**	1.00 U
Perfluorobutanesulfonic acid (PFBS)		**0.320 J**	**0.120 J**	**0.0690 J**	**0.160 J**	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.520**	**0.960**	**0.340**	**0.250 J**	0.200 U
Perfluorododecanoic acid (PFDoA)		**0.110 J**	0.200 U	0.190 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.430**	**0.510**	**0.430**	**0.380**	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**5.50**	**5.80**	**13.0**	**11.0 J**	**0.380**
Perfluorohexanoic acid (PFHxA)		**1.00**	**1.60**	**1.20**	**1.30**	0.310 U
Perfluorononanoic acid (PFNA)	0.320	**0.120 J**	**0.120 J**	**0.450**	**0.410**	**0.0960 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**65.0**	**33.0**	**530**	**470**	**95.0**
Perfluorooctanoic acid (PFOA)	0.720	**1.80**	**2.50**	**1.80**	**2.00**	**0.330**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.290 U	0.290 U	0.300 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.200 U	0.190 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		**0.160 J**	**0.130 J**	0.190 U	0.200 U	0.200 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 31, Former Moore Army Air Field Fire Training Area

	Location	31SB-19-02	31SB-19-02	31SB-19-02	31SB-19-02	31SB-19-02
	Field Sample ID	31SB-19-02-0-0.5	31SB-19-02-0.5-3	31SB-19-02-3-7	A3-SB-DUP01-101719	31SB-19-02-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/17/2019	10/17/2019	10/17/2019	10/17/2019	10/17/2019
	SDG	320554781	320554781	320554781	320554781	320554781
	Sample Type	Normal	Normal	Normal	Field Duplicate	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		**1.60 J**	**1.30 J**	**2.40 J**	**2.40 J**	**2.80 J**
8:2 Fluorotelomer sulfonate (8:2 FTS)		**3.30 J**	**3.70**	**43.0**	**34.0**	**62.0**
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.00 U	1.20 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**0.380 J**	**0.480 J**	**3.30**	**1.80 J**	**3.60**
Perfluorobutanesulfonic acid (PFBS)		**0.0690 J**	0.180 U	**0.100 J**	**0.0850 J**	**0.210 J**
Perfluorodecanoic acid (PFDA)	0.300	**0.190 J**	**0.270 J**	**0.430**	**0.280 J**	**0.240 J**
Perfluorododecanoic acid (PFDoA)		0.210 U	**0.100 J**	**0.170 J**	**0.210 J**	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.120 J**	**0.230 J**	**0.500**	**0.470**	**0.170 J**
Perfluorohexanesulfonic acid (PFHxS)	0.300	**2.00**	**2.80**	**5.40**	**6.50**	**7.60**
Perfluorohexanoic acid (PFHxA)		**0.490**	**0.430**	**1.60**	**1.60**	**0.930**
Perfluorononanoic acid (PFNA)	0.320	**0.150 J**	**0.150 J**	**0.310 J**	**0.370**	**0.280 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**29.0 J**	**49.0 J**	**76.0 J**	**71.0 J**	**230 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.640**	**1.10**	**2.00**	**2.30**	**1.50**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.300 U	0.360 U	0.310 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.200 U	0.240 U	0.210 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.200 U	**0.140 J**	**0.130 J**	0.210 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 31, Former Moore Army Air Field Fire Training Area

	Location	31SB-19-03	31SB-19-03	31SB-19-03	31SB-19-03
	Field Sample ID	31SB-19-03-0-0.5	31SB-19-03-0.5-3	31SB-19-03-3-7	31SB-19-03-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/17/2019	10/17/2019	10/17/2019	10/17/2019
	SDG	320554781	320554781	320554781	320554781
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.00 U	**1.50 J**	**0.730 J**
8:2 Fluorotelomer sulfonate (8:2 FTS)		**1.40 J**	**6.00**	**29.0 J**	**17.0**
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.00 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	**0.400 J**	**0.440 J**	**0.330 J**
Perfluorobutanesulfonic acid (PFBS)		**0.0930 J**	**0.0860 J**	**0.500**	**0.120 J**
Perfluorodecanoic acid (PFDA)	0.300	0.210 U	**0.300 J**	**0.140 J**	**0.120 J**
Perfluorododecanoic acid (PFDoA)		0.210 U	0.200 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.120 J**	**0.150 J**	**0.210 J**	**0.140 J**
Perfluorohexanesulfonic acid (PFHxS)	0.300	**2.50**	**1.60**	**7.80**	**3.60**
Perfluorohexanoic acid (PFHxA)		**0.420**	**0.310**	**0.990**	**0.390**
Perfluorononanoic acid (PFNA)	0.320	0.210 U	**0.0900 J**	**0.230 J**	**0.190 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**18.0 J**	**25.0 J**	**190 J**	**180 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.630**	**0.760**	**2.60**	**1.30**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.310 U	0.300 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.200 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.200 U	0.200 U	0.200 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 31, Former Moore Army Air Field Fire Training Area

	Location	31SB-19-04	31SB-19-04	31SB-19-04	31SB-19-04
	Field Sample ID	31SB-19-04-0-0.5	31SB-19-04-0.5-3	31SB-19-04-3-7	31SB-19-04-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/16/2019	10/16/2019	10/16/2019	10/16/2019
	SDG	320554481	320554481	320554481	320554481
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		**0.730 J**	20.0 U	1.90 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		**3.50**	**27.0**	**84.0**	**20.0**
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.10 U	1.00 U	0.950 U	0.990 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.10 U	**0.760 J**	**1.10 J**	**0.430 J**
Perfluorobutanesulfonic acid (PFBS)		**0.0690 J**	0.180 U	0.170 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.200 J**	**0.530**	**0.230 J**	**0.120 J**
Perfluorododecanoic acid (PFDoA)		**0.120 J**	0.200 U	0.190 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.160 J**	**0.200 J**	**0.130 J**	**0.0950 J**
Perfluorohexanesulfonic acid (PFHxS)	0.300	**2.00**	**1.50**	**1.30**	**2.40**
Perfluorohexanoic acid (PFHxA)		**0.380**	**0.370**	**0.440**	**0.370**
Perfluorononanoic acid (PFNA)	0.320	0.210 U	**0.130 J**	**0.100 J**	**0.0900 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**13.0 J**	**26.0 J**	**31.0 J**	**74.0 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.700**	**0.770**	**0.700**	**0.830**
Perfluorotetradecanoic acid (PFTA)		0.320 U	0.300 U	0.290 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.200 U	0.190 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		**0.130 J**	**0.130 J**	0.190 U	0.200 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 31, Former Moore Army Air Field Fire Training Area

	Location	31SB-19-05	31SB-19-05	31SB-19-05	31SB-19-05
	Field Sample ID	31SB-19-05-0-0.5	31SB-19-05-0.5-3	31SB-19-05-3-7	31SB-19-05-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/17/2019	10/17/2019	10/17/2019	10/17/2019
	SDG	320554781	320554781	320554781	320554781
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		**0.810 J**	200 U	**56.0**	**26.0 J**
8:2 Fluorotelomer sulfonate (8:2 FTS)		**13.0**	**16.0**	**0.320 J**	**5.20**
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**0.680 J**	1.00 U	1.00 U	1.20 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**2.10**	**0.360 J**	1.00 U	1.20 U
Perfluorobutanesulfonic acid (PFBS)		**0.100 J**	0.180 U	0.180 U	0.220 U
Perfluorodecanoic acid (PFDA)	0.300	**0.610**	0.200 U	0.200 U	0.240 U
Perfluorododecanoic acid (PFDoA)		**0.190 J**	0.200 U	0.200 U	0.240 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.390**	**0.310**	**0.370**	**0.240 J**
Perfluorohexanesulfonic acid (PFHxS)	0.300	**2.60**	**35.0**	**67.0**	**25.0**
Perfluorohexanoic acid (PFHxA)		**0.860**	**0.680**	**0.540**	**0.530**
Perfluorononanoic acid (PFNA)	0.320	**0.450**	**0.250 J**	0.200 U	**0.130 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**35.0 J**	**360**	**53.0 J**	**150 J**
Perfluorooctanoic acid (PFOA)	0.720	**2.50**	**12.0**	**53.0**	**22.0**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.300 U	0.300 U	0.360 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.200 U	0.200 U	0.240 U
Perfluoroundecanoic acid (PFUnA)		**0.230 J**	0.200 U	0.200 U	0.240 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 31, Former Moore Army Air Field Fire Training Area

	Location	31SB-19-06	31SB-19-06
	Field Sample ID	31SB-19-06-0-1	31SB-19-06-3-7
	Sampling Depth	0.00 - 1.00	3.00 - 7.00
	Sampling Date	10/16/2019	10/16/2019
	SDG	320554481	320554481
	Sample Type	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.30 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	0.200 U
Perfluorodecanoic acid (PFDA)	0.300	0.210 U	0.230 U
Perfluorododecanoic acid (PFDoA)		0.210 U	0.230 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.0940 J**	0.230 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.330**	**0.960**
Perfluorohexanoic acid (PFHxA)		0.310 U	**0.0980 J**
Perfluorononanoic acid (PFNA)	0.320	0.210 U	**0.120 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**7.10**	**140 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.110 J**	**0.140 J**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.340 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.230 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.230 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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Bolded and highlighted results indicate detections of PFAS above criteria
Criteria = Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 31, Former Moore Army Air Field Fire Training Area

	Location	31SB-19-07	31SB-19-07	31SB-19-07	31SB-19-07
	Field Sample ID	31-CONCRETE_OCT19	31SB-19-07-0-1	31SB-19-07-3-7	A3-SB-DUP01-101619
	Sampling Depth	0.00 - 1.00	0.00 - 1.00	3.00 - 7.00	3.00 - 7.00
	Sampling Date	10/16/2019	10/16/2019	10/16/2019	10/16/2019
	SDG	320554482	320554481	320554481	320554481
	Sample Type	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		**9.50**	2.10 U	2.00 U	2.30 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		**7.20**	**0.840 J**	1.00 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	**0.600 J**	1.00 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	**2.60**	1.00 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		**2.50**	0.190 U	**0.110 J**	**0.100 J**
Perfluorodecanoic acid (PFDA)	0.300	0.210 U	0.210 U	0.200 U	0.230 U
Perfluorododecanoic acid (PFDoA)		0.210 U	0.210 U	0.200 U	0.230 U
Perfluoroheptanoic acid (PFHpA)	0.500	**1.60**	**0.120 J**	**0.170 J**	**0.190 J**
Perfluorohexanesulfonic acid (PFHxS)	0.300	**41.0**	**12.0**	**15.0**	**17.0**
Perfluorohexanoic acid (PFHxA)		**7.30**	0.460 U	**0.500**	**0.540**
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.210 U	**0.0960 J**	**0.0990 J**
Perfluorooctanesulfonic acid (PFOS)	2.00	**95.0**	**120**	**250**	**220**
Perfluorooctanoic acid (PFOA)	0.720	**4.90**	**2.10**	**3.00**	**3.50**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.310 U	0.310 U	0.340 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.210 U	0.200 U	0.230 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.210 U	0.200 U	0.230 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

AOC 50

Soil Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-01	50SB-19-01	50SB-19-01	50SB-19-01	50SB-19-01
	Field Sample ID	50SB-19-01-0-0.5	50SB-19-01-0.5-3	50SB-19-01-3-7	50SB-19-01-7-15	50SB-19-01-44-46
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	44.00 - 46.00
	Sampling Date	10/24/2019	10/24/2019	10/24/2019	10/24/2019	10/24/2019
	SDG	320557011	320557011	320557011	320557011	320557011
	Sample Type	Normal	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.50 U	2.10 U	2.10 UJ	2.00 U	2.10 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.20 U	1.00 U	1.10 UJ	1.00 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**1.20 J**	1.00 U	1.10 UJ	1.00 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.20 U	1.00 U	1.10 UJ	1.00 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.220 U	0.190 U	0.190 U	0.180 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	**0.410**	**0.210 J**	0.210 U	**0.110 J**	0.210 U
Perfluorododecanoic acid (PFDoA)		**0.690**	0.210 U	0.210 U	0.200 U	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.250 U	0.210 U	0.210 U	0.200 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.230 J**	0.210 U	0.210 U	**0.0800 J**	0.210 U
Perfluorohexanoic acid (PFHxA)		0.250 U	0.210 U	0.210 U	0.200 U	0.210 U
Perfluorononanoic acid (PFNA)	0.320	0.250 U	0.210 U	0.210 U	0.200 U	0.210 U
Perfluorooctanesulfonic acid (PFOS)	2.00	1.60 U	1.00 U	**2.20**	1.00 U	1.10 U
Perfluorooctanoic acid (PFOA)	0.720	**0.120 J**	0.210 U	0.210 U	0.200 U	0.210 U
Perfluorotetradecanoic acid (PFTA)		**0.270 J**	0.310 U	0.320 U	0.300 U	0.320 U
Perfluorotridecanoic acid (PFTrDA)		**0.220 J**	0.210 U	0.210 U	0.200 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		**0.610**	0.210 U	0.210 U	0.200 U	0.210 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-02	50SB-19-02	50SB-19-02	50SB-19-02
	Field Sample ID	50SB-19-02-0-0.5	50SB-19-02-0.5-3	50SB-19-02-3-7	50SB-19-02-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	3.00 - 7.00
	Sampling Date	10/24/2019	10/24/2019	10/24/2019	10/24/2019
	SDG	320557011	320557011	320557011	320557011
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.20 U	2.10 U	2.10 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.10 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.10 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	1.10 U	1.00 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	0.200 U	0.190 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	0.210 U	0.220 U	0.210 U	0.210 U
Perfluorododecanoic acid (PFDoA)		0.210 U	0.220 U	0.210 U	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.210 U	0.220 U	0.210 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.490**	**0.530**	**1.70**	**0.620**
Perfluorohexanoic acid (PFHxA)		**0.0840 J**	**0.110 J**	**0.0790 J**	**0.0960 J**
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.220 U	0.210 U	0.210 U
Perfluorooctanesulfonic acid (PFOS)	2.00	1.50 U	**12.0**	**5.60**	**2.30**
Perfluorooctanoic acid (PFOA)	0.720	**0.110 J**	0.220 U	**0.580**	**0.230 J**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.330 U	0.310 U	0.310 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.220 U	0.210 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.220 U	0.210 U	0.210 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-03	50SB-19-03	50SB-19-03	50SB-19-03	50SB-19-03
	Field Sample ID	50SB-19-03-0-0.5	50SB-19-03-0.5-3	50SB-19-03-3-7	50SB-19-03-7-15	A3-SB-DUP1-102319
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00
	Sampling Date	10/23/2019	10/23/2019	10/23/2019	10/23/2019	10/23/2019
	SDG	320556101	320556101	320556101	320556101	320556101
	Sample Type	Normal	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.00 U	2.00 U	2.50 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	1.00 U	1.20 U	0.980 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	1.00 U	1.20 U	0.980 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	1.00 U	1.20 U	0.980 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.180 U	0.180 U	0.220 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	0.200 U	0.200 U	0.250 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.200 U	0.200 U	0.250 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.200 U	**0.190 J**	**0.130 J**	**0.480**	**0.320**
Perfluorohexanesulfonic acid (PFHxS)	0.300	**12.0**	**19.0**	**6.80**	**6.80 J**	**3.40 J**
Perfluorohexanoic acid (PFHxA)		**0.0950 J**	**0.130 J**	0.250 U	**0.240 J**	**0.160 J**
Perfluorononanoic acid (PFNA)	0.320	**0.100 J**	0.200 U	0.250 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**45.0 J**	**0.600 J**	**0.680 J**	**0.770 J**	**0.420 J**
Perfluorooctanoic acid (PFOA)	0.720	**22.0**	**26.0**	**11.0**	**15.0 J**	**7.80 J**
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.300 U	0.370 U	0.290 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.200 U	0.200 U	0.250 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.200 U	0.200 U	0.250 U	0.200 U	0.200 U

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-04	50SB-19-04	50SB-19-04	50SB-19-04
	Field Sample ID	50SB-19-04-0-0.5	50SB-19-04-0.5-3	50SB-19-04-3-7	50SB-19-04-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/23/2019	10/23/2019	10/23/2019	10/23/2019
	SDG	320556101	320556101	320556101	320556101
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.30 U	2.10 U	2.00 U	2.20 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.10 U	1.10 U	1.00 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.10 U	1.10 U	1.00 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.10 U	1.10 U	1.00 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.200 U	0.190 U	0.180 U	0.200 U
Perfluorodecanoic acid (PFDA)	0.300	0.230 U	0.210 U	0.200 U	0.220 U
Perfluorododecanoic acid (PFDoA)		0.230 U	0.210 U	0.200 U	0.220 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.230 U	0.210 U	0.200 U	0.220 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.230 U	**0.110 J**	0.200 U	0.220 U
Perfluorohexanoic acid (PFHxA)		0.230 U	0.210 U	0.200 U	0.220 U
Perfluorononanoic acid (PFNA)	0.320	0.230 U	0.210 U	0.200 U	0.220 U
Perfluorooctanesulfonic acid (PFOS)	2.00	0.570 U	**0.350 J**	**0.480 J**	0.560 U
Perfluorooctanoic acid (PFOA)	0.720	0.230 U	0.210 U	0.200 U	0.220 U
Perfluorotetradecanoic acid (PFTA)		0.340 U	0.320 U	0.310 U	0.330 U
Perfluorotridecanoic acid (PFTrDA)		0.230 U	0.210 U	0.200 U	0.220 U
Perfluoroundecanoic acid (PFUnA)		0.230 U	0.210 U	0.200 U	0.220 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-05	50SB-19-05	50SB-19-05	50SB-19-05	50SB-19-05	50SB-19-05
	Field Sample ID	50SB-19-05-0-0.5	50SB-19-05-0.5-3	50SB-19-05-3-7	50SB-19-05-7-15	A3-SB-DUP02-102319	50SB-19-05-51-53
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00	51.00 - 53.00
	Sampling Date	10/23/2019	10/23/2019	10/23/2019	10/23/2019	10/23/2019	10/23/2019
	SDG	320556101	320556101	320556101	320556101	320556101	320556101
	Sample Type	Normal	Normal	Normal	Normal	Field Duplicate	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.40 U	2.10 U	2.30 U	2.30 U	1.90 U	**2.80 J**
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.20 U	1.10 U	1.10 U	1.20 U	0.970 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.20 U	1.10 U	1.10 U	1.20 U	0.970 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.20 U	1.10 U	1.10 U	1.20 U	0.970 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.210 U	0.190 U	0.200 U	0.210 U	0.180 U	0.190 U
Perfluorodecanoic acid (PFDA)	0.300	0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
Perfluorododecanoic acid (PFDoA)		0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.270 J**	**1.10**	**0.390**	**0.230 J**	**0.460**	**7.30**
Perfluorohexanoic acid (PFHxA)		**0.0850 J**	**0.170 J**	0.230 U	0.230 U	0.190 U	**0.330**
Perfluorononanoic acid (PFNA)	0.320	0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**2.00 J**	**0.330 J**	**0.350 J**	**0.430 J**	**0.640 J**	0.540 U
Perfluorooctanoic acid (PFOA)	0.720	**0.200 J**	**1.20**	**0.550**	**0.140 J**	**0.220 J**	**12.0**
Perfluorotetradecanoic acid (PFTA)		0.360 U	0.320 U	0.340 U	0.350 U	0.290 U	0.320 U
Perfluorotridecanoic acid (PFTrDA)		0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U
Perfluoroundecanoic acid (PFUnA)		0.240 U	0.210 U	0.230 U	0.230 U	0.190 U	0.210 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-06	50SB-19-06	50SB-19-06	50SB-19-06	50SB-19-06
	Field Sample ID	50SB-19-06-0-0.5	50SB-19-06-0.5-3	50SB-19-06-3-7	50SB-19-06-7-15	50SB-19-06-60-62
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00	60.00 - 62.00
	Sampling Date	10/28/2019	10/28/2019	10/28/2019	10/28/2019	10/28/2019
	SDG	320558522	320558522	320558522	320558522	320558522
	Sample Type	Normal	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.10 U	2.00 U	2.00 U	1.90 U	2.20 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.00 U	0.980 U	1.00 U	0.960 U	1.10 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.00 U	0.980 U	1.00 U	0.960 U	1.10 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.00 U	0.980 U	1.00 U	0.960 U	1.10 U
Perfluorobutanesulfonic acid (PFBS)		0.190 U	0.180 U	0.180 U	0.170 U	0.200 U
Perfluorodecanoic acid (PFDA)	0.300	**0.130 J**	0.200 U	0.200 U	0.190 U	0.220 U
Perfluorododecanoic acid (PFDoA)		0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
Perfluorohexanoic acid (PFHxA)		0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
Perfluorononanoic acid (PFNA)	0.320	0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
Perfluorooctanesulfonic acid (PFOS)	2.00	1.10 U	0.980 U	1.00 U	0.960 U	0.560 U
Perfluorooctanoic acid (PFOA)	0.720	0.210 U	0.200 U	**0.160 J**	0.190 U	0.220 U
Perfluorotetradecanoic acid (PFTA)		0.310 U	0.290 U	0.300 U	0.290 U	0.330 U
Perfluorotridecanoic acid (PFTrDA)		0.210 U	0.200 U	0.200 U	0.190 U	0.220 U
Perfluoroundecanoic acid (PFUnA)		0.210 U	0.200 U	0.200 U	0.190 U	0.220 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
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Criteria = Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-07	50SB-19-07	50SB-19-07	50SB-19-07
	Field Sample ID	50SB-19-07-0-0.5	50SB-19-07-3-7	50SB-19-07-7-15	A3-SB-DUP01-102519
	Sampling Depth	0.00 - 0.50	3.00 - 7.00	7.00 - 15.00	7.00 - 15.00
	Sampling Date	10/25/2019	10/25/2019	10/25/2019	10/25/2019
	SDG	320557011	320557011	320557011	320557011
	Sample Type	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		3.10 U	2.00 U	2.10 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.60 U	1.00 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.60 U	1.00 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.60 U	1.00 U	1.00 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.280 U	0.180 U	0.190 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.160 J**	0.200 U	0.210 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.310 U	0.200 U	0.210 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.310 U	0.200 U	0.210 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.310 U	0.200 U	0.210 U	0.200 U
Perfluorohexanoic acid (PFHxA)		0.310 U	0.200 U	0.210 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	0.310 U	0.200 U	0.210 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	1.80 U	1.00 U	1.00 U	1.00 U
Perfluorooctanoic acid (PFOA)	0.720	0.310 U	**0.160 J**	0.210 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		0.470 U	0.300 U	0.310 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.310 U	0.200 U	0.210 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.310 U	0.200 U	0.210 U	0.200 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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Bolded and highlighted results indicate detections of PFAS above
Criteria = Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-08	50SB-19-08	50SB-19-08	50SB-19-08
	Field Sample ID	50SB-19-08-0-0.5	50SB-19-08-0.5-3	50SB-19-08-3-7	50SB-19-08-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	10/25/2019	10/25/2019	10/25/2019	10/25/2019
	SDG	320557011	320557011	320557011	320557011
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.70 U	2.40 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.40 U	1.20 U	0.990 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.40 U	1.20 U	0.990 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.40 U	1.20 U	0.990 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.240 U	0.220 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.260 J**	0.240 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.270 U	0.240 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.170 J**	0.240 U	0.200 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**0.0840 J**	0.240 U	0.200 U	0.200 U
Perfluorohexanoic acid (PFHxA)		**0.160 J**	0.240 U	0.200 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	**0.210 J**	0.240 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**2.40**	1.20 U	0.490 U	0.500 U
Perfluorooctanoic acid (PFOA)	0.720	**0.770**	0.240 U	0.200 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		0.410 U	0.370 U	0.300 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.270 U	0.240 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		**0.160 J**	0.240 U	0.200 U	0.200 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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Bolded and highlighted results indicate detections of PFAS above
Criteria = Massachusetts Contingency Plan, 2019 Proposed PFAS Revisions

‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-09	50SB-19-09	50SB-19-09	50SB-19-09	50SB-19-09
	Field Sample ID	50SB-19-09-0-0.5	50SB-19-09-0.5-3	A3-SB-DUP01-103119	50SB-19-09-3-5	50SB-19-09-5-7
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	0.50 - 3.00	3.00 - 5.00	5.00 - 7.00
	Sampling Date	10/31/2019	10/31/2019	10/31/2019	10/31/2019	10/31/2019
	SDG	320559202	320559202	320559202	320559202	320559202
	Sample Type	Normal	Normal	Field Duplicate	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.80 U	2.60 U	2.70 U	2.40 U	2.40 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.40 U	1.30 U	1.30 U	1.20 U	1.20 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.40 U	1.30 U	1.30 U	1.20 U	1.20 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.40 U	1.30 U	1.30 U	1.20 U	1.20 U
Perfluorobutanesulfonic acid (PFBS)		0.260 U	0.230 U	0.240 U	**0.0760 J**	0.210 U
Perfluorodecanoic acid (PFDA)	0.300	0.280 U	0.260 U	0.270 U	0.240 U	0.240 U
Perfluorododecanoic acid (PFDoA)		0.280 U	0.260 U	0.270 U	0.240 U	0.240 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.120 J**	**0.120 J**	**0.140 J**	**0.100 J**	0.240 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**2.10**	**2.40**	**1.80**	**1.70**	**0.120 J**
Perfluorohexanoic acid (PFHxA)		**0.210 J**	**0.240 J**	**0.280 J**	**0.240 J**	0.240 U
Perfluorononanoic acid (PFNA)	0.320	**0.130 J**	0.260 U	0.270 U	0.240 U	0.240 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**10.0**	**8.20**	**5.90**	**4.90**	**0.970 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.740**	**0.730**	**0.730**	**0.580**	0.240 U
Perfluorotetradecanoic acid (PFTA)		0.430 U	0.390 U	0.400 U	0.360 U	0.350 U
Perfluorotridecanoic acid (PFTrDA)		0.280 U	0.260 U	0.270 U	0.240 U	0.240 U
Perfluoroundecanoic acid (PFUnA)		0.280 U	0.260 U	0.270 U	0.240 U	0.240 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-10	50SB-19-10	50SB-19-10	50SB-19-10	50SB-19-10
	Field Sample ID	50SB-19-10-0-0.5	50SB-19-10-0.5-3	50SB-19-10-3-5	A3-SB-DUP02-103119	50SB-19-10-5-7
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 5.00	3.00 - 5.00	5.00 - 7.00
	Sampling Date	10/31/2019	10/31/2019	10/31/2019	10/31/2019	10/31/2019
	SDG	320559202	320559202	320559202	320559202	320559202
	Sample Type	Normal	Normal	Normal	Field Duplicate	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.40 U	2.20 U	2.50 U	2.30 U	2.30 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.20 U	1.10 U	1.30 U	1.10 U	1.20 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.20 U	1.10 U	1.30 U	1.10 U	1.20 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.20 U	1.10 U	1.30 U	1.10 U	1.20 U
Perfluorobutanesulfonic acid (PFBS)		0.210 U	0.200 U	0.230 U	0.210 U	0.210 U
Perfluorodecanoic acid (PFDA)	0.300	**0.120 J**	0.220 U	0.250 U	0.230 U	0.230 U
Perfluorododecanoic acid (PFDoA)		0.240 U	0.220 U	0.250 U	0.230 U	0.230 U
Perfluoroheptanoic acid (PFHpA)	0.500	**0.150 J**	**0.370**	0.250 U	0.230 U	0.230 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	**1.50**	**1.70**	**1.50**	**1.50**	**0.110 J**
Perfluorohexanoic acid (PFHxA)		**0.290 J**	**0.610**	**0.250 J**	**0.210 J**	0.230 U
Perfluorononanoic acid (PFNA)	0.320	**0.160 J**	**0.150 J**	0.250 U	0.230 U	0.230 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**6.40**	**4.70**	**0.540 J**	1.10 U	1.20 U
Perfluorooctanoic acid (PFOA)	0.720	**0.660**	**1.80**	**0.210 J**	**0.190 J**	0.230 U
Perfluorotetradecanoic acid (PFTA)		0.350 U	0.330 U	0.380 U	0.340 U	0.350 U
Perfluorotridecanoic acid (PFTrDA)		0.240 U	0.220 U	0.250 U	0.230 U	0.230 U
Perfluoroundecanoic acid (PFUnA)		0.240 U	0.220 U	0.250 U	0.230 U	0.230 U

Notes:
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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-11	50SB-19-11	50SB-19-11	50SB-19-11
	Field Sample ID	50SB-19-11-0-0.5	50SB-19-11-0.5-3	50SB-19-11-3-7	50SB-19-11-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	11/25/2019	11/25/2019	11/25/2019	11/25/2019
	SDG	320566652	320566652	320566652	320566652
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.20 U	2.00 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.10 U	1.00 U	1.00 U	1.00 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.10 U	1.00 U	1.00 U	1.00 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.10 U	1.00 U	1.00 U	1.00 U
Perfluorobutanesulfonic acid (PFBS)		0.200 U	0.180 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	0.220 U	0.200 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.220 U	0.200 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.220 U	0.200 U	0.200 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.220 U	0.200 U	0.200 U	0.200 U
Perfluorohexanoic acid (PFHxA)		0.220 U	0.200 U	0.200 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	**0.130 J**	0.200 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**1.00 J**	**0.390 J**	**0.330 J**	**0.260 J**
Perfluorooctanoic acid (PFOA)	0.720	**0.150 J**	**0.140 J**	0.200 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		0.330 U	0.300 U	0.300 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.220 U	0.200 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.220 U	0.200 U	0.200 U	0.200 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Soil Boring Samples-Area 3
AOC 50, Former Moore Army Air Field

	Location	50SB-19-12	50SB-19-12	50SB-19-12	50SB-19-12
	Field Sample ID	50SB-19-12-0-0.5	50SB-19-12-0.5-3	50SB-19-12-3-7	50SB-19-12-7-15
	Sampling Depth	0.00 - 0.50	0.50 - 3.00	3.00 - 7.00	7.00 - 15.00
	Sampling Date	11/18/2019	11/18/2019	11/18/2019	11/18/2019
	SDG	320564851	320564851	320564851	320564851
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.20 U	2.20 U	2.00 U	2.00 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.10 U	1.10 U	1.00 U	0.990 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.10 U	1.10 U	1.00 U	0.990 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.10 U	1.10 U	1.00 U	0.990 U
Perfluorobutanesulfonic acid (PFBS)		0.200 U	0.200 U	0.180 U	0.180 U
Perfluorodecanoic acid (PFDA)	0.300	**0.120 J**	0.220 U	0.200 U	0.200 U
Perfluorododecanoic acid (PFDoA)		0.220 U	0.220 U	0.200 U	0.200 U
Perfluoroheptanoic acid (PFHpA)	0.500	0.220 U	0.220 U	0.200 U	0.200 U
Perfluorohexanesulfonic acid (PFHxS)	0.300	0.220 U	0.220 U	0.200 U	0.200 U
Perfluorohexanoic acid (PFHxA)		0.220 U	0.220 U	0.200 U	0.200 U
Perfluorononanoic acid (PFNA)	0.320	**0.0990 J**	0.220 U	0.200 U	0.200 U
Perfluorooctanesulfonic acid (PFOS)	2.00	**1.40**	**0.690 J**	0.500 U	0.490 U
Perfluorooctanoic acid (PFOA)	0.720	0.220 U	0.220 U	0.200 U	0.200 U
Perfluorotetradecanoic acid (PFTA)		0.330 U	0.330 U	0.300 U	0.300 U
Perfluorotridecanoic acid (PFTrDA)		0.220 U	0.220 U	0.200 U	0.200 U
Perfluoroundecanoic acid (PFUnA)		0.220 U	0.220 U	0.200 U	0.200 U

Notes:
ug/kg = micrograms per kilogram; U = not detected; J = estimated
The LOQ value will be used to report non-detects when blank contamination occurs

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Bolded and highlighted results indicate detections of PFAS above
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‡ PFAS-Related revisions to the Massachusetts Contingency Plan ("MCP", 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

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PFAS in Surface Water and Sediment and TOC in Sediment

AOC 20 Unnamed Pond

Surface Water and Sediment Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	UP-19-01
	Field Sample ID	UP-19-01-SW-OCT19
	Sampling Depth	0.00 - 0.00
	Sampling Date	10/17/2019
	SDG	320554761
	Sample Type	Normal
PFAS Isotope Dilution	**Limits (ng/l)**	Results (ng/L)
6:2 Fluorotelomer sulfonate (6:2 FTS)		20.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		10.0 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		10.0 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		10.0 U
Perfluorobutanesulfonic acid (PFBS)	2030000	**3.10**
Perfluorodecanoic acid (PFDA)		**2.30**
Perfluorododecanoic acid (PFDoA)		1.50 U
Perfluoroheptanoic acid (PFHpA)		**9.90**
Perfluorohexanesulfonic acid (PFHxS)		**6.40**
Perfluorohexanoic acid (PFHxA)		**11.0**
Perfluorononanoic acid (PFNA)		**5.90**
Perfluorooctanesulfonic acid (PFOS)	2030	**82.0**
Perfluorooctanoic acid (PFOA)	2030	**19.0**
Perfluorotetradecanoic acid (PFTA)		3.00 U
Perfluorotridecanoic acid (PFTrDA)		3.00 U
Perfluoroundecanoic acid (PFUnA)		1.50 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

Bolded results indicate detections of PFAS

Bolded and highlighted results indicate detections of PFAS above criteria

Criteria = EPA Region 1 Memorandum - Surface Water 2/28/2019

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
AOC 20, Waste Water Treatment Plant Sand Filter Beds

	Location	UP-19-01
	Field Sample ID	UP-19-01-SE-OCT19
	Sampling Depth	0.00 - 0.50
	Sampling Date	10/17/2019
	SDG	320554761
	Sample Type	Normal
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.60 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.30 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.30 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.30 U
Perfluorobutanesulfonic acid (PFBS)	609000	0.230 U
Perfluorodecanoic acid (PFDA)		0.260 U
Perfluorododecanoic acid (PFDoA)		0.260 U
Perfluoroheptanoic acid (PFHpA)		0.260 U
Perfluorohexanesulfonic acid (PFHxS)		0.260 U
Perfluorohexanoic acid (PFHxA)		0.260 U
Perfluorononanoic acid (PFNA)		0.260 U
Perfluorooctanesulfonic acid (PFOS)	609	1.30 U
Perfluorooctanoic acid (PFOA)	609	0.260 U
Perfluorotetradecanoic acid (PFTA)		0.380 U
Perfluorotridecanoic acid (PFTrDA)		0.260 U
Perfluoroundecanoic acid (PFUnA)		0.260 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

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Bolded and highlighted results indicate detections of PFAS above criteria

Criteria = EPA Region 1 Memorandum - Sediment 2/28/2018

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

AOC 21 Unnamed Stream

Sediment Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
AOC 21, Waste Water Treatment Plant Sludge Drying Beds

	Location	US-19-01
	Field Sample ID	US-19-01-SE-OCT19
	Sampling Depth	0.00 - 0.50
	Sampling Date	10/18/2019
	SDG	320554761
	Sample Type	Normal
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		5.30 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		2.70 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**2.00 J**
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**0.860 J**
Perfluorobutanesulfonic acid (PFBS)	609000	0.480 U
Perfluorodecanoic acid (PFDA)		**0.640 J**
Perfluorododecanoic acid (PFDoA)		**0.620 J**
Perfluoroheptanoic acid (PFHpA)		0.530 U
Perfluorohexanesulfonic acid (PFHxS)		0.530 U
Perfluorohexanoic acid (PFHxA)		0.530 U
Perfluorononanoic acid (PFNA)		**0.210 J**
Perfluorooctanesulfonic acid (PFOS)	609	**6.70**
Perfluorooctanoic acid (PFOA)	609	**0.460 J**
Perfluorotetradecanoic acid (PFTA)		0.800 U
Perfluorotridecanoic acid (PFTrDA)		**0.280 J**
Perfluoroundecanoic acid (PFUnA)		**0.660 J**

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

Bolded results indicate detections of PFAS

Bolded and highlighted results indicate detections of PFAS above criteria

Criteria = EPA Region 1 Memorandum - Sediment 2/28/2018

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

Airfield Wetland

Surface Water and Sediment Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
AOC 50, Former Moore Army Air Field

	Location	AFW-19-01	AFW-19-02
	Field Sample ID	AFW-19-01_SW-OCT19	AFW-19-02_SW-OCT19
	Sampling Depth	0.00 - 0.00	0.00 - 0.00
	Sampling Date	10/18/2019	10/18/2019
	SDG	320554761	320554761
	Sample Type	Normal	Normal
PFAS Isotope Dilution	**Limits (ng/l)**	Results (ng/L)	Results (ng/L)
6:2 Fluorotelomer sulfonate (6:2 FTS)		20.0 U	20.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		9.80 U	10.0 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		9.80 U	10.0 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		9.80 U	10.0 U
Perfluorobutanesulfonic acid (PFBS)	2030000	**0.510 J**	**1.50 J**
Perfluorodecanoic acid (PFDA)		**0.600 J**	**0.820 J**
Perfluorododecanoic acid (PFDoA)		1.50 U	1.50 U
Perfluoroheptanoic acid (PFHpA)		**3.40**	**4.40**
Perfluorohexanesulfonic acid (PFHxS)		**4.90**	**12.0**
Perfluorohexanoic acid (PFHxA)		**3.00**	**6.20**
Perfluorononanoic acid (PFNA)		**1.00 J**	**1.60 J**
Perfluorooctanesulfonic acid (PFOS)	2030	**6.70**	**13.0**
Perfluorooctanoic acid (PFOA)	2030	**4.50**	**9.30**
Perfluorotetradecanoic acid (PFTA)		2.90 U	3.00 U
Perfluorotridecanoic acid (PFTrDA)		2.90 U	3.00 U
Perfluoroundecanoic acid (PFUnA)		1.50 U	1.50 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

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Criteria = EPA Region 1 Memorandum - Surface Water 2/28/2019

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
AOC 50, Former Moore Army Air Field

	Location	AFW-19-01	AFW-19-02
	Field Sample ID	AFW-19-01_SE-OCT19	AFW-19-02_SE-OCT19
	Sampling Depth	0.00 - 0.50	0.00 - 0.50
	Sampling Date	10/18/2019	10/18/2019
	SDG	320554761	320554761
	Sample Type	Normal	Normal
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		11.0 U	12.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		5.40 U	5.90 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		5.40 U	**2.00 J**
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		5.40 U	5.90 U
Perfluorobutanesulfonic acid (PFBS)	609000	0.980 U	1.10 U
Perfluorodecanoic acid (PFDA)		**0.530 J**	**1.10 J**
Perfluorododecanoic acid (PFDoA)		1.10 U	**0.640 J**
Perfluoroheptanoic acid (PFHpA)		1.10 U	1.20 U
Perfluorohexanesulfonic acid (PFHxS)		**1.10 J**	**1.90**
Perfluorohexanoic acid (PFHxA)		1.10 U	1.20 U
Perfluorononanoic acid (PFNA)		1.10 U	**0.640 J**
Perfluorooctanesulfonic acid (PFOS)	609	**5.30 J**	**16.0**
Perfluorooctanoic acid (PFOA)	609	**0.770 J**	**1.20 J**
Perfluorotetradecanoic acid (PFTA)		1.60 U	1.80 U
Perfluorotridecanoic acid (PFTrDA)		1.10 U	1.20 U
Perfluoroundecanoic acid (PFUnA)		1.10 U	**1.40 J**

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

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Bolded and highlighted results indicate detections of PFAS above criteria

Criteria = EPA Region 1 Memorandum - Sediment 2/28/2018

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

Nashua River

Surface Water and Sediment Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
Nashua River

	Location	NR-19-01	NR-19-02	NR-19-02	NR-19-03	NR-19-04	NR-19-05
	Field Sample ID	NR-19-01-SW-OCT19	A3-SW-DUP-101619	NR-19-02-SW-OCT19	NR-19-03-SW-OCT19	NR-19-04-SW-OCT19	NR-19-05-SW-OCT19
	Sampling Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
	Sampling Date	10/17/2019	10/16/2019	10/16/2019	10/16/2019	10/16/2019	10/16/2019
	SDG	320554761	320554451	320554451	320554451	320554451	320554451
	Sample Type	Normal	Field Duplicate	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ng/l)**	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)
6:2 Fluorotelomer sulfonate (6:2 FTS)		20.0 U	18.0 U	19.0 U	18.0 U	18.0 U	19.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		9.80 U	9.10 U	9.30 U	9.20 U	8.90 U	9.30 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		9.80 U	9.10 U	9.30 U	9.20 U	8.90 U	9.30 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		9.80 U	9.10 U	9.30 U	9.20 U	8.90 U	9.30 U
Perfluorobutanesulfonic acid (PFBS)	2030000	**7.10**	**11.0**	**9.90**	**9.70**	**9.70**	**9.20**
Perfluorodecanoic acid (PFDA)		**1.30 J**	**0.780 J**	**0.810 J**	**0.850 J**	**0.770 J**	**0.770 J**
Perfluorododecanoic acid (PFDoA)		1.50 U	1.40 U	1.40 U	1.40 U	1.30 U	**0.950 J**
Perfluoroheptanoic acid (PFHpA)		**6.90**	**10.0**	**9.70**	**9.50**	**9.30**	**9.70**
Perfluorohexanesulfonic acid (PFHxS)		**2.20**	**2.90**	**2.90**	**2.70**	**2.80**	**3.80**
Perfluorohexanoic acid (PFHxA)		**14.0**	**20.0**	**19.0**	**19.0**	**18.0**	**19.0**
Perfluorononanoic acid (PFNA)		**1.60 J**	**1.40 J**	**1.30 J**	**1.40 J**	**1.30 J**	**1.30 J**
Perfluorooctanesulfonic acid (PFOS)	2030	**7.90**	**6.80**	**6.40**	**6.10**	**6.40**	**7.20**
Perfluorooctanoic acid (PFOA)	2030	**13.0**	**16.0**	**16.0**	**16.0**	**16.0**	**15.0**
Perfluorotetradecanoic acid (PFTA)		3.00 U	2.70 U	2.80 U	2.80 U	2.70 U	2.80 U
Perfluorotridecanoic acid (PFTrDA)		3.00 U	2.70 U	2.80 U	2.80 U	2.70 U	2.80 U
Perfluoroundecanoic acid (PFUnA)		1.50 U	1.40 U	1.40 U	1.40 U	1.30 U	1.40 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

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Criteria = EPA Region 1 Memorandum - Surface Water 2/28/2019

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
Nashua River

	Location	NR-19-06	NR-19-07	NR-19-08	NR-19-09	NR-19-10	NR-19-11
	Field Sample ID	NR-19-06-SW-OCT19	NR-19-07-SW-OCT19	NR-19-08-SW-OCT19	NR-19-09-SW-OCT19	NR-19-10-SW-OCT19	A3-SW-DUP-101419
	Sampling Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
	Sampling Date	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/14/2019
	SDG	320554451	320554451	320554451	320554451	320554451	320554451
	Sample Type	Normal	Normal	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution	**Limits (ng/l)**	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)
6:2 Fluorotelomer sulfonate (6:2 FTS)		18.0 U	19.0 U	19.0 U	19.0 U	19.0 U	19.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		9.20 U	9.50 U	9.40 U	9.30 U	9.30 U	9.40 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		9.20 U	9.50 U	9.40 U	9.30 U	9.30 U	9.40 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		9.20 U	9.50 U	9.40 U	9.30 U	9.30 U	9.40 U
Perfluorobutanesulfonic acid (PFBS)	2030000	**8.40**	**7.70**	**7.90**	**8.10**	**7.30**	**7.20**
Perfluorodecanoic acid (PFDA)		**3.10**	**0.900 J**	**0.820 J**	**0.900 J**	**0.860 J**	**0.860 J**
Perfluorododecanoic acid (PFDoA)		1.40 U	1.40 U	1.40 U	**0.710 J**	1.40 U	1.40 U
Perfluoroheptanoic acid (PFHpA)		**14.0**	**9.30**	**9.30**	**9.10**	**8.50**	**7.60**
Perfluorohexanesulfonic acid (PFHxS)		**8.50**	**4.10**	**12.0**	**8.30**	**4.50**	**4.30**
Perfluorohexanoic acid (PFHxA)		**20.0**	**17.0**	**19.0**	**18.0**	**17.0**	**16.0**
Perfluorononanoic acid (PFNA)		**2.80**	**1.50 J**	**1.40 J**	**1.40 J**	**1.40 J**	**1.30 J**
Perfluorooctanesulfonic acid (PFOS)	2030	**56.0**	**10.0**	**8.10**	**9.00**	**8.10**	**7.90**
Perfluorooctanoic acid (PFOA)	2030	**28.0**	**15.0**	**17.0**	**17.0**	**15.0**	**14.0**
Perfluorotetradecanoic acid (PFTA)		2.80 U	2.80 U	2.80 U	2.80 U	2.80 U	2.80 U
Perfluorotridecanoic acid (PFTrDA)		2.80 U	2.80 U	2.80 U	2.80 U	2.80 U	2.80 U
Perfluoroundecanoic acid (PFUnA)		**0.990 J**	1.40 U	1.40 U	1.40 U	1.40 U	1.40 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

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Criteria = EPA Region 1 Memorandum - Surface Water 2/28/2019

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
Nashua River

	Location	NR-19-11	NR-19-12	NR-19-13	NR-19-14
	Field Sample ID	NR-19-11-SW-OCT19	NR-19-12-SW-OCT19	NR-19-13-SW-OCT19	NR-SW-19-14-DEC19
	Sampling Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
	Sampling Date	10/14/2019	10/14/2019	10/14/2019	12/18/2019
	SDG	320554451	320554451	320554451	320572931
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ng/l)**	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)
6:2 Fluorotelomer sulfonate (6:2 FTS)		18.0 U	18.0 U	18.0 U	17.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		9.20 U	9.20 U	9.00 U	8.70 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		9.20 U	9.20 U	9.00 U	8.70 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		9.20 U	9.20 U	9.00 U	8.70 U
Perfluorobutanesulfonic acid (PFBS)	2030000	**7.40**	**6.80**	**6.60**	**1.80**
Perfluorodecanoic acid (PFDA)		**0.850 J**	**1.00 J**	**1.00 J**	**0.650 J**
Perfluorododecanoic acid (PFDoA)		1.40 U	1.40 U	1.40 U	1.30 U
Perfluoroheptanoic acid (PFHpA)		**7.50**	**8.40**	**8.30**	**5.00**
Perfluorohexanesulfonic acid (PFHxS)		**4.40**	**4.30**	**6.30**	**1.20 J**
Perfluorohexanoic acid (PFHxA)		**16.0**	**15.0**	**15.0**	**8.10**
Perfluorononanoic acid (PFNA)		**1.40 J**	**1.20 J**	**1.60 J**	**1.40 J**
Perfluorooctanesulfonic acid (PFOS)	2030	**8.20**	**8.20**	**10.0**	**6.10**
Perfluorooctanoic acid (PFOA)	2030	**13.0**	**14.0**	**15.0**	**10.0**
Perfluorotetradecanoic acid (PFTA)		2.80 U	2.80 U	2.70 U	2.60 U
Perfluorotridecanoic acid (PFTrDA)		2.80 U	2.80 U	2.70 U	2.60 U
Perfluoroundecanoic acid (PFUnA)		1.40 U	1.40 U	1.40 U	1.30 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

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Criteria = EPA Region 1 Memorandum - Surface Water 2/28/2019

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
Nashua River

	Location	NR-19-01	NR-19-02	NR-19-02	NR-19-03	NR-19-04	NR-19-05
	Field Sample ID	NR-19-01-SE-OCT19	A3-SE-DUP-101619	NR-19-02-SE-OCT19	NR-19-03-SE-OCT19	NR-19-04-SE-OCT19	NR-19-05-SE-OCT19
	Sampling Depth	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50
	Sampling Date	10/17/2019	10/16/2019	10/16/2019	10/16/2019	10/16/2019	10/16/2019
	SDG	320554761	320554451	320554451	320554451	320554451	320554451
	Sample Type	Normal	Field Duplicate	Normal	Normal	Normal	Normal
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		6.50 U	3.30 U	3.20 U	5.10 U	3.30 U	4.40 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		3.30 U	1.70 U	1.60 U	2.60 U	1.70 U	2.20 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**8.50**	**0.710 J**	**0.570 J**	**1.20 J**	1.70 U	**4.90 J**
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**3.70 J**	1.70 U	1.60 U	2.60 U	1.70 U	**0.840 J**
Perfluorobutanesulfonic acid (PFBS)	609000	0.590 U	0.300 U	0.290 U	0.460 U	0.300 U	0.400 U
Perfluorodecanoic acid (PFDA)		**0.920 J**	**0.160 J**	0.320 U	0.510 U	**0.300 J**	0.440 U
Perfluorododecanoic acid (PFDoA)		**1.10**	0.330 U	0.320 U	**0.260 J**	0.330 U	0.440 U
Perfluoroheptanoic acid (PFHpA)		0.650 U	0.330 U	0.320 U	0.510 U	0.330 U	0.440 U
Perfluorohexanesulfonic acid (PFHxS)		0.650 U	**0.200 J**	**0.150 J**	**0.290 J**	**0.120 J**	**0.770 J**
Perfluorohexanoic acid (PFHxA)		0.650 U	**0.160 J**	**0.140 J**	**0.330 J**	**0.150 J**	0.440 U
Perfluorononanoic acid (PFNA)		0.650 U	0.330 U	0.320 U	0.510 U	**0.160 J**	0.440 U
Perfluorooctanesulfonic acid (PFOS)	609	**4.20**	**2.10**	**1.80**	**1.30 J**	**2.90**	**1.80 J**
Perfluorooctanoic acid (PFOA)	609	**0.590 J**	**0.400 J**	**0.330 J**	**0.360 J**	**0.360 J**	0.440 U
Perfluorotetradecanoic acid (PFTA)		**0.370 J**	0.500 U	0.490 U	0.770 U	0.500 U	0.670 U
Perfluorotridecanoic acid (PFTrDA)		**0.380 J**	0.330 U	0.320 U	0.510 U	0.330 U	**0.270 J**
Perfluoroundecanoic acid (PFUnA)		**2.20**	0.330 U	0.320 U	0.510 U	0.330 U	0.440 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

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Criteria = EPA Region 1 Memorandum - Sediment 2/28/2018

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
Nashua River

	Location	NR-19-06	NR-19-07	NR-19-08	NR-19-09	NR-19-10	NR-19-11
	Field Sample ID	NR-19-06-SE-OCT19	NR-19-07-SE-OCT19	NR-19-08-SE-OCT19	NR-19-09-SE-OCT19	NR-19-10-SE-OCT19	A3-SE-DUP-101419
	Sampling Depth	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50
	Sampling Date	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/14/2019
	SDG	320554451	320554451	320554451	320554451	320554451	320554451
	Sample Type	Normal	Normal	Normal	Normal	Normal	Field Duplicate
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		2.40 U	3.20 U	3.50 U	2.70 U	2.90 U	3.30 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.20 U	1.60 U	1.70 U	1.30 U	1.40 U	1.60 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.20 U	**3.70**	1.70 U	1.30 U	1.40 U	**0.590 J**
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**0.520 J**	**1.50 J**	1.70 U	1.30 U	1.40 U	1.60 U
Perfluorobutanesulfonic acid (PFBS)	609000	0.220 U	0.290 U	0.310 U	0.240 U	0.260 U	0.290 U
Perfluorodecanoic acid (PFDA)		0.240 U	0.320 U	0.350 U	0.270 U	0.290 U	0.330 U
Perfluorododecanoic acid (PFDoA)		0.240 U	0.320 U	0.350 U	0.270 U	0.290 U	0.330 U
Perfluoroheptanoic acid (PFHpA)		0.240 U	0.320 U	0.350 U	0.270 U	0.290 U	0.330 U
Perfluorohexanesulfonic acid (PFHxS)		0.240 U	**0.270 J**	**1.50**	**0.0970 J**	**0.170 J**	**0.300 J**
Perfluorohexanoic acid (PFHxA)		0.240 U	**0.110 J**	**0.200 J**	0.270 U	**0.320 J**	0.330 U
Perfluorononanoic acid (PFNA)		0.240 U	0.320 U	0.350 U	0.270 U	0.290 U	0.330 U
Perfluorooctanesulfonic acid (PFOS)	609	**0.930 J**	**2.10**	**2.10**	**0.700 J**	**0.720 J**	**1.20 J**
Perfluorooctanoic acid (PFOA)	609	0.240 U	0.320 U	**0.570**	0.270 U	**0.140 J**	0.330 U
Perfluorotetradecanoic acid (PFTA)		0.360 U	0.480 U	0.520 U	0.400 U	0.430 U	0.490 U
Perfluorotridecanoic acid (PFTrDA)		0.240 U	0.320 U	0.350 U	0.270 U	0.290 U	0.330 U
Perfluoroundecanoic acid (PFUnA)		0.240 U	0.320 U	0.350 U	0.270 U	0.290 U	0.330 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

Bolded results indicate detections of PFAS

Bolded and highlighted results indicate detections of PFAS above criteria

Criteria = EPA Region 1 Memorandum - Sediment 2/28/2018

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Area3
Nashua River

	Location	NR-19-11	NR-19-12	NR-19-13	NR-19-14
	Field Sample ID	NR-19-11-SE-OCT19	NR-19-12-SE-OCT19	NR-19-13-SE-OCT19	NR-SED-19-14-DEC19
	Sampling Depth	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50
	Sampling Date	10/14/2019	10/14/2019	10/14/2019	12/18/2019
	SDG	320554451	320554451	320554451	320572931
	Sample Type	Normal	Normal	Normal	Normal
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		3.10 U	4.50 U	2.40 U	3.30 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.60 U	2.20 U	1.20 U	1.70 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		**0.520 J**	**2.00 J**	1.20 U	**0.760 J**
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		1.60 U	**1.70 J**	1.20 U	**1.00 J**
Perfluorobutanesulfonic acid (PFBS)	609000	0.280 U	0.400 U	0.210 U	0.300 U
Perfluorodecanoic acid (PFDA)		0.310 U	**0.660 J**	0.240 U	**0.210 J**
Perfluorododecanoic acid (PFDoA)		0.310 U	**0.570 J**	0.240 U	**0.300 J**
Perfluoroheptanoic acid (PFHpA)		0.310 U	0.450 U	0.240 U	0.330 U
Perfluorohexanesulfonic acid (PFHxS)		**0.390 J**	**0.390 J**	0.240 U	0.500 U
Perfluorohexanoic acid (PFHxA)		0.310 U	0.450 U	0.240 U	0.330 U
Perfluorononanoic acid (PFNA)		0.310 U	0.450 U	0.240 U	0.330 U
Perfluorooctanesulfonic acid (PFOS)	609	**1.20 J**	**5.20**	1.20 U	**1.60 J**
Perfluorooctanoic acid (PFOA)	609	0.310 U	**0.340 J**	0.240 U	**0.170 J**
Perfluorotetradecanoic acid (PFTA)		0.470 U	**0.250 J**	0.350 U	0.500 U
Perfluorotridecanoic acid (PFTrDA)		0.310 U	**0.320 J**	0.240 U	**0.300 J**
Perfluoroundecanoic acid (PFUnA)		0.310 U	**0.590 J**	0.240 U	**0.440 J**

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

Bolded results indicate detections of PFAS

Bolded and highlighted results indicate detections of PFAS above criteria

Criteria = EPA Region 1 Memorandum - Sediment 2/28/2018

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

Background Locations

Surface Water and Sediment Results

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Background
Background

	Location	BB-20-01	FP-20-01	FP-20-02	FP-20-02	NRBK-19-01	NRBK-19-02
	Field Sample ID	BB-20-01-SW_MAY20	FP-20-01-SW_MAY20	BK-SW-DUP_052020	FP-20-02-SW_MAY20	NRBK-SW-19-01-DEC19	NRBK-SW-19-02-DEC19
	Sampling Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
	Sampling Date	05/20/2020	05/20/2020	05/20/2020	05/20/2020	12/20/2019	12/20/2019
	SDG	320610571	320610571	320610571	320610571	320572951	320572951
	Sample Type	Normal	Normal	Field Duplicate	Normal	Normal	Normal
PFAS Isotope Dilution	**Limits (ng/l)**	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)	Results (ng/L)
6:2 Fluorotelomer sulfonate (6:2 FTS)		16.0 U	17.0 U	19.0 U	17.0 U	19.0 U	19.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		8.20 U	8.50 U	9.50 U	8.40 U	9.40 U	9.50 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		8.20 U	8.50 U	9.50 U	8.40 U	9.40 U	9.50 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		8.20 U	8.50 U	9.50 U	8.40 U	9.40 U	9.50 U
Perfluorobutanesulfonic acid (PFBS)	2030000	**1.10 J**	**0.780 J**	**0.950 J**	**0.830 J**	**2.90**	**3.20**
Perfluorodecanoic acid (PFDA)		0.820 U	**0.510 J**	0.950 U	**0.680 J**	0.940 U	0.950 U
Perfluorododecanoic acid (PFDoA)		1.20 U	1.30 U	1.40 U	1.30 U	1.40 U	1.40 U
Perfluoroheptanoic acid (PFHpA)		**1.50 J**	**1.50 J**	**4.10**	**4.50**	**5.20**	**5.30**
Perfluorohexanesulfonic acid (PFHxS)		**0.600 J**	**0.640 J**	**0.920 J**	**0.770 J**	**1.30 J**	**1.30 J**
Perfluorohexanoic acid (PFHxA)		**1.90**	**1.70**	**5.00**	**5.10**	**8.70**	**8.80**
Perfluorononanoic acid (PFNA)		**0.420 J**	**0.550 J**	**1.50 J**	**1.40 J**	**1.10 J**	**1.20 J**
Perfluorooctanesulfonic acid (PFOS)	2030	**2.40 J**	**3.20 J**	**5.40**	**5.70**	**4.00**	**4.20**
Perfluorooctanoic acid (PFOA)	2030	**3.30**	**4.30**	**10.0**	**11.0**	**10.0**	**10.0**
Perfluorotetradecanoic acid (PFTA)		2.50 U	2.60 U	2.90 U	2.50 U	2.80 U	2.80 U
Perfluorotridecanoic acid (PFTrDA)		2.50 U	2.60 U	2.90 U	2.50 U	2.80 U	2.80 U
Perfluoroundecanoic acid (PFUnA)		1.20 U	1.30 U	1.40 U	1.30 U	1.40 U	1.40 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

The LOQ value will be used to report non-detects when blank contamination occurs

Bolded results indicate detections of PFAS

Bolded and highlighted results indicate detections of PFAS above criteria

Criteria = EPA Region 1 Memorandum - Surface Water 2/28/2019

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Background
Background

	Location	SR-19-01	SR-19-01	WAB-19-01
	Field Sample ID	BK-SW-DUP-121819	SR-SW-19-01-DEC19	WAB-SW-19-01-DEC19
	Sampling Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
	Sampling Date	12/18/2019	12/18/2019	12/18/2019
	SDG	320572951	320572951	320572951
	Sample Type	Field Duplicate	Normal	Normal
PFAS Isotope Dilution	**Limits (ng/l)**	Results (ng/L)	Results (ng/L)	Results (ng/L)
6:2 Fluorotelomer sulfonate (6:2 FTS)		19.0 U	20.0 U	20.0 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		9.50 U	9.80 U	9.90 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		9.50 U	9.80 U	9.90 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		9.50 U	9.80 U	9.90 U
Perfluorobutanesulfonic acid (PFBS)	2030000	**0.550 J**	**0.600 J**	**7.80**
Perfluorodecanoic acid (PFDA)		0.950 U	0.980 U	0.990 U
Perfluorododecanoic acid (PFDoA)		1.40 U	1.50 U	1.50 U
Perfluoroheptanoic acid (PFHpA)		**2.50**	**2.40**	**6.10**
Perfluorohexanesulfonic acid (PFHxS)		**0.920 J**	**0.890 J**	**1.20 J**
Perfluorohexanoic acid (PFHxA)		**8.00**	**8.20**	**33.0**
Perfluorononanoic acid (PFNA)		**0.630 J**	**0.620 J**	1.50 U
Perfluorooctanesulfonic acid (PFOS)	2030	**2.60 J**	**2.80 J**	**1.50 J**
Perfluorooctanoic acid (PFOA)	2030	**7.90**	**7.80**	**6.20**
Perfluorotetradecanoic acid (PFTA)		2.90 U	2.90 U	3.00 U
Perfluorotridecanoic acid (PFTrDA)		2.90 U	2.90 U	3.00 U
Perfluoroundecanoic acid (PFUnA)		1.40 U	1.50 U	1.50 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

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Criteria = EPA Region 1 Memorandum - Surface Water 2/28/2019

† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

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PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Background
Background

	Location	BB-20-01	FP-20-01	FP-20-02	FP-20-02	NRBK-19-01	NRBK-19-02
	Field Sample ID	BB-20-01-SED_MAY20	FP-20-01-SED_MAY20	BK-SED-DUP_052020	FP-20-02-SED_MAY20	NRBK-SED-19-01-DEC19	NRBK-SED-19-02-DEC19
	Sampling Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.50	0.00 - 0.50
	Sampling Date	05/20/2020	05/20/2020	05/20/2020	05/20/2020	12/20/2019	12/20/2019
	SDG	320610571	320610571	320610571	320610571	320572951	320572951
	Sample Type	Normal	Normal	Field Duplicate	Normal	Normal	Normal
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		110 U	3.60 U	4.40 U	2.80 U	3.00 U	2.90 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		53.0 U	1.80 U	2.20 U	1.40 U	1.50 U	1.40 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		53.0 U	1.80 U	2.20 U	1.40 U	1.50 U	1.40 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		53.0 U	1.80 U	2.20 U	1.40 U	1.50 U	1.40 U
Perfluorobutanesulfonic acid (PFBS)	609000	9.60 U	0.330 U	0.400 U	0.250 U	0.270 U	0.260 U
Perfluorodecanoic acid (PFDA)		11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	**0.170 J**
Perfluorododecanoic acid (PFDoA)		11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	0.290 U
Perfluoroheptanoic acid (PFHpA)		11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	0.290 U
Perfluorohexanesulfonic acid (PFHxS)		11.0 U	**0.120 J**	0.440 U	0.280 U	0.300 U	0.430 U
Perfluorohexanoic acid (PFHxA)		11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	0.290 U
Perfluorononanoic acid (PFNA)		11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	0.290 U
Perfluorooctanesulfonic acid (PFOS)	609	27.0 U	0.910 U	1.10 U	0.700 U	**0.420 J**	**0.750 J**
Perfluorooctanoic acid (PFOA)	609	11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	**0.180 J**
Perfluorotetradecanoic acid (PFTA)		16.0 U	0.540 U	0.670 U	0.420 U	0.460 U	0.430 U
Perfluorotridecanoic acid (PFTrDA)		11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	0.290 U
Perfluoroundecanoic acid (PFUnA)		11.0 U	0.360 U	0.440 U	0.280 U	0.300 U	0.290 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

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Criteria = EPA Region 1 Memorandum - Sediment 2/28/2018

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‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

PFAS Summary Report – Soil, Sediment, and Surface Water
Former Fort Devens, PFAS Remedial Investigation
KOMAN, PFAS RI, Surface Water/Sediment-Background
Background

	Location	SR-19-01	SR-19-01	WAB-19-01
	Field Sample ID	BK-SED-DUP-121819	SR-SED-19-01-DEC19	WAB-SED-19-01-DEC19
	Sampling Depth	0.00 - 0.50	0.00 - 0.50	0.00 - 0.50
	Sampling Date	12/18/2019	12/18/2019	12/18/2019
	SDG	320572951	320572951	320572951
	Sample Type	Field Duplicate	Normal	Normal
PFAS Isotope Dilution Sediment	**Limits (ug/kg)**	Results (µg/kg)	Results (µg/kg)	Results (µg/kg)
6:2 Fluorotelomer sulfonate (6:2 FTS)		3.40 U	3.30 U	2.40 U
8:2 Fluorotelomer sulfonate (8:2 FTS)		1.70 U	1.60 U	1.20 U
N-Ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)		1.70 U	1.60 U	1.20 U
N-Methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)		**0.530 J**	**0.620 J**	1.20 U
Perfluorobutanesulfonic acid (PFBS)	609000	0.300 U	0.290 U	0.220 U
Perfluorodecanoic acid (PFDA)		**0.540**	**0.550**	0.240 U
Perfluorododecanoic acid (PFDoA)		0.340 U	0.330 U	0.240 U
Perfluoroheptanoic acid (PFHpA)		**0.830**	**0.800**	0.240 U
Perfluorohexanesulfonic acid (PFHxS)		0.500 U	0.490 U	0.240 U
Perfluorohexanoic acid (PFHxA)		**0.850**	**0.850**	**0.140 J**
Perfluorononanoic acid (PFNA)		**0.840**	**0.770**	0.240 U
Perfluorooctanesulfonic acid (PFOS)	609	**7.50**	**7.90**	**0.720 J**
Perfluorooctanoic acid (PFOA)	609	**2.80**	**2.70**	0.240 U
Perfluorotetradecanoic acid (PFTA)		0.500 U	0.490 U	0.370 U
Perfluorotridecanoic acid (PFTrDA)		0.340 U	0.330 U	0.240 U
Perfluoroundecanoic acid (PFUnA)		**0.190 J**	**0.210 J**	0.240 U

Notes:

ng/L = nanograms per liter; ug/kg = micrograms per kilogram; U = not detected; J = estimated

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† Lifetime Health Advisory, US Environmental Protection Agency, May 2016

‡ PFAS-Related revisions to the Massachusetts Contingency Plan (“MCP”, 310 CMR 40.0000), Massachusetts Department of Environmental Protection, April 19, 2019

All Locations

TOC Results

KOMAN, PFAS RI, Sediment-Area3
Total Organic Carbon Data

Locations:	UP-19-01	US-19-01	AFW-19-01	AFW-19-02
Field Sample ID:	UP-19-01-SE-OCT19	US-19-01-SE-OCT19	AFW-19-01_SE-OCT19	AFW-19-02_SE-OCT19
Sample Begin Depth:	0	0	0	0
Sample End Depth:	0.5	0.5	0.5	0.5
Sample Date:	10/17/2019	10/18/2019	10/18/2019	10/18/2019
Gen. Chemistry (MG/KG)				
Total Organic Carbon	**7,000**	**130,000**	**160,000**	**300,000**

Detects are displayed in bold font

Units

MG/KG = milligrams per kilogram

KOMAN, PFAS RI, Sediment-Area3
Total Organic Carbon Data

Locations:	NR-19-01	NR-19-02	NR-19-02 (FD)	NR-19-03	NR-19-04	NR-19-05
Field Sample ID:	NR-19-01-SE-OCT19	NR-19-02-SE-OCT19	A3-SE-DUP-101619	NR-19-03-SE-OCT19	NR-19-04-SE-OCT19	NR-19-05-SE-OCT19
Sample Begin Depth:	0	0	0	0	0	0
Sample End Depth:	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date:	10/17/2019	10/16/2019	10/16/2019	10/16/2019	10/16/2019	10/16/2019
Gen. Chemistry (MG/KG)						
Total Organic Carbon	**130,000**	**11,000**	**10,000**	**67,000**	**17,000**	**22,000**

Detects are displayed in bold font

J = estimated result

Units

MG/KG = milligrams per kilogram

KOMAN, PFAS RI, Sediment-Area3
Total Organic Carbon Data

Locations:	NR-19-06	NR-19-07	NR-19-08	NR-19-09	NR-19-10	NR-19-11
Field Sample ID:	NR-19-06-SE-OCT19	NR-19-07-SE-OCT19	NR-19-08-SE-OCT19	NR-19-09-SE-OCT19	NR-19-10-SE-OCT19	NR-19-11-SE-OCT19
Sample Begin Depth:	0	0	0	0	0	0
Sample End Depth:	0.5	0.5	0.5	0.5	0.5	0.5
Sample Date:	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/15/2019	10/14/2019
Gen. Chemistry (MG/KG)						
Total Organic Carbon	**1,500 J**	**21,000**	**12,000**	**5,400**	**6,700**	**13,000**

Detects are displayed in bold font

J = estimated result

Units

MG/KG = milligrams per kilogram

KOMAN, PFAS RI, Sediment-Area3
Total Organic Carbon Data

Locations:	NR-19-11 (FD)	NR-19-12	NR-19-13	NR-19-14
Field Sample ID:	A3-SE-DUP-101419	NR-19-12-SE-OCT19	NR-19-13-SE-OCT19	NR-SED-19-14-DEC19
Sample Begin Depth:	0	0	0	0
Sample End Depth:	0.5	0.5	0.5	0.5
Sample Date:	10/14/2019	10/14/2019	10/14/2019	12/18/2019
Gen. Chemistry (MG/KG)				
Total Organic Carbon	**13,000**	**62,000**	**3,000**	**25,000**

Detects are displayed in bold font

J = estimated result

Units

MG/KG = milligrams per kilogram

Former Fort Devens

KOMAN, PFAS
RI,Sediment
Background

Locations:	BB-20-01	FP-20-01	FP-20-02	FP-20-02 (FD)	NRBK-19-01	NRBK-19-02
Field Sample ID:	BB-20-01-SED_MAY20	FP-20-01-SED_MAY20	FP-20-02-SED_MAY20	BK-SED-DUP_052020	NRBK-SED-19-01-DEC19	NRBK-SED-19-
Sample Begin Depth:	0	0	0	0	0	0
Sample End Depth:	0	0	0	0	0.5	0.5
Sample Date:	05/20/2020	05/20/2020	05/20/2020	05/20/2020	12/20/2019	12/20/2019
Gen. Chemistry (MG/KG)						
Total Organic Carbon	**230,000 J**	**28,000**	**8,400**	**7,900**	**11,000**	**22,000**

Detects are displayed in bold font

Data Qualifier Definitions

J: The analyte was positively identified, but the associated numerical value is estimated.

Units

MG/KG = milligrams per kilogram

Former Fort Devens

KOMAN, PFAS
RI,Sediment
Background

Locations:	SR-19-01	SR-19-01 (FD)	WAB-19-01
Field Sample ID: -02-DEC19	SR-SED-19-01-DEC19	BK-SED-DUP-121819	WAB-SED-19-01-DEC19
Sample Begin Depth:	0	0	0
Sample End Depth:	0.5	0.5	0.5
Sample Date:	12/18/2019	12/18/2019	12/18/2019
Gen. Chemistry (MG/KG)			
Total Organic Carbon	**26,000**	**23,000**	**2,200**

Detects are displayed in bold font

Data Qualifier Definitions

J: The analyte was positively identified, but the associated numerical value is estimated.

Units

MG/KG = milligrams per kilogram

Appendix C

USEPA Region 1 Site-Specific Screening Levels (2023) and Update Documentation

From USEPA Region 1 file named "062023 UPDATED v2 Ft. Devens PFAS w PFHxA SL Tables 1-5":

Summary of Updated PFAS Site-Specific Screening Levels for Ft. Devens based on EPA's latest toxicity values available for PFAS

Receptor [Exposure Route & Medium]	**Adult**								**Child**							
	PFOA	**PFOS**	**PFBS**	**PFNA**	**PFHxS**	**HFPO-DA (GenX)**	**PFBA**	**PFHxA**	**PFOA**	**PFOS**	**PFBS**	**PFNA**	**PFHxS**	**HFPO-DA (GenX)**	**PFBA**	**PFHxA**
Child Resident [dermal + ingestion, soil] (mg/kg)									**1.90E-02**	**1.26E-02**	**1.90E+00**	**1.90E-02**	**1.26E-01**	2.35E-02	7.82E+00	**3.16E+00**
Child Resident [ingestion, groundwater] (ug/L)									6.02E-03	4.01E-03	6.01E-01	5.89E-03	3.94E-02	6.02E-03	1.85E+00	9.92E-01
Child Recreator [dermal + ingestion, sediment] (mg/kg)									**9.14E-02**	**6.09E-02**	**9.14E+00**	**9.14E-02**	**6.09E-01**	1.10E-01	3.65E+01	**1.52E+01**
Child Recreator [ingestion + dermal, surface water] (ug/L)									**3.04E-01**	**2.03E-01**	**3.04E+01**	**2.87E-01**	**1.93E+00**	3.04E-01	1.01E+02	**4.92E+01**
Commercial Worker [ingestion + dermal, soil] (mg/kg)	**2.46E-01**	**1.64E-01**	**2.46E+01**	**2.46E-01**	**1.64E+00**	3.50E-01	1.17E+02	**4.10E+01**								
Commercial Worker [ingestion, groundwater] (ug/L)	3.50E-02	3.50E-02	3.50E+00	3.50E-02	2.34E-01	3.50E-02	1.17E+01	5.84E+00								
Fish Consumption [in fish tissue] (mg/kg)	1.19E-03	7.95E-04	1.19E-01	1.19E-03	7.95E-03	1.19E-03	3.97E-01	1.99E-01	9.20E-04	6.13E-04	9.20E-02	9.20E-04	6.13E-03	9.20E-04	3.07E-01	1.53E-01
Construction Worker [ingestion + dermal, soil] (mg/kg)	**8.04E-02**	**5.36E-02**	**8.04E+00**	**8.04E-02**	**5.36E-01**	1.06E-01	3.54E+01	**1.34E+01**								

* **BOLD** values indicates SL for combined dermal and ingestion route.

PD Updated June 13, 2023

From USEPA Region 1 file named "UPDATED v2 Ft. Devens PFAS w PFHxA SL Tables 1-5 (June 2023)":

Table 2. Screening Levels for PFOA, PFOS, PFBS, PFNA, PFHxS, HFPO-DA (GenX), PFBA, and PFHxA in Sediment and Surface Water for Child Recreator*

Receptor	Exposure Route	Exposure Medium	PFOA SL	PFOS SL	PFBS SL	PFNA SL	PFHxS SL	HFPO-DA (GenX) SL	PFBA SL	PFHxA SL	Units	THQ (unitless)	EF† (d/yr)	ED (yr)	ET† (hrs/d)	EV† ents	SA¥ (cm^2)	BW (kg)	IRW (L/d)	IRS (mg/d)	AT-N (days)	CFS (kg/mg)	CFW (mg/µg)	RfD (mg/kg-d)								AF (mg/cm^2)	ABS‡ (unitless)	GIABS (unitless)
																								PFOA	PFOS	PFBS	PFNA	PFHxS	HFPO-DA(GenX)	PFBA	PFHxA			
Child Recreator	ingestion	sediment	1.10E-01	7.30E-02	1.10E+01	1.10E-01	7.30E-01	1.10E-01	3.65E+01	1.83E+01	mg/kg	0.1	75	6	1	1	1978.61	15		200	2190	1.0E-06		3.0E-06	2.0E-06	3.0E-04	3.0E-06	2.0E-05	3.0E-06	1.0E-03	5.0E-04	0.2	0.1	1
Child Recreator	dermal	sediment	5.53E-01	3.69E-01	5.53E+01	5.53E-01	3.69E+00	-	-	9.22E+01	mg/kg	0.1	75	6	1	1	1978.61	15		200	2190	1.0E-06		3.0E-06	2.0E-06	3.0E-04	3.0E-06	2.0E-05	3.0E-06	1.0E-03	5.0E-04	0.2	0.1	1
Child Recreator	ingestion + dermal	sediment	**9.14E-02**	**6.09E-02**	**9.14E+00**	**9.14E-02**	**6.09E-01**	**1.10E-01**	**3.65E+01**	**1.52E+01**	mg/kg	0.1	75	6	1	1	1978.61	15		200	2190	1.0E-06		3.0E-06	2.0E-06	3.0E-04	3.0E-06	2.0E-05	3.0E-06	1.0E-03	5.0E-04	0.2	0.1	1
Child Recreator	ingestion	surface water	3.04E-01	2.03E-01	3.04E+01	3.04E-01	2.03E+00	3.04E-01	1.01E+02	5.07E+01		0.1	45	6	1	1	1978.61	15	0.12		2190		1.0E-03	3.0E-06	2.0E-06	3.0E-04	3.0E-06	2.0E-05	3.0E-06	1.0E-03	5.0E-04			
Child Recreator	dermal	surface water	-	-	1.54E+04	5.19E+00	4.03E+01	-	-	1.69E+03		0.1	45	6	1	1	1978.61	15	0.12		2190		1.0E-03	3.0E-06	2.0E-06	3.0E-04	3.0E-06	2.0E-05	3.0E-06	1.0E-03	5.0E-04			
Child Recreator	ingestion+dermal	surface water	**3.04E-01**	**2.03E-01**	**3.04E+01**	**2.87E-01**	**1.93E+00**	**3.04E-01**	**1.01E+02**	**4.92E+01**	µg/L	0.1	45	6	1	1	1978.61	15	0.12		2190		1.0E-03	3.0E-06	2.0E-06	3.0E-04	3.0E-06	2.0E-05	3.0E-06	1.0E-03	5.0E-04			

**Screening levels for sediment and surface water for the recreator scenario were calculated using the EPA RSL calculator.*

†Defaults for exposure frequency (EF), exposure time (ET) and events (EV) were obtained from RAIS Tool

¥Skin area (SA) was modified to 1978.61 cm^2 to reflect wading child, calculated as a time-weighted average of the surface area of legs and feet for children ages 0 to 6.

± ABS for HFPO-DA and PFBA is 0.

Bold SL= Selected Screening Levels for Use
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid
PFBS = Perfluorobutanesulfonic acid
PFNA = Perfluorononanoic acid
PFHxS = Perflurohexanesulfonic acid
HFPO-DA = Hexafluoropropylene oxide dimer acid (and its ammonium salt), (also sometimes referred to as GenX chemicals)
PFBA = Perfluorobutanoic acid
PFHxA = Perfluorohexanoic acid

SL	Screening Level
THQ	Target Hazard Quotient
EF	Exposure Frequency
ED	Exposure Duration
ET	Exposure Time
EV	Event
SA	Skin Surface Area
BW	Body Weight
IRW	Drinking Water Ingestion Rate
IRS	Soil Ingestion Rate
AT-N	Non-Cancer Averaging Time
CFS	Soil Conversion Factor
CFW	Water Conversion Factor
RfD	Reference Dose
AF	Adherence Factor
ABS	Absorption, frction of contaminant absorbed
GIABS	GI Absorption Factor

Site-specific
Recreator Surface Water Inputs

Variable	Recreator Surface Water Default Value	Site-Specific Value
BW_{0-2} (body weight) kg	15	15
BW_{2-6} (body weight) kg	15	15
BW_{6-16} (body weight) kg	80	80
BW_{16-26} (body weight) kg	80	80
BW_{a} (body weight - adult) kg	80	80
BW_{rec-a} (body weight - adult) kg	80	80
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	256699.98
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	632116.56
ED_{rec} (exposure duration - recreator) years	26	26
ED_{0-2} (exposure duration) years	2	2
ED_{2-6} (exposure duration) years	4	4
ED_{6-16} (exposure duration) years	10	10
ED_{16-26} (exposure duration) years	10	10
ED_{rec-a} (exposure duration - adult) years	20	20
EF_{rec-w} (exposure frequency) days/year	0	45
EF_{2-6} (exposure frequency) days/year	0	45
EF_{6-16} (exposure frequency) days/year	0	45
EF_{16-26} (exposure frequency) days/year	0	45
EF_{rec-a} (adult exposure frequency) days/year	0	45
ET_{0-2} (exposure time) hours/event	0	1
ET_{2-6} (exposure time) hours/event	0	1
ET_{6-16} (exposure time) hours/event	0	1
ET_{16-26} (exposure time) hours/event	0	1
ET_{rec-a} (adult exposure time) hours/event	0	1
EV_{0-2} (events) events/day	0	1
EV_{2-6} (events) events/day	0	1
EV_{6-16} (events) events/day	0	1
EV_{16-26} (events) events/day	0	1
EV_{rec-a} (adult) events/day	0	1
THQ (target hazard quotient) unitless	0.1	0.1
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	3.398
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	14.167
IRW_{0-2} (water intake rate) L/hour	0.12	0.12
IRW_{2-6} (water intake rate) L/hour	0.12	0.12
IRW_{6-16} (water intake rate) L/hour	0.124	0.124
IRW_{16-26} (water intake rate) L/hour	0.0985	0.0985
IRW_{rec} (water intake rate - adult) L/day	0.11	0.11
IRW_{rec-a} (water intake rate - adult) L/hr	0.11	0.11
LT (lifetime - recreator) years	70	70
SA_{0-2} (skin surface area) cm^2	6365	1978.61
SA_{2-6} (skin surface area) cm^2	6365	1978.61
SA_{6-16} (skin surface area) cm^2	19652	19652
SA_{16-26} (skin surface area) cm^2	19652	19652
SA_{rec} (skin surface area - adult) cm^2	19652	19652
SA_{rec-a} (skin surface area - adult) cm^2	19652	19652
Apparent thickness of stratum corneum (cm)	0.001	0.001
TR (target risk) unitless	0.000001	0.000001

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Site-specific

Recreator Risk-Based Regional Screening Levels (RSL) for Surface Water

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit

Chemical	CAS Number	Mutagen?	Volatile?	SF_o(mg/kg-day)$^{-1}$	SF_oRef	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$	$DA_{event\ (nc\ adult)}$	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL (Child) THQ=0.1 (ug/L)	Dermal SL (Child) THQ=0.1 (ug/L)	Noncarcinogenic SL (Child) THQ=0.1 (ug/L)	Screening Level (ug/L)
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	No	Yes	-		3.00E-06	D	-		1.00E+00	8.67E-02	3.30E+02	8.00E-01	Yes	-	1.84E-05	9.91E-06	-	-	-	3.04E-01	3.53E-02	3.17E-02	1.88E-02 nc
Perfluorobutanesulfonic acid (PFBS)	375-73-5	No	No	-		3.00E-04	P	-		1.00E+00	1.93E-05	3.00E+02	1.00E+00	Yes	-	1.84E-03	9.91E-04	-	-	-	3.04E+01	1.54E+04	3.04E+01	3.04E+01 nc
Perfluorobutanoic acid (PFBA)	375-22-4	No	Yes	-		1.00E-03	I	-		1.00E+00	4.06E-03	2.14E+02	1.00E+00	Yes	-	6.15E-03	3.30E-03	-	-	-	1.01E+02	4.25E+02	8.19E+01	8.19E+01 nc
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	No	No	-		2.00E-05	A	-		1.00E+00	2.58E-04	4.00E+02	1.00E+00	Yes	-	1.23E-04	6.60E-05	-	-	-	2.03E+00	4.03E+01	1.93E+00	1.93E+00 nc
Perfluorohexanoic acid (PFHxA)	307-24-4	No	No	-		5.00E-04	I	-		1.00E+00	2.69E-04	3.14E+02	1.00E+00	Yes	-	3.07E-03	1.65E-03	-	-	-	5.07E+01	1.69E+03	4.92E+01	4.92E+01 nc
Perfluorononanoic acid (PFNA)	375-95-1	No	No	-		3.00E-06	A	-		1.00E+00	1.99E-04	4.64E+02	1.00E+00	Yes	-	1.84E-05	9.91E-06	-	-	-	3.04E-01	5.19E+00	2.87E-01	2.87E-01 nc
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	No	No	-		2.00E-06	A	-		1.00E+00	4.69E-07	5.00E+02	1.00E+00	No	-	-	-	-	-	-	2.03E-01	-	2.03E-01	2.03E-01 nc
Perfluorooctanoic acid (PFOA)	335-67-1	No	No	7.00E-02	D	3.00E-06	A	-		1.00E+00	2.16E-05	4.14E+02	1.00E+00	Yes	1.42E-03	1.84E-05	9.91E-06	1.07E+02	5.08E+03	1.05E+02	3.04E-01	6.59E+01	3.03E-01	3.03E-01 nc

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Appendix D

Regional Groundwater Flow Model of the Former Fort Devens, Massachusetts

Regional Groundwater Flow Model of the Former Fort Devens, Massachusetts

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

SERES Engineering & Services, LLC
ARCADIS
a joint venture

November 22, 2022

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List of Acronyms

AOC	Area of Concern
CHD	Constant-Head (package - MODFLOW)
CLN	Connected Linear Network (package - MODFLOW)
DRN	Drain (package - MODFLOW)
ETA	Engineering Technologies Associates, Inc.
GWF	Groundwater Flow (process)
HSU	hydrostratigraphic unit
HUF	Hydrogeologic-Unit Flow (package - MODFLOW)
LAK	Lake (package - MODFLOW)
LHA	lifetime health advisory
MNW	Multi-Node Well (package)
PVC	polyvinyl chloride
RIV	River (package - MODFLOW)
S-A JV	SERES-Arcadis 8(a) Joint Venture 2, LLC
SFR	Streamflow-Routing (package - MODFLOW)
SHL	Shepley's Hill Landfill
SSP&A	S.S. Papadopulos & Associates, Inc.
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WEL	Well (package - MODFLOW)
WWTP	wastewater treatment plant

REPORT

Section 1
Introduction

S.S. Papadopulos and Associates, Inc. (SSP&A), as a subcontractor to SERES-Arcadis 8(a) Joint Venture 2, LLC (S-A JV), prepared this report on behalf of the United States Army Corps of Engineers, New England District to document a regional numerical groundwater model of the former Fort Devens U.S. Army post in Worcester and Middlesex counties in central Massachusetts (Figure 1). The model was developed to (a) combine conceptual and structural details from existing regional and local models encompassing the area within, and extending beyond, the former Fort Devens U.S. Army post footprint; and (b) calculate groundwater flow paths within the overburden sands throughout the facilities. Areas identified as being contaminated with per- and polyfluoroalkyl substances (PFAS) on the Former Fort Devens were grouped into three focus areas (Figure 2). However, flow-path analyses were conducted on areas with perfluorooctane sulfonate/ perfluorooctanoic acid (PFOS/PFOA) contamination in Focus Area 1, on the former Main Post.

The model was constructed using USG-Transport (Panday, 2020) to take advantage of its unstructured grid capabilities, specifically a quad-tree grid type for targeted grid refinement, and the Connected Linear Network (CLN) package to simulate surface water features. The model was calibrated using PEST_HP (Watermark Numerical Computing, 2020a) and pilot-point techniques. Flow paths were calculated using mod-PATH3DU (SSP&A, 2020). The model domain for this groundwater model encompasses approximately 60 square miles centered about the former Fort Devens as shown on Figure 2.

The foundation for the models currently in use for groundwater investigations throughout the former Fort Devens is a regional groundwater flow model developed in 1993 by Engineering Technologies Associates, Inc. (ETA). The purpose of this model was to calculate directions and velocities of groundwater flow to assist in the evaluation of impacts to groundwater quality from contaminated areas (ETA, 1993). Subsequently, models of the former South Post (1994) and Main and North Posts (1995) were developed by ETA. The purpose of these models was the same, but with a focus on their respective areas (ETA, 1994 and 1995). Arcadis (2002) developed a local-scale groundwater flow and transport model of the former North Post, focusing on the Area of Concern 50 (AOC 50) area, that was used to assist in the development and evaluation of alternative remedies to address contaminated groundwater. In 2013 Sovereign Consulting Inc. modified a groundwater model developed in the mid-1990's of the area around the Shepley's Hill Landfill (SHL). The purpose of this model was to evaluate arsenic migration in groundwater (Sovereign, 2013). Since 2016, Geosyntec Consultants have maintained and updated this model to support and evaluate existing and proposed remedies at the Shepley's Hill Landfill (Geosyntec, 2016 and 2020). The extent of each of these models is shown in Figure 2. The current model domain is similar to the area of the 1993 Regional Model but extends further to the east, to include the Bowers Brook watershed, and to the north, to include Flannagan Pond and Lower Long Pond.

The hydrogeology of the model domain and conceptualization of groundwater flow are well documented in the previous modeling studies and formed the foundation of the development of this model. In particular, ETA (1993) and ETA (1995) were the two models that the current model primarily relied upon because they contain excellent summaries of regional groundwater flow characteristics.

Section 2
Hydrogeologic Setting

2.1 Surface Water and Drainage

The former Fort Devens is in the watershed of the Nashua River, which is a tributary of the Merrimack River. The North Nashua River is in the western extent of the former South Post, it flows southeast into the Nashua River, which flows north and is the eastern extent of the former South Post and the western extent of the former Main and North Posts (Figure 3a). The model domain, on the eastern side, also includes a portion of the Bennett's Brook watershed, which is outside of the Nashua River watershed. The Nashua River watershed in the model domain is punctuated throughout by small drainages consisting of creeks, ponds, lakes, and wetlands. Approximately 125 miles of river and creeks, 1,000 acres of ponds and lakes, and 4,000 acres of wetlands, have been mapped within the extent of the model, these features are shown on Figure 3b. Representation of these features in a groundwater model is important because, conceptually, the flow of groundwater is from recharged upland areas to these surface-water bodies (ETA, 1993).

2.2 Hydrostratigraphy

The geologic setting of the model area consists of glacial-derived overburden materials, overlying glacial till and igneous and metamorphic bedrock. The bedrock surface is an eroded and irregular surface. It includes elevated upland areas with exposed or nearly-exposed bedrock, and lowland areas where the bedrock surface has been eroded and overlain by fluvial, glaciofluvial, and glacial sediments. A map of the bedrock surface was developed by S-A JV (2020a) and is shown in Appendix H, Figure H.1. The glacial deposits include Pleistocene-age glacial till that was deposited on the bedrock surface and overburden material, which includes glaciofluvial and ice-contact deposits that were deposited above the till and bedrock (Jahns, 1953, and Stone et al., 2018).

The eastern portion of the model domain consists of an upland bedrock area with a veneer of glacial till. In most upland areas, the till is thin but isolated pockets of thick till occur and are associated with glacial drumlins (Jahns, 1953). The western part of the model area is underlain predominantly by coarse-grained glaciofluvial overburden deposits, filling in ancestral bedrock valleys (Stone et al., 2018). Till underlies the overburden throughout much of the model area. A geologic map of surficial deposits is shown in Figure 7.

The conceptualization of the regional hydrostratigraphy is the same as in the previous models: a coarse-grained glacial outwash (overburden) aquifer of variable thickness underlain by a till of nominal thickness (in most areas), both of which overly bedrock, the upper 50 feet of which is weathered. Groundwater flow occurs primarily in the overburden materials with flow limited in the underlying bedrock. The uppermost bedrock is weathered, based on log descriptions, and some groundwater flow likely occurs within the weathered bedrock zone, but groundwater flow in the underlying crystalline bedrock is limited to non-existent.

Both the 1993 regional and 1994 South Post models had two layers; the first layer represented the glacial outwash aquifer and the second the weathered bedrock. The 1995 model of the Main and North Posts had 3 layers; the glacial outwash aquifer was represented by two model

layers to account for localized areas where deeper and thicker gravel deposits were present, while the third layer represented the weathered bedrock. The till was represented implicitly in these three models as an aquitard. Arcadis (2002) had five model layers. The first three represented the overburden sands, the fourth explicitly represented the till deposits as they were mapped to be thicker here, and the fifth represented the weathered bedrock. The Geosyntec (2020) model of the Shepley's Hill Landfill area has six model layers. The first five layers are consistent with the layering in Arcadis (2002), while the sixth explicitly represented 200 feet of competent bedrock.

Section 3
Model Structure

The groundwater flow model was implemented using USG-Transport v.1.5.0, a finite difference flow simulation code originally developed by the U.S. Geological Survey (USGS) as MODFLOW-USG, but is currently maintained by its author, Sorab Panday, for GSI Environmental Inc. (Panday et al., 2017; Panday, 2020). Only standard features in USG-Transport were implemented and are discussed in the following sections. The structure of the groundwater flow model is described in this section. A steady-state model was developed to be representative of average flow conditions.

3.1 Grid

The finite-difference model grid encompasses an area of approximately 60 square miles as shown on Figure 2. The extents of the model correspond to natural barriers to groundwater flow where the regional bedrock is at or near the surface; thus, the model is bounded by implicit no-flow boundaries. The model domain is similar to the area of the 1993 Regional Model but extends further to the east, to include the Bowers Brook watershed, and to the north, to include Flannagan Pond and Lower Long Pond.

The model was developed based upon the Massachusetts (Mainland) State Plane coordinate system in US feet, referenced to the North American Datum of 1983 (NAD83). The offset for the lower-left corner of the model grid is 594440.0 feet in the x-direction and 2981380.0 in the y-direction. There is no rotation.

3.1.1 Discretization

A quadtree grid[1] was used to focus cell refinement along surface water features, near pumping and monitoring wells, and around other features in key areas of the model domain like bedrock outcrops and the barrier wall installed as part of the SHL remediation system. The USGS quadtree grid generation program, GRIDGEN (Lien et al., 2015), was used to create the grid. The model grid is shown in Figures 4a and 4b. All grid cells are square and range in width from 2.5 feet along the SHL barrier wall to a maximum of 640 feet in areas off-base. On the former South and North Posts (Insets A, B, and C of Figure 4b), the largest cell is 320 feet wide, with refinement to 160 feet along the Nashua River and 80 feet along tributaries on the former North Post. Cells are refined to 40 feet around ponds and lakes, and 10 feet around pumping and monitoring wells. On the former Main Post, the largest cell size is 320 feet, with the southern portion within Focus Area 1 refined to 160 feet (Inset D of Figure 4b). Cells along and around surface water features are, at most, 40 feet and are 10 feet around pumping and monitoring wells.

[1] A quadtree grid is comprised of square or rectangular cells in which a quadrant can be recursively subdivided.

3.1.2 Layering

There are 8 model layers. The upper 7 correspond to one or a combination of the overburden sands, till or bedrock, while layer 8 represents at least 200 feet of lower (competent) bedrock.

The existing models were developed using a terrain following grid concept in which layers represent a dominant hydrostratigraphic unit (HSU) and their respective elevations follow those mapped for that unit. An alternative approach is described by Anderman and Hill (2000) for the MODFLOW Hydrogeologic-Unit Flow (HUF) package[2]. In this package, the properties of the HSUs are apportioned to different layers based on their relative thickness. Here, a hybrid approach is used in which the available thickness between the ground surface and top of competent bedrock is distributed equally between the first 6 model layers; thus, layer thickness varies spatially, but for a given point, the first 6 layers have the same thickness. The aquifer properties in each cell are determined by the relative thickness of overburden, till, or upper bedrock within the cell using the approach described by Anderman and Hill (2000).

This HUF approach was used here primarily because both unit thickness and hydraulic conductivity can be parameterized to calibrate aquifer transmissivity. When using a terrain following grid, structure thickness is fixed, and hydraulic conductivity can take on a surrogate role accounting for both hydraulic conductivity and unit thickness. Further, because HSUs are not represented by a fixed number of layers, the principal unit in an area is represented by the most layers: where overburden is the dominant unit along the deeper river and creek corridors it is represented by up to 6 layers (layer 7 being upper bedrock and layer 8 being lower bedrock, both of which, conceptually, are present everywhere), and on the east side of Bowers Brook where there is little to no overburden, the available till and bedrock are represented by up to 7 layers (layer 8 being lower bedrock). The percent bedrock in each model layer are shown in Appendix A. The maps in Appendix A were generated by calculating the relative proportion of bedrock in each model cell, based on its top and bottom elevation and the bedrock surface elevation (if present) and the assumed thickness.

A map of till thickness was produced by combining data from a variety of sources. Till thickness was previously mapped by Arcadis (2002) for the former North Post, and by Geosyntec (2020) for the model of the SHL. A point data set of till thickness was developed from the following sources:

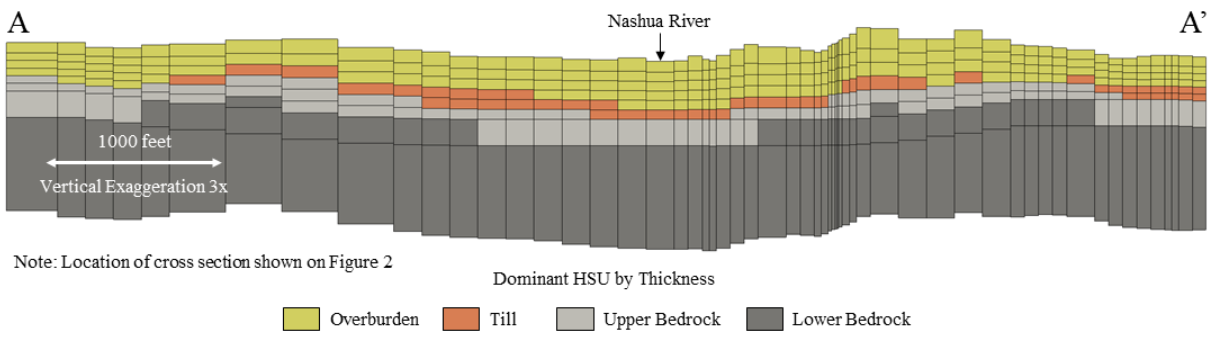
- Till thickness at the cell centers of the Arcadis (2002) model,
- Till thickness picks identified by Geosyntec (2020) and shown on Figure 5-3 of that report,

[2] The HUF package is not available for USG-Transport. A pre-processing script was developed to implement the necessary features of the package for use here.

- Point data from lithologic borehole logs[3] where a compact till[4] above the bedrock was identified.

This point data set was interpolated to a fine, regular grid, using simple kriging with a mean of 5 feet[5], and then augmented in areas mapped as surficial till with the thickness calculated by subtracting the bedrock surface from the LIDAR surface provided by S-A JV (2020b). The resulting thickness map is shown on Figure 5. The thickness of the overburden was calculated by subtracting the till thickness from the difference between the LIDAR and bedrock surfaces and is shown on Figure 6.

The elevations for each model layer were calculated as follows. The ground surface elevation, top of model layer 1, was derived from a LIDAR surface developed for the model extent by S-A JV (2020b) and is shown in Appendix H, Figure H.2. The bedrock surface map developed by S-A JV (2020a) represents the top of the upper (weathered) bedrock. The upper bedrock is 50 feet thick everywhere, as such, the bottom of the competent bedrock was calculated by subtracting 250 feet from the top of the upper bedrock surface; this surface was assigned to the bottom of model layer 8. The elevations of layers 2 through 6 were calculated by equally distributing the available thickness between the ground surface and top of bedrock after lightly smoothing[6] each. The top of layer 7 corresponds to the smoothed top of bedrock surface, while the bottom of layer 7 is 50 feet below that. An example cross section through the former North Post showing model layers and the corresponding dominant HSU in each model cell is shown on the figure below.



3.2 Boundary Conditions

3.2.1 Surface Water Features

The myriad surface water features identified within the model domain are all simulated using the CLN package (Figures 4a and 4b). As the name suggests, this package provides a generic framework to represent connected features. It is a separate flow process that is solved

[3] Source: Arcadis (email July 29, 2020); Area 1 Geology Workbook rev3.xlsx, Area 2 Geology Workbook_rev1.xlsx, and Area 3 Geology Workbook_rev1.xlsx.

[4] Two types of till are described in Jahns (1953) – one a hard compacted till and the other a loose poorly-compacted till.

[5] The assumed till thickness specified in ETA (1993).

[6] Arcmap tool – Focal Statistics

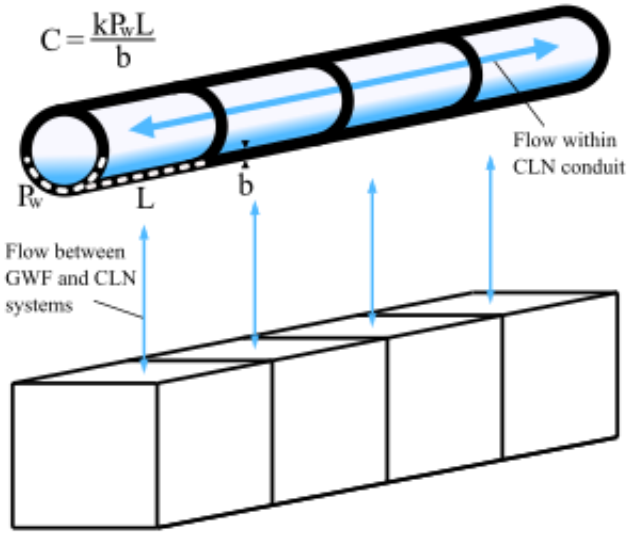
simultaneously with the Groundwater Flow (GWF) process. Different CLN to GWF connectivity options give the CLN package the flexibility to simulate a variety of features like multi-aquifer pumping wells[7], rivers, lakes, or wetlands. The Thiem equation can be used for wells or a leakance term for rivers and lakes (Panday, 2020). Further, because it is a separate flow system, boundary conditions can be applied to it, independent of the GWF system. The well (WEL) package was used to represent the net of precipitation and potential evapotranspiration, and the Constant-Head (CHD) package was used to represent the stages of the Nashua River and Bennett's Brook where they intersect the boundary of the model domain. The outlet stages were estimated from the LIDAR surface and are 198.5 feet for the Nashua River, and 261 feet for Bennett's Brook (Figure 4a).

The interconnectivity of CLN cells (or nodes) is specified using the same approach as the unstructured discretization package for the GWF system, namely, for each CLN cell, there is a listing of those cells to which it is connected. This flexibility allows for a surface water network that can better represent the interconnectivity of rivers, creeks, ponds, lakes, and wetlands than is possible with the boundary packages commonly used with other MODFLOW versions, like the River (RIV), Drain (DRN), Streamflow-Routing (SFR) or Lake (LAK) packages. Specifically, here, much of the Nashua River and its tributaries flow through low-lying wetland areas that can be significant groundwater discharge areas. Simulating this interaction is cumbersome using other boundary packages because they only allow for a single inlet and outlet for a given length of river. With the CLN package, for example, a river CLN cell flowing through a low-lying area can be connected to wetland CLN cells on either side. Further, the CLN package is flow conserved and can simulate flow-through features like ponds and lakes, for which the net exchange of groundwater is zero.

For surface water features, the input parameters for the CLN package are consistent with the RIV, DRN, SFR and LAK packages. These parameters are GWF cell (location), river or lakebed elevation, and conductance (C) terms: bed length (L), width (wetted perimeter, P_w), thickness (b), and vertical hydraulic conductivity (k). A schematic illustrating these conductance terms is shown on the next page. Use of the CLN package to represent different surface water feature types is detailed in Muffels et al. (2022). GIS shapefiles delineating each surface water feature were obtained from MassGIS[8] and augmented manually using satellite imagery. CLN cells were structured to corresponded to GWF cells. The final delineations were apportioned to CLN cells using GIS intersection tools and the model grid. A feature was included if it covered at least 2% of the cell area for ponds and lakes, and 10% for wetlands. The following sections detail the source of the initial values and process by which the values are assigned to the different surface water features for each input parameter type.

[7] Wells whose screened interval spans multiple model layers.

[8] https://www.mass.gov/orgs/massgis-bureau-of-geographic-information.



3.2.1.1 Bed Elevation

3.2.1.1.1 ***Rivers and Creeks***

River and creek bed elevations were determined by subtracting an offset (or depth) from an initial estimate of the stage in each model cell that was determined from available staff gages and the LIDAR surface. The LIDAR surface was contoured at 10-foot intervals and intersected with the river and creek delineations. The stage estimate in each CLN cell was calculated by linearly interpolating from the staff gage and intersection points to the mid-point of each feature segment within a cell. Initially, an offset (or depth) of 2.5 feet was assigned to the Nashua and North Nashua rivers, and 1 foot for each creek. These values are consistent with the depths used in the ETA (1995) model of the former Main and North posts. The offset assigned to each CLN cell was calculated by linearly interpolating from control-points to the mid-point of a feature segment within that cell. The staff gage and control-point locations are shown on Figure 3b.

3.2.1.1.2 ***Ponds and Lakes***

Bathymetry maps were available for Plow Shop and Grove ponds from a study by Mercadante et. al (1999) and for Robbins Pond and Bare Hill Lake from MassGIS. The bathymetry contours were digitized and the corresponding depth calculated using the reported stage of 216.9 feet for Plow Shop and Grove ponds, and the average LIDAR value for Robbins Pond and Bare Hill Lake. The depth contours were interpolated to a fine and regular grid using simple kriging[9], from which the average depth within each CLN cell was calculated. Initial bed elevations for all other lakes and ponds were calculated as an offset from the available LIDAR; smaller ponds (mostly unnamed) were assumed to be one-foot deep, larger features like Mirror Lake and Cranberry Pond were assumed to be 5 feet deep, while Little Mirror Lake was assumed to be 3 feet deep.

[9] Mean depth of zero.

*3.2.1.1.3 **Wetlands***

For connected wetlands, those through which a river or creek flows, their elevation was taken from the nearest river or creek CLN cell and adjusted depending on the slope[10] of the LIDAR surface within that cell. Conceptually, these connected wetlands are expected to be deeper along the river or creek flowing through it, getting shallower moving away from it. For shallow slopes, between 0 and 1 feet per foot, which are indicative of a flat surface, a CLN cell is predominantly wetland and is expected to have the same depth as the nearby river or creek cell. At the other end of the spectrum, for slopes greater than 5, which reflect more the topography outside the wetland, the river or creek depth is scaled by 0.01. For slopes between 1 and 3, and 3 and 5, the river or creek depth is scaled by 0.50 and 0.25, respectively. Flow-through wetlands were assumed to be 1 foot deep. The elevation of each wetland CLN cell was calculated as the average LIDAR elevation within it minus the corresponding depth.

3.2.1.2 Bed Vertical Hydraulic Conductivity

*3.2.1.2.1 **Rivers and Creeks***

The vertical hydraulic conductivity initially assigned to river and creek CLN cells was 13 feet/day and 3 feet/day, respectively. The normalized vertical hydraulic conductivity of river and creek beds (K_n, feet/day) is defined here as the product of vertical hydraulic conductivity (K, feet/day), width (W, feet), and 1/thickness (M, feet):

$$K_n = \frac{KW}{M}$$

Bed conductance (C, feet^2/day), is then:

$$C = K_n L$$

where L is the length (feet) of the river or creek within a model cell.

The riverbed normalized vertical hydraulic conductivity is 130 feet/day, which is consistent with the 1993 and 1995 ETA models, which used normalized vertical hydraulic conductivities of 213 and 100 feet/day, respectively. For creek beds, the normalized vertical hydraulic conductivity is 30 feet/day, again consistent with the 1993 and 1995 ETA models, which had values of 50 and 10 feet/day, respectively.

[10] Calculated using GIS tools.

3.2.1.2.2 Ponds, Lakes, and Wetlands

The 1995 ETA model specified a bed leakance of 0.5 feet^2/day for ponds, lakes, and wetlands. Leakance is the product of bed vertical hydraulic conductivity and thickness. Assuming a uniform bed thickness of 1 foot for these surface water features[11], and the constant value of 0.5 feet^2/day for bed leakance, the initial vertical hydraulic conductivity is 0.5 feet/day for ponds, lakes, and wetlands. Bed conductance (C, feet^2/day) for a model cell is calculated as the product of vertical hydraulic conductivity (K, feet/day), area (A, feet^2) of the feature within the model cell, and 1/thickness (M, feet):

$$C = \frac{KA}{M}$$

Vertical hydraulic conductivity was calculated for each CLN cell using the control-points and linear interpolation scheme developed for elevation.

3.2.1.3 Bed Length, Width and Thickness

3.2.1.3.1 Rivers and Creeks

The length of each river and creek in a CLN cell was calculated using GIS intersection tools. For all rivers and creeks bed thickness and width were uniform, 1 foot thick and 10 feet wide, for numerical stability. As discussed in the previous subsection, bed conductance is the ratio of the product of length, width, and vertical hydraulic conductivity to thickness. Although bed width is an important property in calculating stream stage within the CLN network, the modeling focus here is on groundwater flow paths for which the flow exchange between the stream and the aquifer is important, including where this exchange occurs, which is determined by the bed elevation. Therefore, the width and thickness terms were integrated into the normalized vertical hydraulic conductivity for rivers and creeks, which are 130 and 30 feet/day, respectively, and hence the effective width and thickness of the riverbeds is greater than that of the creek beds.

3.2.1.3.2 Ponds, Lakes, and Wetlands

Bed area for each CLN cell was calculated using GIS intersection tools. Mercadante et. al (1999) mapped bed thickness for Plow Shop and Grove ponds. These contours were digitized and incorporated into the model using the same approach as the bathymetry contours. For all other ponds, lakes and wetlands, a bed thickness of 1 foot was specified.

3.2.2 Domestic and Water Supply Pumping

Within the modeled domain there are several municipal supply wells, smaller community supply wells and open hole residential wells; all of which were simulated using the CLN package[12].

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[11] Excepting Plow Shop and Grove ponds, for which bed thickness was mapped by Mercadante et al. (1999). Therefore, leakance is variable for these ponds, and ranges between approximately 0.03 and 0.5 feet^2/day.

[12] The CLN package is the only boundary package in USG-Transport that supports multi-aquifer or multi-layer wells and is comparable in functionality to the Multi-Node Well (MNW) package available with previous MODFLOW releases.

Details for the supply wells, including the annual volume pumped from 2016 for the municipal wells and 2015 for the smaller community wells, through 2019, were compiled by S-A JV (2020c). These wells were simulated in the model using the CLN package and pumped at the average volumetric pumping rate for their available time frame. Representative pumping rates for the residential wells were not available and were specified as zero in the model as these pumping rates are likely very small with negligible impact on groundwater flow directions.

The municipal and community wells, and pertinent details about each, including the average pumping rate applied in the model, are listed in Appendix B, Tables B.1a and B.1b. Details for each residential well are provided in Appendix B, Table B.2.

3.2.3 Recharge

Groundwater recharge was specified using the approach developed by ETA (1995) for the model of the Main and North Posts, and similar rates were calculated. The approach employed by ETA (1995) involved estimating a maximum rate for the region and adjusting it spatially by the surficial geology and land cover.

ETA (1995) estimated the maximum regional recharge rate to be 20.5 inches/year by subtracting an estimate of the actual annual evapotranspiration, 22.14 inches, from the annual average precipitation of 42.64 inches in 1993[13]. This maximum rate applies to flat sandy overburden soils and a corresponding maximum rate for flat surficial till and bedrock of 9.5 inches/year was used (ETA, 1995). The extent of the area modeled in 1995 included little surficial till, while here, it is the dominant type in the eastern portion of the domain. Here, because the till is more permeable than the bedrock, a maximum recharge rate of 11.5 inches/year was used. The surficial geology for the area of the model was taken from Stone et al. (2018) and is shown in Figure 7.

The most recent land cover available for the modeled area, 2016, was obtained from the MassGIS website and is shown in Figure 8. The cover types were generalized into five categories, consistent with those used by ETA (1995):

- Impervious, commercial, and industrial;
- Open space, forest, and agriculture;
- Residential and recreational;
- Open water, and wetlands; and
- Landfill cap.

The landfill cap category is introduced here because the 2016 cover-type for the SHL Landfill is “grassland”, however, underlying this grass cover is a 30 to 40 mil thick polyvinyl chloride (PVC) membrane cap (Geosyntec, 2016). Each of the land cover categories was assigned a factor, listed in the table below, that was used to scale the maximum recharge rate for each surficial geology type.

[13] The average annual precipitation at Fitchburg Municipal Airport, Fitchburg, Massachusetts (Station: USW00004780) for the period 1998 – 2020 is 43 inches.

Land Cover Group	2016 Land Cover Name	Recharge Factor	Model Area
Impervious, commercial, and industrial	Impervious	0.35	8%
Open space, forest, and agriculture	Bare land, cultivated, forest, grassland, pasture/hay, and scrub	1.00	62%
Residential and recreational	Developed open space	0.75	11%
Open water and wetlands	Water and wetland	0.00[14]	18%
Landfill cap	-	0.00	0.2%

The surficial geology and land cover maps were intersected with the model grid using GIS tools to get the relative amount of each map's categories in a model cell. The recharge rate for each model cell was calculated from these fractions and the rate adjustments outlined above, as the product of the area weighted average surficial geology rate and the area weighted average land cover factor. The calculated recharge rates for the model domain are shown in Figure 9. The average recharge rate for the entire model domain is 11.8 inches/year. Within the domains of the 1993 regional, 1994 South Post, and 1995 Main and North Post models developed by ETA, the average recharge is 13.3, 14.2, and 13.3 inches/year, respectively. These rates compare well with the average rate of 13.7 inches/year in the ETA (1995) model. Over the predominantly till and bedrock areas (approximately 40% of the model domain) the average recharge rate is 9.5 inches/year.

Two infiltration basins were represented in one or more of the previous models as a zone of higher recharge: the rapid infiltration basin associated with the wastewater treatment plant (WWTP) on the former North Post (ETA, 1995; Arcadis, 2002), and the storm water collection basins located south of the SHL (Geosyntec, 2020). Both basins are represented in the CLN package, and their respective recharge applied using the WEL package. The rate used by Arcadis (2002), 215 inches/year, was applied uniformly over the WWTP infiltration basin. The recharge zone used by Geosyntec (2020) to represent the stormwater collection basin corresponded to a mapped wetland. The same volumetric rate of water, 3.3 acre-feet/year, was applied to this feature; corrected for the relative area difference between the recharge zone and wetland, this volume is an equivalent recharge rate of 360 inches/year.

ETA (1995) estimated the annual potential evapotranspiration to be 40.9 inches in 1993. This estimate was derived using the average estimate from five different techniques using average climatic data – these calculations made by ETA are reproduced in Appendix I. At open surface water features like ponds, lakes, and wetlands, the net difference of 1.8 inches between the average annual precipitation and potential evapotranspiration was applied to the corresponding CLN cells using the WEL package.

[14] Represented as the net of precipitation and potential evapotranspiration and simulated using the WEL and CLN packages.

3.3 Hydraulic Properties

The initial horizontal and vertical hydraulic conductivity distributions in the overburden, till, and bedrock were derived from the existing models. Where there is overlap in the extents of these models, the hydraulic conductivity of the most recently developed model was used. However, because of updates to the bedrock surface in areas on the former Main and North posts since these models were last calibrated, uniform horizontal hydraulic conductivities were used for the overburden throughout the respective former posts. For the former Main Post, a horizontal hydraulic conductivity of 30 feet/day was specified, while the initial vertical hydraulic conductivity was specified to be $1/10^{th}$ of the horizontal hydraulic conductivity in the ETA (1995) model. For the former North Post, uniform horizontal and vertical hydraulic conductivities of 38 and 3.8 feet/day, respectively, were specified, consistent with the dominant overburden zone calibrated by Arcadis (2002). Uniform horizontal and vertical hydraulic conductivities of 5 and 0.5 feet/day, respectively, were specified for the till, consistent with the 2020 SHL Model (Geosyntec, 2020). Initial horizontal hydraulic conductivity for the upper bedrock was specified based on the previous models and ranged between 0.2 and 2 feet/day. The initial vertical hydraulic conductivity of the upper bedrock was specified to be 1.7 feet/day, based on the value used most recently for the SHL model (GeoSyntec, 2020). For the deeper bedrock, the initial horizontal and vertical hydraulic conductivities were specified as 0.005 and 0.0005 feet/day, respectively.

The barrier wall installed as part of the SHL remedial system was simulated as low horizontal hydraulic conductivity cells – the spacing of these cells is 2.5 feet to reflect the excavation width (Sovereign, 2013). The hydraulic conductivity was assigned the value calibrated by Geosyntec (2020), 1.1e-4 feet/day, for the SHL model and assigned to all cells within the overburden.

Section 4
Model Calibration

The development of an appropriate inverse[15] model is a critical step in any groundwater model development exercise. The inverse model serves two important, but distinct functions – the first is to calibrate the parameters and other inputs of the model, and the second is to help identify and, to the extent possible, quantify sources of uncertainty in predictions made by the calibrated model. Here, the focus is on the calibration component of the inverse model and the discussion in this section details that development.

4.1 Procedure

Calibration of a groundwater model involves adjusting the initial estimates of model parameters to improve the correspondence between model calculated outputs and field observations ("calibration targets"). Calibration is a necessary process because initial estimates of model parameter values are generally not well constrained. Calibration of the parameters of the groundwater flow model is based upon a combination of (a) manual and principally qualitative adjustments, plus (b) automated and more quantitative procedures, each facilitated using the inverse modeling code PEST_HP v.17.1 (Watermark Numerical Computing, 2020a).

Manual and automated calibration are iterative processes that estimate parameter values by minimizing the differences between model outputs and targets in the weighted least-squares sense (i.e., the sum of the squared differences between model outputs and measurements, termed the objective function). Parameter values are determined according to their sensitivity to observed or measured values. The resulting parameter values are considered optimal with respect to the measured data set and any underlying assumptions and may then be used to make predictions under conditions comparable to calibration conditions.

Formulation of a well-posed inverse model is important to effective model calibration. The following sections describe the basic components of the inverse model, including the target and parameter definitions.

For this model, calibration was undertaken in steps, with each step focusing on a different post (i.e., South Post, the Former Main Post, and the Former North Post). This approach was implemented because model calibration within each post was not expected to be impacted by targets in other posts. Model calibration results, presented in Section 4.5 illustrate the validity of this approach.

[15] The groundwater flow model is termed the forward model because hydraulic heads, base flows, etc., are calculated by the model from the specified parameter values input to it. Conversely, the inverse model determines parameter values from field observations.

4.2 Multi-Component Objective Function

4.2.1 Water Levels

Historical water levels were downloaded for the Main and North Posts from the Former Fort Devens database[16] and for the South Post, as a series of document and spreadsheet tables. These water levels are provided in Table E.1. Nearly 1700 locations, including monitoring wells, pumping wells, residential wells, and staff gages were identified in these sources. Of these, 662 had measured levels. Excluding duplicates, pumping wells, staff gages, and monitoring wells without screen information, a total of 559 target locations were identified and used in the model calibration – 62 on the South Post, 108 on the former North Post, and 389 on or near the former Main Post. These target locations are shown on Figures 10a, 10b, and 10c, respectively. The historical average, regardless of time frame, was used as the target value to support the calibration of a groundwater model that simulates steady-state, average conditions. The target water levels are provided in Table E.2. Target water levels ranged between 201 and 365 feet. Because the purpose is to calibrate a regional model to average water levels it is important that all areas are represented in the composite objective function (Moore and Doherty, 2005). For this reason, observation weights were not developed on the basis of presumed measurement accuracy but rather were developed using professional judgement as part of the process of developing the inverse model. Weights were 1.0 for target locations in most areas. However, in areas with fewer target locations on the South Post and former North Post, weights were ascribed 1.5 or 2.0 such that the magnitude of their contribution to the measurement objective function was consistent with other areas with more target locations. Monitoring wells were represented in the model using the CLN package and the calculated water level for each was extracted from the CLN head-save file written by USG-Transport.

These average water levels formed the primary basis of the multi-component objective function that was used for model calibration. Additional target types in the objective function include gradient magnitude and direction calculated using a three-point approach, and horizontal head differences between piezometer pairs installed on either side of the barrier wall. These target types effectively supplement the weights on the corresponding water levels to focus calibration on the information that affects flow directions, rather than the water level itself.

4.2.2 Three-point Gradient Method - Magnitudes and Directions

The magnitude and direction of horizontal gradients calculated using the three-point method (described by Pinder et al., 1981; Silliman and Frost, 1998) for 160 triangles were included as calibration targets. Fifteen triangles were identified on the South Post, 122 on the former Main Post, and 23 on the former North Post – these triangles are shown on Figures 10a, 10b, and 10c, respectively. Table E.3 lists the monitoring well triad used for each triangle as well as the corresponding target gradient direction and magnitude.

A custom program was used to calculate the observed and corresponding simulated equivalents of gradient magnitude and direction for each triangle. The program internally

[16] Former Fort Devens EDMS Portal: ftdevens.org

calculates the direction residual[17] to account for the relative position of the reference angle (which is both 0 and 360 degrees) aligned along the positive y-axis; thus, the target value for direction is zero for all triangles. The magnitude and direction calculated for an example well triad (SHL-12, SHL-17, 32Z-99-02X), using the USEPA (2014) 3PE tool, is shown on Figure E.1. The 3PE calculated magnitudes of 0.0161 and 0.0138 based on the target and simulated water levels, respectively, are the same as those calculated by the custom program (Table E.3). The same is true for the calculated 3PE target and simulated directions of 349.31 and 359.89, respectively. Both the 3PE tool and the custom program use the equations from Silliman and Frost (1998) for their respective calculations. Simulated equivalents were calculated as the square root of the absolute value of the azimuth difference. Weights ascribed were either 0.25 or 0.50 to reflect their desired relative contribution to the total objective function and their respective density in different areas of the model domain.

Observed gradient magnitudes ranged over three orders of magnitude, between 1×10^{-4} and 1×10^{-1}, while target water levels are on the order of several hundred feet. The relative magnitude differences between these two target types can be problematic for model calibration. By transforming the gradient magnitude values as the square root of their reciprocal, the resultant magnitude values ranged between 3 and 51, a range more in line with water level values. Again, weights were 0.25 or 0.50 to reflect their desired relative contribution to the total objective function.

4.2.3 Head Differences Across the Barrier Wall

Five sets of piezometer pairs were installed along the SHL barrier wall, one on either side, to measure the water level change across it (Sovereign, 2013). The average change[18] between each pair was included as a calibration target and assigned a weight of 10.0 to reflect their desired relative contribution to the total objective function. The locations of the piezometer pairs are shown on Figure 10b and their respective target differences are provided in Table E.4.

4.2.4 Soft Target Types

Calibration targets that are based upon quantitative measurements made in the field and that correspond to a model-calculated output are often referred to as “hard” targets. In addition to these hard targets, “soft” targets can be used to help condition the inverse model by providing independent information on a model parameter such as hydraulic conductivity. The following sections describe several soft target types that were incorporated to condition the model calibration in areas for which hard targets were either unavailable or for which the available observation data were insufficient to constrain parameter estimates. The weights assigned to these target types reflect their desired relative contribution to the total objective function.

[17] Observed minus model calculated.

[18] Calculated as the historical average water level of the upgradient piezometer minus that of the downgradient piezometer.

4.2.4.1 Surface Water Levels – Staff Gages and LIDAR Based

Thirty-nine staff gages were identified in the provided water-level data sources discussed previously. The historical average stage elevations for 24 of these were consistent with the average water levels in nearby monitoring wells and therefore were included in the calibration. These values were not considered hard targets because (a) the corresponding stage calculated by the model is based primarily on baseflow (i.e., exchange between surface water and groundwater), not the complete surface water budget, and (b) some simplifying assumptions are necessary regarding the geometry of each surface water feature (although it is noted that the gage data included in the calibration correspond to ponds, lakes, or wetlands, for which the spatial extent of the feature is better delineated and for which groundwater baseflow is the primary component of streamflow). The locations of gages included in the calibration are shown in Figure 11 and listed in Table E.5a with their corresponding target stage. Weights of 1.0 or 2.0 were assigned to these surface water targets to reflect their desired relative contribution to the total objective function.

Some surface water features – especially ponds, lakes, and wetlands, occurring along the creeks, rivers, and their floodplain corridors – are surficial expressions of the water table. Additional stage soft target values were developed for select features by inspecting aerial imagery[19] for features that are visibly open water and calculating the corresponding average LIDAR elevation. These locations are shown on Figure 11 and listed in Table E.5a with their corresponding target stage. These soft calibration targets were assigned a weight of 1.0 to reflect their desired relative contribution to the total objective function.

In each case, the weights selected resulted in these targets providing sufficient contribution to the objective function to help condition the calibration without compromising the fit to the hard targets.

4.2.4.2 Transmissivity and Pumping Rate Constraints

Two additional soft-target types were used to constrain estimates of hydraulic conductivity that can occur when using the automatic pumping rate reduction capabilities of USG-Transport as described in the following paragraphs.

The "AUTOFLOWREDUCE" option available with the USG-Transport WEL package was used for pumping wells. This option provides a constraint that ensures the desired pumping rate does not exceed the maximum rate supported by the well and aquifer properties by reducing the specified pumping rate if the calculated water level in the well falls below its bottom elevation. Any rates that are adjusted by this option during the course of a simulation are recorded in output to a text file.

Use of "AUTOFLOWREDUCE" can be problematic when calibrating a model for which there are target water levels near a pumping well. The expectation is that these historical average water levels reflect the long-term drawdown due to specified average pumping rates at any nearby pumping wells. Drawdown is theoretically proportional to the ratio of pumping rate and aquifer transmissivity, and this relationship is important to the parameter estimation process – however,

[19] World Imagery (Clarity) - Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

when the "AUTOFLOWREDUCE" option is used, the pumping rate is not necessarily fixed, and as a consequence the transmissivity is not well constrained because a particular water level can be simulated using any number of pumping rate-to-transmissivity ratios. For example: if the initial hydraulic conductivity is too low, and the specified pumping rate causes a well to go dry, its rate is reduced, and sensitivities calculated by PEST_HP will reflect a combination of the change in hydraulic conductivity and corresponding change in pumping rate.

The two soft target types used to mitigate this issue were:

1. Estimates of transmissivity in the vicinity of several of the large community well systems, that were compiled by Vanasse Hangen Brustlin, Inc. (1994). Using the average water level from a nearby monitoring well and an estimate of the bedrock elevation at that location, a corresponding hydraulic conductivity was estimated at 11 of these wells and included as a soft target in the model calibration[20]. The hydraulic conductivity in the model was extracted at the location of the monitoring well used to estimate the saturated thickness. Table B.1c in Appendix B summarizes the calculation parameters and the resulting hydraulic conductivity estimate for these wells.
2. Estimates of the flow reduction at each pumping well. A soft target value of 0 was specified for the total calculated flow reduction at pumping wells. The simulated equivalent was calculated by taking the square root of the total flow reduction reported in the USG-Transport output file in gallons/minute. These soft targets were assigned a weight of 2.0.

The targets associated with these two soft-target types are provided in Table E.5b of Appendix E.

4.3 Parameterization

Flow paths in the overburden are largely controlled by the properties of the overburden aquifer and by the distribution of surface water features.

Aquifer parameterization focused on the overburden materials but did also estimate values for the underlying weathered bedrock. Aquifer properties were parameterized using pilot-points – a parameterization device that enables the distribution and magnitude of parameter values to be calibrated without enforcing *a-priori* zones of parameter constancy (Doherty, 2003). The pilot-points for aquifer properties were defined as scalars on the initial model properties and interpolated to the model grid using a kriging approach[21] available with PLPROC, a program in the PEST suite (Watermark Numerical Computing, 2020b). Parameters estimated for the overburden material included horizontal and vertical hydraulic conductivity and competent bedrock thickness[22]. Horizontal and vertical hydraulic conductivity were also calibrated for the upper bedrock. For both

[20] The target value was the square root of the estimated hydraulic conductivity.

[21] The principal anisotropy direction is defined by a series of lines representing the river and creek delineations to provide a basis for spatial interpolation that follows the alluvial system.

[22] The parameter was defined as a scalar on the lower bedrock thickness, a surrogate for overburden thickness; [Overburden thickness] = [Model top] – [Till thickness] – [Upper bedrock thickness (50 feet)] – [Lower bedrock thickness * thickness scalar].

the overburden and upper bedrock, the vertical hydraulic conductivity parameter was defined as a scalar on the initial ratio of horizontal to vertical hydraulic conductivity. The same set of 1378 pilot-point locations was used to represent the five unit properties – 228 for the South Post, 873 for the former Main Post, 125 for the former North Post, and 152 for the off-facility area.

Pilot-points were also used as the parameterization device for the surface water properties[23]. In this case, the property values at each CLN cell were calculated by linearly interpolating between pilot points along the corresponding feature. Estimated surface water feature parameters included bed elevation through an offset term[24], and (normalized) vertical hydraulic conductivity. For the surface water features, the same set of 84 pilot-points were used to represent both the bed elevation change and vertical hydraulic conductivity. Pilot-point locations are shown on Figure 12.

4.4 Regularization

Tikhonov regularization (Doherty, 2015) was employed to constrain calibrated parameter values. With Tikhonov regularization, the objective function is augmented with a model misfit term whereby the total objective function minimized during calibration is the sum of the measurement and regularization terms. The model misfit term is a measure of how different the calibrated parameter set is from a preferred condition. With regularized inversion, the role of calibration becomes a trade-off, between fitting the data and honoring the parameter value constraints; as a consequence this approach is often referred to as "penalized least squares" because deviation from the preferred condition incurs a penalty in the calibration. One end member of this trade-off (especially when using highly parameterized inversion as undertaken here) is over-fitting the data where the data misfit is small and the model misfit is large. The other end member is under-fitting the data, where the data misfit is large and the model misfit is small. In this calibration, an approach for optimizing the level of fit that follows the guidelines in Doherty (2015) was used. First, the model was calibrated with a target data misfit of zero to establish the over-fitting end member[25], at the conclusion of which the (relative) contributions to the total objective function by the measurement and regularization[26] components were reviewed. The optimal level of model-to-measurement fit was established as the calibration iteration for which the change in both the measurement and model misfit terms were small. An example of this procedure is provided in Appendix C. The parameter set corresponding to this iteration was then used, or the calibration was repeated using this updated target objective function.

[23] Except for flow-through features, whose properties were uniform over the feature and represented as zones.

[24] The depth relative to the estimated stage derived from staff gages and LIDAR as discussed in Section 3.2.1.1.1.

[25] The under-fitting end member corresponds to the initial parameter set.

[26] The regularization contribution is calculated here as the parameter variance, var, relative to the initial parameter value; $var = E[(X_{calib} - X_{init})^2]$

Tikhonov regularization constraints are commonly expressed as either preferred-value[27] or preferred-difference[28]. A combination of approaches was used in different areas of the model. Generally, for the overburden and upper bedrock parameters, a preferred-difference constraint was used. For the former Main and North Posts, the initial aquifer properties were homogeneous, however, calibration of the previous models resulted in heterogeneous zones. A preferred-difference regularization scheme was used for these two posts because targets are clustered in localized areas and this regularization device constrains the calibrated values for pilot-points in less sensitive areas to be consistent with the values determined for the more sensitive areas nearer to targets.

4.5 Results

As mentioned earlier, calibration was undertaken in steps, each step focusing on a different post (i.e., South Post, the Former Main Post, and the Former North Post). This approach was implemented because model calibration within each post was not expected to be impacted by targets in other posts. Figure J.1 in Appendix J shows the composite sensitivity of each horizontal hydraulic conductivity pilot point in the overburden to water-level targets at AOC-41. This AOC is located at the north end of New Cranberry Pond on South Post. Figure J.1 illustrates that overburden horizontal hydraulic conductivity pilot points on the Former Main and Former North Posts are insensitive to AOC-41 water levels, and therefore, each post could be calibrated independently of one another.

Surface water parameter values were generally manually calibrated, except along the Nashua River and an unnamed tributary on the North Post, and the bed vertical hydraulic conductivity for a portion of Plow Shop Pond. Contour maps of the calculated steady state water table for the regional domain and each post are depicted in Appendix D.

The model fit for each post was evaluated graphically following guidelines by Hill and Tiedeman (2007). Plots of the measured versus simulated water levels, the measured water levels versus residuals, and the cumulative frequency of water level residuals for South Post, the Former Main Post, and Former North Post are shown on Figures 13a-13c, respectively. Classed post maps of the water level residuals are posted on figures in Appendix D, as are the estimated and calculated three-point gradients. Together, these figures indicate good correspondence between observed and calculated water levels and demonstrate little systematic bias throughout the posts. Calibration targets, corresponding simulated values and residuals are tabulated in Appendix E. Graphical summaries of the estimated parameter values for the overburden and upper bedrock units are shown on Figure 14a, and 14b, respectively. These figures summarize the pre- and post-calibration distribution of hydraulic conductivity values, as a percentage of the area, for each post. Confidence intervals cannot be calculated when regularized inversion is used (Doherty, 2015). Moreover, because recharge and hydraulic conductivity are highly correlated and recharge was not calibrated as part of this effort, estimates of parameter value confidence intervals would not include the contribution from this parameter type. For this reason, the appropriateness of the calibrated values

[27] The preferred-value being a parameter's initial value, here a scalar of 1.

[28] Referred to as a preferred homogeneity condition where the difference between neighboring pilot-point values is specified to be zero.

for hydraulic conductivity are assessed qualitatively against the expected values determined from the previous modeling efforts and encapsulated in the model inversion as prior information. The comparison with expected values is shown in Figures 14a and 14b. Appendix F contains maps depicting the spatial distribution of horizontal and vertical hydraulic conductivity for the overburden and upper bedrock units, and the bedrock thickness scalar. Appendix G contains maps depicting the spatial distribution of surface water properties. Appendix J contains classed post maps showing the sensitivity of each pilot point for the different parameter types. The calculated groundwater budget per HSU is provided in Table 1.

4.5.1 South Post

On the South Post, water levels are bimodal, reflecting the divide between those near AOC 41 and New Cranberry Pond, and an unnamed creek near AOCs 25, 26 and 27. The median water level residual value is -0.20 feet, the mean water level residual is +0.01 feet, and the standard deviation is 1.5 feet, which may suggest some bias towards overestimation of water levels. However, the bias is small and does not appear systematic based on Figures 13a and D.2. From Figure 13a, the range in measured water levels spanned by residuals between +/-1 feet, is about 1 standard deviation, or 68% of the water levels, which covers water levels on both sides of the divide. The only area of probable estimation bias appears to be in water levels near AOC 27.

Triangles for three-point gradient calculations for the South Post are focused near AOCs 25 and 26. The median direction residual is -2.7 degrees, the mean is -1.0 degrees, and the standard deviation is 6.5 degrees. Generally, the calculated gradient magnitudes correspond well (Figure 13d) to values estimated using the three-point gradient approach. However, there is some tendency to overestimate the magnitude of the gradient, although this apparent bias does not appear to be large, and average long term flow gradients in this area are well represented by the model. The calibrated horizontal hydraulic conductivity of the overburden within this post ranges between 0.1 and 128 feet/day, with 82% of the area between 5 and 35 feet/day, and 60% of the area between 25 and 35 feet/day (Figure 14a). The vertical hydraulic conductivity of the overburden ranges between 0.01 feet/day and 16.6 feet/day, with 88% of the area between 1 and 10 feet/day (Figure 14a). The calibrated horizontal hydraulic conductivity of the upper bedrock within this post ranges between 0.6 and 1.3 feet/day (Figure 14b). The vertical hydraulic conductivity of the upper bedrock ranges between 1.5 and 2.2 feet/day (Figure 14b).

4.5.2 Former Main Post

On the former Main Post measured water levels range between 205 and 365 feet. The median water level residual is +0.13 feet, the mean water level residual is +0.24 feet, and the standard deviation is 1.3 feet, which may suggest some bias towards underestimating water levels. However, from Figure 13b, the range in measured water levels spanned by residuals between +/-2 feet (94% of the target locations) is 157.5 feet, and the simulated range is comparable at 157.0 feet, which indicates the bias is likely not systematic. From Figure D.3 in Appendix D, it can be seen the bias is due to target locations that are mostly on the periphery of mapped bedrock outcrops near SHL. It is likely the weathered bedrock is more variable in these areas than what is represented in the model.

The median gradient direction residual is -0.0, the mean is +1.3 degrees, and the standard deviation is 20.6 degrees. The largest direction residuals are predominantly along the northwest

shoreline of Plow Shop Pond (Figure D.5b, in Appendix D). Likely, the localized interaction between that part of the pond and the mapped wetlands impacts model calibration in that area. From Figure 13d, the calculated gradient magnitudes correspond well to the values estimated using the three-point approach. Flow gradients throughout the post are well represented by the model.

Head differences across the barrier wall calculated by the model correspond well to the average measured values for each piezometer pair as shown on Figure 13e. These differences range between 0.4 and 1.7 feet. The median difference residual is +0.10 feet, the mean is +0.05 feet, and the standard deviation is 0.1 feet.

The calibrated horizontal hydraulic conductivity of the overburden within this post ranges between 0.1 and 401 feet/day, with 66% of the area between 5 and 35 feet/day (Figure 14a). The vertical hydraulic conductivity of the overburden ranges between 0.0006 feet/day and 92 feet/day, with 82% of the area between 0.1 and 10 feet/day (Figure 14a). The calibrated horizontal hydraulic conductivity of the upper bedrock within this post ranges between 0.02 and 10.2 feet/day, with 75% of the area between 0.5 and 1 feet/day (Figure 14b). The vertical hydraulic conductivity of the upper bedrock ranges between 0.03 and 9 feet/day, with 87% of the area between 1 and 2 feet/day (Figure 14b).

4.5.3 Former North Post

On the former North Post measured water levels generally range between 201 and 214 feet, except for MW-06 and MW-07 west of the WWTP, which have measured water levels of 222.1 and 219.8, respectively. The median water level residual is +0.02 feet, the mean water level residual is -0.06 feet, and the standard deviation is 0.9 feet. From Figure 13c there is little systematic bias in the calculated water levels as the positive and negative residuals are well balanced throughout the range in water levels.

The median gradient direction residual is +0.9 degrees, the mean is +5.1 degrees, and the standard deviation is 21.3 degrees. From Figure 13d, the calculated gradient magnitudes correspond well to the values estimated using the three-point gradient approach. Flow gradients in this area are well represented by the model. The largest gradient residuals are along the narrow corridor of wells installed as part of the AOC 50 investigation (Figure D.5b in Appendix D). The wells used to define the triangles in this area are close together with a small range in water levels. As a result, the gradient calculation is sensitive to small changes in water levels. A better fit to these estimates of gradients would likely involve overfitting of the average water levels.

The calibrated horizontal hydraulic conductivity of the overburden within this post ranges between 4.4 and 413 feet/day, with 81% of the area between 15 and 75 feet/day, and 47% of the area between 25 and 45 feet/day (Figure 14a). The vertical hydraulic conductivity of the overburden ranges between 0.4 feet/day and 55 feet/day, with 89% of the area between 1 and 10 feet/day (Figure 14a). The calibrated horizontal hydraulic conductivity of the upper bedrock within this post ranges between 0.4 and 1.2 feet/day (Figure 14b). The vertical hydraulic conductivity of the upper bedrock ranges between 1 and 3 feet/day (Figure 14b).

Section 5
Flow Path Analysis – Focus Area 1

Particle tracking analyses were used to evaluate flow paths and travel times within Focus Area 1 to and from areas and receptors of interest identified by S-A JV. These analyses are described below and the calculated pathlines presented in Figures 15b-d, for which Figure 15a is a reference map showing their relative extents.

Flow paths were calculated for areas of PFOS/PFOA contamination delineated by S-A JV (2020d) to U.S. Environmental Protection Agency's (USEPA's) lifetime health advisory (LHA) of 70 parts per trillion (USEPA, 2016) within Focus Area 1. The mapped contamination includes a small area on the eastern edge of Robbins Pond, an area near AOC 43G to the west of Robbins Pond, an area south of AOC 75, an area between the Patton Well and the headwaters of Cold Spring Brook near AOC 40, and an area south of the Grove Pond well field to AOC 57 along Bowers Brook (Figure 15b).

The base estimates of effective porosity specified for the particle tracking analyses were taken from Geosyntec (2020) for the SHL model – 30% for the overburden, 25% for the till, and 0.1% for the bedrock units. Like what was done for other aquifer properties, the effective porosity in each model cell was calculated as the thickness weighted average of the effective porosities of each HSU within it. Effective porosity is a scalar on particle travel time. A range in potential travel times for each area was calculated by using an alternate set of effective porosities: 15% for the overburden and till units, 10% in the upper bedrock, and 2% in the competent bedrock. This alternate set of effective porosities reflect our professional judgement of the best estimate based on our experience and is consistent with differences between effective porosity estimated from textural data (e.g., grain size and moisture retention) and field calibrated values to a tracer test reported by Stephens et al. (1998). Stephens et al. (1998) concluded that porosities derived from textural data resulted in effective porosity estimates that were between 50 and 90% larger than an estimate resulting from a calibration to a field tracer test for a sand and gravel aquifer. The base overburden effective porosity is 90% larger than the alternate value, and 67% larger for the till. The alternate porosities for the bedrock units are consistent with values discussed by Fetter (2001) for fractured crystalline bedrock. Retardation was assumed to be negligible, and thus specified as 1.

Particles were released throughout the overburden[29] at regular intervals[30] within the identified PFOS/PFOA contamination areas. Forward paths were calculated to identify potential discharge areas, while backwards paths were calculated to identify potential recharge areas. Particle paths were calculated using mod-PATH3DU v.2.1.5 (SSP&A, 2020). The resulting flow paths are shown on Figures 15b and 15c.

[29] The middle of any layer for model cells in which the overburden constitutes at least 30% of the layer thickness.

[30] One-hundred foot spacing in each area except for the smaller one east of Robbins Pond in which particles were released at 50-foot intervals.

The forward particle paths indicate that discharge from these PFOS/PFOA contamination areas are primarily to nearby creeks or rivers. Particles released east of Robbins Pond discharge to gaining portions of Willow Branch or for deeper releases, follow the brook ultimately discharging to a bend in the Nashua River just west of a reach of Willow Branch calculated to be losing water to the groundwater system. Particles released from the area west of Robbins Pond discharge to Robbins Pond or Willow Branch. Particles released from the area south of AOC 75 discharge to Cold Spring Brook or the low-lying wetland areas through which it flows. Particles released near AOC 40 discharge to either the Patton Well or Cold Spring Brook depending on which side of the groundwater divide in this area they originate. Particles released from the area between the Grove Pond well field and AOC 57 discharge to Bowers Brook or the wetlands through which it runs, Grove Pond or the Grove Pond well field. Particle travel times, in years, are summarized in Table 2 for the base and alternate set of effective porosities. Generally, travel times for the alternate effective porosity scenario are half those of the base effective porosity, as expected given effective porosity in the overburden for the alternate scenario is half of the base value. This result is made evident by comparing the median travel times. For two areas, the one east of Robbins Pond, and the one south of AOC 75, the maximum travel time is longer for the alternate scenario as the effective porosity in the upper bedrock is 100 times higher than the base scenario. This result indicates that for these two scenarios some particles travel through cells that are comprised mainly of bedrock. However, the longest travel time for these areas is, at most, twice that of the base scenario, which indicates the particles, regardless of area, are predominantly travelling through the overburden and that particle paths in the bedrock are shallow and largely confined to the upper bedrock.

Backward particle paths indicate the calculated recharge areas for the groundwater in the identified PFOS/PFOA contaminated areas generally extend to groundwater divides at topographic highs. For the contaminated area just east of Robbins Pond, the recharge area extends west, below Robbins Pond, through AOC 43G, to the groundwater divide at a topographic high. The recharge area also includes a portion on the northeast side of Robbins Pond where it is calculated to be losing to the groundwater system. For the contaminated area west of Robbins Pond, the recharge area extends further west to the groundwater divide at a topographic high. For the area south of AOC 75, the calculated recharge area extends to the ridge of bedrock outcrops just east of Robbins Pond that is the calculated groundwater divide between the Willow Branch and Cold Spring Brook watersheds. The calculated recharge area for the contaminated area between the Patton Well and the headwaters of Cold Spring Brook extends predominantly to the bedrock hill to the southeast with a small area towards the hill to the west. The recharge area of the PFOS/PFOA contamination area identified between the Grove Pond well field and AOC 57 extends to the bedrock ridge to the west that is the calculated groundwater divide between the Willow Branch and Cold Spring Brook watersheds. Particle travel times are summarized in Table 2 for the base and alternate set of effective porosities. Generally, travel times for the alternate effective porosity scenario are half those of the base effective porosity, as expected given effective porosity in the overburden for the alternate scenario is half of the base value. This result is made evident by comparing the median travel times. Largely the maximum travel time for each area is less for the alternative scenario compared to the base one, which indicates that particles are predominantly travelling through the overburden from their recharge areas. The exception is for the area south of AOC 75, which has a maximum travel time 24% longer for the alternate scenario compared to the base one. This result indicates that the reverse particle paths are still predominantly through the overburden for this area,

but a small portion of some pathways travel through cells that are comprised mostly of upper bedrock.

The 5-, 25-, and 50-year capture zones for the Patton and Shabokin wells, and the Grove Pond Well Field were calculated using backward particle tracking analysis. The model cells from which these wells are pumping are 10x10 square feet. For the backward tracking analysis, a circle of particles was released around each well at a radius of 7 feet from the cell center. Particles were released at one-degree intervals (1.2 feet between particles) at 9 vertical release points per layer in which a well was screened. These vertical release points corresponded to 10% intervals of a cell's thickness, from 10% through 90%. At these intervals, 3240 particles are released per model layer that a well is screened within.

The Shabokin Well is screened in model layers 4 and 5, thus 6480 particles were used to delineate its capture zone, while Patton Well is screened in model layer 3 and its capture zone was delineated using 3240 particles. Particles were also released at the water table from the gaining areas of any pond, lake, or wetland, within a capture zone of the Patton and Shabokin Wells as these are small flow-through features. The resulting capture zones are shown on Figures 15d and 15e for the base and alternate set of effective porosities, respectively. The recharge areas for these wells extend to the topographic highs to the west and east. Figures K.1 and K.2 show the extent of capture within each HSU[31], for the base and alternate effective porosity sets, respectively. Wells 1 and 6 in the Grove Pond Well Field are screened in model layers 2 and 3, while wells 7 and 8 are screened in model layer 3. As such, 6480 particles were used to delineate Grove Pond Wells 1 and 6, and 3240 particles were used to delineate Grove Pond Wells 6 and 7. The resulting capture zones are shown on Figures 15f and 15g for the base and alternate set of effective porosities, respectively, while Appendix K, Figures K.3 and K.4 show the extent of capture within each HSU for the base and alternate effective porosity sets, respectively.

[31] A particle pathway is shown if at least 50% of a cell's thickness is comprised of the designated HSU.

Section 6
Summary and Conclusions

This report documents the development and calibration of a regional steady-state groundwater flow model of the former Fort Devens U.S. Army post. The groundwater model was developed to (a) combine conceptual and structural details from existing regional and local models encompassing the area within, and extending beyond, the former Fort Devens U.S. Army post footprint; and (b) calculate groundwater flow paths within the overburden sands throughout the facilities. The groundwater model was constructed using USG-Transport.

Conceptually, the regional flow of groundwater is from recharged upland areas to the myriad surface water features, including the Nashua River, contributing creeks, ponds, lakes, and wetlands, that punctuate the area. The hydrostratigraphy of the region consists of a coarse-grained glacial outwash aquifer of variable thickness underlain by a till of nominal thickness (in most areas), both of which overly bedrock. The uppermost bedrock is weathered based on log descriptions. Groundwater flow occurs primarily in the overburden materials with some flow likely occurring in the weathered portion of the bedrock. Flow in the underlying crystalline bedrock is limited to non-existent.

The inverse model was developed for calibrating the groundwater model, using pilot-points to represent both aquifer and surface water properties. The inverse model includes a multi-component objective function comprising historical average water levels, gradient magnitude and direction calculated using a three-point approach, and horizontal hydraulic-head differences between piezometer pairs installed on either side of the SHL barrier wall. Additional soft target constraints, incorporated into the objective function, included surface water levels derived from staff gages and LIDAR elevations, and estimates of hydraulic conductivity at several pumping wells. Tikhonov regularization was employed to constrain the parameter values estimated during the calibration process. The inverse model was constructed using PEST_HP.

Following groundwater model development and calibration, the potential discharge and recharge areas for PFOS/PFOA contaminated regions identified by the S-A JV within Focus Area 1 were calculated. The S-A JV identified five (5) contaminated areas. Particles were released throughout the overburden in these areas and were tracked forward and backward using the particle tracking program mod-PATH3DU. The discharge areas for each of these locations were calculated to be downgradient surface water features, or nearby supply wells, and the calculated recharge areas are groundwater divides that correspond to upgradient topographic highs. In addition, the 5-, 25-, and 50-year capture zones for the Patton and Shabokin supply wells were calculated using a backward tracking analysis.

Section 7
Model Usefulness and Limitations

Calibrating regional models poses unique challenges – typically, the model is not expected to answer a specific question for a particular area, rather the purpose, as it is here, is to provide a vehicle to understand optimized flow directions given the available monitoring data. As was the case for the ETA (1993) regional model, the model presented herein was developed to be the foundation for future investigations requiring groundwater modeling. However, owing to current best practices for groundwater model development and calibration that are employed here, this model can be used directly to answer questions specific to different areas, as needed.

As built, the groundwater flow model is a useful tool to understand potential recharge and discharge areas of mapped PFOS/PFOA contamination under historically average conditions described by the available water level data and best estimate of recharge. The discharge areas are largely controlled by the elevation, and to a lesser degree, the conductance of the surface water features. The recharge areas are controlled by the upstream recharge and hydraulic conductivity distribution, and the ratio of the two is reasonably constrained by the available water-level data. However, travel time is not well constrained, as it is controlled by the hydraulic conductivity and porosity of the overburden, neither of which are uniquely identifiable through calibration of water levels alone.

Baseflow estimated from surface water flow measurements provide a direct measure of the bulk average recharge to the contributing watershed area. This type of data would help to better inform recharge estimation or calibration and as a result better constrain the hydraulic conductivity. Incorporating data types related to contaminant migration are important to constraining travel time and the transport parameters controlling it, especially the product of retardation and the ratio of hydraulic conductivity to effective porosity. This data type would also bolster flow direction information and can be used to supplant estimates based on a three-point gradient analysis.

The inverse model developed here is a useful tool to test hypotheses about the flow of groundwater in the overburden. The use of pilot-points to represent both aquifer and surface water properties provides a robust mechanism to evaluate sensitivity throughout the model domain. If the model is used to make more specific predictions in the future, this inverse model is a useful tool to evaluate the uncertainty of such a prediction. Further, the framework developed here is readily extendable to other parameter types as needed.

The geometry and properties of the different surface water features were developed for the purposes of a regional model, and therefore the interaction between these features in the model reflects this assumption.

Section 8
References

ARCADIS. 2002. Groundwater Flow & Transport Model Report. Appendix B of the AOC 50 FS in 2002.

Anderman, E.R., and M.C. Hill. 2000. *MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model - Documentation of the Hydrogeologic-Unit Flow (HUF) Package*. U.S. Geological Survey. Open-File Report 2000-342.

Doherty, J. 2003. Ground Water Model Calibration Using Pilot Points and Regularization: *Groundwater* 41, no. 2:170–177.

Doherty, J. 2015. *Calibration and Uncertainty Analysis for Complex Environmental Models*. PEST: Complete Theory and What It Means for Modelling the Real World. Brisbane, Australia: Watermark Numerical Computing.

Engineering Technologies Associates, Inc. (ETA). 1993. Ground Water Flow Model at Fort Devens, Massachusetts, Final Report. Published for the U.S. Army Environmental Center by Engineering Technologies Associates, Inc., Ellicott City, Maryland. May 24.

Engineering Technologies Associates, Inc. (ETA). 1994. Fort Devens South Post, MA, Groundwater Flow Model, Draft Report, Appendix F, Remedial Investigations Report, Functional Area 1, Volume 5 of 5, Appendices, Prepared by Ecology and Environment Inc., Arlington, Virginia. March.

Engineering Technologies Associates, Inc. (ETA). 1995. Detailed Flow Model for Main and North Post, Fort Devens, Massachusetts, Final Report. Published for the U.S. Army Environmental Center by Engineering Technologies Associates, Inc., Ellicott City, Maryland. May 19.

Fetter, C.W. 2001. Applied Hydrogeology. Fourth Edition. Upper Saddle River, New Jersey: Prentice-Hall Inc.

Geosyntec Consultants (Geosyntec). 2016. Draft Shepley's Hill Landfill Groundwater Flow Model Revision Report, Former Fort Devens Army Installation, Devens, Massachusetts. October.

Geosyntec Consultants (Geosyntec). 2020. Final Shepley's Hill Landfill Groundwater Flow Model Revision Report, Former Fort Devens Army Installation, Devens, Massachusetts. Published for the Department of the Army, U.S. Army Corps of Engineers New England District by Geosyntec Consultants, Acton, MA, July.Hill, M.C., and C.R. Tiedeman. 2007. Effective Groundwater Model Calibration: With Analysis of Data, Sensitivities, Predictions, and Uncertainty. Hoboken, New Jersey: John Wiley & Sons, Inc.

Jahns, R. H. 1953. *Surficial Geology of the Ayer Quadrangle*, Massachusetts. U.S. Geological Survey in cooperation with the Commonwealth of Massachusetts. Geologic Quadrangle 21.

Lien, Jyh-Ming, Guilin Liu, and C.D. Langevin. 2015. *GRIDGEN version 1.0—A Computer Program for Generating Unstructured Finite-Volume Grids*. U.S. Geological Survey. Open-File Report 2014–1109.

Mercadante, A.M., J.A. Colman, and M.L. Buursink. 1999. Map Showing Morphometry, Bathymetry and Soft Sediment Thickness of Plow Shop Pond and Grove Pond, Ayer, Massachusetts. U.S. Geological Survey. Water-Resources Investigations Report 99-4241.

Moore, C., and J. Doherty. 2005. The Role of the Calibration Process in Reducing Model Predictive Error: *Water Resources Research* 41, no. 5: W05020.

Muffels, C., S. Panday, C. Andrews, M. Tonkin, and A. Spiliotopoulos. 2022. Simulating Groundwater Interaction with a Surface Water Network Using Connected Linear Networks: *Groundwater* 60, no. 6: 801-807.

Panday, Sorab, C.D. Langevin, R.G. Niswonger, M. Ibaraki, and J.D. Hughes. 2017. *MODFLOW-USG version 1.4.00: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation*: U.S. Geological Survey Software Release, October 27, https://dx.doi.org/10.5066/F7R20ZFJ.

Panday, S. 2020. USG-Transport Version 1.5.0: Block-Centered Transport Process for MODFLOW-USG, GSI Environmental, July, https://www.gsi-net.com/en/software/free-software/modflow-usg.html.

Pinder, G. F., M. A. Celia, and W. G. Gray. 1981. Velocity Calculation from Randomly Located Hydraulic Heads: *Ground Water* 19, no. 3: 262-264.

S. S. Papadopulos and Associates, Inc. (SSP&A). 2020. User's Guide for mod-PATH3DU, a Groundwater Path and Travel-Time Simulator. Retrieved from http://mp3du.sspa.com/man/.

SERES-Arcadis 8(a) Joint Venture 2, LLC (S-A JV). 2020a. Top of Bedrock surface, filename: Bedrock-Final_Revised WB1_Shab.grd, Former Fort Devens, Massachusetts Database, shared via email from Marc Killingstad on November 4, 2020.

SERES-Arcadis 8(a) Joint Venture 2, LLC (S-A JV). 2020b. LIDAR surface, filename: Lidar-Smoothed.grd, shared via WeTransfer link in email from Jennifer Wahlburg on July 16, 2020.

SERES-Arcadis 8(a) Joint Venture 2, LLC (S-A JV). 2020c. Devens Summary Table of Water Supply and Other Wells, filename: Devens Community Wells 9_Updated (1).xlsx, received via email from Tony Mancini on October 27, 2020.

SERES-Arcadis 8(a) Joint Venture 2, LLC (S-A JV). 2020d. Shapefile Delineating PFOS/PFOA Plumes Above 70ng/L, filename: PFOS_PFOA_above_70_plume.shp, received via email from Marc Killingstad on December 16, 2020.

Silliman, S.E., and C. Frost. 1998. Monitoring Hydraulic Gradient Using Three-Point Estimator: *Journal of Environmental Engineering* 124, no. 6: 517-523.

Sovereign. 2013. Draft Shepley's Hill Landfill Groundwater Model Revision, Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. October.

Stephens, D.B., K. Hsu, M.A. Prieksat, M.D. Ankeny, N. Blandford, T.L. Roth, J.A. Kelsey, and J.R. Whitworth. 1998. A comparison of estimated and calculated effective porosity: *Hydrogeology Journal* 6: 156-165.

Stone, J.R., B.D. Stone, M.L. DiGiacomo-Cohen, and S.B. Mabee, comps. 2018. *Surficial Materials of Massachusetts—A 1:24,000-Scale Geologic Map Database*. U.S. Geological Survey. Scientific Investigations Map 3402, 189 sheets, scale 1:24,000; index map, scale 1:250,000; 58-p. pamphlet; and geodatabase files.

U.S. Environmental Protection Agency (USEPA). 2014. 3PE: A Tool for Estimating Groundwater Flow Vectors. Office of Research and Development. EPA 600/R-14/273. September.

USEPA. 2016. Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS). EPA 822-R-16-004. Washington, DC: Office of Water U.S. EPA, Health and Ecological Criteria Division. https://www.epa.gov/sites/production/files/2016-05/documents/pfos_health_advisory_final_508.pdf.

Vanesse Hangen Brustlin, Inc. 1994. Devens Water Resources Protection Report. November.

Watermark Numerical Computing. 2020a. PEST_HP Version 17.1: PEST for Highly Parallelized Computing Environments, Watermark Numerical Computing, August, https://pesthomepage.org/.

Watermark Numerical Computing. 2020b. PLRPOC, A Parameter List Processor, Watermark Numerical Computing, May, https://pesthomepage.org/.

FIGURES

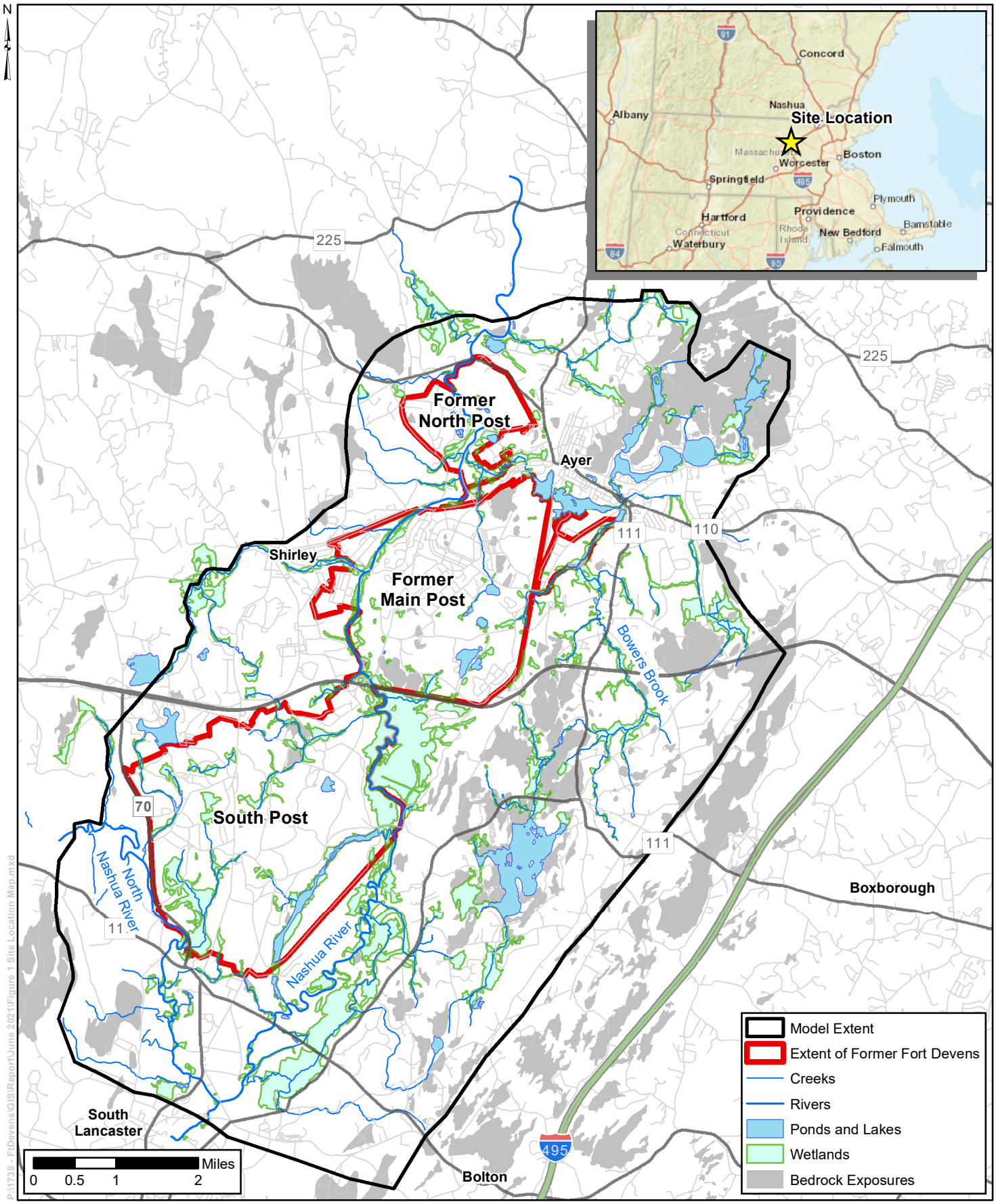


Figure 1 Site Location Map

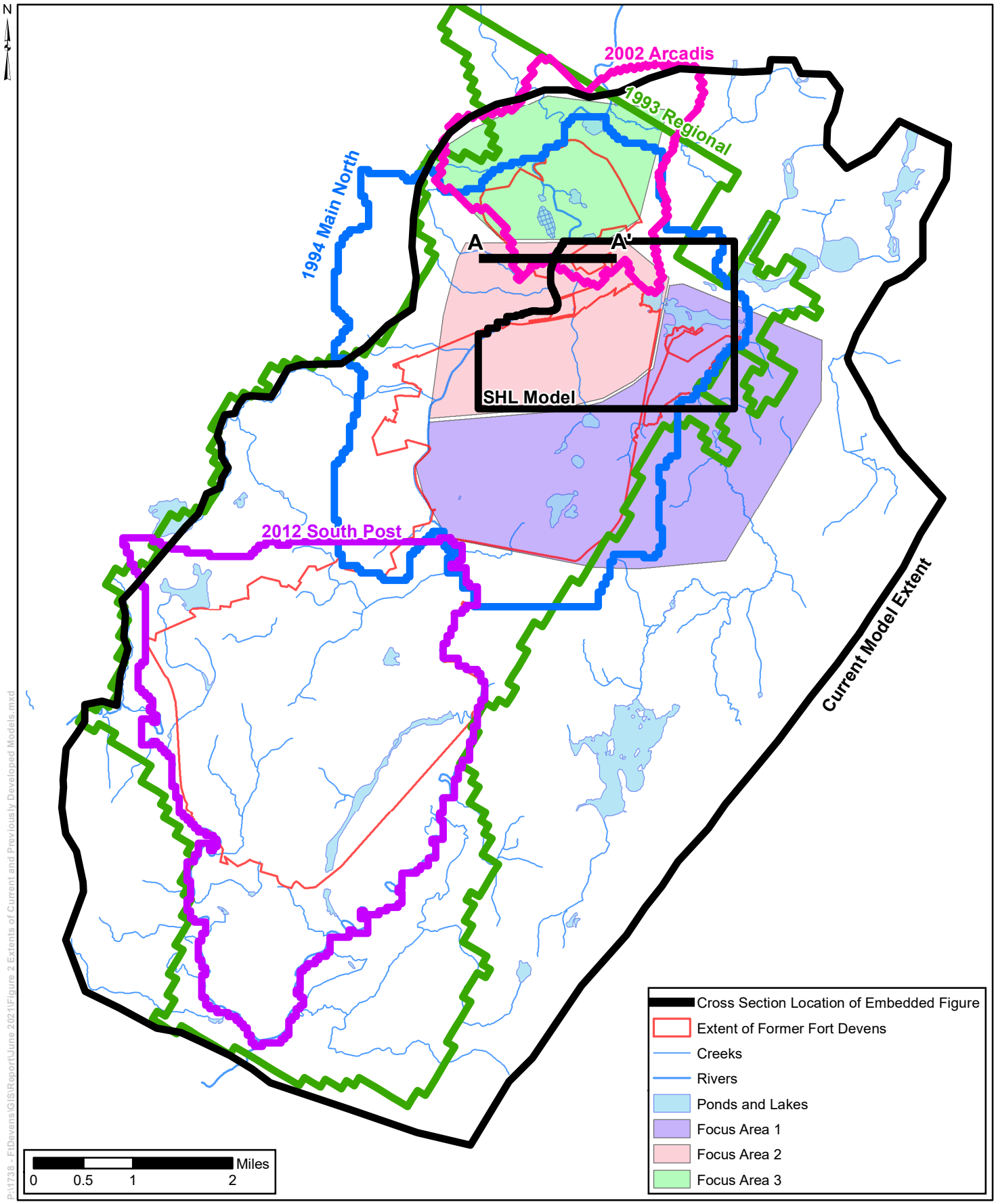


Figure 2 Extents of Current and Previously Developed Models

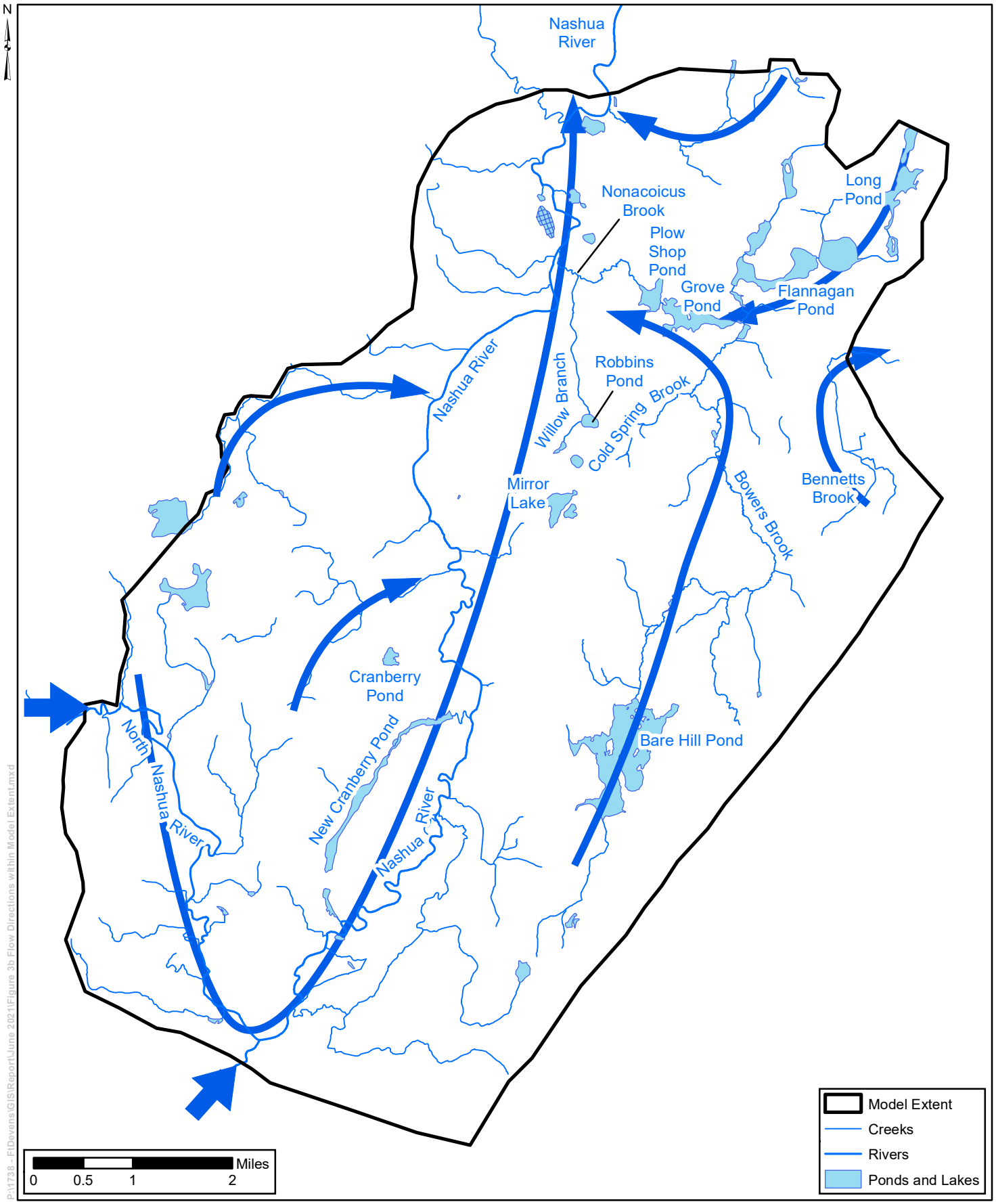


Figure 3a Surface Water Flow Directions

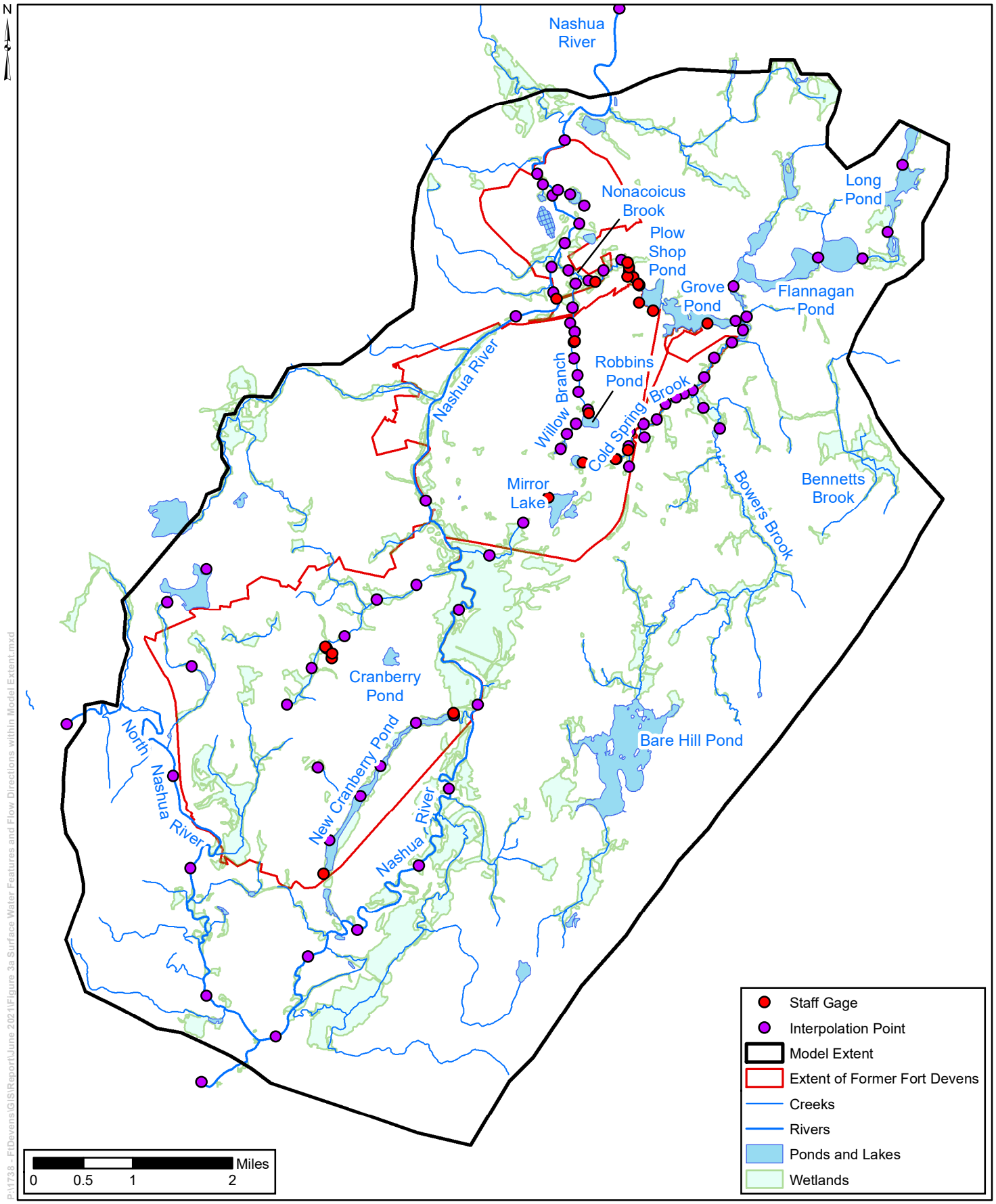


Figure 3b Surface Water Features within Model Domain

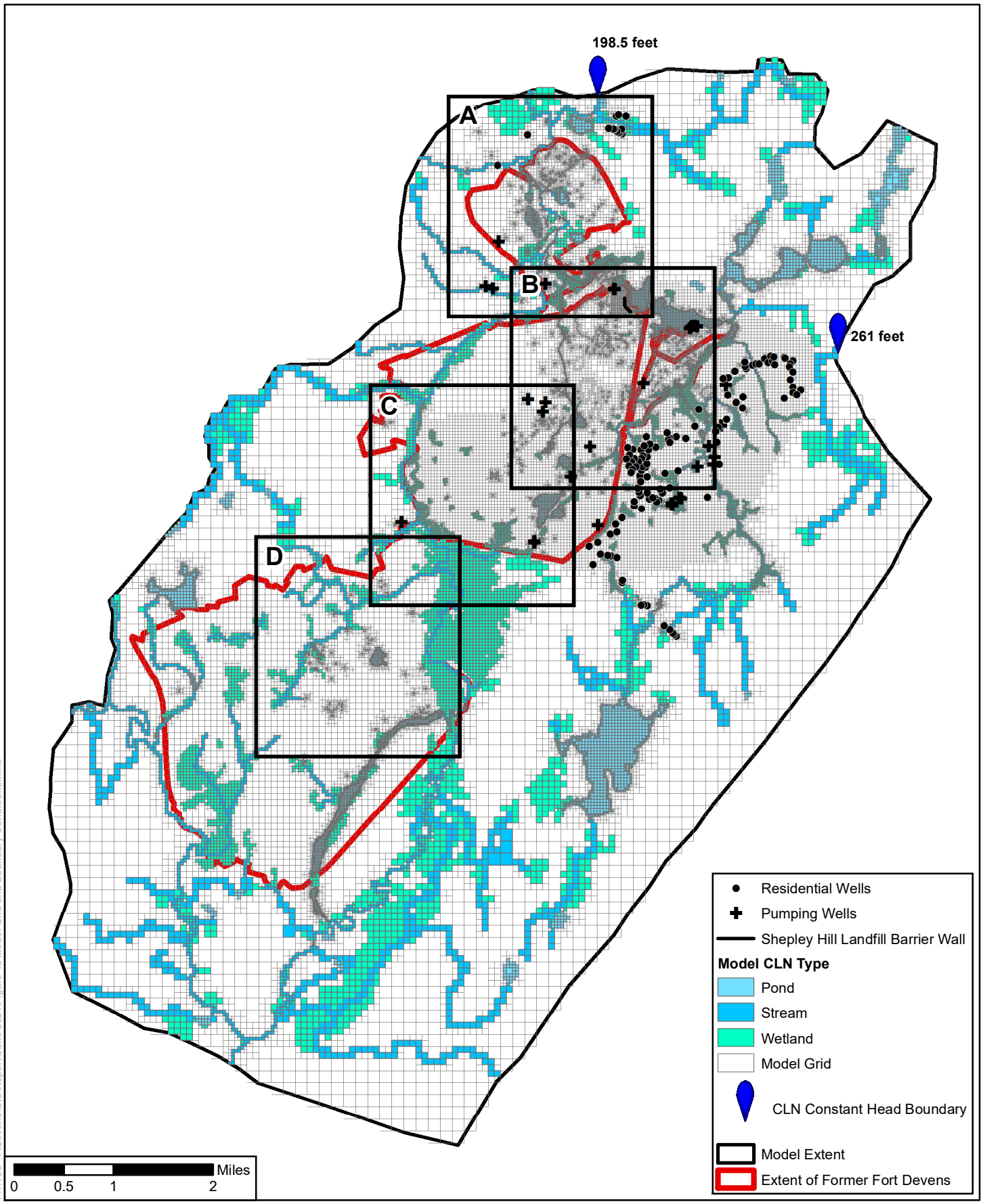


Figure 4a Model Grid and Boundary Conditions

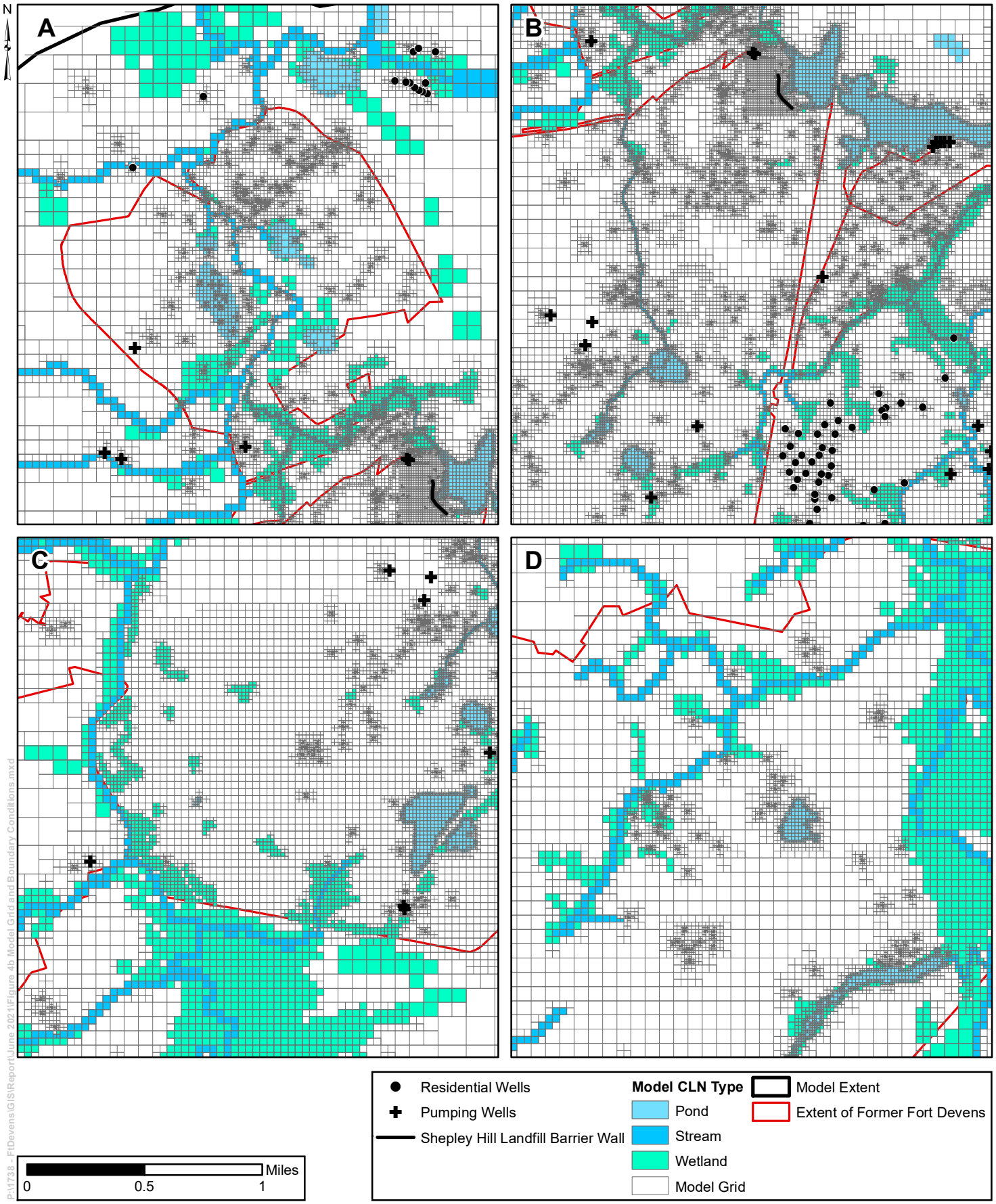


Figure 4b Model Grid and Boundary Conditions - Insets A-D

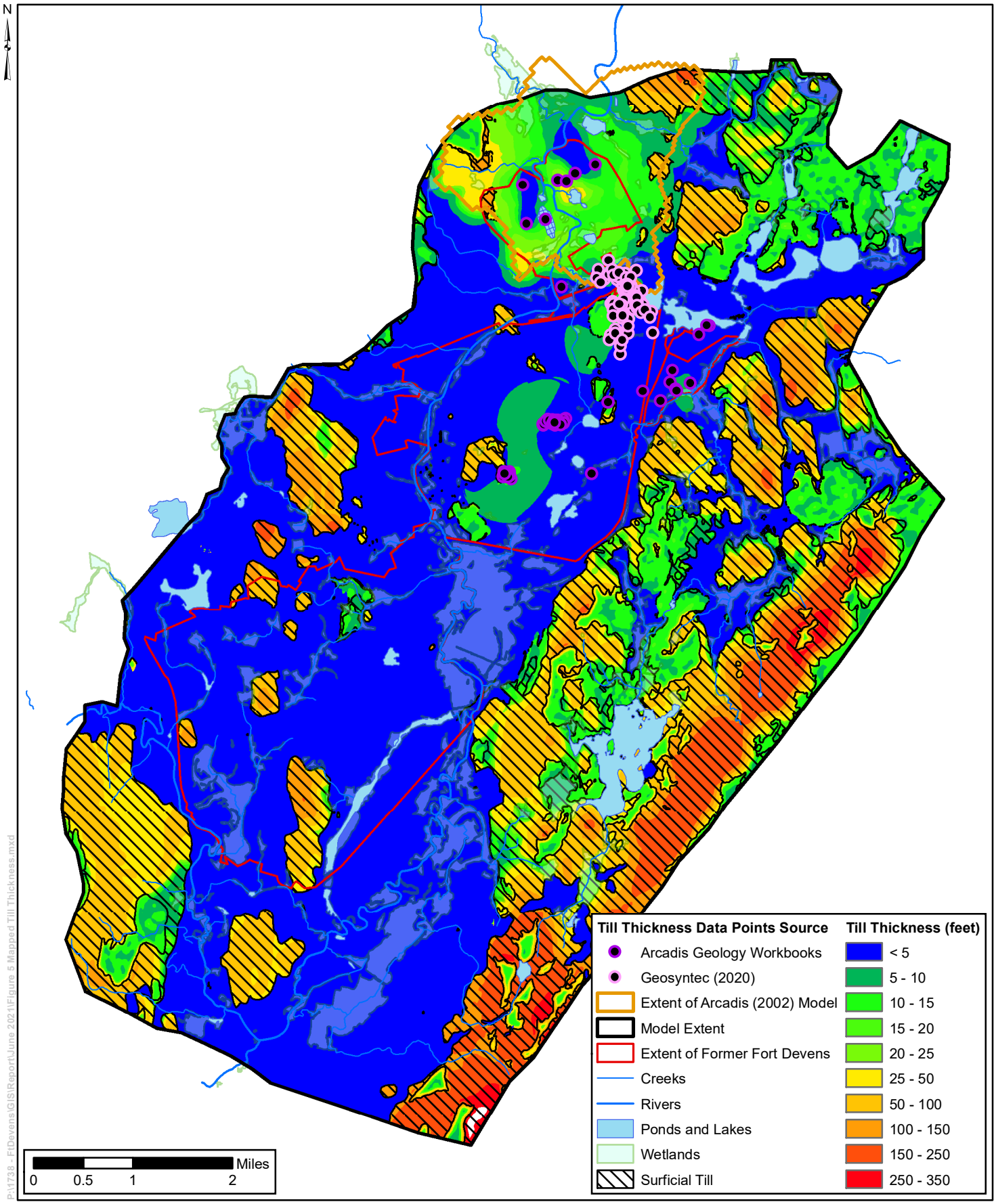


Figure 5 Mapped Till Thickness

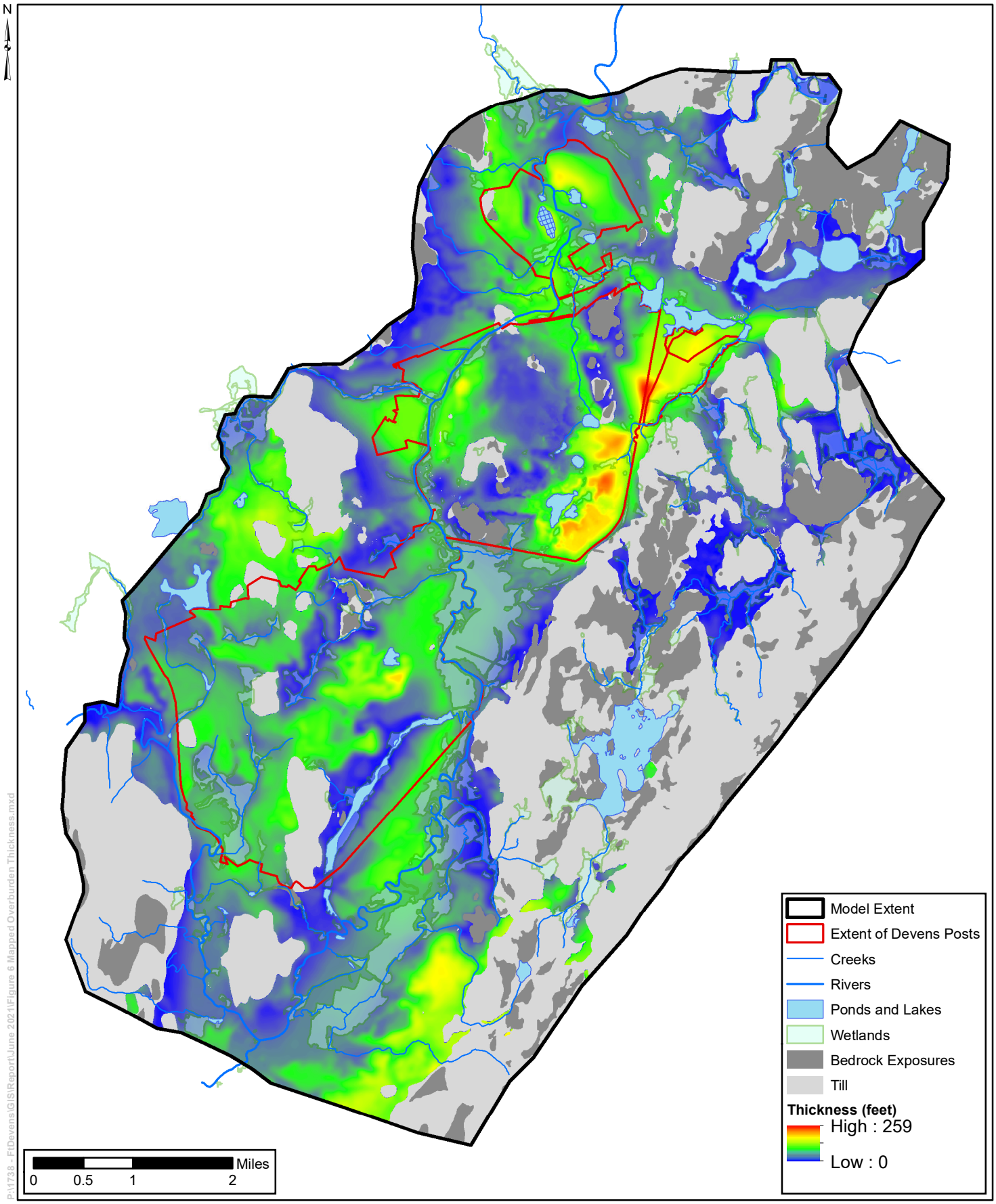


Figure 6 Mapped Overburden Thickness

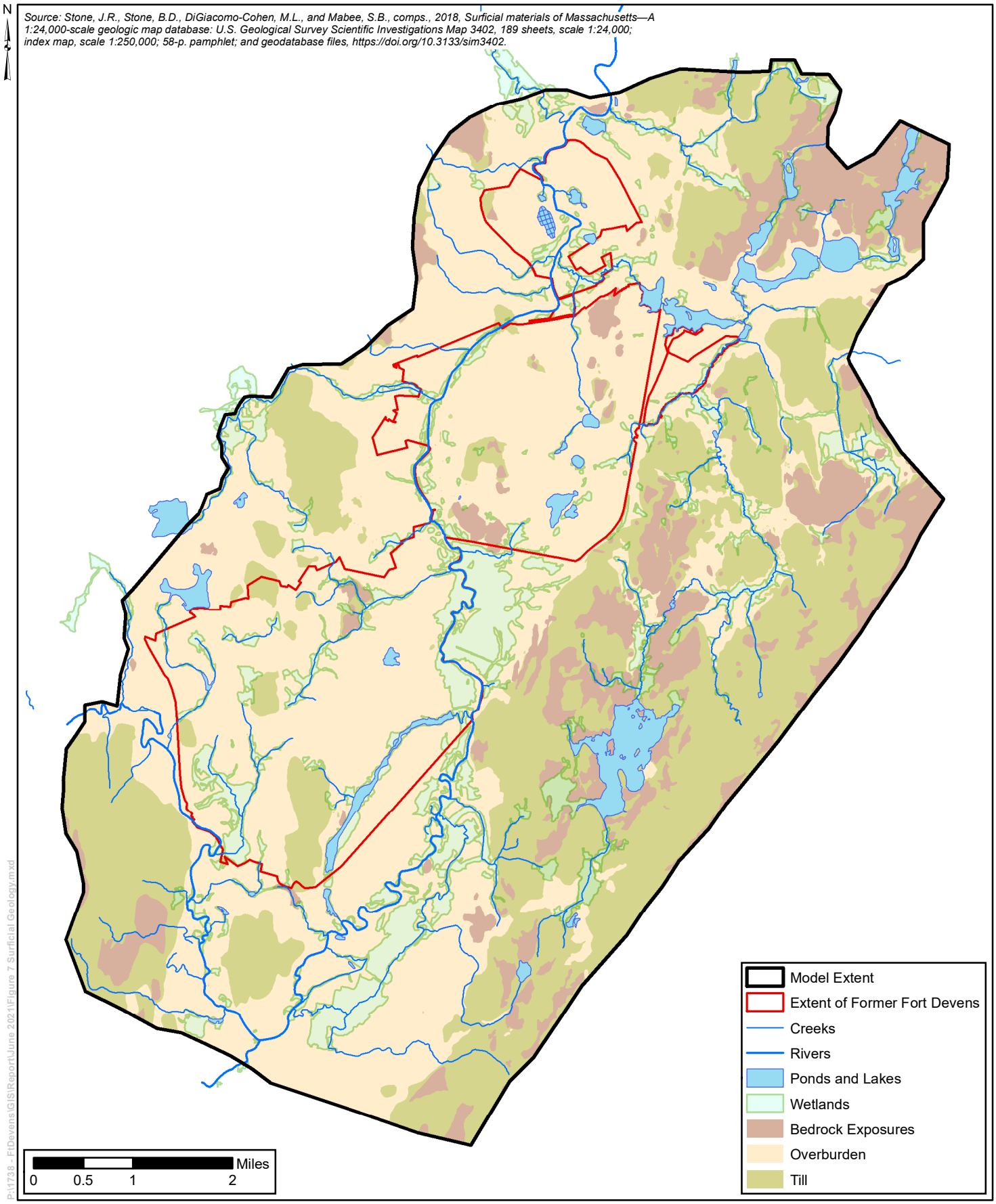


Figure 7 Surficial Geology

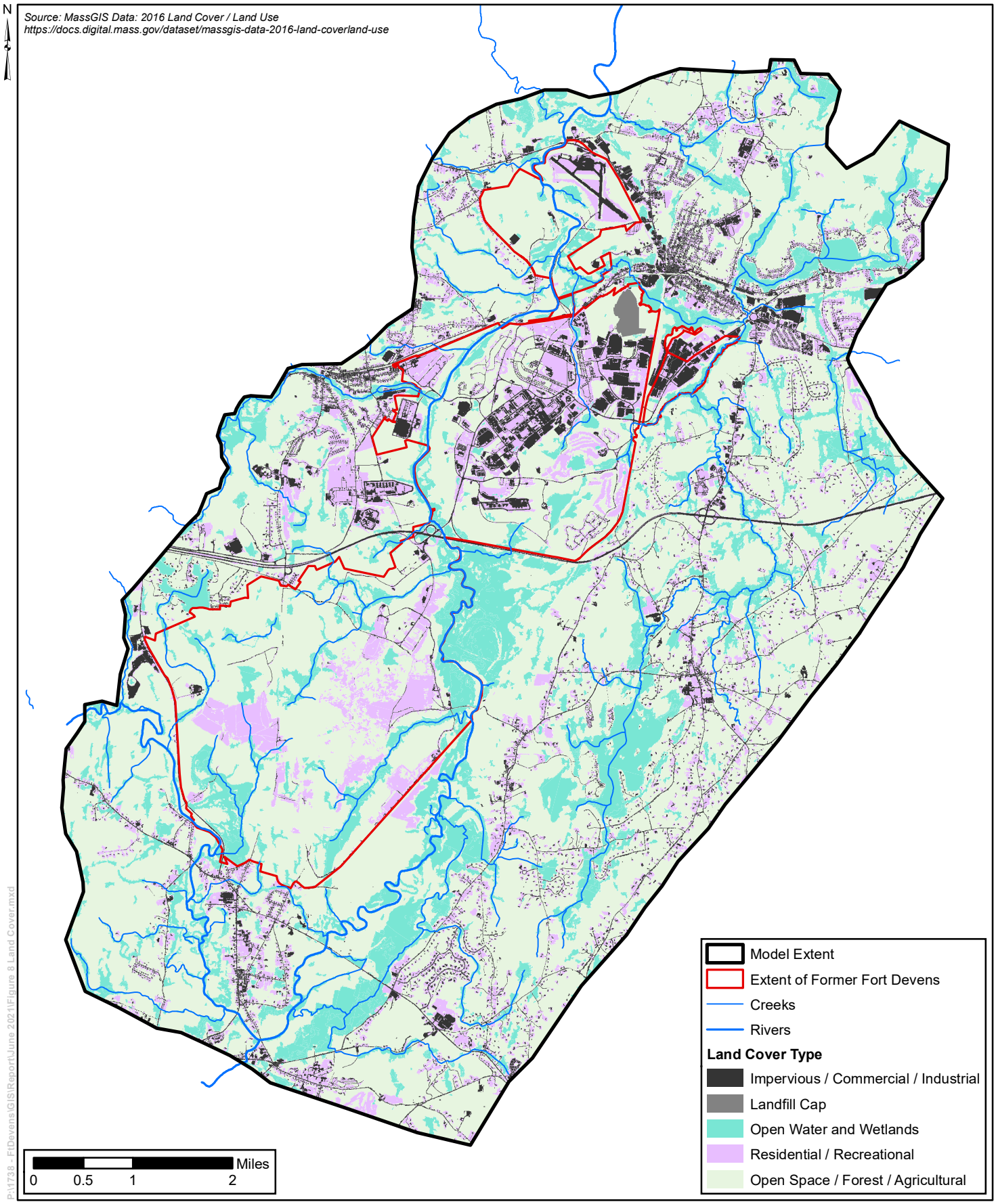


Figure 8 Land Cover

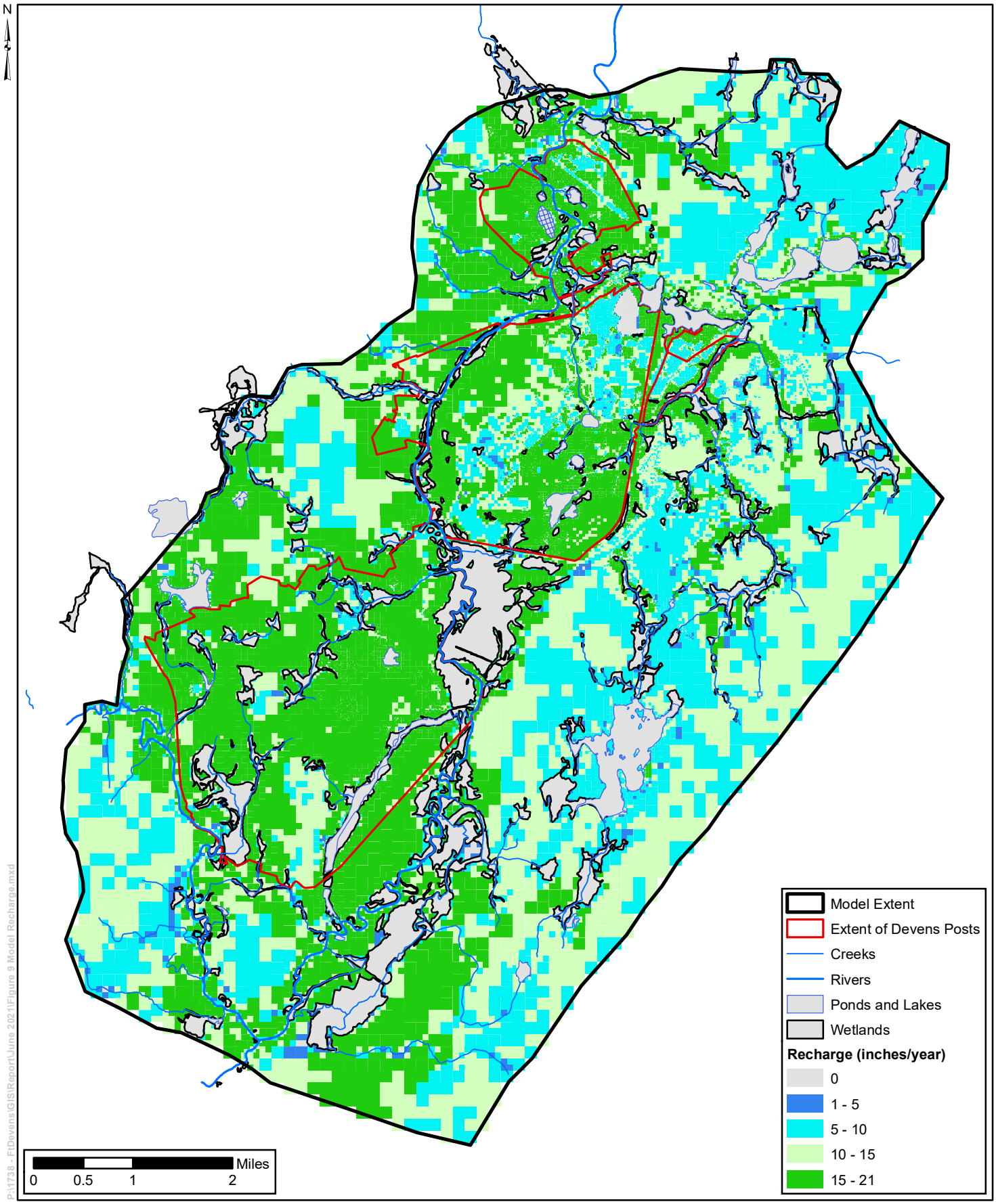


Figure 9 Model Recharge

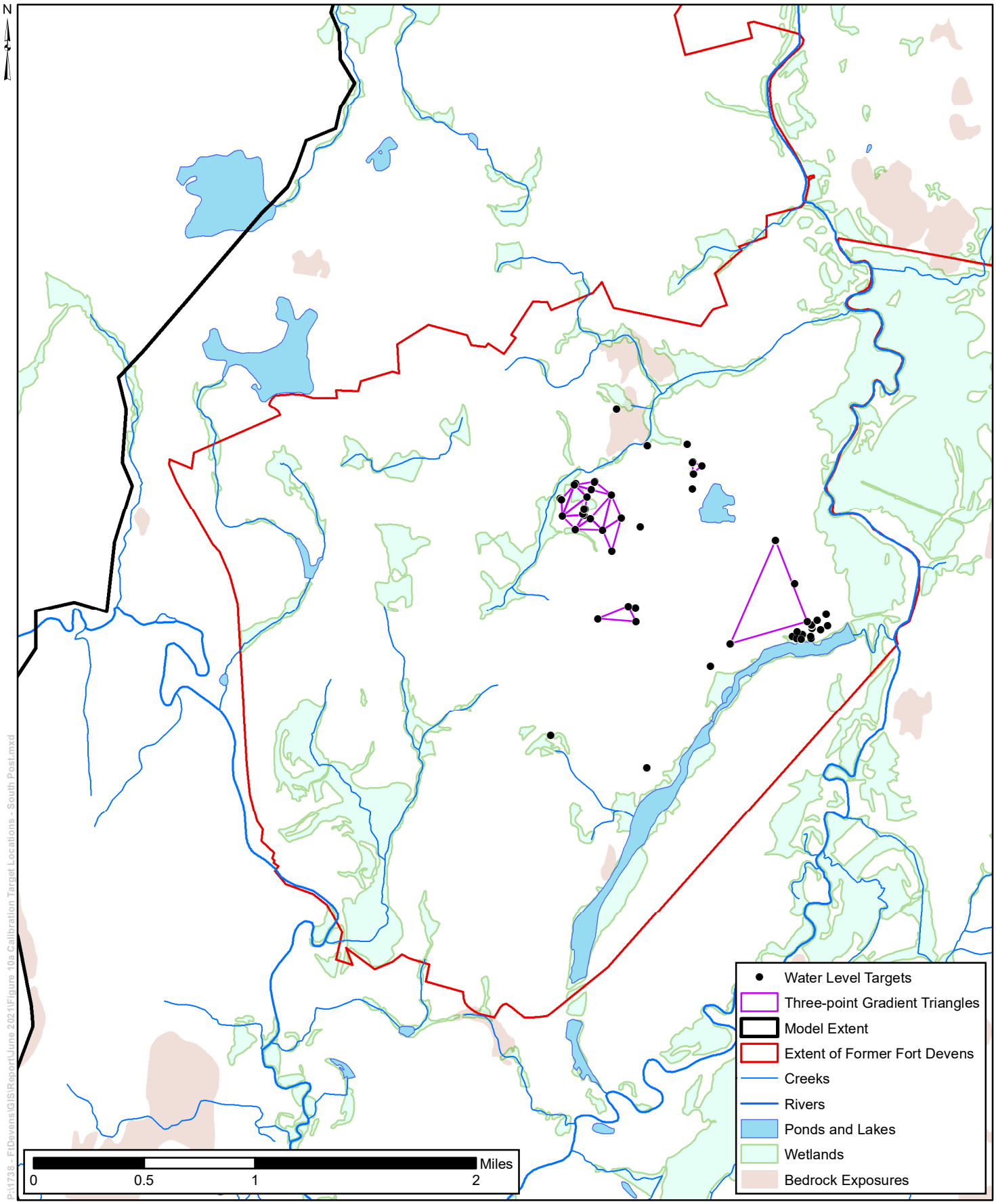


Figure 10a Calibration Target Locations - South Post

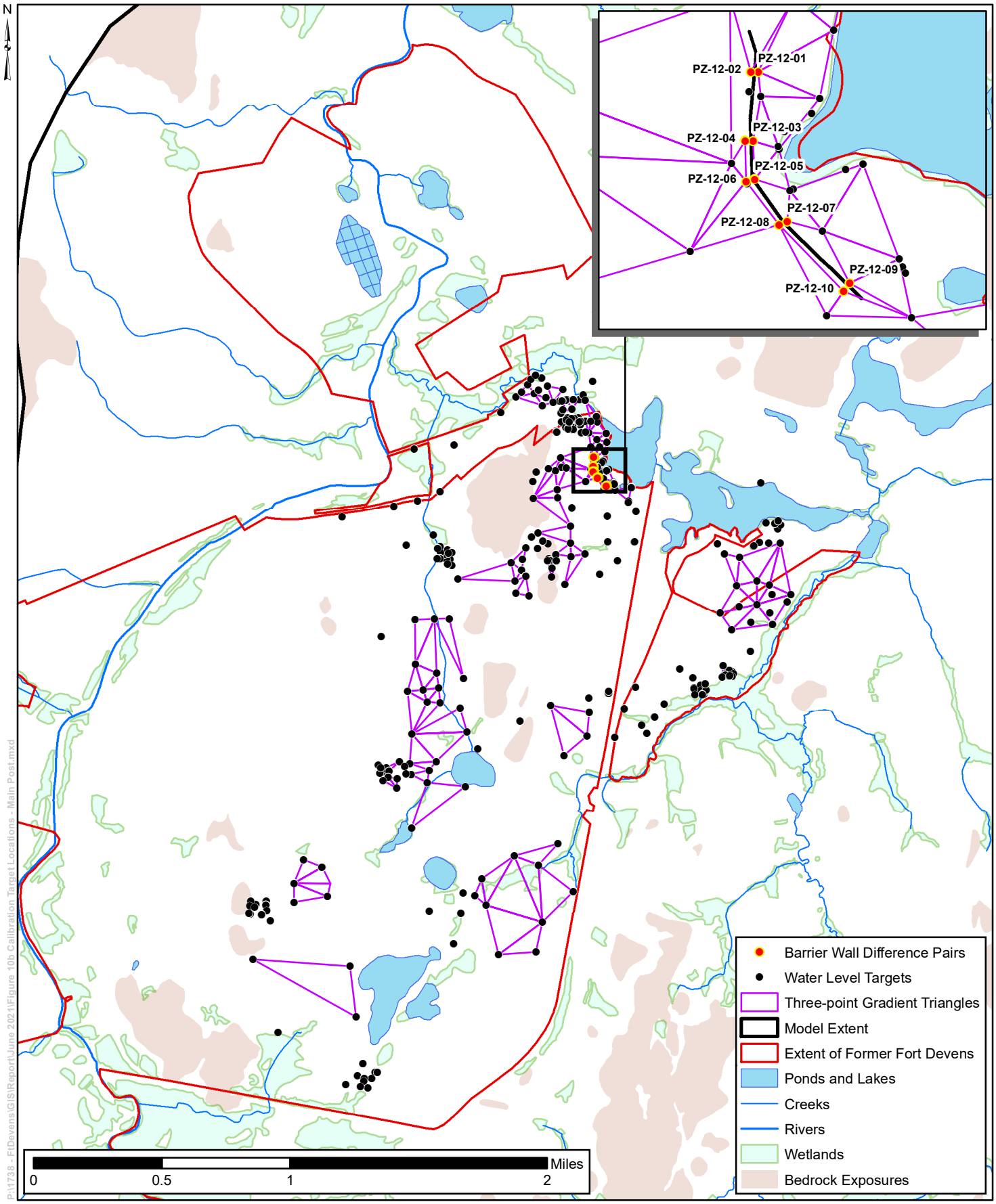


Figure 10b Calibration Target Locations - Former Main Post

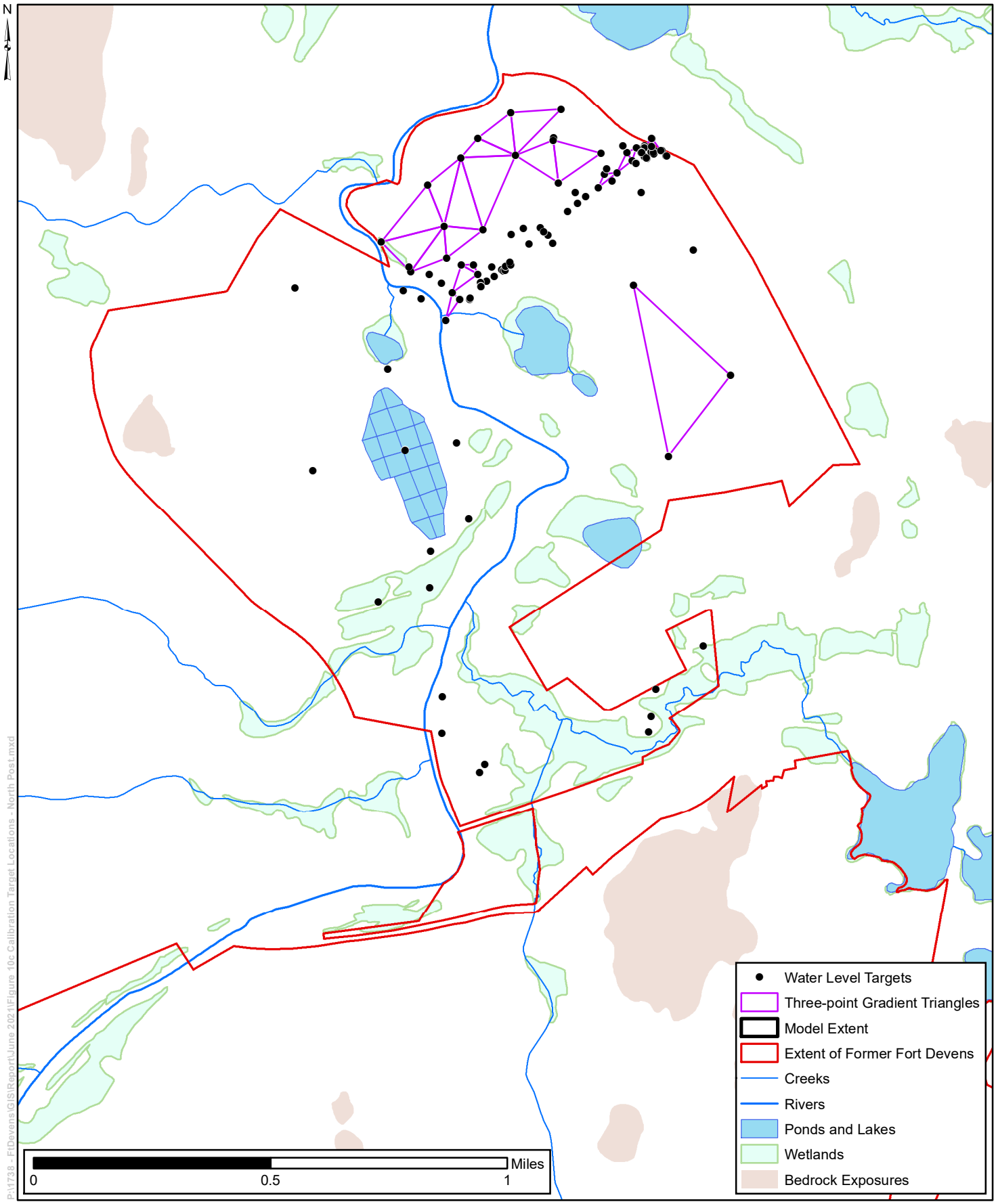


Figure 10c Calibration Target Locations - Former North Post

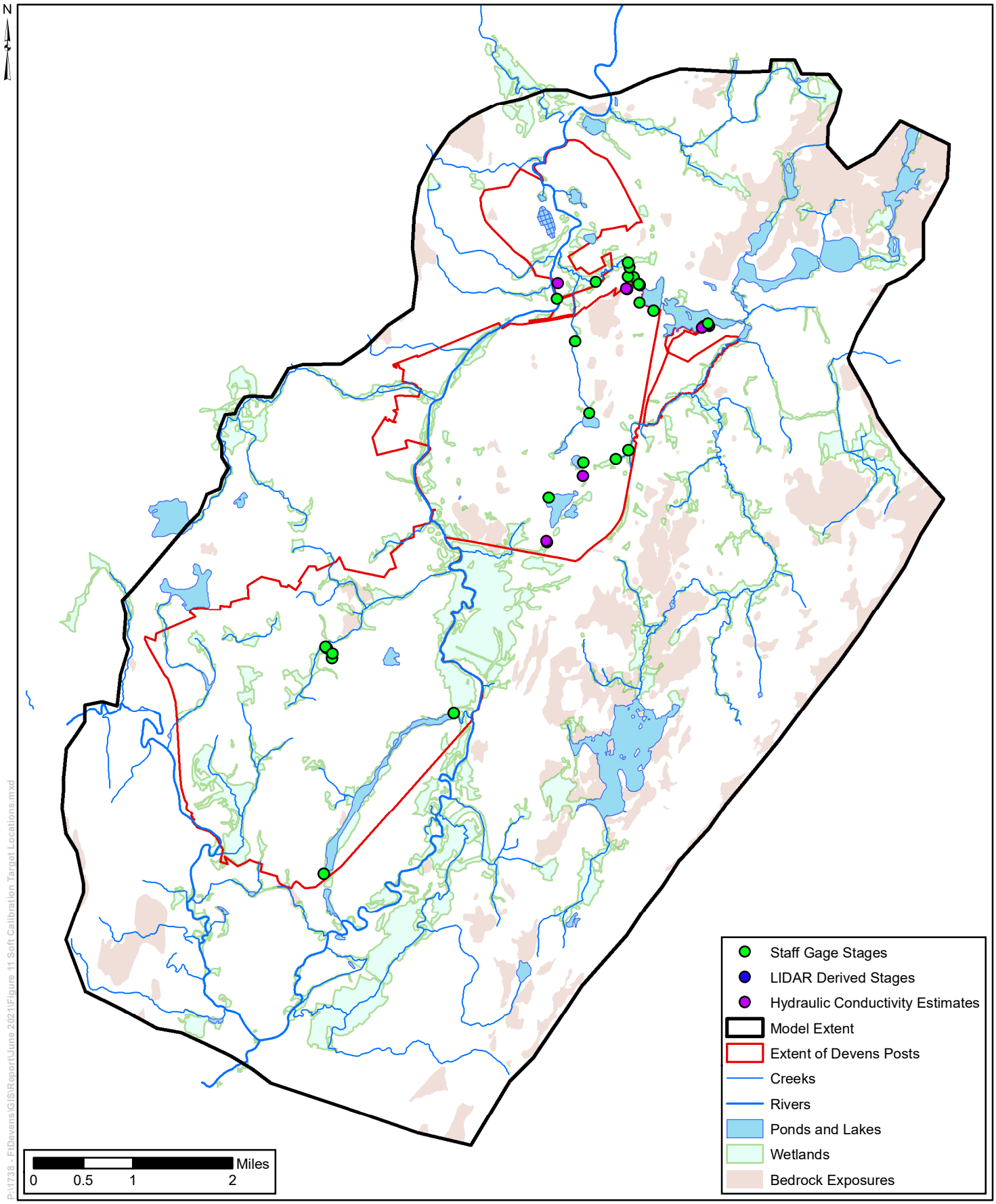


Figure 11 Soft Calibration Target Locations

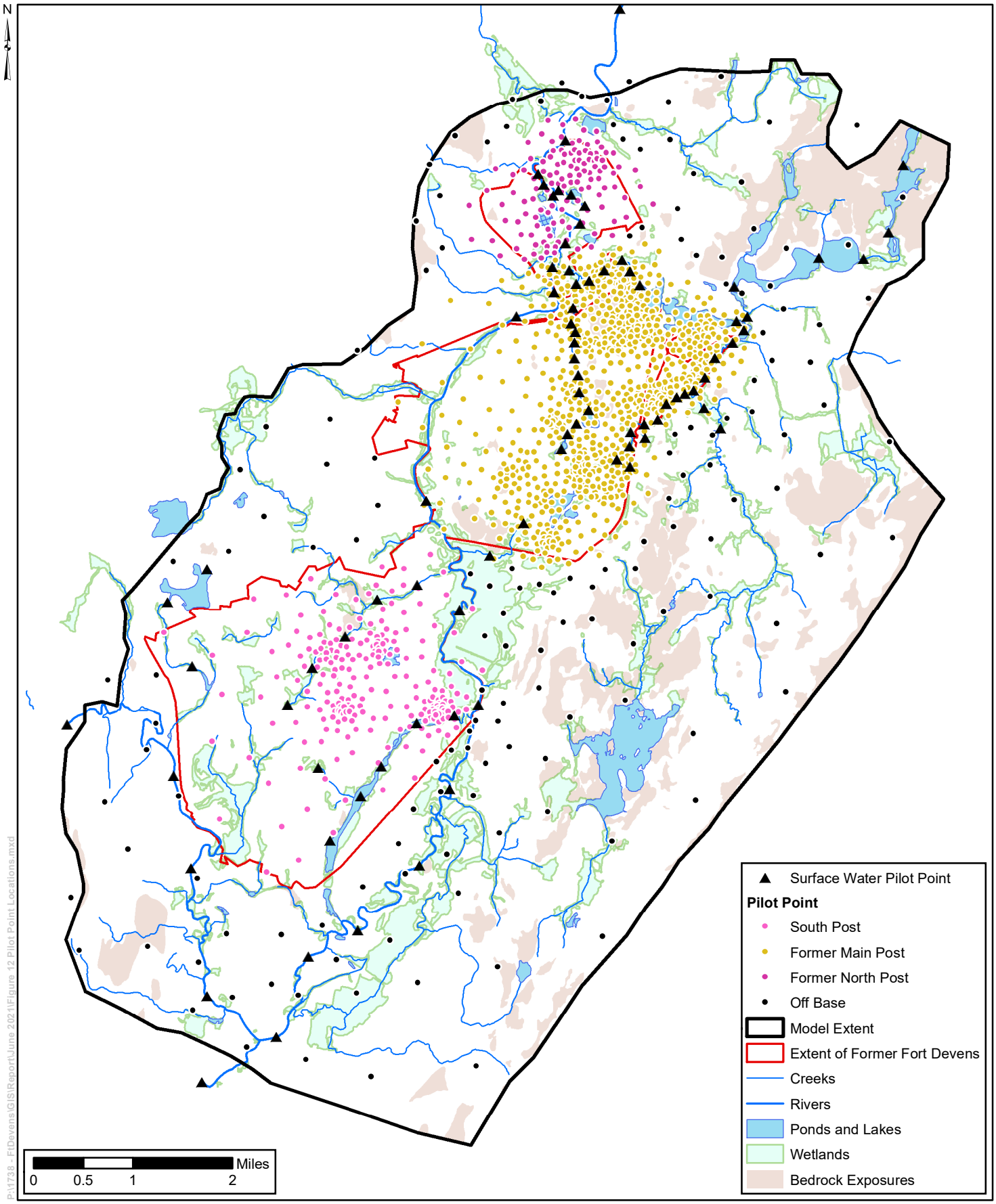
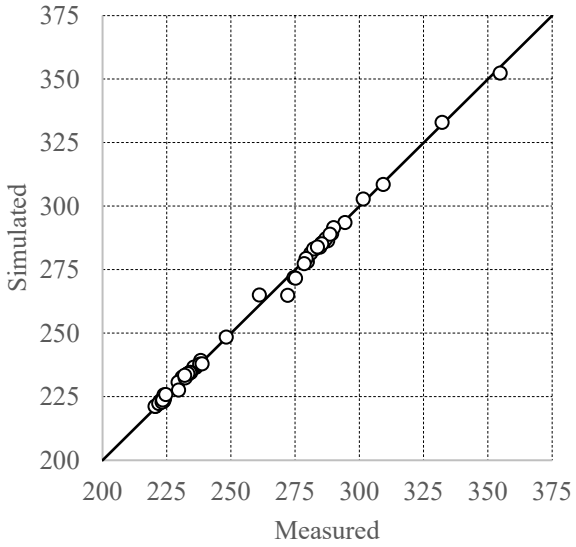
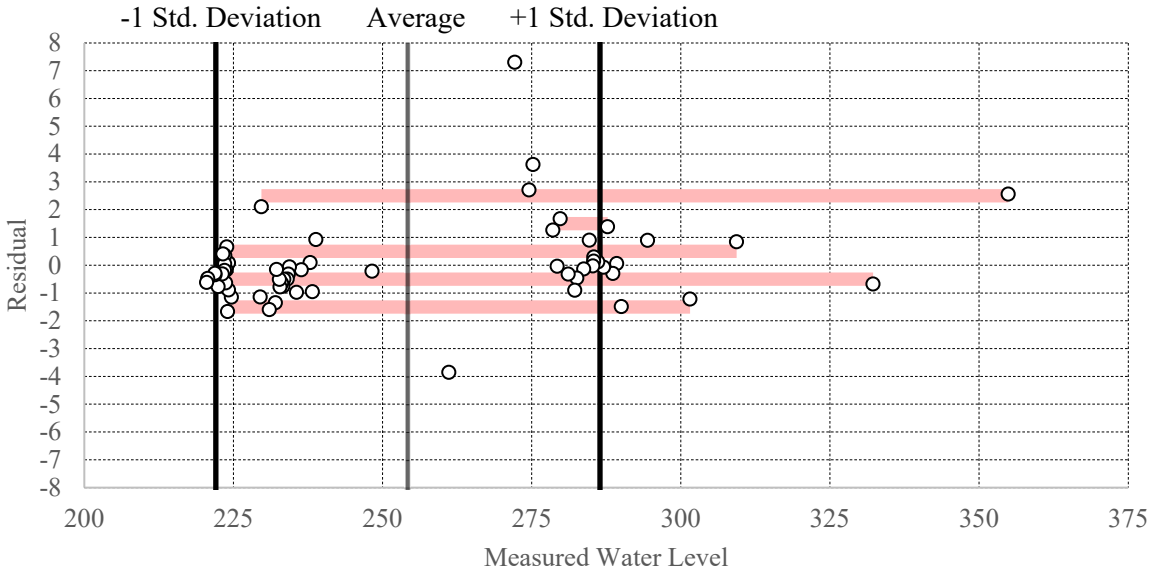


Figure 12 Pilot Point Locations





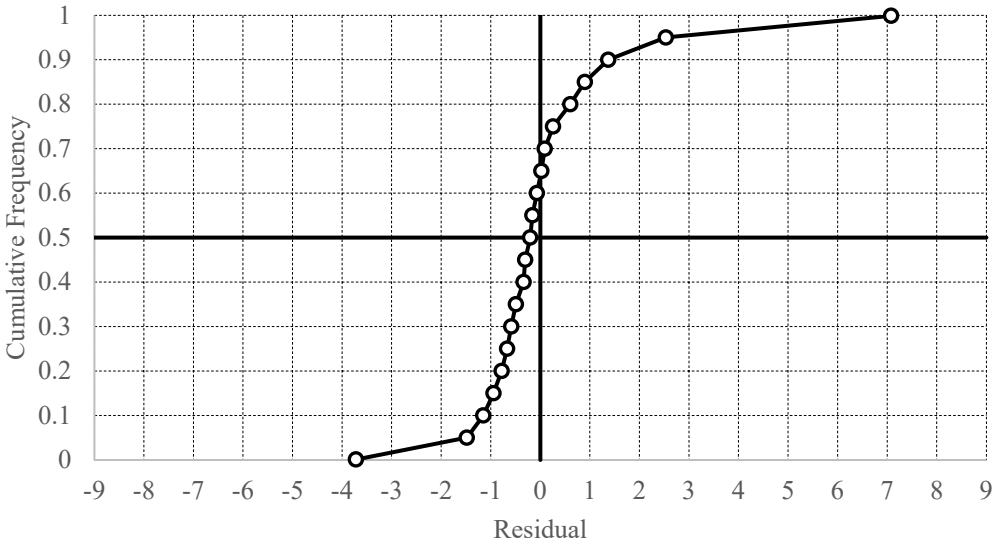
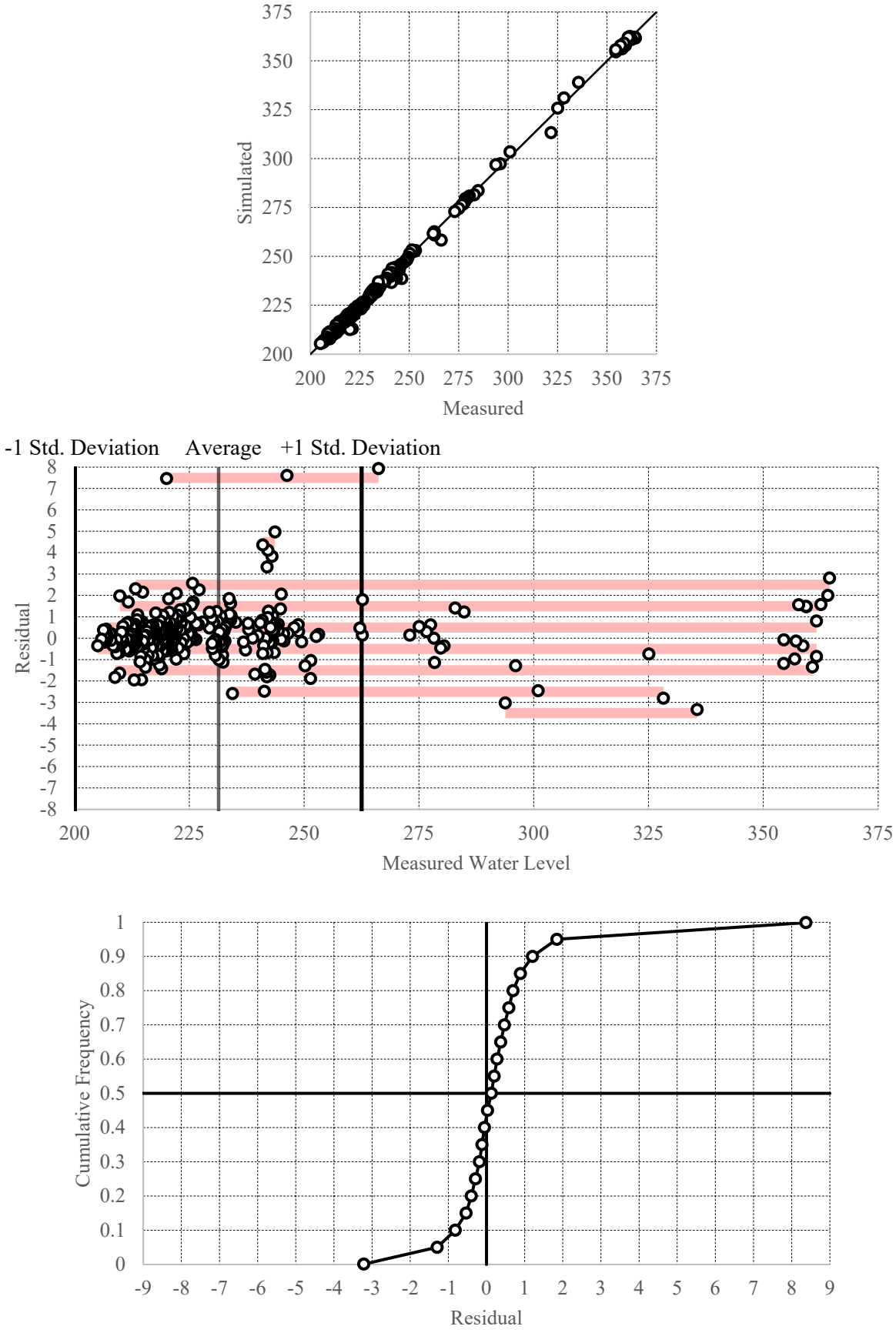


Figure 13a Graphical Summary of Water Level Residuals – South Post



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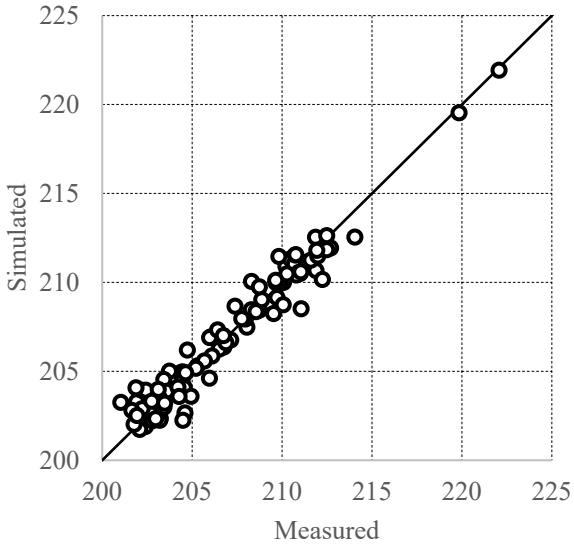
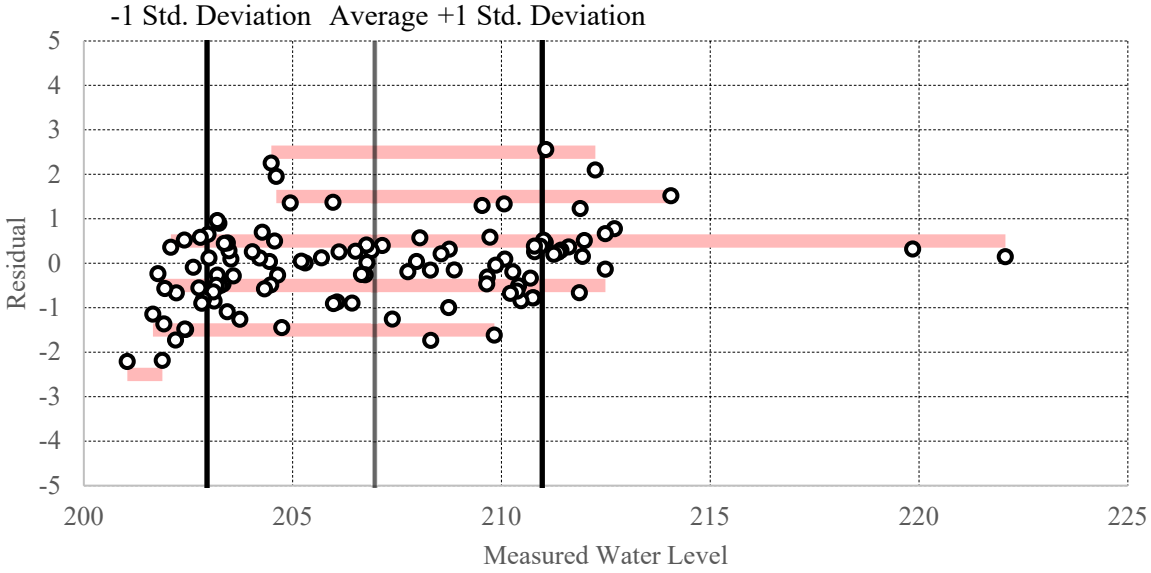




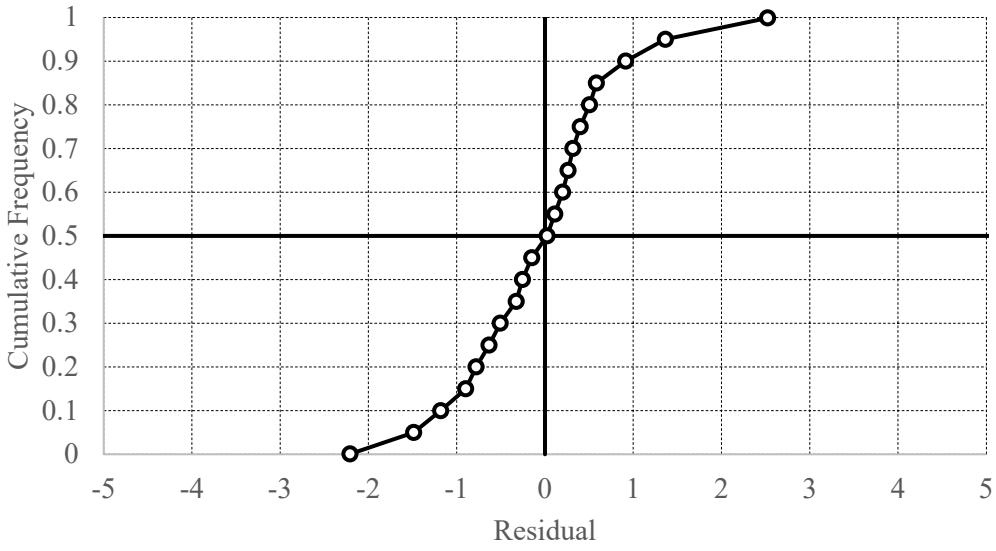
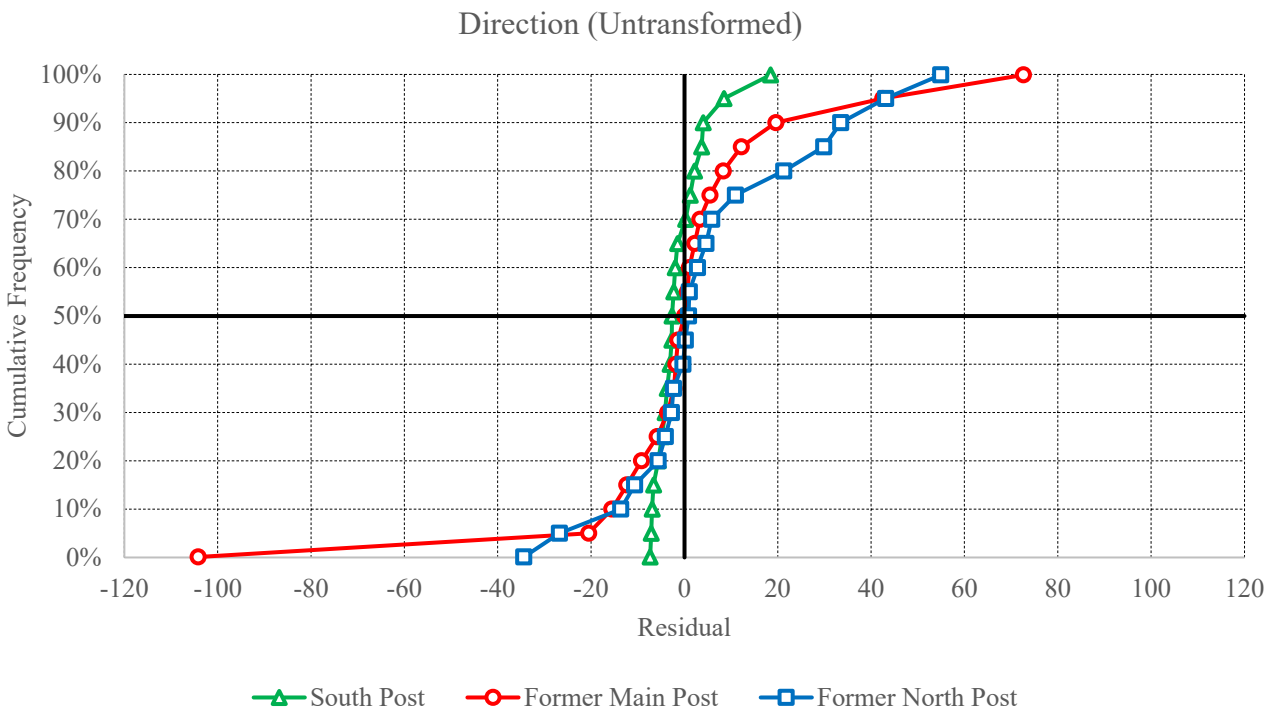


Figure 13c Graphical Summary of Water Level Residuals – Former North Post



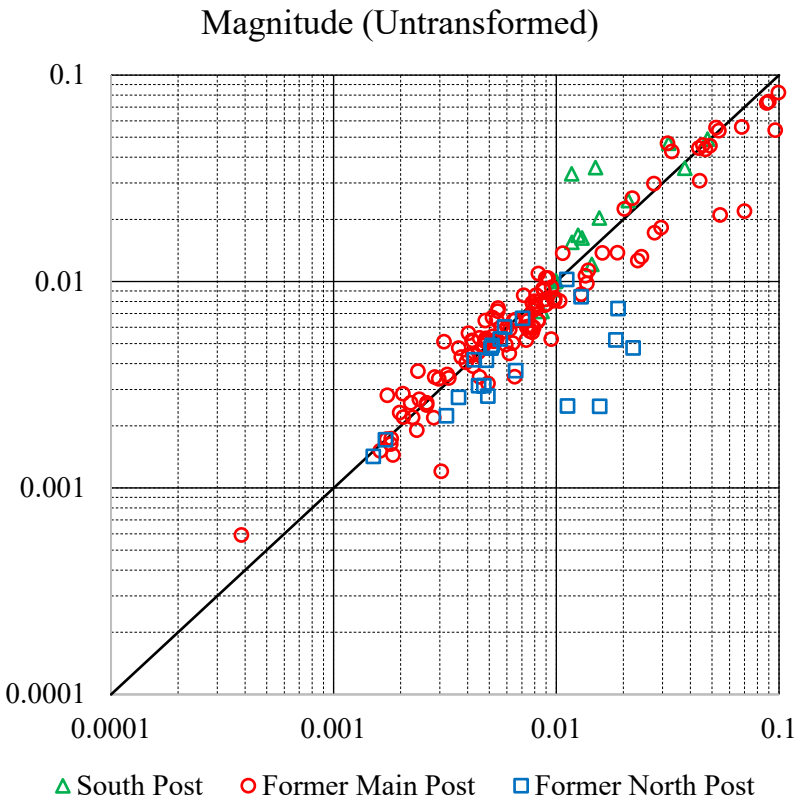


Figure 13d Graphical Summary of Three-Point Gradient Residuals

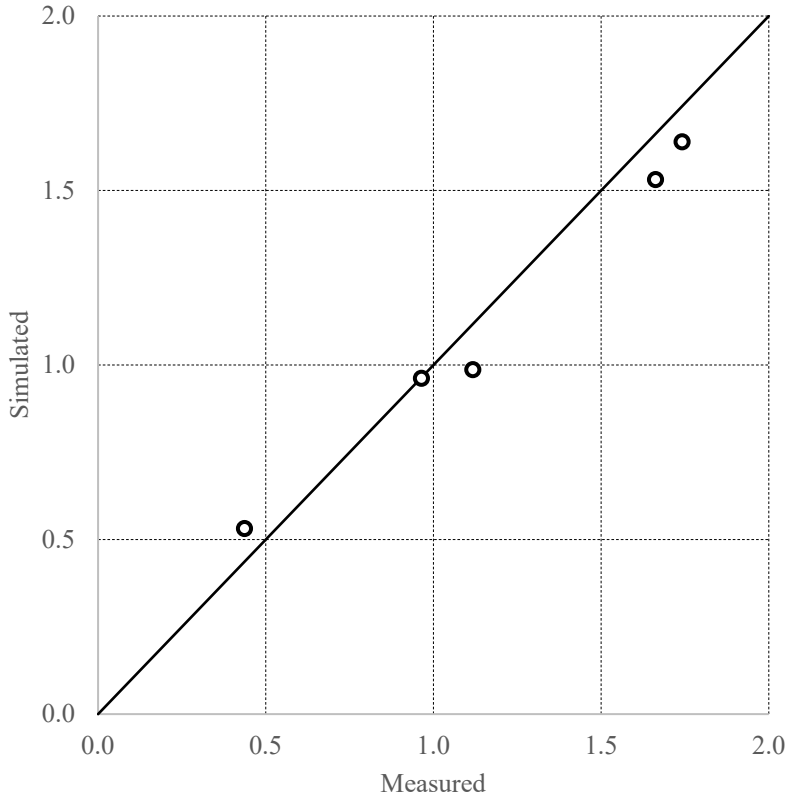
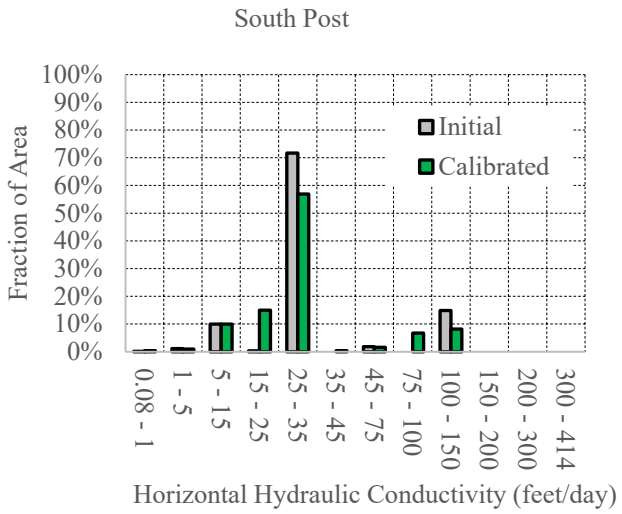
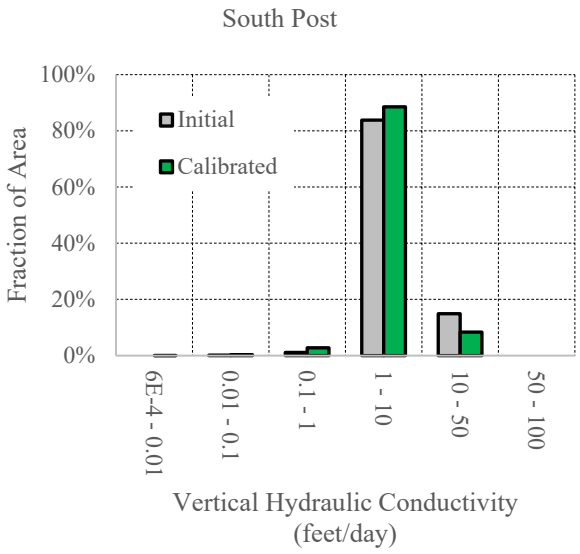
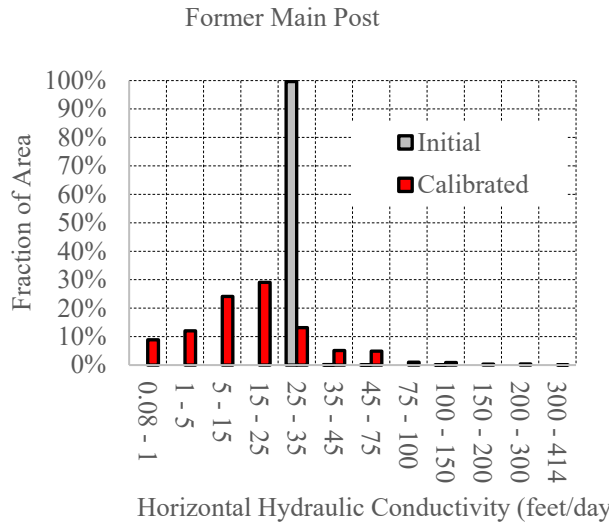
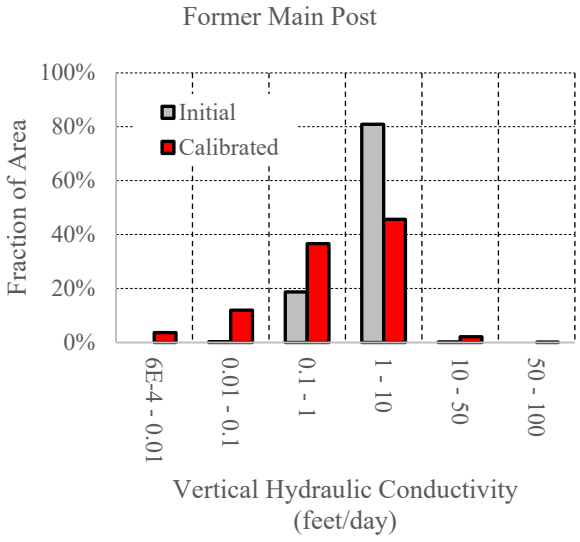


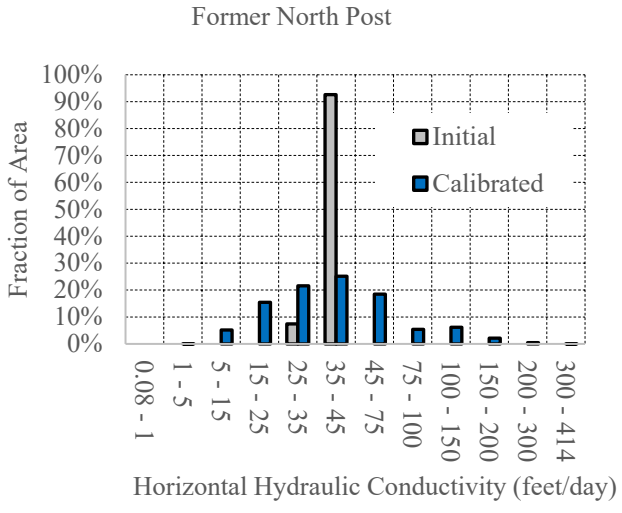
Figure 13e Graphical Summary of Barrier Wall Difference Residuals











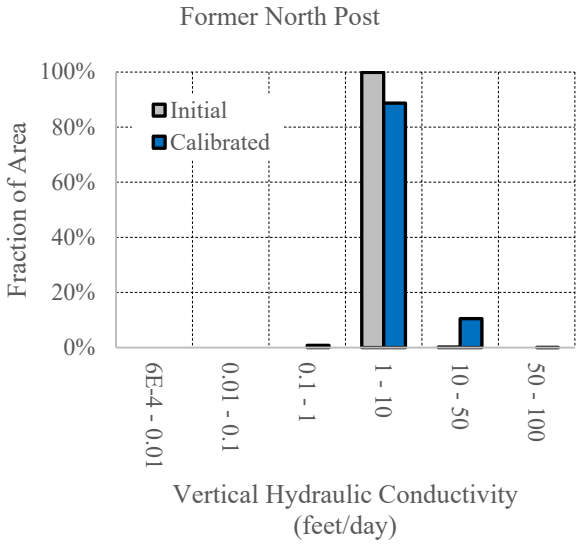
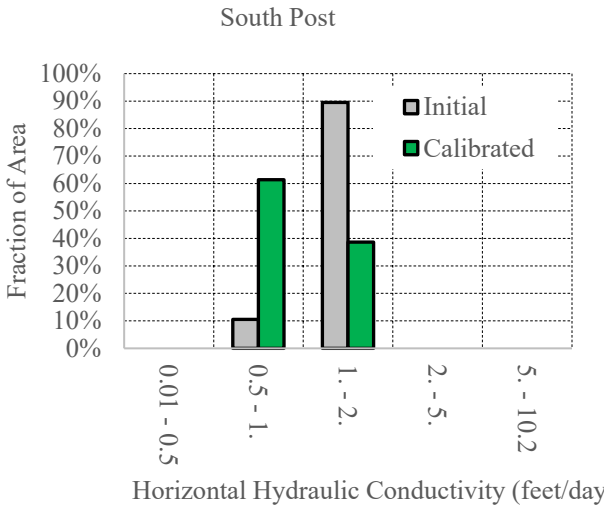
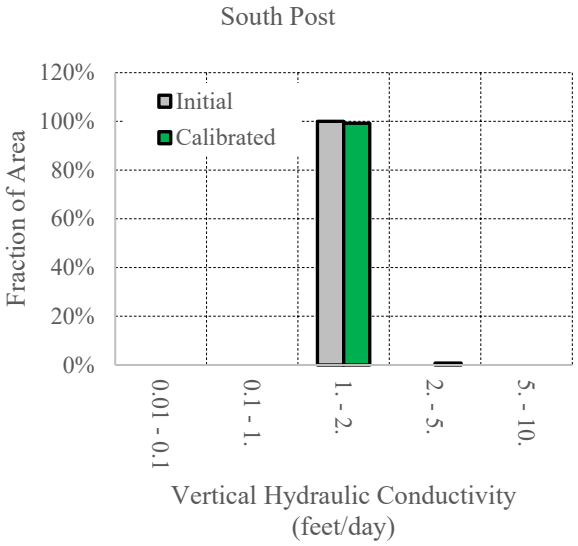
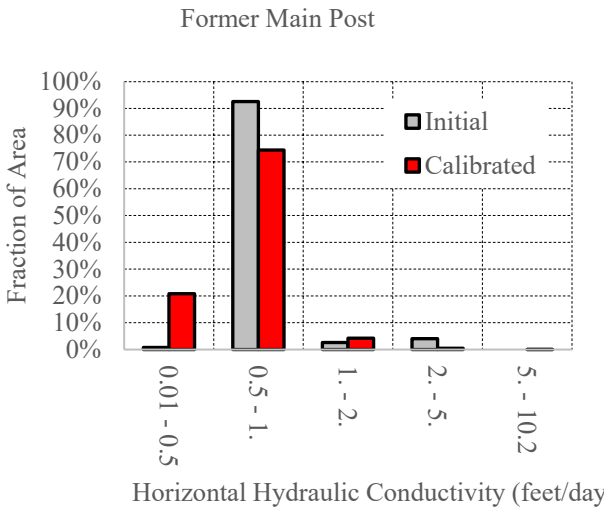
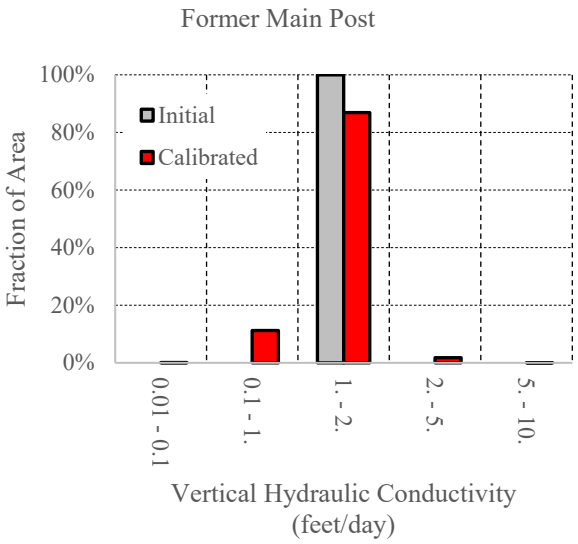


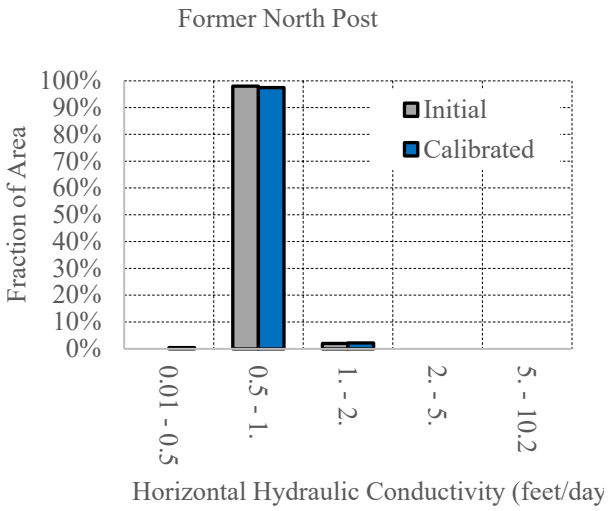
Figure 14a Summary of Overburden Hydraulic Conductivity











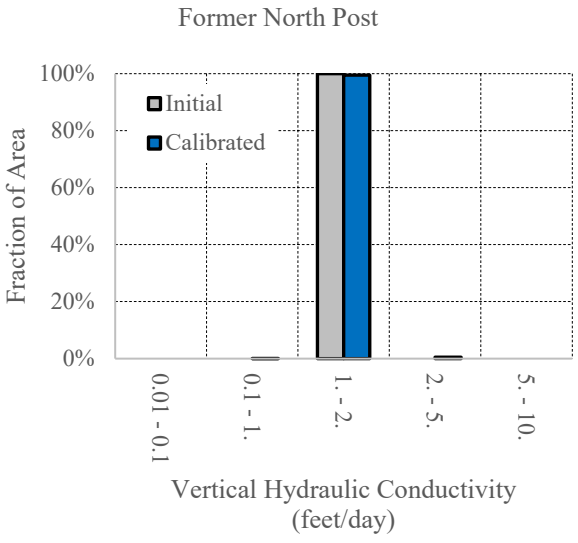


Figure 14b Summary of Upper Bedrock Hydraulic Conductivity

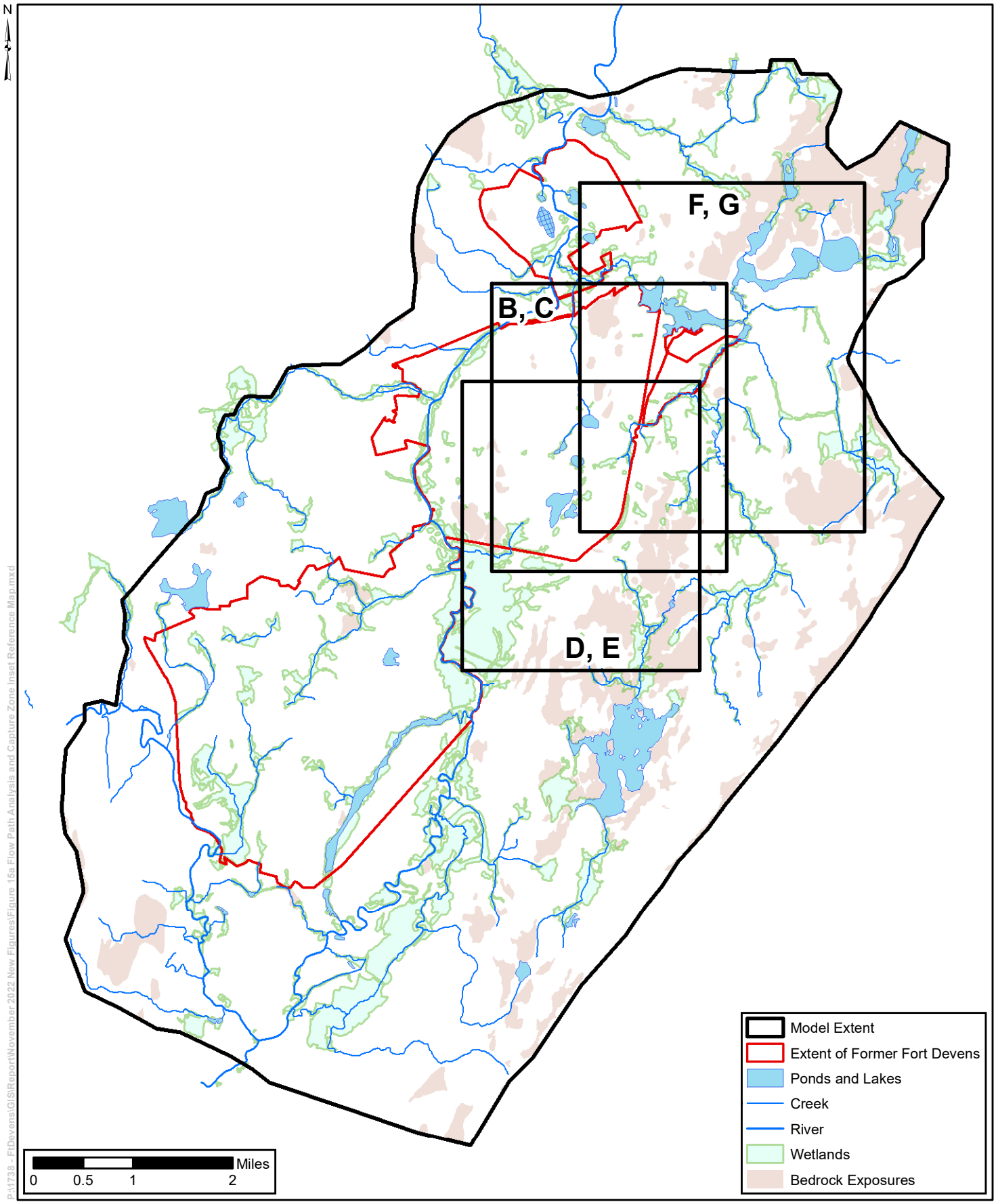


Figure 15a Flow Path Analysis and Capture Zone - Inset Reference Map

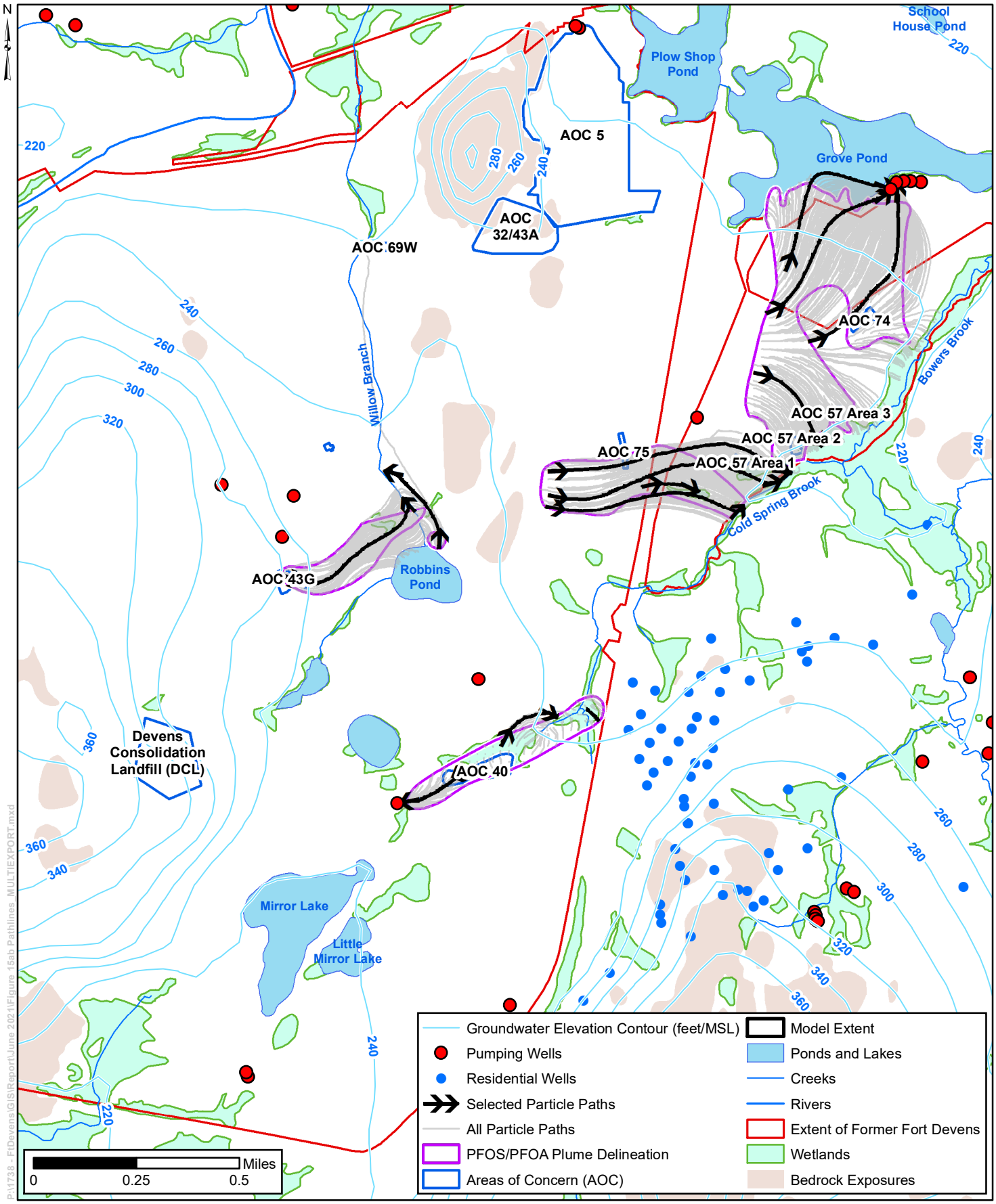


Figure 15b Flow Path Analysis, Focus Area 1 - Forward Particle Paths

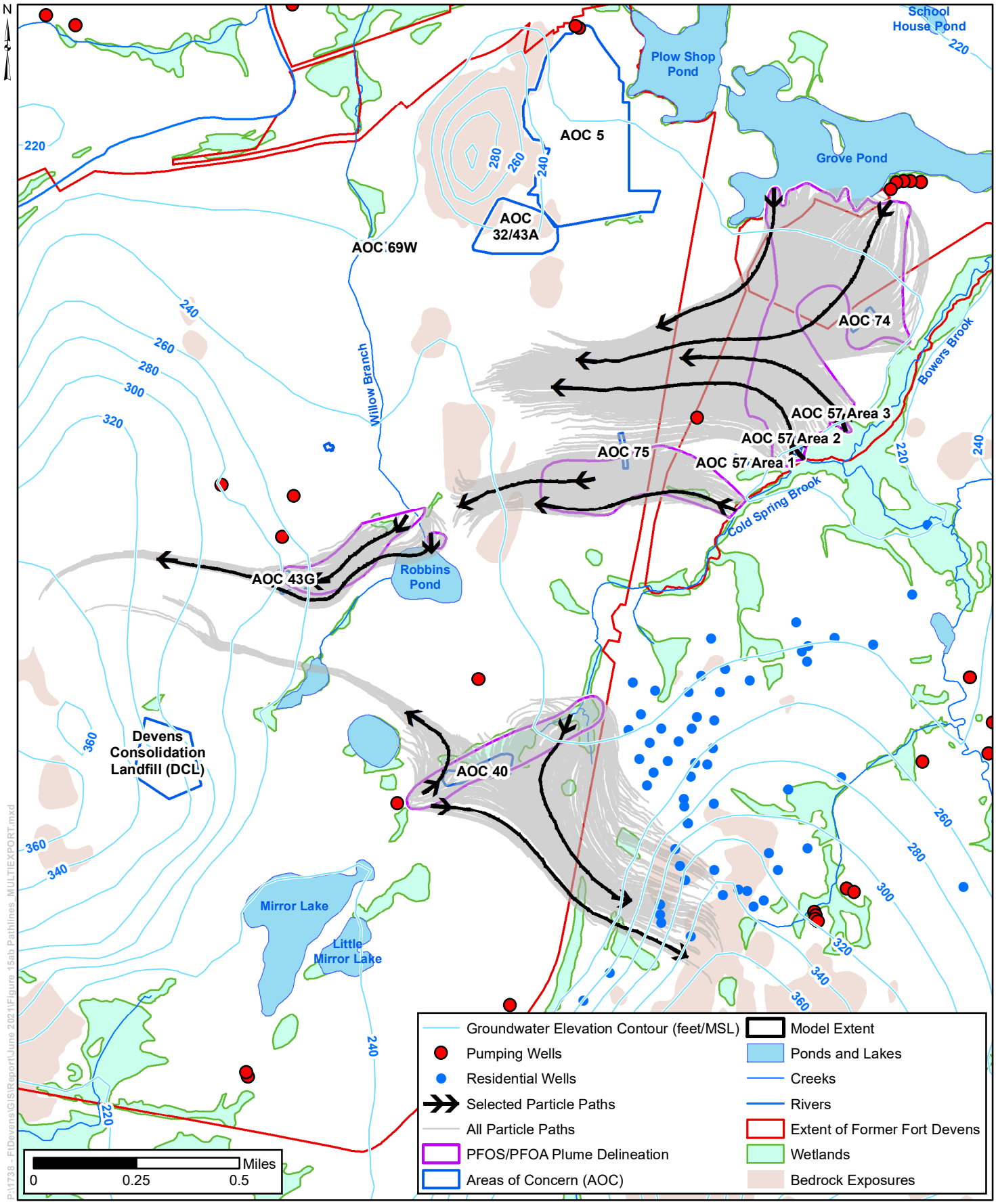


Figure 15c Flow Path Analysis, Focus Area 1 - Backward Particle Paths

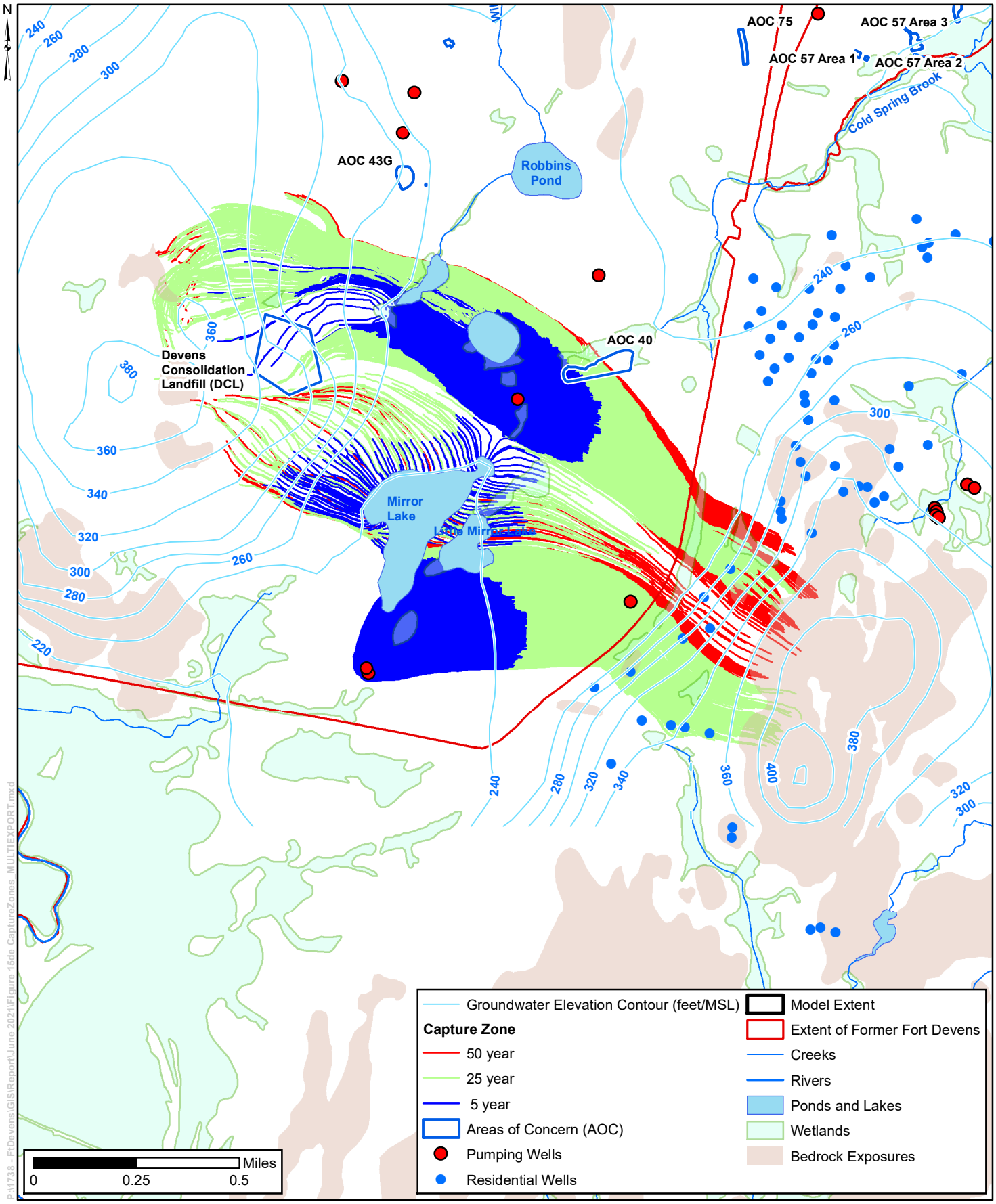


Figure 15d Five-, Twenty-five-, and Fifty-year Capture Zones for Patton and Shabokin Wells – Base Effective Porosity

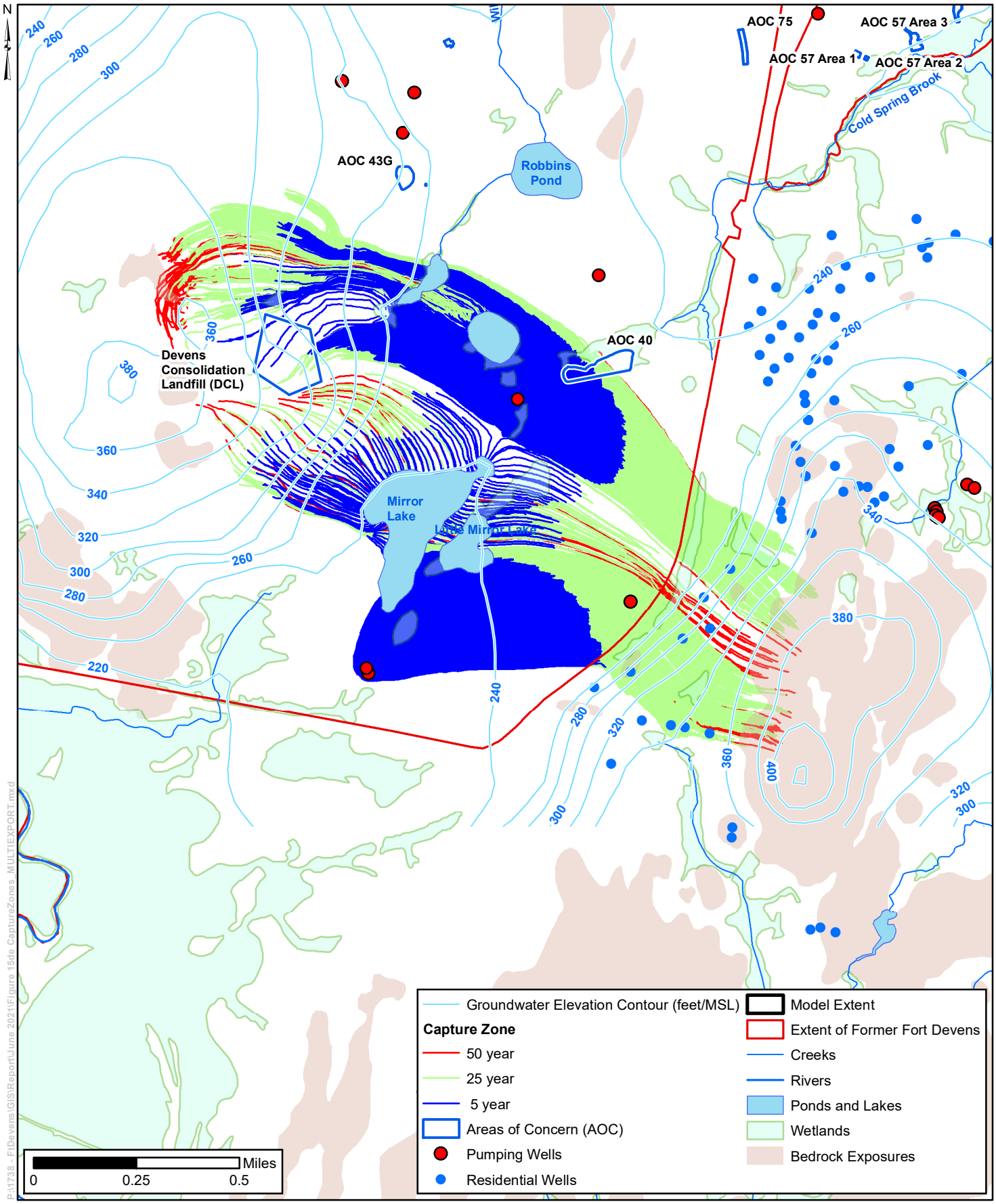


Figure 15e Five-, Twenty-five-, and Fifty-year Capture Zones for Patton and Shabokin Wells – Alternate Effective Porosity

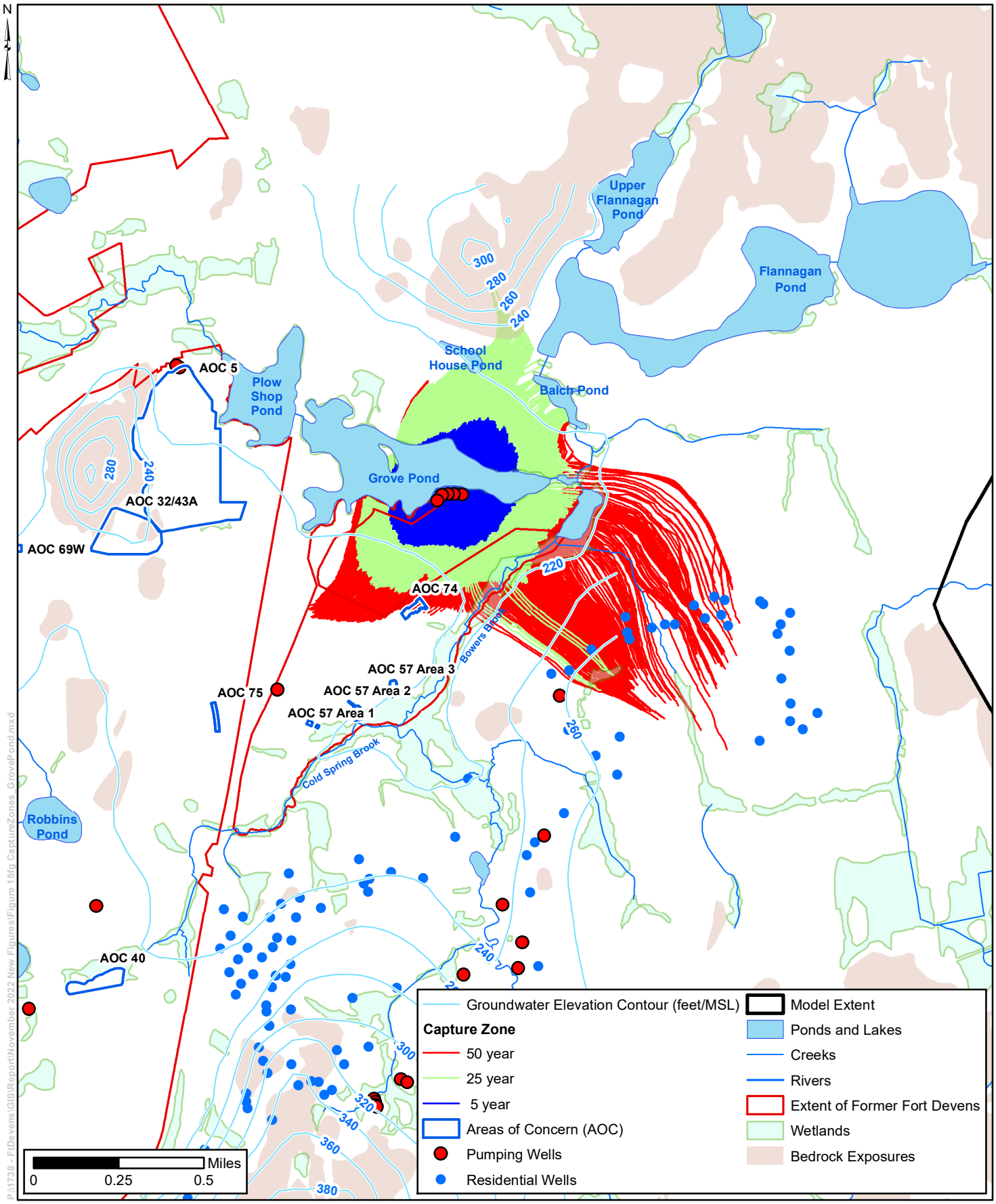


Figure 15f Five-, Twenty-five-, and Fifty-year Capture Zones for the Grove Pond Well Field – Base Effective Porosity

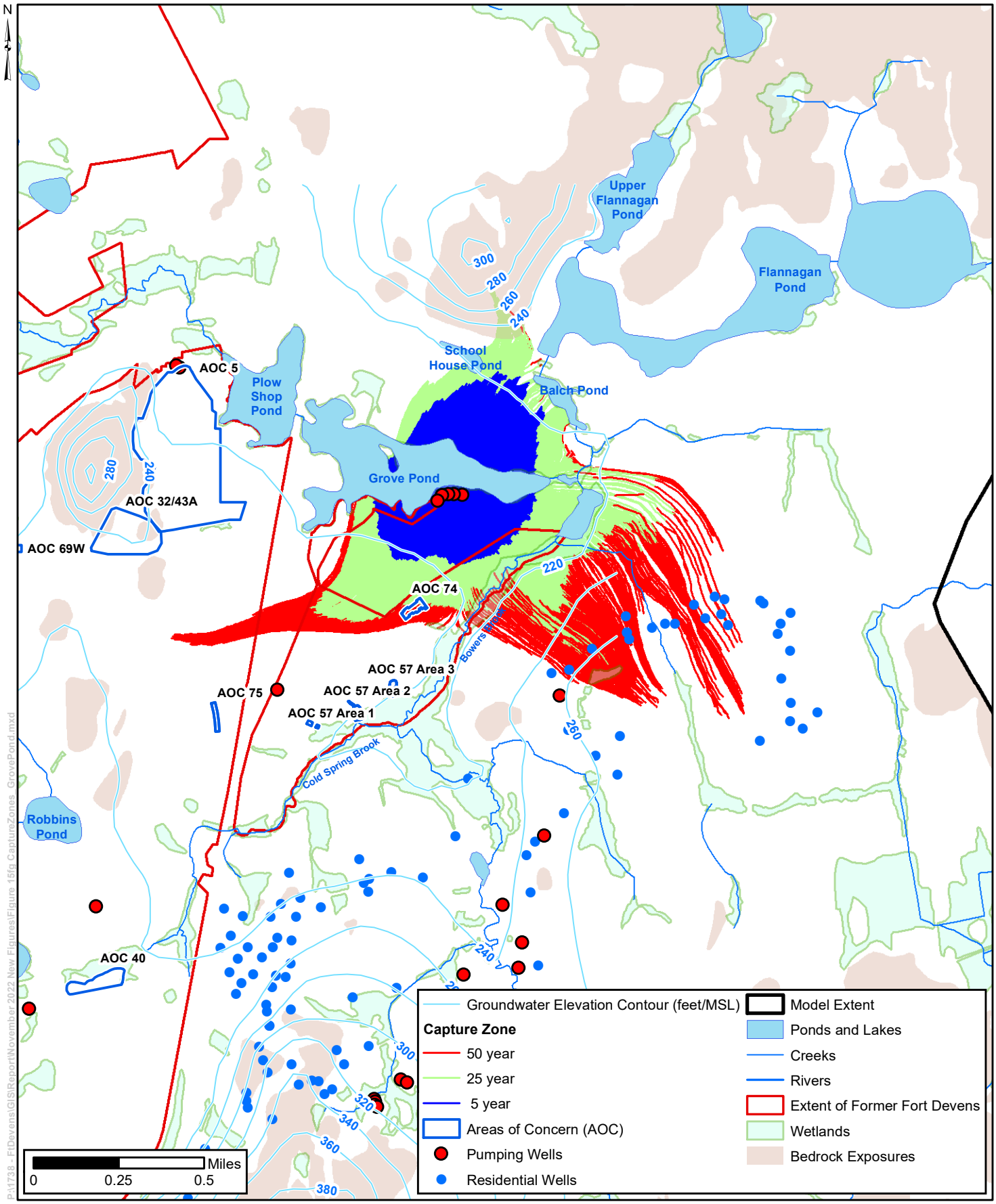


Figure 15g Five-, Twenty-five-, and Fifty-year Capture Zones for the Grove Pond Well Field – Alternate Effective Porosity

TABLES

Table 1

Groundwater Budget Per Hydrostratigraphic Unit
(acre-ft/year)

		In (from)						Out (to)						In	Out
HSU	**HSU Code**	**CLN[1]**	**RCH[2]**	**OBD**	**TIL**	**UPR**	**LWR**	**CLN[1]**	**RCH[2]**	**OBD**	**TIL**	**UPR**	**LWR**	**Total**	**Total**
Overburden	OBD	7,507	24,625	-	13,168	8,372	2	35,448	-	-	9,832	8,392	0	53,674	53,672
Till	TIL	818	12,043	9,832	-	11,082	110	9,906	-	13,168	-	10,788	21	33,885	33,883
Weathered Bedrock	UPR	93	827	8,392	10,788	-	1,379	550	-	8,372	11,082	-	1,474	21,479	21,479
Competent Bedrock	LWR	4	-	0	21	1,474	-	7	-	2	110	1,379	-	1,498	1,498

Notes:

[1] Includes discharge to / flow through surface water features, flow through monitoring wells screened across multiple layers, and pumping wells

[2] Recharge

Table 2

Flow Path Analysis, Focus Area 1 - Summary of Particle Travel Time

Forward Tracking Analysis								
	Particle Travel Time (years)							
	Base Effective Porosity[1]				Alternate Effective Porosity[2]			
PFOS/PFOA Contaminated Zone	Min	Max	Average	Median	Min	Max	Average	Median
Small area east side of Robbins Pond	1.9	146	65	57	1.0	308	43	29
Area near AOC 43G to the west of Robbins Pond	0.2	65	11	9	0.1	35	6	4
Area south of AOC 75	0.03	82	29	27	0.02	187	18	15
Area between the Patton Well and the headwaters of Cold Spring Brook near AOC 40	0.03	94	16	6	0.02	53	8	3
Area south of the Grove Pond well field to AOC 57 along Bowers Brook	0.03	195	24	16	0.01	136	13	8

Backward Tracking Analysis								
	Particle Travel Time (years)							
	Base Effective Porosity[1]				Alternate Effective Porosity[2]			
PFOS/PFOA Contaminated Zone	Min	Max	Average	Median	Min	Max	Average	Median
Small area east side of Robbins Pond	2.1	194	41	35	1.1	160	31	18
Area near AOC 43G to the west of Robbins Pond	0.2	115	8	4	0.1	68	5	2
Area south of AOC 75	0.23	91	21	17	0.1	113	12	9
Area between the Patton Well and the headwaters of Cold Spring Brook near AOC 40	0.11	82	27	27	0.1	67	15	14
Area south of the Grove Pond well field to AOC 57 along Bowers Brook	0.01	219	34	29	0.004	203	18	14

Notes:

[1] Overburden: 30%, Till: 25%, Upper and Lower Bedrock: 0.1%

[2] Overburden: 15%, Till: 15%, Upper Bedrock: 10%, Lower Bedrock 2%

APPENDICES

Appendix A

Percent Bedrock in Each Model Layer

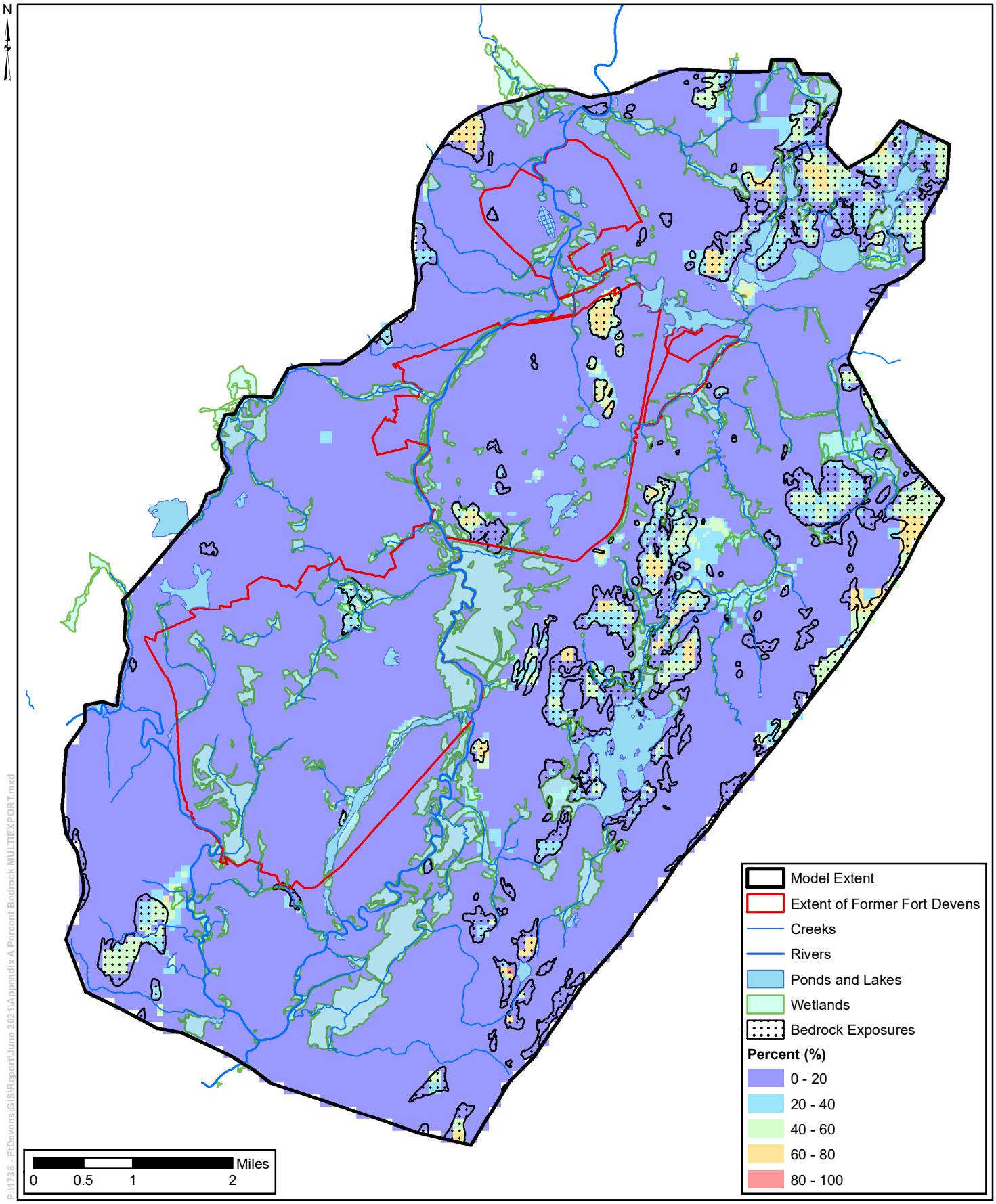


Figure A.1 Percent Bedrock Model Layer 1

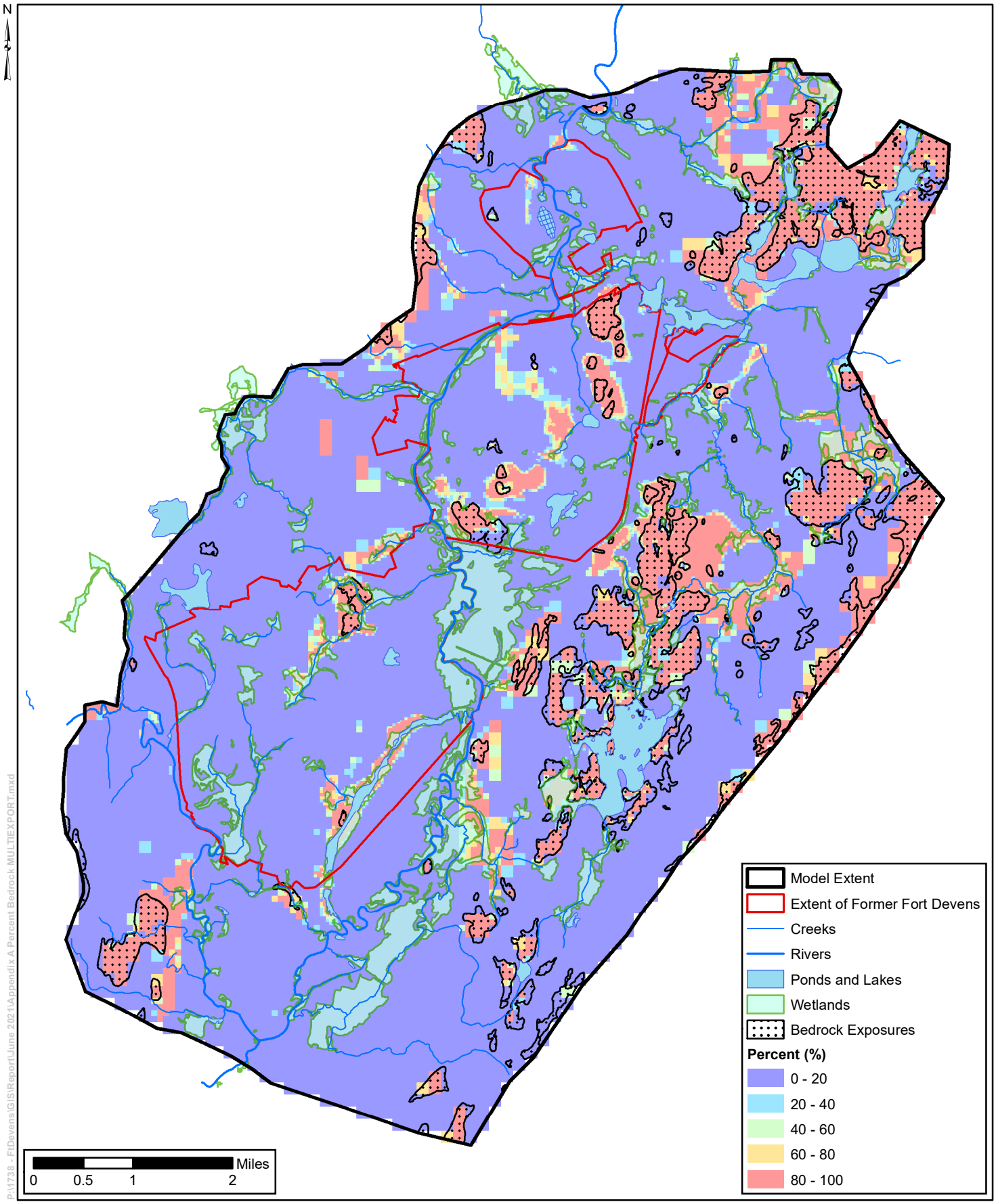


Figure A.2 Percent Bedrock Model Layer 2

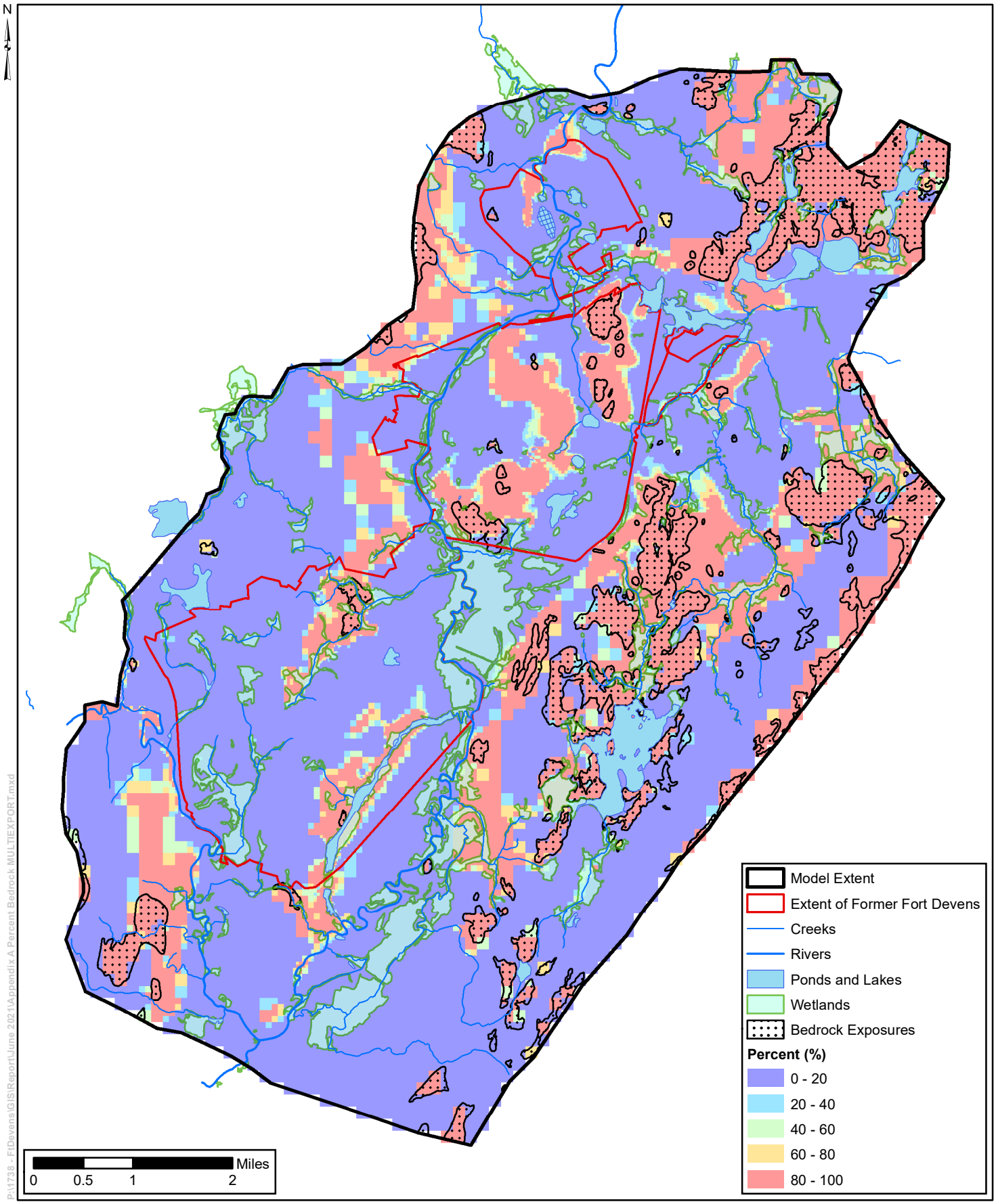


Figure A.3 Percent Bedrock Model Layer 3

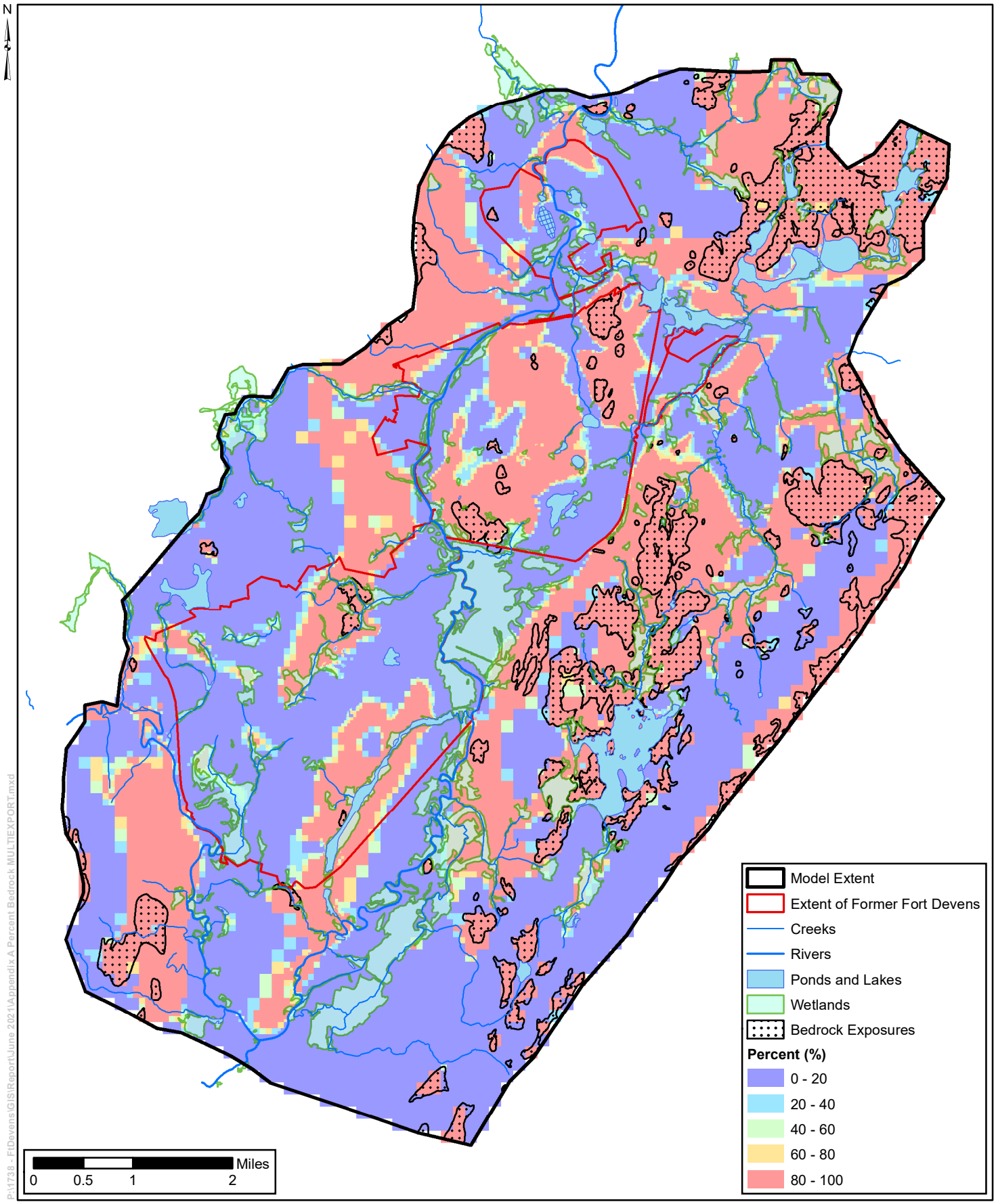


Figure A.4 Percent Bedrock Model Layer 4

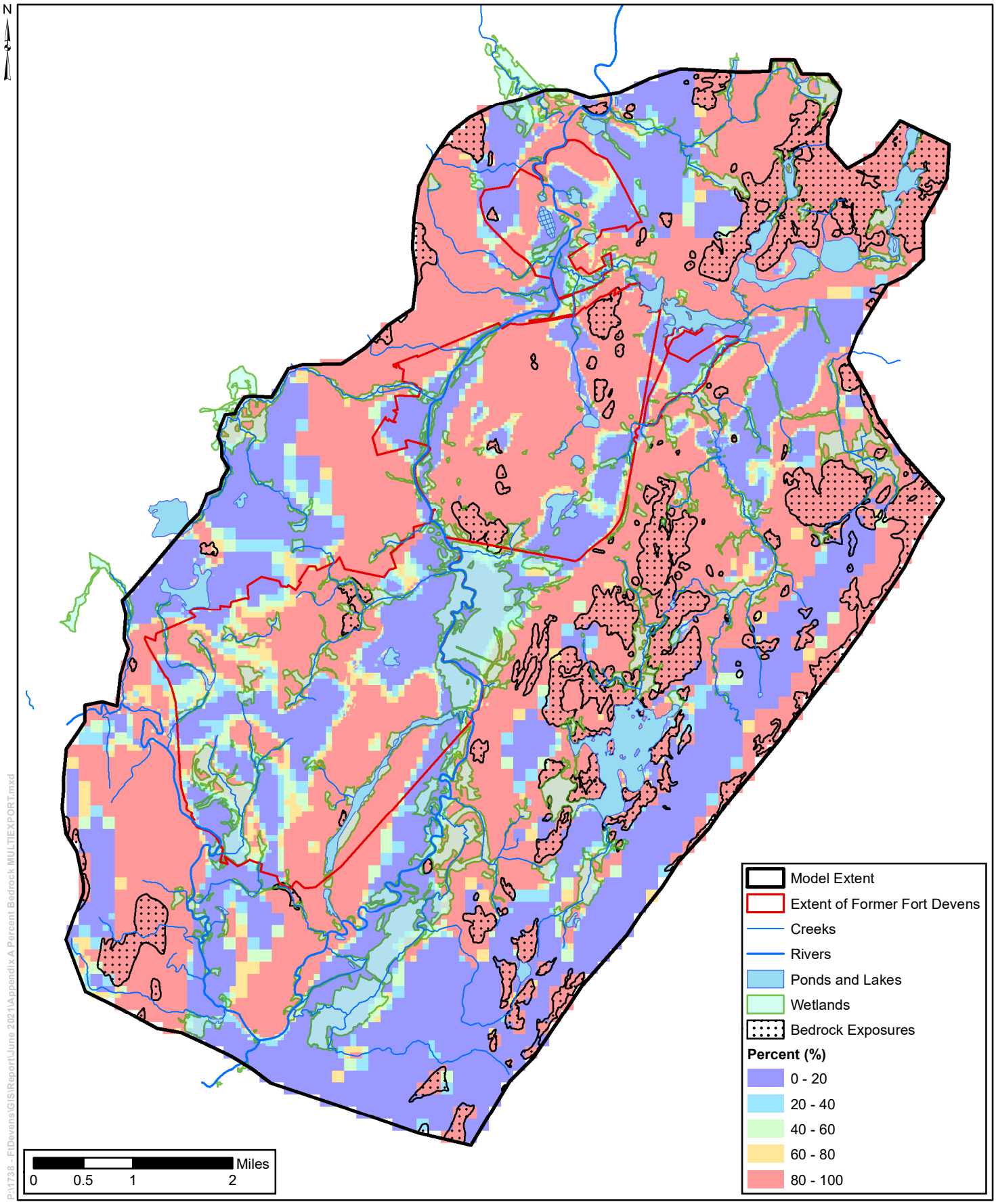


Figure A.5 Percent Bedrock Model Layer 5

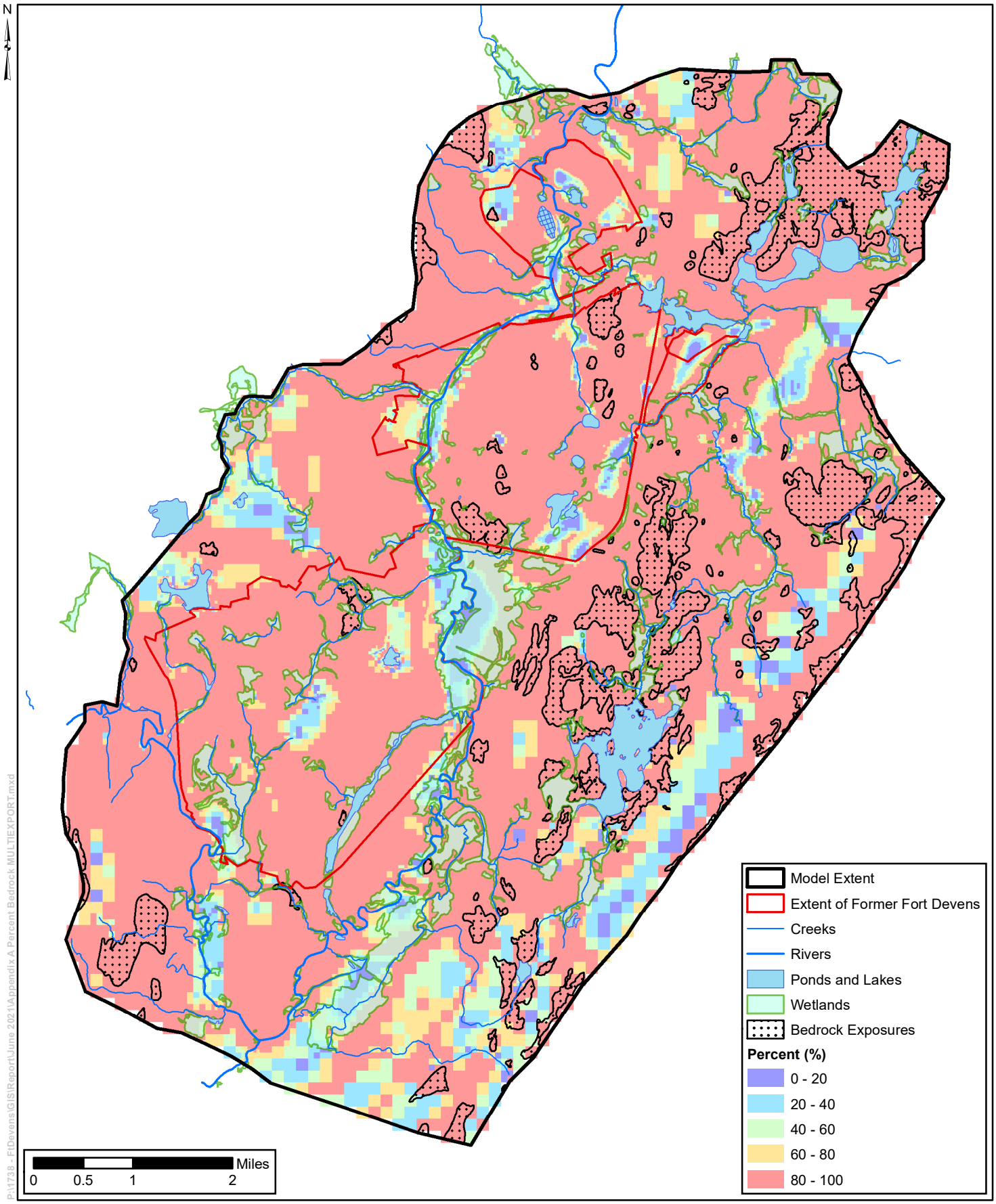


Figure A.6 Percent Bedrock Model Layer 6

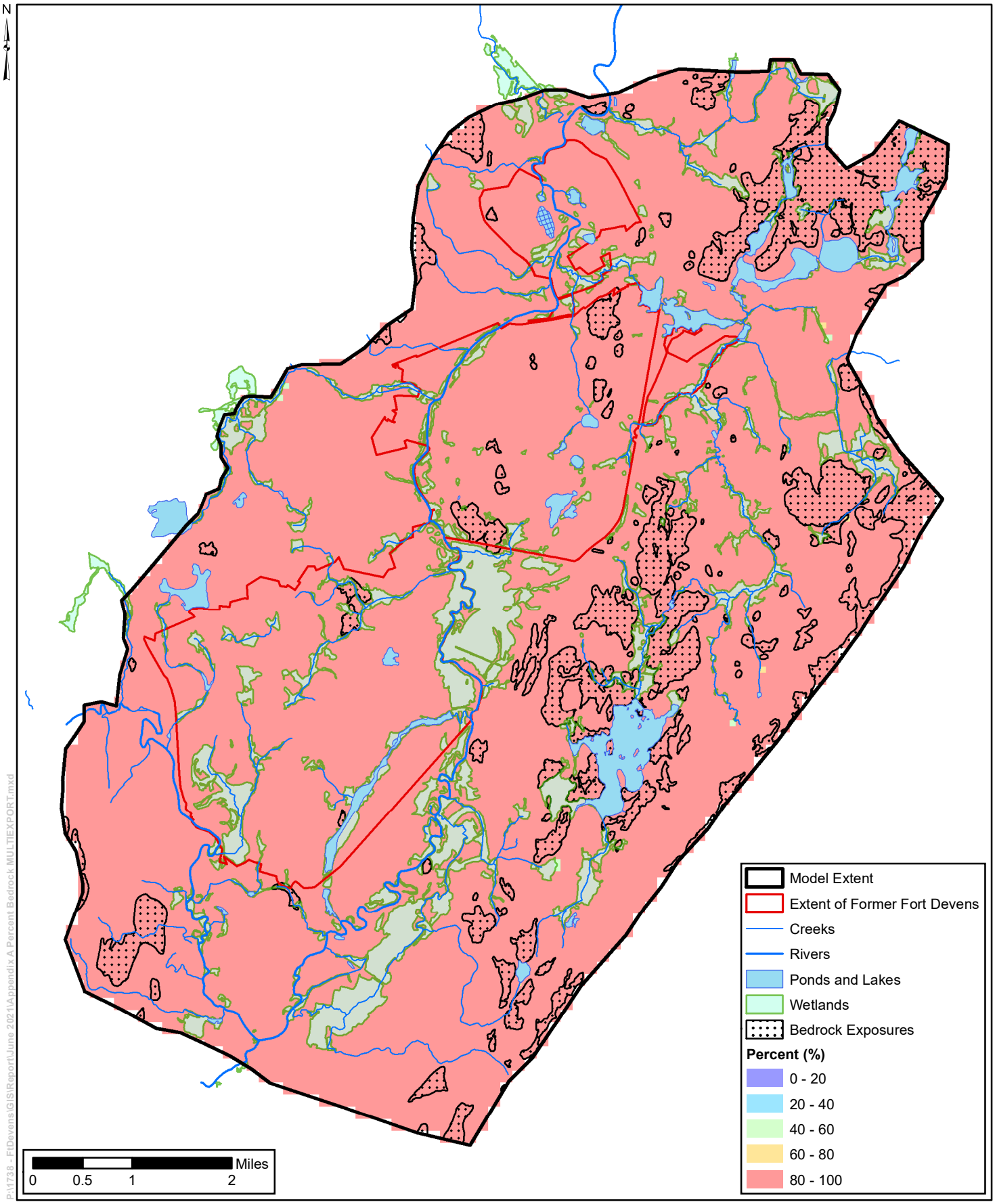


Figure A.7 Percent Bedrock Model Layer 7

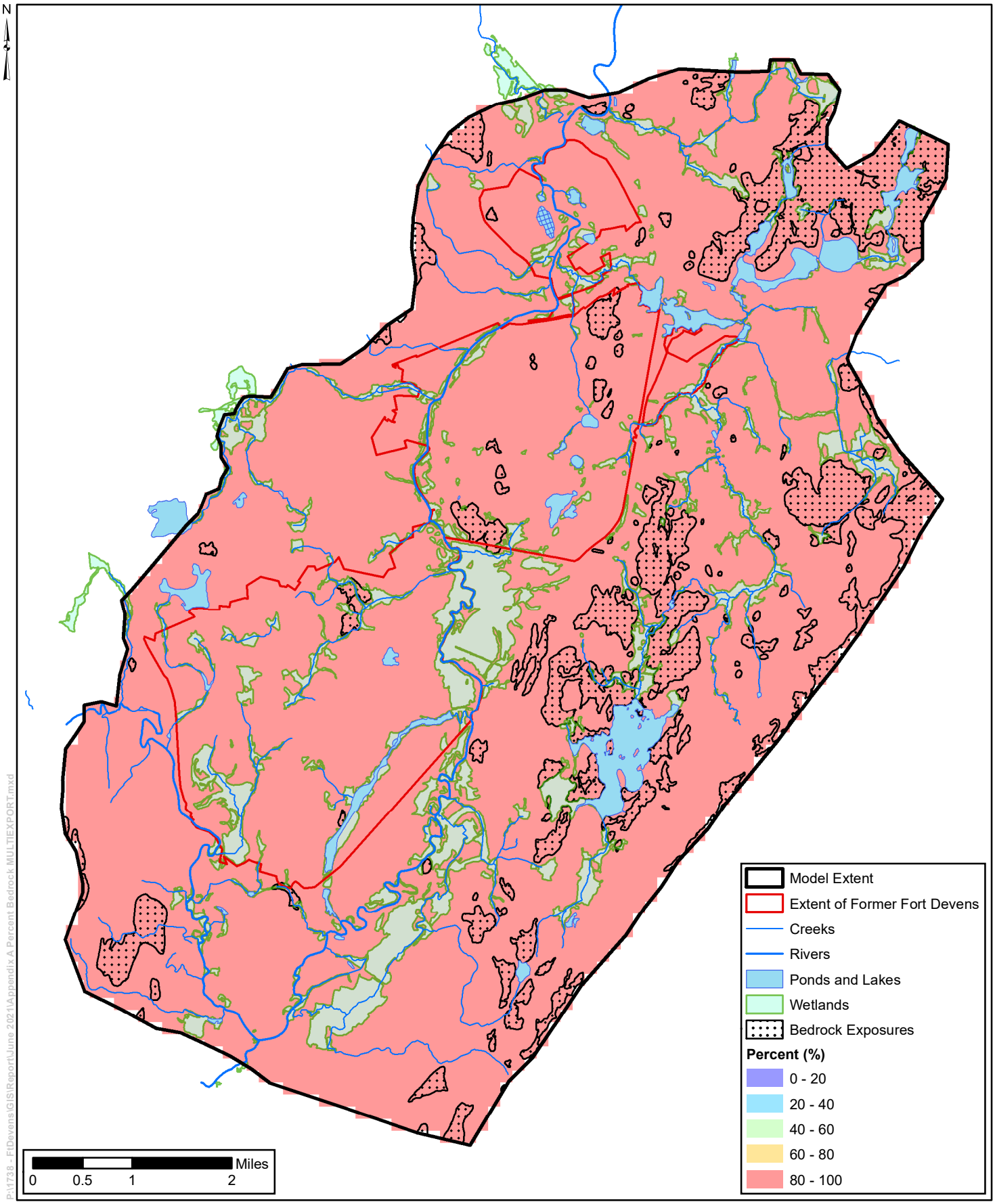


Figure A.8 Percent Bedrock Model Layer 8

Appendix B

Municipal, Community, and Residential Well Details

Table B.1a

Municipal and Community Well Details

PWS Name	Source Name	Short Name	Type of Well	Easting	Northing	LIDAR Elevation[1] (feet/MSL)	Top of Bedrock[2] (feet/MSL)	Well Depth (feet/BGS[3])	Screen / Open Interval (feet/BGS[3])	Screen / Open Interval (feet/MSL)
Devens MASSDevelopment	Shabokin Gravel Packed Well	Shabokin_Inactive	Gravel-Packed	625695.1	3014510.0	243.6	141.0	77.5	unknown	196 - 166
Devens MASSDevelopment	Shabokin Replacement Well	Shabokin Well	Gravel-Packed	625672.8	3014574.2	243.1	138.5	85.0	55 - 85	188 - 158
Devens MASSDevelopment	MacPherson NaturallyDeveloped Well	MacPherson Well	Gravel-Packed	626266.5	3028262.9	217.2	105.1	93.0	unknown	144 - 124
Devens MASSDevelopment	Patton Replacement Well	Patton Well	Gravel-Packed	627610.6	3018025.9	257.6	154.3	86.5	61 - 83	197 - 175
Ayer DPW Water Division	Grove Pond Well #1	Grove Pond Well #1	Gravel-Packed	634322.1	3025990.7	221.1	103.5	62.0	42 - 62	179 - 159
Ayer DPW Water Division	Grove Pond Well #2	Grove Pond Well #2	Gravel-Packed	634192.5	3026001.7	221.3	102.9	60.5	42 - 62	179 - 159
Ayer DPW Water Division	Well 6	Grove Pond Well #6	Gravel-Packed	634103.6	3026000.4	223.8	103.9	57.0	47 - 57	177 - 167
Ayer DPW Water Division	Well 7	Grove Pond Well #7	Gravel-Packed	634010.9	3025986.2	226.5	105.3	71.0	56 - 71	170 - 155
Ayer DPW Water Division	Well 8	Grove Pond Well #8	Gravel-Packed	633937.5	3025897.4	235.8	103.8	73.0	60 - 73	176 - 163
Shirley Water District	Patterson Well	Patterson Well	Gravel-Packed	623106.7	3028127.0	225.5	180.0	53.0	unknown	195 - 185
Shirley Water District	Walker Well	Walker Well	Gravel-Packed	623485.8	3028002.5	240.6	179.9	70.5	60.5 - 70.5	195 - 185
MCI Shirley	GP Well 1	MCI Shirley GP Well 1	Gravel-Packed	629054.7	3015433.3	354.0	203.5	60.0	unknown	304 - 294
MCI Shirley	GP Well 2	MCI Shirley GP Well 2	Gravel-Packed	618637.9	3015579.9	247.6	194.6	40.0	unknown	218 - 208
The Appleworks	Well 1	The Appleworks	Bedrock	635832.3	3022877.4	282.7	245.2	450.0	-	240 - -167
Harvard Plaza	Well 1	Harvard Plaza	Bedrock	635589.7	3020712.1	283.2	211.3	unknown	-	206 - -31
Lancaster County Road LLC	Rock Well	Rock Well 1	Bedrock	634343.5	3018557.3	262.6	226.0	365.0	-	221 - -102
Foxglove Apartments	6" BEDROCK DW WELL	Foxglove Apartments	Bedrock	634948.3	3019636.5	260.8	213.3	240.0	-	208 - 21
Harvard Green Condominiums	Well 1	Harvard Green Well 1	Bedrock	633371.8	3016931.4	321.2	286.2	300.0	-	281 - 21
Harvard Green Condominiums	Well 2	Harvard Green Well 2	Bedrock	633468.2	3016883.9	320.5	285.8	400.0	-	281 - -80
Shaker Place Offices	Well #1	Shaker Place Offices	Bedrock	635246.9	3019055.7	269.1	208.6	200.0	-	204 - 69
Ayer Road Properties LLC	Well 1	Ayer Road Well 1	Bedrock	632957.1	3016629.7	332.7	302.7	245.0	-	298 - 88
Ayer Road Properties LLC	Well 2	Ayer Road Well 2	Bedrock	632975.4	3016587.0	332.8	305.4	360.0	-	300 - -27
Ayer Road Properties LLC	Well 3	Ayer Road Well 3	Bedrock	632965.1	3016537.4	333.4	309.1	360.0	-	304 - -27
Ayer Road Properties LLC	Well 4	Ayer Road Well 4	Bedrock	633002.3	3016507.2	332.4	309.8	300.0	-	305 - 32
School House 1870 Trust	Rock Well	Rock Well 2	Bedrock	635190.8	3018660.3	258.5	207.4	235.0	-	202 - 24
SHL Extraction Well EW-1	Shepley Hill Landfill	EW-01	Overburden	629942.8	3027960.2	226.5	130.9	85.0	60 - 85	167 - 142
SHL Extraction Well EW-4	Shepley Hill Landfill	EW-04	Overburden	629895.3	3027991.0	228.6	130.2	95.0	70 - 95	159 - 137
Red Tail GC Irrigation Well	Red Tail Golf Course	Red Tail Golf Course	Overburden	628650.3	3019614.9	273.0	95.3	72.0	56 - 66	217 - 207
LLFARM-SHI	105 Walker Rd, Shirley	LLFARM-SHI	Overburden	623789.5	3030476.1	267.3	166.5	unknown	50 - 60	217 - 207
Hilton Garden Inn	59 Andrews Parkway, Harvard	Hilton Garden Inn	Bedrock	626136.8	3021440.8	299.1	270.1	920.0	20 - 920	265 - -621

Table B.1a

Municipal and Community Well Details

PWS Name	Source Name	Short Name	Type of Well	Easting	Northing	LIDAR Elevation[1] (feet/MSL)	Top of Bedrock[2] (feet/MSL)	Well Depth (feet/BGS[3])	Screen / Open Interval (feet/BGS[3])	Screen / Open Interval (feet/MSL)
Springhill Suites - Marriot Hotel	27 Andrews Parkway, Harvard	Springhill Suites	Bedrock	626284.1	3021960.6	289.3	250.4	600.0	31 - 600	245 - -311
Primrose Car Wash	2 Andrews Parkway, Ayer	Primrose Car Wash	Bedrock	625355.6	3022108.0	316.4	284.2	420.0	20 - 420	279 - -104
Devens Irrigation Well	78 Barnum Road, Devens	Devens Irrigation Well	Bedrock	631458.4	3022970.3	249.8	55.1	505.0	-	50 - -255

Notes:

Original source: Seres-Arcadis (2020c); Devens Community Wells 9_Updated(1).xlsx

[1] Source: LIDAR Surface Map developed by Seres-Arcadis (2020b)

[2] Source: Bedrock Surface Map developed by Seres-Arcadis (2020a)

[3] Reference elevation unknown. Screen / open interval elevation calculated from LIDAR

Screen / Open Interval Assumptions:

Assumed same screen length as replacement.	Assumed top of screen is 5 feet below bedrock surface.
53 foot depth puts well just below top of bedrock, assuming it is 5 feet above bedrock surface with a 10 foot screen.	Adjusted bottom of screen elevation to just above bedrock surface.
Assumed 20 foot screen.	Assumed shallow well, screened interval 50 - 60 feet below LIDAR surface.
Assumed 10 foot screen.	The provided top of screen is just above top of bedrock, adjusted to be 5 feet below bedrock surface.
Assumed well depth was average of other Small Community Wells, and top-of-screen is 5 feet below bedrock surface.	

Table B.1b

Municipal and Community Well Pumping Rates

Short Name	2015 Volume (Mgal)	2016 Volume (Mgal)	2017 Volume (Mgal)	2018 Volume (Mgal)	2019 Volume (Mgal)	Average Pumping Rate (gpm)
Shabokin_Inactive		-	-	-	-	-
Shabokin Well		135.3	132.1	153.6	158.4	275.4
MacPherson Well		63.2	65.5	5.0	65.8	94.8
Patton Well		139.0	120.9	148.3	103.4	243.2
Grove Pond Well #1		0.0	0.0	30.1	58.3	42.0
Grove Pond Well #2		0.0	0.0	0.0	0.0	0.0
Grove Pond Well #6		88.7	124.4	122.6	114.8	214.1
Grove Pond Well #7		103.5	107.5	116.8	88.5	197.8
Grove Pond Well #8		117.7	83.4	15.8	27.4	116.1
Patterson Well		87.9	26.2	90.4	61.8	126.6
Walker Well		30.0	109.1	27.4	31.6	94.1
MCI Shirley GP Well 1		40.7	49.1	76.6	32.9	94.7
MCI Shirley GP Well 2		20.4	47.7	32.4	39.6	66.6
The Appleworks	0.2	0.2	0.2	0.2	0.1	0.4
Harvard Plaza	0.3	0.4	0.4	0.3	0.3	0.6
Rock Well 1	0.6	0.6	0.5	0.4	0.4	1.0
Foxglove Apartments	0.6	0.5	0.5	0.5	0.5	1.0
Harvard Green Well 1	0.6	0.8	0.6	0.6	0.7	1.2
Harvard Green Well 2	0.6	0.9	0.6	0.6	0.6	1.2
Shaker Place Offices	0.0	0.0	0.0	0.0	0.0	0.1
Ayer Road Well 1	0.4	0.3	0.6	0.2	0.1	0.6
Ayer Road Well 2	0.3	0.3	0.6	0.4	0.3	0.7
Ayer Road Well 3	0.3	0.3	0.6	0.3	0.3	0.7
Ayer Road Well 4	0.3	0.2	0.6	0.4	0.4	0.7
Rock Well 2	0.0	0.0	0.0	0.1	0.1	0.1
EW-01	14.0	17.0	16.7	16.0	16.2	30.4
EW-04	11.5	10.9	9.9	8.9	8.8	19.0
Red Tail Golf Course	25.0	25.0	25.0	25.0	25.0	47.5
LLFARM-SHI	0.0	0.0	0.0	0.0	0.0	0.0
Hilton Garden Inn					5.3	10.0
Springhill Suites					7.9	15.0
Primrose Car Wash					21.0	40.0
Devens Irrigation Well					7.9	15.0

Notes:

Original source: Seres-Arcadis (2002c); Devens Community Wells 9_Updated(1).xlsx

Source: SHL Extraction Well Flow Data 081720.xlsx, received 08/18/2020 from Michael Kulbersh

Table B.1c

Estimates of Hydraulic Conductivity at Select Municipal and Community Pumping Wells

Short Name	Top of Bedrock[1] (feet/MSL)	Estimated Transmissivity (feet^2/day)	Transmissivity Constraint[2] (feet^2/day)	Reference Monitoring Well	Reference Water Level[3] (feet/MSL)	Estimated Hydraulic Conductivity[4] (feet/day)
Shabokin_Inactive	141.0	24,600*	24,600	Estimated from Nearby Bedrock Wells	230.5	275
Shabokin Well	138.5	24,600*	24,600	Estimated from Nearby Bedrock Wells	230.5	267
MacPherson Well	105.1	40,291*	40,291	McPh-Sentinel	204.3	406
Patton Well	154.3	23,900*	23,900	PTW-A	242.2	272
Grove Pond Well #1	103.5	21,000 - 51,600*	36,300	GF-2	214.5	327
Grove Pond Well #2	102.9	21,000 - 51,600*	36,300	GF-2	214.5	325
Grove Pond Well #6	103.9	21,000 - 51,600*	36,300	GF-2	214.5	328
Grove Pond Well #7	105.3	21,000 - 51,600*	36,300	GF-2	214.5	333
Grove Pond Well #8	103.8	21,000 - 51,600*	36,300	GF-2	214.5	328
Patterson Well	180.0					
Walker Well	179.9					
MCI Shirley GP Well 1	203.5	28,650 - 57,300*	42,975	No wells nearby		
MCI Shirley GP Well 2	194.6	28,650 - 57,300*	42,975	No wells nearby		
The Appleworks	245.2					
Harvard Plaza	211.3					
Rock Well 1	226.0					
Foxglove Apartments	213.3					
Harvard Green Well 1	286.2					
Harvard Green Well 2	285.8					
Shaker Place Offices	208.6					
Ayer Road Well 1	302.7					
Ayer Road Well 2	305.4					
Ayer Road Well 3	309.1					
Ayer Road Well 4	309.8					
Rock Well 2	207.4					
EW-01	130.9	1,150 - 3,500	2,325	SHP-2016-1A	212.5	28
EW-04	130.2	1,300 - 4,000	2,650	SHP-2016-1A	212.5	32

Table B.1c

Estimates of Hydraulic Conductivity at Select Municipal and Community Pumping Wells

Short Name	Top of Bedrock[1] (feet/MSL)	Estimated Transmissivity (feet^2/day)	Transmissivity Constraint[2] (feet^2/day)	Reference Monitoring Well	Reference Water Level[3] (feet/MSL)	Estimated Hydraulic Conductivity[4] (feet/day)
Red Tail Golf Course	95.3	4,205 - 6,800	5,503	No wells nearby		
LLFARM-SHI	166.5					
Hilton Garden Inn	270.1					
Springhill Suites	250.4					
Primrose Car Wash	284.2					
Devens Irrigation Well	55.1					

Notes:

Original source: Seres-Arcadis (2002c); Devens Community Wells 9_Updated(1).xlsx

[1] Source: LIDAR Surface Map developed by Seres-Arcadis (2020b).

[2] Average of estimated range

[3] Historical average water level

[4] Calculated as Estimated Transmissivity / (Reference Water Level - Top of Bedrock)

* Transmissivities reported in Devens Water Resource Protection Report by Vanasse Hangen Brustlin Inc. and Haley and Aldrich, Inc., November, 1994.

Table B.2

Residential Well Details

Street Address	Town	Location in Database[1]	Easting	Northing	Well Depth (feet)	Reference Elevation[2] (feet/MSL)	Top of Bedrock[3] (feet/MSL)	Open Interval[4,5] (feet/MSL)
202 Ayer Road	Harvard, MA	202-AR	634864.8	3016949.9	365	277.9	251.6	247 - -87
232 Ayer Road	Harvard, MA	232-AR	635496.6	3018697.0	unknown	283.5	205.4	200 - 0
259 Ayer Road	Harvard, MA	259-AR	635372.9	3019831.6	unknown	278.8	220.7	216 - 16
276 Ayer Road	Harvard, MA	276-AR	635443.4	3020619.3	unknown	284.2	217.7	213 - 13
284 Ayer Road	Harvard, MA	284-AR	635891.8	3021057.5	unknown	281.4	208.9	204 - 4
292 Ayer Road	Harvard, MA	292-AR	636721.0	3021658.5	unknown	330.5	195.8	191 - -9
294 Ayer Road	Harvard, MA	294-AR	634408.3	3021595.1	~100 (owner) 245 (driller)	272.9	205.5	201 - 1
304 Ayer Road	Harvard, MA	304-AR	636380.6	3021952.1	unknown	272.4	201.8	197 - -3
306 Ayer Road	Harvard, MA	306-AR	636760.5	3022251.0	276	323.4	200.7	196 - 47
310 Ayer Road	Harvard, MA	310-AR	635959.6	3022352.2	unknown	280.6	227.2	222 - 22
327 Ayer Road	Harvard, MA	327-AYR-S	635973.2	3023277.3	unknown	286.0	255.9	251 - 51
327 Ayer Road	Harvard, MA	327-AYR-D	635700.5	3023227.2	365	289.0	256.4	251 - -76
335 Ayer Road	Harvard, MA	335-AR	636323.1	3023606.3	600	272.3	250.0	245 - -328
344 Ayer Road	Harvard, MA	344-AR	636905.7	3023757.1	600	277.5	219.1	214 - -322
345 Ayer Road	Harvard, MA	345-AR	636870.6	3023856.9	unknown	266.9	224.0	219 - 19
346 Ayer Road	Harvard, MA	346-AR	636870.6	3023856.9	~40	257.2	224.0	219 - 179
350 Ayer Road	Harvard, MA	350-AR	636846.6	3024106.4	unknown	268.7	235.3	230 - 30
1 Blanchard Road	Harvard, MA	01-BLR	631375.3	3016315.4	~120 ft	379.7	365.7	361 - 260
2 Blanchard Road	Harvard, MA	2-BLR	631783.6	3016847.3	245	376.5	372.0	367 - 132
14 Blanchard Road	Harvard, MA	14-BLR	631675.2	3017172.9	unknown	375.5	366.3	361 - 161
15 Blanchard Road	Harvard, MA	15-BLR	631301.6	3017041.3	unknown	367.3	357.8	353 - 153
17 Blanchard Road	Harvard, MA	17-BLR	631234.1	3017224.5	~80	363.1	350.7	346 - 266
19 Blanchard Road	Harvard, MA	19-BLR	631172.6	3017437.6	unknown	351.9	336.3	331 - 131
21 Blanchard Road	Harvard, MA	21-BLR	631332.2	3017769.2	320	344.9	307.7	303 - 25
31 Blanchard Road	Harvard, MA	31-BLR	631290.8	3017988.6	400	334.6	280.3	275 - -65
33 Blanchard Road	Harvard, MA	33-BLR	631281.7	3018084.9	unknown	332.5	273.3	268 - 68
34 Blanchard Road	Harvard, MA	34-BLR	631665.8	3018017.1	66	331.4	303.9	299 - 233
37 Blanchard Road	Harvard, MA	37-BLR	631373.9	3018366.5	230	328.4	269.2	264 - 98
40 Blanchard Road	Harvard, MA	40-BLR	631584.1	3018523.0	unknown	332.0	275.5	271 - 71
42 Blanchard Road	Harvard, MA	42-BLR	631430.6	3018546.8	155	328.3	265.7	261 - 173

Table B.2

Residential Well Details

Street Address	Town	Location in Database[1]	Easting	Northing	Well Depth (feet)	Reference Elevation[2] (feet/MSL)	Top of Bedrock[3] (feet/MSL)	Open Interval[4,5] (feet/MSL)
48 Blanchard Road	Harvard, MA	48-BLR	631658.4	3018728.1	~120	330.7	265.7	261 - 211
56 Blanchard Road	Harvard, MA	56-BLR	631674.7	3019085.3	220	319.4	240.3	235 - 99
62 Blanchard Road	Harvard, MA	62-BLR	631746.1	3019450.5	unknown	309.7	219.7	215 - 15
4 Cedar Ledge Road	Harvard, MA	04-CLR	632489.6	3017171.9	~100	351.5	298.7	294 - 194
8 Cedar Ledge Road	Harvard, MA	08-CLR	632375.5	3017392.8	unknown	362.0	330.1	325 - 125
2 Depot Road	Harvard, MA	02-DPR	633225.0	3009539.6	705	392.6	374.2	369 - -312
6 Depot Road	Harvard, MA	06-DPR	633107.1	3009634.6	500	390.8	333.3	328 - -109
8 Depot Road	Harvard, MA	08-DPR	633032.3	3009710.6	8	389.8	303.6	299 - 291
14 Depot Road	Harvard, MA	14-DPR	632872.1	3009889.5	140	383.3	303.6	299 - 243
20 Depot Road	Harvard, MA	20-DPR	632569.4	3010096.0	505	397.4	365.5	360 - -108
21 Depot Road	Harvard, MA	21-DPR	631332.2	3017769.2	unknown	395.5	307.7	303 - 103
56 Depot Road	Harvard, MA	56-DPR	631679.8	3011198.8	245	359.0	342.2	337 - 114
58 Depot Road	Harvard, MA	58-DPR	631487.6	3011253.8	unknown	351.8	338.6	334 - 134
61 Depot Road	Harvard, MA	61-DPR	631359.2	3011231.8	120	352.5	341.1	336 - 233
89 Depot Road	Harvard, MA	89-DPR	630350.7	3012409.4	~110	359.8	352.1	347 - 250
100 Depot Road	Harvard, MA	100-DPR	630359.1	3012535.6	~350-375	367.7	358.7	354 - 18
124 Depot Road	Harvard, MA	124-DPR	629747.5	3013825.8	unknown	351.3	335.8	331 - 131
140 Depot Road	Harvard, MA	140-DPR	629719.4	3014958.5	unknown	328.0	306.7	302 - 102
141 Depot Road	Harvard, MA	141-DPR	629054.0	3014533.5	unknown	315.6	300.4	295 - 95
143 Depot Road	Harvard, MA	143-DPR	628589.8	3014337.7	550	307.6	286.4	281 - -242
144 Depot Road	Harvard, MA	144-DPR	630069.9	3015092.6	unknown	348.2	315.8	311 - 111
152 Depot Road	Harvard, MA	152-DPR	630334.0	3015852.5	unknown	345.6	294.4	289 - 89
156 Depot Road	Harvard, MA	156-DPR	629996.1	3015493.2	unknown	335.9	291.3	286 - 86
38 Lancaster County Road	Harvard, MA	38-LCR	633300.5	3018354.2	unknown	305.7	262.6	258 - 58
52 Lancaster County Road	Harvard, MA	52-LCR	632621.6	3018204.2	~100	321.2	280.7	276 - 176
52 Lancaster County Road	Harvard, MA	52B-LCR	632865.2	3017445.8	~100	321.2	281.9	277 - 177
65 Lancaster County Road	Harvard, MA	65-LCR	632304.1	3016780.8	unknown	364.4	320.1	315 - 115
68 Lancaster County Road	Harvard, MA	68-LCR	632094.1	3016902.3	unknown	378.9	359.0	354 - 154
71 Lancaster County Road	Harvard, MA	71-LCR	632180.7	3016701.8	unknown	368.1	334.8	330 - 130
74 Lancaster County Road	Harvard, MA	74-LCR	631984.4	3016915.2	205	382.5	369.9	365 - 177

Table B.2

Residential Well Details

Street Address	Town	Location in Database[1]	Easting	Northing	Well Depth (feet)	Reference Elevation[2] (feet/MSL)	Top of Bedrock[3] (feet/MSL)	Open Interval[4,5] (feet/MSL)
81 Lancaster County Road	Harvard, MA	81-LCR	630975.9	3016597.6	425	346.7	322.0	317 - -78
83 Lancaster County Road	Harvard, MA	83-LCR	630995.9	3016495.9	unknown	348.4	321.4	316 - 116
87 Lancaster County Road	Harvard, MA	87-LCR	630976.2	3016722.4	~200-400	344.3	326.8	322 - 44
15 Myrick Lane	Harvard, MA	15-MYR	637254.3	3023934.7	unknown	263.0	205.9	201 - 1
19 Myrick Lane	Harvard, MA	19-MYR	637455.3	3023994.1	unknown	271.5	206.8	202 - 2
22 Myrick Lane	Harvard, MA	22-MYR	637614.5	3023994.1	~200-250	277.6	204.6	200 - 53
29 Myrick Lane	Harvard, MA	29-MYR	637904.2	3024287.0	~450	290.5	203.6	199 - -159
32 Myrick Lane	Harvard, MA	32-MYR	638080.7	3024078.9	unknown	308.0	202.6	198 - -2
33 Myrick Lane	Harvard, MA	33-MYR	638225.9	3024415.5	~200	313.7	204.0	199 - 114
36 Myrick Lane	Harvard, MA	36-MYR	638328.4	3024136.4	unknown	317.4	199.3	194 - -6
39 Myrick Lane	Harvard, MA	39-MYR	638380.6	3024370.3	200	319.4	203.4	198 - 119
40 Myrick Lane	Harvard, MA	40-MYR	638434.9	3023968.8	unknown	323.0	199.2	194 - -6
47 Myrick Lane	Harvard, MA	47-MYR	638934.2	3024349.7	300	319.3	199.3	194 - 19
51 Myrick Lane	Harvard, MA	51-MYR	638982.7	3024307.7	unknown	318.3	198.2	193 - -7
52 Myrick Lane	Harvard, MA	52-MYR	638929.3	3022180.1	420	327.3	192.4	187 - -93
53 Myrick Lane	Harvard, MA	53-MYR	639400.0	3024165.8	unknown	307.8	198.9	194 - -6
55 Myrick Lane	Harvard, MA	55-MYR	639250.9	3023993.6	500	316.1	198.1	193 - -184
57 Myrick Lane	Harvard, MA	57-MYR	639204.5	3023836.1	~300-600	316.3	194.6	190 - -84
63 Myrick Lane	Harvard, MA	63-MYR	639393.4	3023574.3	unknown	320.8	197.9	193 - -7
70 Myrick Lane	Harvard, MA	70-MYR	639261.1	3023145.6	~250	324.2	194.2	189 - 74
80 Myrick Lane	Harvard, MA	80-MYR	639403.0	3022768.0	unknown	323.6	199.1	194 - -6
82 Myrick Lane	Harvard, MA	82-MYR	639395.2	3022487.2	unknown	316.5	198.8	194 - -6
85 Myrick Lane	Harvard, MA	85-MYR	639819.7	3022616.0	~100-300	329.5	221.9	217 - 129
86 Myrick Lane	Harvard, MA	86-MYR	639593.9	3022369.9	unknown	318.9	210.6	206 - 6
6 Old Mill Road	Harvard, MA	06-OMR	635316.0	3020409.0	unknown	272.8	221.0	216 - 16
22 Old Mill Road	Harvard, MA	22-OMR	634211.6	3020699.3	unknown	237.2	200.8	196 - -4
41 Old Mill Road	Harvard, MA	41-OMR	633710.1	3020058.4	unknown	268.1	201.7	197 - -3
48 Old Mill Road	Harvard, MA	48-OMR	633218.8	3020148.7	~30	275.9	221.3	216 - 186
54 Old Mill Road	Harvard, MA	54-OMR	632879.4	3020044.3	unknown	288.3	218.0	213 - 13
56 Old Mill Road	Harvard, MA	56-OMR	632793.9	3019974.8	unknown	292.3	219.9	215 - 15

Table B.2

Residential Well Details

Street Address	Town	Location in Database[1]	Easting	Northing	Well Depth (feet)	Reference Elevation[2] (feet/MSL)	Top of Bedrock[3] (feet/MSL)	Open Interval[4,5] (feet/MSL)
57 Old Mill Road	Harvard, MA	57-OMR	632862.2	3019845.7	505	294.9	231.3	226 - -210
58 Old Mill Road	Harvard, MA	58-OMR	632723.0	3020348.8	600	279.6	184.7	180 - -320
71 Old Mill Road	Harvard, MA	71-OMR	632126.4	3019599.6	~100-125	301.0	222.0	217 - 117
76 Old Mill Road	Harvard, MA	76-OMR	631634.4	3020135.6	200	275.6	170.5	166 - 76
80 Old Mill Road	Harvard, MA	80-OMR	631809.9	3019748.5	~100	297.9	203.4	198 - 98
88 Old Mill Road	Harvard, MA	88-OMR	631345.2	3019449.0	unknown	294.1	201.5	197 - -3
91 Old Mill Road	Harvard, MA	91-OMR	631451.8	3019133.6	unknown	310.9	229.9	225 - 25
92 Old Mill Road	Harvard, MA	92-OMR	631508.7	3019656.9	unknown	290.9	194.6	190 - -10
94 Old Mill Road	Harvard, MA	94-OMR	630919.6	3019466.3	~420	274.0	174.2	169 - -146
95 Old Mill Road	Harvard, MA	95-OMR	631385.1	3018983.5	unknown	314.0	235.9	231 - 31
96 Old Mill Road	Harvard, MA	96-OMR	630629.2	3019574.9	> 100	260.5	135.6	131 - -69
97 Old Mill Road	Harvard, MA	97-OMR	631218.2	3018824.3	unknown	308.0	232.7	228 - 28
100 Old Mill Road	Harvard, MA	100-OMR	630992.7	3018982.5	180	291.8	209.3	204 - 112
102 Old Mill Road	Harvard, MA	102-OMR	630734.7	3019166.5	287	272.6	171.6	167 - -14
104 Old Mill Road	Harvard, MA	104-OMR	630845.8	3018801.5	unknown	289.6	207.4	202 - 2
106 Old Mill Road	Harvard, MA	106-OMR	630570.8	3018966.2	~500-600	268.7	166.3	161 - -231
107 Old Mill Road	Harvard, MA	107-OMR	631081.0	3018566.1	unknown	311.7	232.4	227 - 27
108 Old Mill Road	Harvard, MA	108-OMR	630712.7	3018595.0	unknown	287.2	201.7	197 - -3
109 Old Mill Road	Harvard, MA	109-OMR	630897.7	3018422.8	unknown	306.2	218.5	213 - 13
113 Old Mill Road	Harvard, MA	113-OMR	630812.9	3018256.7	300	304.2	212.4	207 - 4
112 Old Shirley Road	Harvard, MA	112-OSR	630064.3	3013739.4	unknown	365.8	343.1	338 - 138
4 Prospect Hill Road	Harvard, MA	04-PHR	629571.6	3013845.5	unknown	350.6	332.8	328 - 128
10 Prospect Hill Road	Harvard, MA	10-PHR	629199.3	3013908.2	unknown	349.7	327.6	323 - 123
20 Prospect Hill Road	Harvard, MA	20-PHR	628803.4	3013357.8	500	357.1	337.4	332 - -143
13 James Brook Way	Ayer, MA	13-JBW	630041.6	3037137.1	~300	222.1	191.5	187 - -78
15 James Brook Way	Ayer, MA	15-JBW	630156.8	3037203.9	unknown	227.9	178.2	173 - -27
17 James Brook Way	Ayer, MA	17-JBW	630538.9	3037130.8	415	217.9	165.4	160 - -197
31 Groton Shirley Road	Ayer, MA	31-GSR	630349.1	3036188.7	unknown	222.3	170.8	166 - -34
33 Groton Shirley Road	Ayer, MA	33-GSR	630244.1	3036247.3	25	221.8	169.7	165 - 140
35 Groton Shirley Road	Ayer, MA	35-GSR	630162.2	3036266.4	unknown	222.0	169.4	164 - -36

Table B.2

Residential Well Details

Street Address	Town	Location in Database[1]	Easting	Northing	Well Depth (feet)	Reference Elevation[2] (feet/MSL)	Top of Bedrock[3] (feet/MSL)	Open Interval[4,5] (feet/MSL)
37 Groton Shirley Road	Ayer, MA	37-GSR	630314.0	3036436.1	320	219.2	172.0	167 - -101
39 Groton Shirley Road	Ayer, MA	39-GSR	630066.7	3036329.9	~125	220.2	168.4	163 - 95
41 Groton Shirley Road	Ayer, MA	41-GSR	629959.4	3036429.0	unknown	216.4	166.6	162 - -38
43 Groton Shirley Road	Ayer, MA	43-GSR	629872.5	3036443.8	unknown	216.1	167.1	162 - -38
49 Groton Shirley Road	Ayer, MA	49-GSR	629619.1	3036481.9	500	218.7	167.5	163 - -281
9 Great Road	Shirley, MA	9-GR	623739.4	3034539.4	10	233.2	145.4	140 - 130
66 Great Road	Shirley, MA	66-GR	625322.2	3036139.4	unknown	246.0	168.0	163 - -37

Notes:

[1] Former Fort Devens EDMS Portal Database (ftdevens.org)

[2] Source: Former Fort Devens Database when available, Seres-Arcadis (2020) LIDAR surface otherwise

[3] Source: Bedrock Surface Map developed by Seres-Arcadis (2020)

[4] Open interval top was assumed to be 5 feet below Top of Bedrock

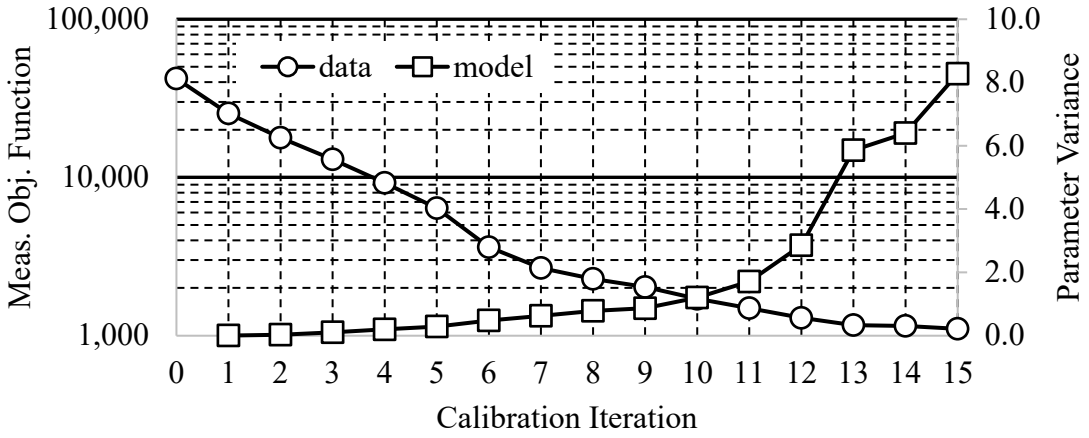
[5] Open interval bottom was calculated as: Reference Elevation - Well Depth (open interval assumed to be 200 feet long if depth unknown)

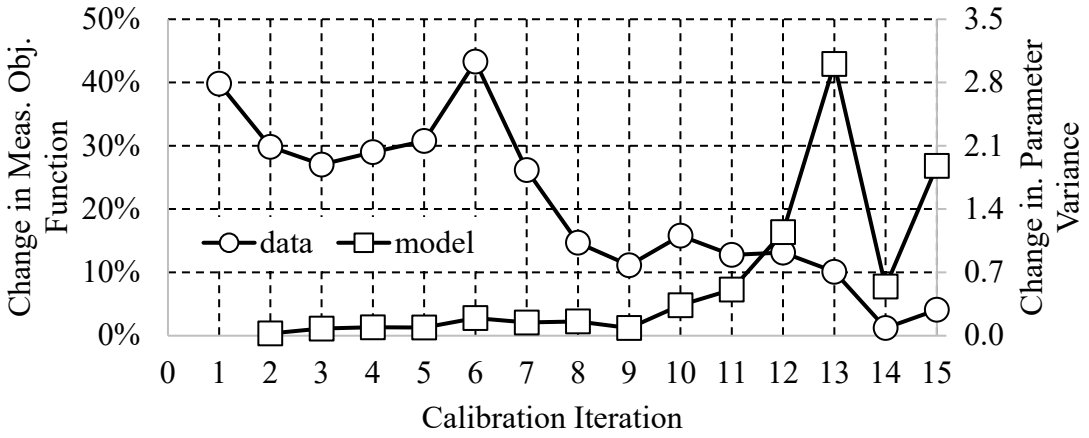
Appendix C

Optimal Level of Measurement-to-Model Misfit Procedure

Appendix C

An example of the regularized inversion procedure is presented here for the primary calibration step of the Main Post. In the first figure below, the measurement and regularization objective function contributions are plotted for each PEST_HP calibration iteration. The initial measurement objective function is approximately 42,000 and after 15 iterations it is reduced to about 1,100, while parameter variance increases from 0 to approximately 8. In the second figure, the relative improvement in the measurement objective function from the previous iteration is shown, as is the relative change in parameter variance. The relative improvement in the measurement objective function for the first 7 iterations is between 25% and 45%, and 1% and 15% for iterations 8 through 15. The change in parameter variance is small for the first 9 iterations but begins to change more rapidly from iteration 10. For this reason, an appropriate trade-off is at iteration 9, which is a measurement objective function of approximately 2,000, about twice the minimum.





Appendix D

Calculated Steady State Water Levels and Residuals

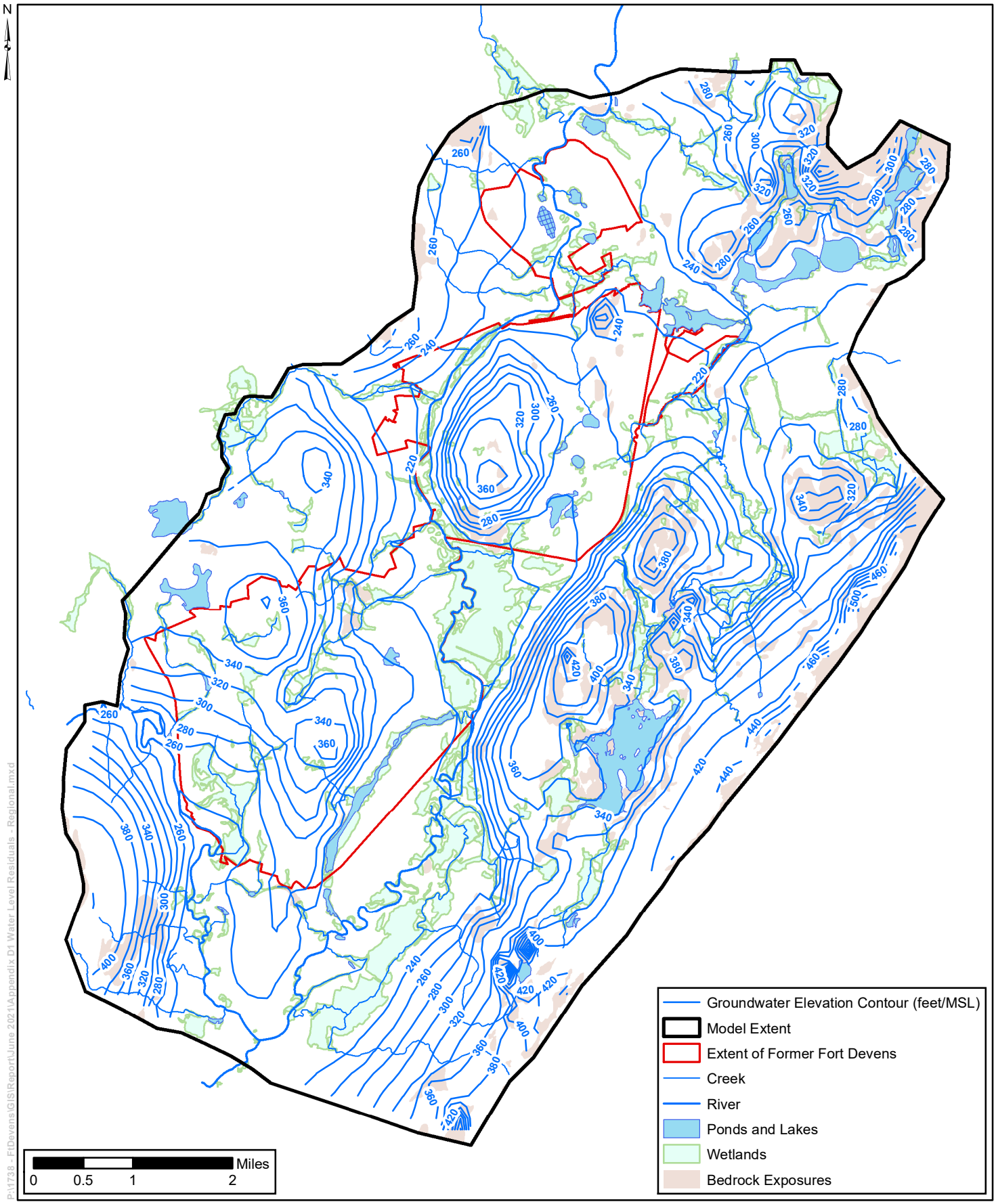


Figure D.1 Calculated Steady State Water Levels – Regional Domain

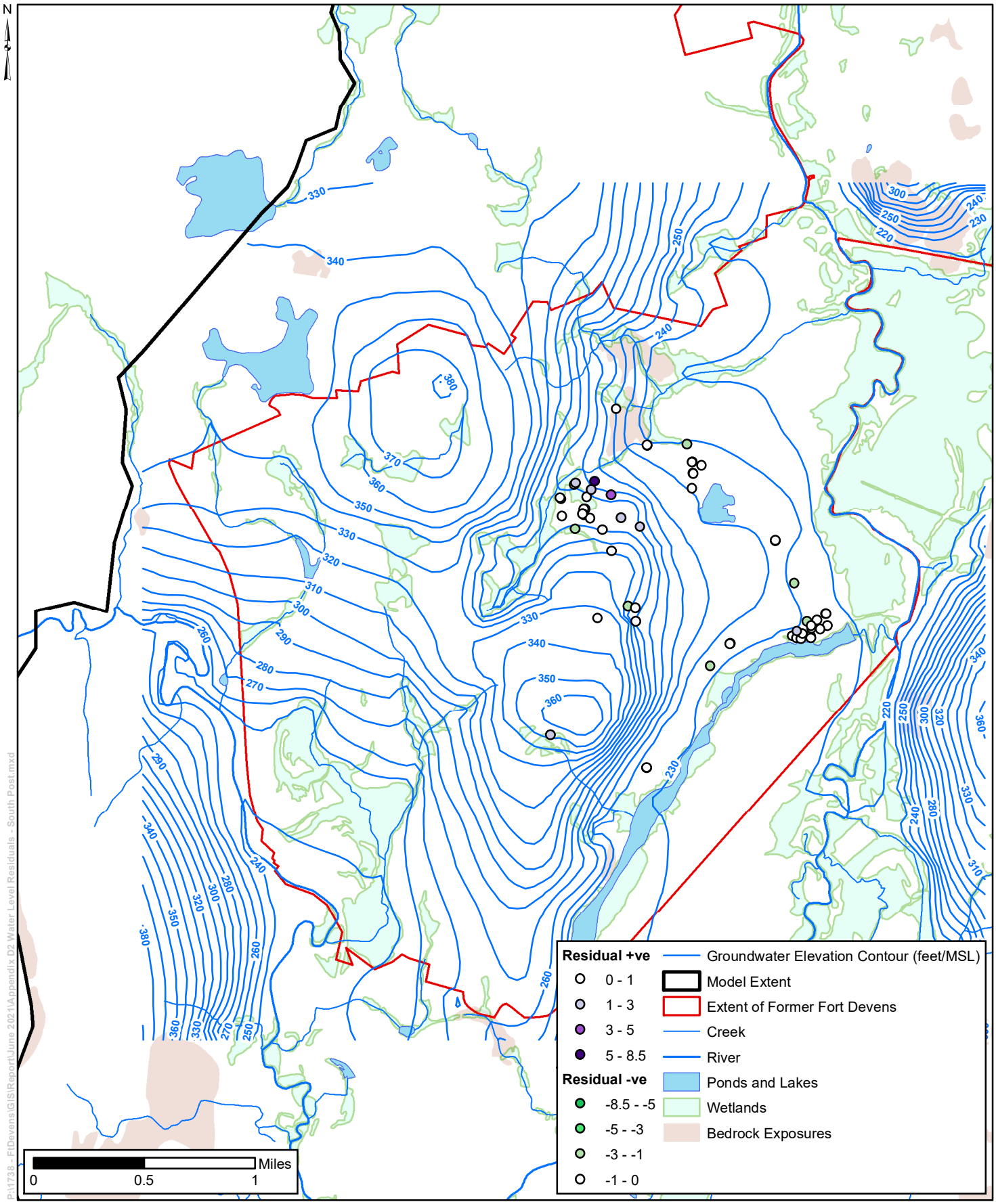


Figure D.2 Calculated Steady State Water Levels with Residuals – South Post

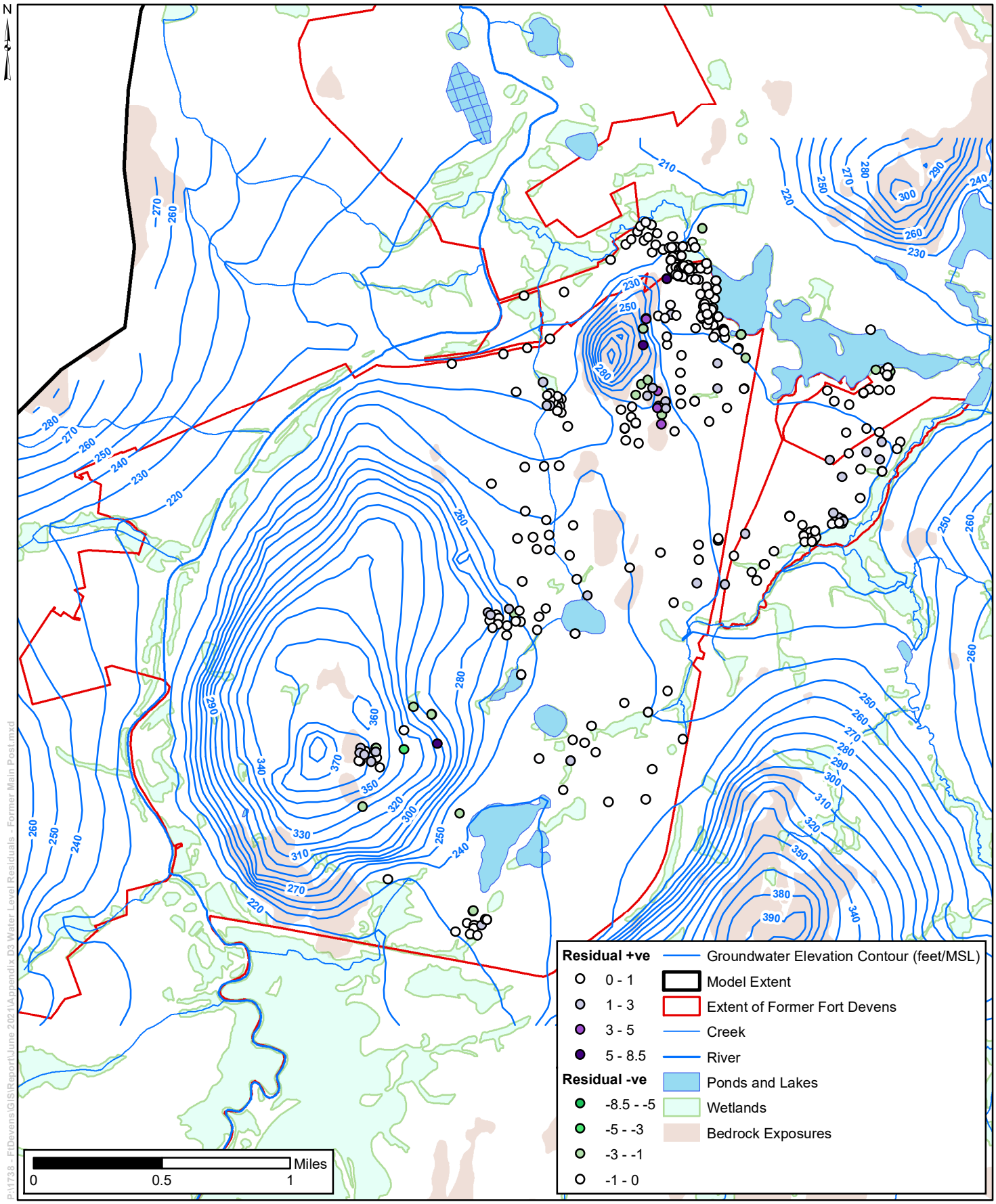


Figure D.3 Calculated Steady State Water Levels with Residuals – Former Main Post

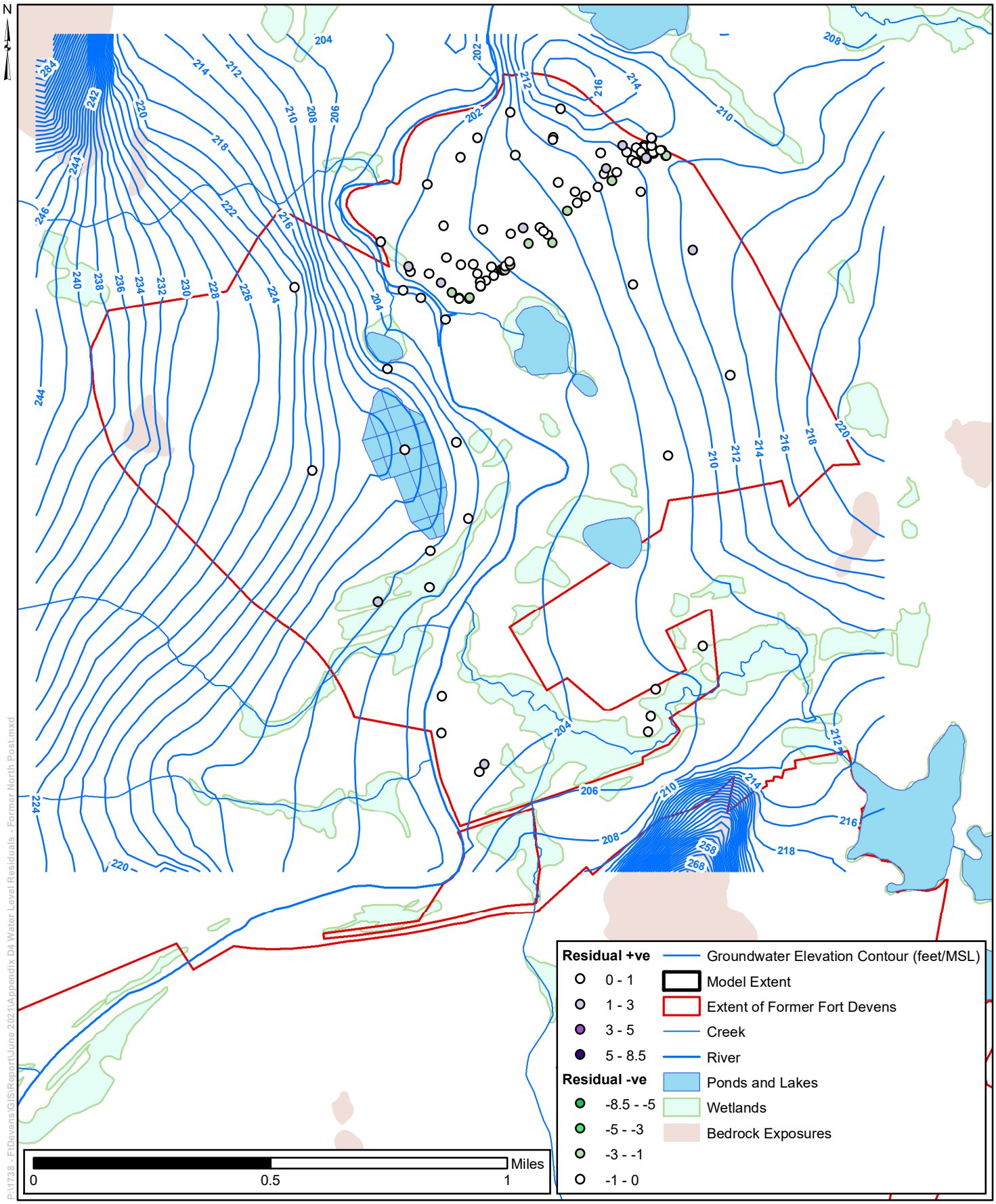


Figure D.4 Calculated Steady State Water Levels with Residuals – Former North Post

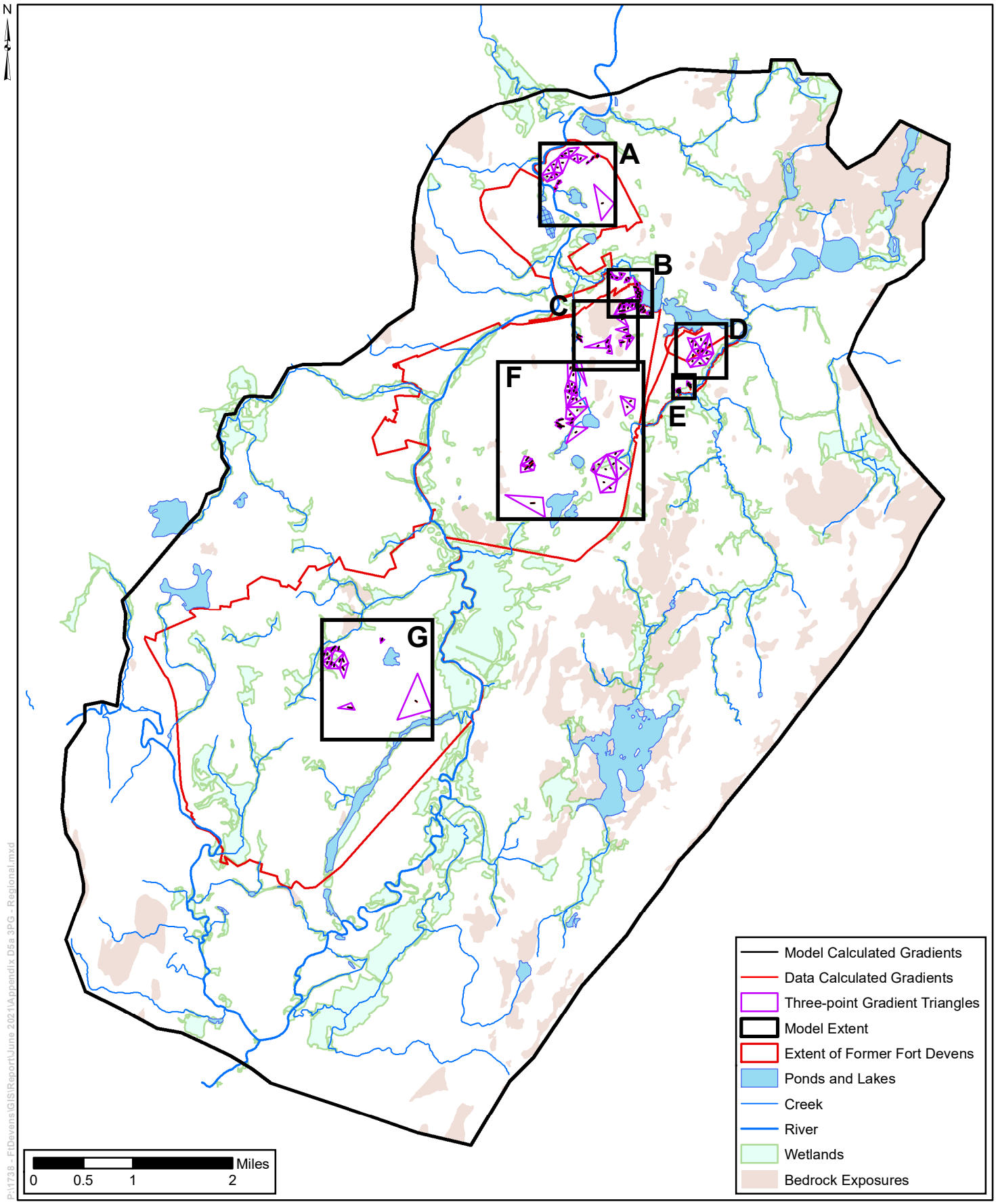
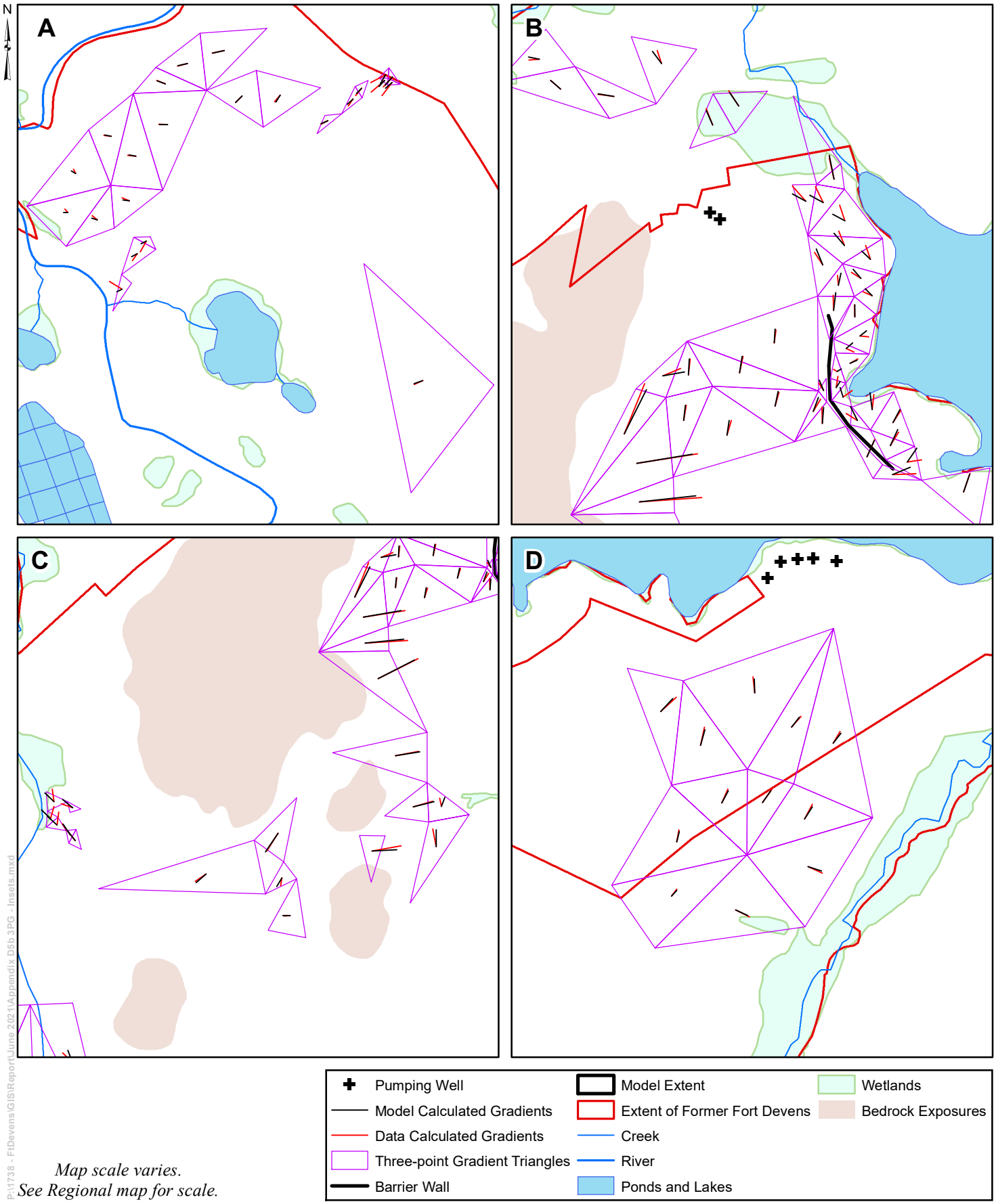


Figure D.5a Three-point Gradient Estimates and Simulated Equivalents - Inset Reference Map



Map scale varies.
See Regional map for scale.

P:\1738 - FtDevens\GIS\Report\June 2021\Appendix D\5b 3PG - Insets.mxd

Figure D.5b Three-point Gradient Estimates and Simulated Equivalents - Insets A-D

Figure D.5c Three-point Gradient Estimates and Simulated Equivalents - Insets E-G

Appendix E

Calibration Targets, Simulated Equivalents, and Residuals

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_20	MW-01A	4/27/2020	206.8	
AOC_20	MW-02A	4/27/2020	206.7	
AOC_20	MW-04	4/27/2020	208.1	
AOC_20	MW-06	4/27/2020	222.1	
AOC_20	MW-07	4/27/2020	219.9	
AOC_20	MW-WC1A	4/27/2020	207.2	
AOC_20	MW-WC2	4/27/2020	209.5	
AOC_20	PZ-1	4/27/2020	211.9	
AOC_20	PZ-2	4/27/2020		
AOC_20	PZ-5	4/27/2020	208.0	
AOC_20	PZ-6	4/27/2020	203.9	
AOC_25	25M-92-05X	1/15/1997	333.4	
AOC_25	25M-92-05X	6/2/1997	332.9	
AOC_25	25M-92-05X	4/23/1998	334.0	
AOC_25	25M-92-05X	12/6/1999	328.6	
AOC_25	25M-92-06X	1/15/1997	294.9	
AOC_25	25M-92-06X	6/2/1997	294.7	
AOC_25	25M-92-06X	10/27/1997	287.5	
AOC_25	25M-92-06X	4/23/1998	294.8	
AOC_25	25M-92-06X	10/14/1998	290.0	
AOC_25	25M-92-06X	10/21/1998	289.6	
AOC_25	25M-92-06X	10/18/1999	285.6	
AOC_25	25M-92-06X	12/6/1999	286.0	
AOC_25	25M-92-06X	10/25/2000	288.4	
AOC_25	25M-92-06X	10/15/2001	287.6	
AOC_25	25M-92-06X	10/21/2002	285.3	
AOC_25	25M-92-06X	10/28/2003	288.3	
AOC_25	25M-92-06X	11/1/2004	287.4	
AOC_25	25M-92-07X	1/15/1997	297.8	
AOC_25	25M-92-07X	6/2/1997	297.7	
AOC_25	25M-92-07X	4/23/1998	297.9	
AOC_25	25M-92-07X	10/14/1998	291.9	
AOC_25	25M-92-07X	12/6/1999	286.9	
AOC_25	25M-92-08X	1/15/1997	305.9	
AOC_25	25M-92-08X	6/2/1997	305.9	
AOC_25	25M-92-08X	4/23/1998	305.9	
AOC_25	25M-92-08X	10/14/1998	298.4	
AOC_25	25M-92-08X	12/6/1999	291.6	
AOC_25	26M-10-09X	10/25/2010	274.5	
AOC_25	26M-10-09X	10/18/2011	274.8	
AOC_25	26M-10-09X	11/13/2012	274.6	
AOC_25	26M-10-09X	11/12/2013	274.4	
AOC_25	26M-10-09X	11/24/2014	274.6	
AOC_25	26M-10-09X	12/10/2015	274.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	26M-10-09X	11/1/2016	274.4	
AOC_25	26M-10-09X	3/13/2017	274.8	
AOC_25	26M-10-09X	5/22/2017	273.8	
AOC_25	26M-10-09X	8/21/2017	274.4	
AOC_25	26M-10-09X	11/27/2017	274.5	
AOC_25	26M-10-09X	11/27/2018	275.2	
AOC_25	26M-10-09X	5/20/2019	274.9	
AOC_25	26M-10-09X	11/21/2019	274.5	
AOC_25	26M-14-10X	11/24/2014	273.7	
AOC_25	26M-14-10X	12/9/2015	273.5	
AOC_25	26M-14-10X	11/1/2016	273.3	
AOC_25	26M-14-10X	3/13/2017	273.4	
AOC_25	26M-14-10X	5/22/2017	275.5	
AOC_25	26M-14-10X	8/21/2017	280.2	
AOC_25	26M-14-10X	11/27/2017	274.2	
AOC_25	26M-14-10X	11/27/2018	276.6	
AOC_25	26M-14-10X	5/20/2019	277.6	
AOC_25	26M-14-10X	11/21/2019	274.2	
AOC_25	26M-14-11X	11/24/2014	286.6	
AOC_25	26M-14-11X	12/9/2015	286.3	
AOC_25	26M-14-11X	11/1/2016		
AOC_25	26M-14-11X	3/13/2017	286.6	
AOC_25	26M-14-11X	5/22/2017	288.2	
AOC_25	26M-14-11X	8/21/2017	288.5	
AOC_25	26M-14-11X	11/27/2017	287.2	
AOC_25	26M-14-11X	11/27/2018	289.4	
AOC_25	26M-14-11X	5/20/2019	289.8	
AOC_25	26M-14-11X	11/21/2019	287.0	
AOC_25	26M-92-01X	6/2/1997	311.4	
AOC_25	26M-92-01X	10/14/1998	307.2	
AOC_25	26M-92-01X	12/6/1999	308.3	
AOC_25	26M-92-01X	10/22/2008	310.0	
AOC_25	26M-92-01X	11/13/2009	306.3	
AOC_25	26M-92-01X	10/25/2010		
AOC_25	26M-92-01X	10/18/2011	310.6	
AOC_25	26M-92-01X	11/13/2012	307.6	
AOC_25	26M-92-01X	11/12/2013		
AOC_25	26M-92-01X	11/24/2014	306.3	
AOC_25	26M-92-01X	12/10/2015		
AOC_25	26M-92-01X	11/1/2016	305.3	
AOC_25	26M-92-01X	3/13/2017	311.2	
AOC_25	26M-92-01X	5/22/2017	315.5	
AOC_25	26M-92-01X	8/21/2017	307.7	
AOC_25	26M-92-01X	11/27/2017	307.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	26M-92-01X	11/27/2018	313.1	
AOC_25	26M-92-01X	5/20/2019	312.0	
AOC_25	26M-92-01X	11/21/2019		
AOC_25	26M-92-02X	1/15/1997	285.9	
AOC_25	26M-92-02X	6/2/1997	286.0	
AOC_25	26M-92-02X	10/27/1997	284.7	
AOC_25	26M-92-02X	4/23/1998	286.4	
AOC_25	26M-92-02X	10/14/1998	285.6	
AOC_25	26M-92-02X	10/21/1998	285.7	
AOC_25	26M-92-02X	10/18/1999	284.7	
AOC_25	26M-92-02X	12/6/1999	284.8	
AOC_25	26M-92-02X	10/25/2000	285.4	
AOC_25	26M-92-02X	10/15/2001	284.8	
AOC_25	26M-92-02X	10/21/2002	284.0	
AOC_25	26M-92-02X	10/28/2003	285.7	
AOC_25	26M-92-02X	11/1/2004	285.4	
AOC_25	26M-92-02X	11/14/2005	286.6	
AOC_25	26M-92-02X	10/23/2006	286.1	
AOC_25	26M-92-02X	10/22/2007	285.9	
AOC_25	26M-92-02X	10/22/2008	286.1	
AOC_25	26M-92-02X	11/13/2009	286.1	
AOC_25	26M-92-02X	10/21/2010	285.3	
AOC_25	26M-92-02X	10/18/2011	286.1	
AOC_25	26M-92-02X	11/13/2012	285.2	
AOC_25	26M-92-02X	11/12/2013	285.1	
AOC_25	26M-92-02X	11/24/2014	284.5	
AOC_25	26M-92-02X	12/9/2015	284.1	
AOC_25	26M-92-02X	11/1/2016	283.9	
AOC_25	26M-92-02X	3/13/2017	284.6	
AOC_25	26M-92-02X	5/22/2017	286.5	
AOC_25	26M-92-02X	8/21/2017	285.5	
AOC_25	26M-92-02X	11/27/2017	284.9	
AOC_25	26M-92-02X	11/27/2018	286.1	
AOC_25	26M-92-02X	5/20/2019	286.5	
AOC_25	26M-92-02X	11/21/2019	284.9	
AOC_25	26M-92-03X	1/15/1997	286.0	
AOC_25	26M-92-03X	6/2/1997	286.4	
AOC_25	26M-92-03X	10/27/1997	284.5	
AOC_25	26M-92-03X	4/23/1998	286.5	
AOC_25	26M-92-03X	10/14/1998	285.6	
AOC_25	26M-92-03X	10/21/1998	285.5	
AOC_25	26M-92-03X	10/18/1999	284.9	
AOC_25	26M-92-03X	12/6/1999	284.6	
AOC_25	26M-92-03X	10/25/2000	285.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	26M-92-03X	10/15/2001	284.7	
AOC_25	26M-92-03X	10/21/2002	283.9	
AOC_25	26M-92-03X	10/28/2003	285.4	
AOC_25	26M-92-03X	11/1/2004	285.2	
AOC_25	26M-92-03X	11/14/2005	286.5	
AOC_25	26M-92-03X	10/23/2006	285.9	
AOC_25	26M-92-03X	10/22/2007	285.6	
AOC_25	26M-92-03X	10/22/2008	285.9	
AOC_25	26M-92-03X	11/13/2009	285.9	
AOC_25	26M-92-03X	10/21/2010	285.1	
AOC_25	26M-92-03X	10/18/2011	286.0	
AOC_25	26M-92-03X	11/13/2012	284.0	
AOC_25	26M-92-03X	11/12/2013	285.0	
AOC_25	26M-92-03X	11/24/2014	284.4	
AOC_25	26M-92-03X	12/8/2015	284.8	
AOC_25	26M-92-03X	11/1/2016	283.9	
AOC_25	26M-92-03X	3/13/2017	284.5	
AOC_25	26M-92-03X	5/22/2017	285.4	
AOC_25	26M-92-03X	8/22/2017	285.3	
AOC_25	26M-92-03X	11/27/2017	284.8	
AOC_25	26M-92-03X	11/27/2018	286.0	
AOC_25	26M-92-03X	5/20/2019	286.4	
AOC_25	26M-92-03X	11/21/2019	284.8	
AOC_25	26M-92-04X	6/2/1997	287.4	
AOC_25	26M-92-04X	4/23/1998	287.1	
AOC_25	26M-92-04X	10/14/1998	286.6	
AOC_25	26M-92-04X	10/21/1998	286.8	
AOC_25	26M-92-04X	10/18/1999	285.5	
AOC_25	26M-92-04X	12/6/1999	285.1	
AOC_25	26M-92-04X	10/25/2000	286.2	
AOC_25	26M-92-04X	10/15/2001	285.6	
AOC_25	26M-92-04X	10/21/2002	284.7	
AOC_25	26M-92-04X	10/28/2003	286.3	
AOC_25	26M-92-04X	11/1/2004	286.0	
AOC_25	26M-92-04X	11/14/2005	287.3	
AOC_25	26M-92-04X	10/23/2006	286.8	
AOC_25	26M-92-04X	10/22/2007	286.4	
AOC_25	26M-92-04X	10/22/2008	286.8	
AOC_25	26M-92-04X	11/13/2009	286.7	
AOC_25	26M-92-04X	10/21/2010	285.9	
AOC_25	26M-92-04X	10/18/2011	286.8	
AOC_25	26M-92-04X	11/13/2012	285.8	
AOC_25	26M-92-04X	11/12/2013	285.8	
AOC_25	26M-92-04X	11/24/2014	285.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	26M-92-04X	12/8/2015	284.8	
AOC_25	26M-92-04X	11/1/2016	284.5	
AOC_25	26M-92-04X	3/13/2017	285.1	
AOC_25	26M-92-04X	5/22/2017	286.1	
AOC_25	26M-92-04X	8/22/2017	286.3	
AOC_25	26M-92-04X	11/27/2017	285.5	
AOC_25	26M-92-04X	11/27/2018	286.9	
AOC_25	26M-92-04X	5/20/2019	287.5	
AOC_25	26M-92-04X	11/21/2019	285.6	
AOC_25	26M-92-05X	1/15/1997	288.3	
AOC_25	26M-92-05X	6/2/1997	288.1	
AOC_25	26M-92-05X	4/23/1998	288.5	
AOC_25	26M-92-05X	12/6/1999	286.8	
AOC_25	26M-92-05X	10/22/2008	288.4	
AOC_25	26M-92-05X	11/13/2009	289.0	
AOC_25	26M-92-05X	10/25/2010	288.0	
AOC_25	26M-92-05X	10/18/2011	288.3	
AOC_25	26M-92-05X	11/13/2012	286.6	
AOC_25	26M-92-05X	11/12/2013	278.3	
AOC_25	26M-92-05X	10/25/2014	287.5	
AOC_25	26M-92-05X	11/24/2014	285.6	
AOC_25	26M-92-05X	12/10/2015	284.8	
AOC_25	26M-92-05X	11/1/2016	285.1	
AOC_25	26M-92-05X	3/13/2017	287.5	
AOC_25	26M-92-05X	5/22/2017	288.6	
AOC_25	26M-92-05X	8/21/2017	287.4	
AOC_25	26M-92-05X	11/27/2017	287.8	
AOC_25	26M-92-05X	11/27/2018	289.1	
AOC_25	26M-92-05X	5/20/2019	288.4	
AOC_25	26M-92-05X	11/21/2019	286.1	
AOC_25	26M-92-06X	1/15/1997	291.5	
AOC_25	26M-92-06X	6/2/1997	291.8	
AOC_25	26M-92-06X	4/23/1998	292.3	
AOC_25	26M-92-06X	10/14/1998	290.8	
AOC_25	26M-92-06X	12/6/1999	288.6	
AOC_25	26M-92-06X	10/22/2008	291.1	
AOC_25	26M-92-06X	11/13/2009	290.8	
AOC_25	26M-92-06X	10/25/2010	289.2	
AOC_25	26M-92-06X	10/18/2011	291.2	
AOC_25	26M-92-06X	11/13/2012	289.6	
AOC_25	26M-92-06X	11/12/2013	288.5	
AOC_25	26M-92-06X	11/24/2014	288.4	
AOC_25	26M-92-06X	12/10/2015	287.3	
AOC_25	26M-92-06X	11/1/2016	286.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	26M-92-06X	3/13/2017	290.4	
AOC_25	26M-92-06X	5/22/2017	291.1	
AOC_25	26M-92-06X	8/21/2017	288.8	
AOC_25	26M-92-06X	11/27/2017	289.5	
AOC_25	26M-92-06X	11/27/2018	292.1	
AOC_25	26M-92-06X	5/20/2019	292.0	
AOC_25	26M-92-06X	11/21/2019	289.2	
AOC_25	26M-92-07X	6/2/1997	291.7	
AOC_25	26M-92-07X	4/23/1998	291.4	
AOC_25	26M-92-07X	10/14/1998	289.9	
AOC_25	26M-92-07X	12/6/1999	287.2	
AOC_25	26M-92-07X	10/22/2008	290.2	
AOC_25	26M-92-07X	11/13/2009	280.3	
AOC_25	26M-92-07X	10/25/2010	288.5	
AOC_25	26M-92-07X	10/18/2011	290.0	
AOC_25	26M-92-07X	11/13/2012	288.3	
AOC_25	26M-92-07X	11/12/2013	288.5	
AOC_25	26M-92-07X	11/24/2014	287.6	
AOC_25	26M-92-07X	12/10/2015	287.1	
AOC_25	26M-92-07X	11/1/2016	286.6	
AOC_25	26M-92-07X	3/13/2017	287.2	
AOC_25	26M-92-07X	5/22/2017	289.3	
AOC_25	26M-92-07X	8/21/2017	289.6	
AOC_25	26M-92-07X	11/27/2017	289.1	
AOC_25	26M-92-07X	11/27/2018	290.7	
AOC_25	26M-92-07X	5/20/2019	290.6	
AOC_25	26M-92-07X	11/21/2019	288.2	
AOC_25	26WP-06-01R	3/13/2017	282.4	
AOC_25	26WP-06-01R	5/22/2017	282.5	
AOC_25	26WP-06-01R	8/21/2017	282.6	
AOC_25	26WP-06-01R	11/27/2017	282.4	
AOC_25	26WP-06-01R	11/27/2018	282.3	
AOC_25	26WP-06-01R	5/20/2019	283.0	
AOC_25	26WP-06-01R	11/21/2019	282.8	
AOC_25	26WP-08-02R	3/13/2017	279.4	
AOC_25	26WP-08-02R	5/22/2017	279.0	
AOC_25	26WP-08-02R	8/21/2017	279.8	
AOC_25	26WP-08-02R	11/27/2017	279.8	
AOC_25	26WP-08-02R	11/27/2018	279.8	
AOC_25	26WP-08-02R	5/20/2019	280.7	
AOC_25	26WP-08-02R	11/21/2019	280.0	
AOC_25	26WP-09-01R	3/13/2017	281.0	
AOC_25	26WP-09-01R	5/22/2017	281.0	
AOC_25	26WP-09-01R	8/21/2017	281.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	26WP-09-01R	11/27/2017	280.8	
AOC_25	26WP-09-01R	11/27/2018	281.3	
AOC_25	26WP-09-01R	5/20/2019	281.7	
AOC_25	26WP-09-01R	11/21/2019	281.2	
AOC_25	26WP-09-02R	3/13/2017	271.5	
AOC_25	26WP-09-02R	5/22/2017	273.5	
AOC_25	26WP-09-02R	8/21/2017	270.4	
AOC_25	26WP-09-02R	11/27/2017	271.0	
AOC_25	26WP-09-02R	11/27/2018	272.6	
AOC_25	26WP-09-02R	5/20/2019	275.3	
AOC_25	26WP-09-02R	11/21/2019	270.9	
AOC_25	26WP-09-03R	3/13/2017	284.2	
AOC_25	26WP-09-03R	5/22/2017	284.4	
AOC_25	26WP-09-03R	8/21/2017		
AOC_25	26WP-09-03R	11/27/2017		
AOC_25	26WP-09-03R	11/27/2018	286.1	
AOC_25	26WP-09-03R	5/20/2019	284.0	
AOC_25	26WP-09-03R	11/21/2019		
AOC_25	27M-93-07X	10/21/2008	236.8	
AOC_25	27M-93-07X	10/25/2010	236.0	
AOC_25	27M-93-07X	11/13/2012	233.8	
AOC_25	27M-93-07X	11/25/2014		
AOC_25	27M-93-07X	11/2/2016		
AOC_25	27M-93-07X	11/26/2018	236.2	
AOC_25	27M-93-07X	11/25/2019	234.4	
AOC_25	27M-93-07X		252.3	
AOC_25	27M-93-09X	10/21/2008	235.3	
AOC_25	27M-93-09X	10/25/2010	234.4	
AOC_25	27M-93-09X	11/13/2012	232.5	
AOC_25	27M-93-09X	11/25/2014		
AOC_25	27M-93-09X	11/2/2016		
AOC_25	27M-93-09X	11/26/2018	234.0	
AOC_25	27M-93-09X	11/25/2019	233.1	
AOC_25	27M-93-09X		249.0	
AOC_25	27M-93-10X	10/21/2008	235.4	
AOC_25	27M-93-10X	10/25/2010	234.5	
AOC_25	27M-93-10X	11/13/2012	232.6	
AOC_25	27M-93-10X	11/25/2014	231.4	
AOC_25	27M-93-10X	11/2/2016	233.6	
AOC_25	27M-93-10X	11/26/2018	235.2	
AOC_25	27M-93-10X	11/25/2019	233.3	
AOC_25	27M-93-10X		248.6	
AOC_25	EOD-1	1/15/1997	331.9	
AOC_25	EOD-1	6/2/1997	331.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	EOD-1	4/23/1998	332.3	
AOC_25	EOD-1	12/6/1999	330.1	
AOC_25	EOD-2	1/15/1997	325.5	
AOC_25	EOD-2	6/2/1997	325.3	
AOC_25	EOD-2	4/23/1998	325.5	
AOC_25	EOD-2	12/6/1999	324.6	
AOC_25	EOD-3	7/23/1996	316.9	
AOC_25	EOD-3	1/15/1997	322.1	
AOC_25	EOD-3	6/2/1997	321.8	
AOC_25	EOD-3	4/23/1998	323.2	
AOC_25	EOD-3	12/6/1999	314.0	
AOC_25	EOD-4	7/23/1996	322.0	
AOC_25	EOD-4	1/15/1997	323.1	
AOC_25	EOD-4	6/2/1997	323.5	
AOC_25	EOD-4	4/23/1998	323.6	
AOC_25	EOD-4	12/6/1999	316.2	
AOC_25	SPM-93-06X	7/23/1996	231.1	
AOC_25	SPM-93-06X	1/15/1997	232.0	
AOC_25	SPM-93-06X	6/2/1997	232.1	
AOC_25	SPM-93-06X	10/27/1997	230.9	
AOC_25	SPM-93-06X	4/23/1998	231.9	
AOC_25	SPM-93-06X	10/14/1998	231.2	
AOC_25	SPM-93-06X	10/21/1998	231.3	
AOC_25	SPM-93-06X	10/18/1999	230.8	
AOC_25	SPM-93-06X	12/6/1999	230.7	
AOC_25	SPM-93-06X	10/25/2000	230.9	
AOC_25	SPM-93-06X	10/15/2001	230.7	
AOC_25	SPM-93-06X	10/21/2002	230.2	
AOC_25	SPM-93-06X	10/28/2003	231.2	
AOC_25	SPM-93-06X	11/1/2004	230.8	
AOC_25	SPM-93-06X	11/14/2005	231.9	
AOC_25	SPM-93-06X	10/23/2006	231.4	
AOC_25	SPM-93-06X	10/22/2007	224.7	
AOC_25	SPM-93-06X	10/21/2008	231.5	
AOC_25	SPM-93-06X	11/12/2009	231.6	
AOC_25	SPM-93-06X	10/26/2010	231.4	
AOC_25	SPM-93-06X	10/17/2011	231.7	
AOC_25	SPM-93-06X	11/13/2012	231.3	
AOC_25	SPM-93-06X	11/13/2013	230.9	
AOC_25	SPM-93-06X	11/25/2014	231.4	
AOC_25	SPM-93-06X	12/8/2015	230.6	
AOC_25	SPM-93-06X	8/22/2016	230.3	
AOC_25	SPM-93-06X	11/2/2016	230.5	
AOC_25	SPM-93-06X	11/13/2017	232.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_25	SPM-93-06X	11/19/2018	233.3	
AOC_25	SPM-93-06X	11/25/2019	230.2	
AOC_25	SPM-97-23X	6/2/1997	231.4	
AOC_25	SPM-97-23X	10/27/1997	229.5	
AOC_25	SPM-97-23X	10/21/1998	231.2	
AOC_25	SPM-97-23X	10/18/1999	228.7	
AOC_25	SPM-97-23X	10/25/2000	229.6	
AOC_25	SPM-97-23X	10/15/2001	229.1	
AOC_25	SPM-97-23X	10/21/2002	227.7	
AOC_25	SPM-97-23X	10/28/2003	229.9	
AOC_25	SPM-97-23X	11/1/2004	229.1	
AOC_25	SPM-97-23X	11/14/2005	231.3	
AOC_25	SPM-97-23X	10/23/2006		
AOC_25	SPM-97-23X	10/24/2007	230.7	
AOC_25	SPM-97-23X	10/21/2008		
AOC_25	SPM-97-23X	10/26/2010		
AOC_25	SPM-97-23X	10/17/2011		
AOC_25	SPM-97-23X	11/13/2012		
AOC_25	SPM-97-23X	11/13/2013	228.9	
AOC_25	SPM-97-23X	11/25/2014	228.7	
AOC_25	SPM-97-23X	12/8/2015	228.0	
AOC_25	SPM-97-23X	11/2/2016	227.3	
AOC_25	SPM-97-23X	11/13/2017	228.4	
AOC_25	SPM-97-23X	11/19/2018	231.6	
AOC_25	SPM-97-23X	11/25/2019	230.0	
AOC_25	SPM-97-23X			
AOC_26	26M-97-08X	10/27/1997	282.4	
AOC_26	26M-97-08X	10/21/1998	283.8	
AOC_26	26M-97-08X	10/18/1999	282.9	
AOC_26	26M-97-08X	12/6/1999	282.9	
AOC_26	26M-97-08X	10/25/2000	312.0	
AOC_26	26M-97-08X	10/15/2001	283.3	
AOC_26	26M-97-08X	10/21/2002	282.2	
AOC_26	26M-97-08X	10/28/2003	283.7	
AOC_26	26M-97-08X	11/1/2004	283.5	
AOC_26	26M-97-08X	11/14/2005	284.7	
AOC_26	26M-97-08X	10/23/2006	284.2	
AOC_26	26M-97-08X	10/22/2007	283.9	
AOC_26	26M-97-08X	10/22/2008	284.1	
AOC_26	26M-97-08X	11/13/2009	284.3	
AOC_26	26M-97-08X	10/21/2010	285.0	
AOC_26	26M-97-08X	10/18/2011	285.9	
AOC_26	26M-97-08X	11/14/2012	284.9	
AOC_26	26M-97-08X	11/12/2013	284.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_26	26M-97-08X	11/24/2014	284.3	
AOC_26	26M-97-08X	12/9/2015	284.0	
AOC_26	26M-97-08X	11/1/2016	288.8	
AOC_26	26M-97-08X	3/13/2017	284.4	
AOC_26	26M-97-08X	5/22/2017	285.4	
AOC_26	26M-97-08X	8/21/2017	285.3	
AOC_26	26M-97-08X	11/27/2017	284.4	
AOC_26	26M-97-08X	11/27/2018	285.8	
AOC_26	26M-97-08X	5/20/2019	286.2	
AOC_26	26M-97-08X	11/21/2019	284.7	
AOC_26	26WP-06-01	10/22/2007		
AOC_26	26WP-06-01	10/22/2008	282.2	
AOC_26	26WP-06-01	11/13/2009	282.5	
AOC_26	26WP-06-01	10/21/2010	282.5	
AOC_26	26WP-06-01	10/18/2011	282.7	
AOC_26	26WP-06-01	11/13/2012	282.5	
AOC_26	26WP-06-01	11/12/2013	282.3	
AOC_26	26WP-06-01	11/24/2014	281.7	
AOC_26	26WP-06-01	12/9/2015	281.6	
AOC_26	26WP-06-01	11/1/2016	282.0	
AOC_26	26WP-06-01			
AOC_26	26WP-08-02	10/22/2008	279.9	
AOC_26	26WP-08-02	11/13/2009	279.9	
AOC_26	26WP-08-02	10/21/2010	276.3	
AOC_26	26WP-08-02	10/18/2011	280.0	
AOC_26	26WP-08-02	11/14/2012	279.5	
AOC_26	26WP-08-02	11/12/2013	279.4	
AOC_26	26WP-08-02	11/24/2014	279.5	
AOC_26	26WP-08-02	12/9/2015	279.4	
AOC_26	26WP-08-02	11/1/2016	279.6	
AOC_26	26WP-08-02			
AOC_26	26WP-09-01	11/13/2009	270.9	
AOC_26	26WP-09-01	10/25/2010		
AOC_26	26WP-09-01	10/18/2011		
AOC_26	26WP-09-01	11/14/2012		
AOC_26	26WP-09-01	11/12/2013		
AOC_26	26WP-09-01	11/24/2014		
AOC_26	26WP-09-01	12/9/2015		
AOC_26	26WP-09-01	8/22/2016		
AOC_26	26WP-09-01	11/1/2016		
AOC_26	26WP-09-02	11/13/2009	261.1	
AOC_26	26WP-09-02	10/25/2010		
AOC_26	26WP-09-02	10/18/2011		
AOC_26	26WP-09-02	11/14/2012		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_26	26WP-09-02	11/12/2013		
AOC_26	26WP-09-02	11/24/2014		
AOC_26	26WP-09-02	12/10/2015		
AOC_26	26WP-09-02	8/22/2016		
AOC_26	26WP-09-02	11/1/2016		
AOC_26	26WP-09-03	11/13/2009	284.9	
AOC_26	26WP-09-03	10/25/2010	284.6	
AOC_26	26WP-09-03	10/18/2011	284.4	
AOC_26	26WP-09-03	11/14/2012	283.3	
AOC_26	26WP-09-03	11/12/2013	283.3	
AOC_26	26WP-09-03	11/24/2014	282.9	
AOC_26	26WP-09-03	12/10/2015		
AOC_26	26WP-09-03	11/1/2016	282.7	
AOC_26	26WP-09-03			
AOC_27	27M-92-01X	9/5/1992	232.4	
AOC_27	27M-92-01X	6/2/1997	236.5	
AOC_27	27M-92-01X	10/27/1997	232.9	
AOC_27	27M-92-01X	4/23/1998	235.2	
AOC_27	27M-92-01X	10/14/1998	234.1	
AOC_27	27M-92-01X	10/21/1998	234.3	
AOC_27	27M-92-01X	10/18/1999	231.1	
AOC_27	27M-92-01X	12/6/1999	230.9	
AOC_27	27M-92-01X	10/25/2000	232.4	
AOC_27	27M-92-01X	10/15/2001	231.9	
AOC_27	27M-92-01X	10/21/2002	229.9	
AOC_27	27M-92-01X	10/28/2003	232.5	
AOC_27	27M-92-01X	11/1/2004	231.7	
AOC_27	27M-92-01X	11/14/2005	235.2	
AOC_27	27M-92-01X	10/23/2006	234.8	
AOC_27	27M-92-01X	10/21/2008	234.8	
AOC_27	27M-92-01X	10/25/2010	233.6	
AOC_27	27M-92-01X	11/13/2012	232.1	
AOC_27	27M-92-01X	11/25/2014	231.1	
AOC_27	27M-92-01X	11/2/2016	229.5	
AOC_27	27M-92-01X	11/26/2018	234.8	
AOC_27	27M-92-01X	11/25/2019	232.9	
AOC_27	27M-92-01X		245.1	
AOC_27	27M-92-02X	9/5/1992	234.5	
AOC_27	27M-92-02X	7/23/1996	237.2	
AOC_27	27M-92-02X	6/2/1997	239.4	
AOC_27	27M-92-02X	4/23/1998	237.7	
AOC_27	27M-92-02X	10/14/1998	236.5	
AOC_27	27M-92-02X	12/6/1999	232.0	
AOC_27	27M-92-02X	10/21/2008	237.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_27	27M-92-02X	10/25/2010	236.3	
AOC_27	27M-92-02X	11/13/2012	234.1	
AOC_27	27M-92-02X	11/25/2014	232.5	
AOC_27	27M-92-02X	11/2/2016	230.7	
AOC_27	27M-92-02X	11/26/2018	236.8	
AOC_27	27M-92-02X	11/25/2019	237.9	
AOC_27	27M-92-02X		252.2	
AOC_27	27M-92-03X	9/5/1992	235.7	
AOC_27	27M-92-03X	7/23/1996	238.3	
AOC_27	27M-92-03X	6/2/1997	240.5	
AOC_27	27M-92-03X	4/23/1998	238.7	
AOC_27	27M-92-03X	10/14/1998	237.4	
AOC_27	27M-92-03X	12/6/1999	232.7	
AOC_27	27M-92-03X	10/21/2008	238.1	
AOC_27	27M-92-03X	10/25/2010	237.1	
AOC_27	27M-92-03X	11/13/2012	234.9	
AOC_27	27M-92-03X	11/25/2014	233.3	
AOC_27	27M-92-03X	11/2/2016	231.4	
AOC_27	27M-92-03X	11/26/2018	237.8	
AOC_27	27M-92-03X	11/25/2019	235.9	
AOC_27	27M-92-03X		255.2	
AOC_27	27M-92-04X	9/5/1992	234.7	
AOC_27	27M-92-04X	7/23/1996	237.4	
AOC_27	27M-92-04X	10/14/1998	236.6	
AOC_27	27M-92-04X	10/21/2008		
AOC_27	27M-92-04X	10/25/2010		
AOC_27	27M-92-04X	11/13/2012		
AOC_27	27M-92-04X	11/25/2014		
AOC_27	27M-92-04X	11/2/2016		
AOC_27	27M-92-04X	11/25/2019		
AOC_27	27M-92-04X			
AOC_27	27M-93-05X	6/2/1997	235.8	
AOC_27	27M-93-05X	10/27/1997	232.2	
AOC_27	27M-93-05X	4/23/1998	234.6	
AOC_27	27M-93-05X	10/14/1998	233.5	
AOC_27	27M-93-05X	10/21/1998	233.6	
AOC_27	27M-93-05X	10/18/1999	230.5	
AOC_27	27M-93-05X	12/6/1999	230.2	
AOC_27	27M-93-05X	10/25/2000	231.8	
AOC_27	27M-93-05X	10/15/2001	231.2	
AOC_27	27M-93-05X	10/21/2002	229.4	
AOC_27	27M-93-05X	10/28/2003	231.8	
AOC_27	27M-93-05X	11/1/2004	231.0	
AOC_27	27M-93-05X	11/14/2005	234.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_27	27M-93-05X	10/23/2006	234.0	
AOC_27	27M-93-05X	10/21/2008	233.9	
AOC_27	27M-93-05X	10/25/2010	230.8	
AOC_27	27M-93-05X	11/13/2012	231.4	
AOC_27	27M-93-05X	11/25/2014	230.4	
AOC_27	27M-93-05X	11/2/2016	228.9	
AOC_27	27M-93-05X	11/26/2018	233.9	
AOC_27	27M-93-05X	11/25/2019	232.0	
AOC_27	27M-93-05X		244.7	
AOC_27	27M-93-06X	6/2/1997	235.7	
AOC_27	27M-93-06X	10/27/1997	232.2	
AOC_27	27M-93-06X	4/23/1998	234.5	
AOC_27	27M-93-06X	10/14/1998	233.4	
AOC_27	27M-93-06X	10/21/1998	234.0	
AOC_27	27M-93-06X	10/18/1999	230.7	
AOC_27	27M-93-06X	12/6/1999	230.6	
AOC_27	27M-93-06X	10/25/2000	232.1	
AOC_27	27M-93-06X	10/15/2001	231.6	
AOC_27	27M-93-06X	10/21/2002	229.6	
AOC_27	27M-93-06X	10/28/2003	232.2	
AOC_27	27M-93-06X	11/1/2004	231.3	
AOC_27	27M-93-06X	11/14/2005	234.3	
AOC_27	27M-93-06X	10/23/2006	234.5	
AOC_27	27M-93-06X	10/21/2008	234.4	
AOC_27	27M-93-06X	10/25/2010	233.5	
AOC_27	27M-93-06X	11/13/2012	231.8	
AOC_27	27M-93-06X	11/25/2014	230.7	
AOC_27	27M-93-06X	11/2/2016	229.2	
AOC_27	27M-93-06X	11/26/2018	234.1	
AOC_27	27M-93-06X	11/25/2019	232.4	
AOC_27	27M-93-06X		245.2	
AOC_27	27M-93-08X	7/23/1996	233.8	
AOC_27	27M-93-08X	6/2/1997	235.6	
AOC_27	27M-93-08X	10/27/1997	232.4	
AOC_27	27M-93-08X	4/23/1998	234.4	
AOC_27	27M-93-08X	10/14/1998	233.4	
AOC_27	27M-93-08X	10/21/1998	233.8	
AOC_27	27M-93-08X	10/18/1999	230.7	
AOC_27	27M-93-08X	12/6/1999	230.4	
AOC_27	27M-93-08X	10/25/2000	231.9	
AOC_27	27M-93-08X	10/15/2001	231.4	
AOC_27	27M-93-08X	10/21/2002	229.6	
AOC_27	27M-93-08X	10/28/2003	232.0	
AOC_27	27M-93-08X	11/1/2004	231.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_27	27M-93-08X	11/14/2005	234.7	
AOC_27	27M-93-08X	10/23/2006	234.3	
AOC_27	27M-93-08X	10/21/2008	234.1	
AOC_27	27M-93-08X	10/25/2010	233.3	
AOC_27	27M-93-08X	11/13/2012	231.6	
AOC_27	27M-93-08X	11/25/2014	230.6	
AOC_27	27M-93-08X	11/2/2016	225.2	
AOC_27	27M-93-08X	11/26/2018	234.1	
AOC_27	27M-93-08X	11/25/2019	232.3	
AOC_27	27M-93-08X		244.1	
AOC_30	30PZ-19-01	8/14/2019	207.0	
AOC_30	30PZ-19-01	10/7/2019	203.5	
AOC_30	30PZ-19-01	4/27/2020	209.1	
AOC_30	30PZ-19-02	8/14/2019	206.2	
AOC_30	30PZ-19-02	10/7/2019	205.1	
AOC_30	30PZ-19-02	4/27/2020	207.0	
AOC_30	30PZ-19-03	8/14/2019	203.3	
AOC_30	30PZ-19-03	10/7/2019	202.2	
AOC_30	30PZ-19-03	4/27/2020	205.1	
AOC_30	30PZ-19-04	8/14/2019	202.6	
AOC_30	30PZ-19-04	10/7/2019	201.7	
AOC_30	30PZ-19-04	4/27/2020	204.8	
AOC_30	30PZ-19-05	8/14/2019	212.7	
AOC_30	30PZ-19-05	10/7/2019	211.5	
AOC_30	30PZ-19-05	4/27/2020	214.0	
AOC_31	31PZ-19-01	8/14/2019	202.5	
AOC_31	31PZ-19-01	10/7/2019	200.7	
AOC_31	31PZ-19-01	4/27/2020	204.7	
AOC_31	31PZ-19-02D	10/7/2019	200.9	
AOC_31	31PZ-19-02D	4/27/2020	203.9	
AOC_31	31PZ-19-02S	10/7/2019	200.6	
AOC_31	31PZ-19-02S	4/27/2020	203.5	
AOC_32	32M-01-13XBR	6/5/2006	243.3	
AOC_32	32M-01-13XBR	6/7/2006	244.0	
AOC_32	32M-01-13XBR	10/17/2006	240.0	
AOC_32	32M-01-13XBR	10/19/2006	239.2	
AOC_32	32M-01-13XBR	5/22/2007	245.0	
AOC_32	32M-01-13XBR	5/23/2007	244.2	
AOC_32	32M-01-13XBR	10/15/2007	238.2	
AOC_32	32M-01-13XBR	10/16/2007	239.0	
AOC_32	32M-01-13XBR	6/25/2008	240.3	
AOC_32	32M-01-13XBR	6/26/2008	241.1	
AOC_32	32M-01-13XBR	10/28/2008	240.7	
AOC_32	32M-01-13XBR	10/29/2008	241.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-13XBR	5/8/2009	244.6	
AOC_32	32M-01-13XBR	5/11/2009	245.4	
AOC_32	32M-01-13XBR	10/26/2009	241.9	
AOC_32	32M-01-13XBR	11/9/2009	242.7	
AOC_32	32M-01-13XBR	5/18/2010	243.6	
AOC_32	32M-01-13XBR	5/20/2010	242.8	
AOC_32	32M-01-13XBR	10/7/2010	243.7	
AOC_32	32M-01-13XBR	10/19/2010	244.4	
AOC_32	32M-01-13XBR	6/30/2011	244.5	
AOC_32	32M-01-13XBR	10/13/2011	244.2	
AOC_32	32M-01-13XBR	5/15/2012	242.9	
AOC_32	32M-01-13XBR	10/22/2012	240.9	
AOC_32	32M-01-13XBR	6/11/2013	247.5	
AOC_32	32M-01-13XBR	10/23/2013	238.2	
AOC_32	32M-01-13XBR	6/17/2014	240.6	
AOC_32	32M-01-13XBR	6/28/2015	237.9	
AOC_32	32M-01-13XBR	10/8/2015	237.4	
AOC_32	32M-01-13XBR	5/17/2016	240.5	
AOC_32	32M-01-13XBR	7/7/2017	240.2	
AOC_32	32M-01-13XBR	4/9/2018	243.9	
AOC_32	32M-01-13XBR	12/5/2018	244.6	
AOC_32	32M-01-13XBR	4/8/2019	241.4	
AOC_32	32M-01-13XBR	4/29/2020	243.7	
AOC_32	32M-01-13XBR	5/14/2020	242.9	
AOC_32	32M-01-14XBR	1/30/2002	229.0	
AOC_32	32M-01-14XBR	4/11/2002	233.8	
AOC_32	32M-01-14XBR	7/10/2002	232.8	
AOC_32	32M-01-14XBR	10/1/2002	231.6	
AOC_32	32M-01-14XBR	3/27/2003	237.0	
AOC_32	32M-01-14XBR	6/19/2003	234.6	
AOC_32	32M-01-14XBR	9/23/2003	232.5	
AOC_32	32M-01-14XBR	12/1/2003	233.0	
AOC_32	32M-01-14XBR	5/25/2004	235.3	
AOC_32	32M-01-14XBR	10/7/2004	233.1	
AOC_32	32M-01-14XBR	6/13/2005	235.3	
AOC_32	32M-01-14XBR	10/3/2005	231.7	
AOC_32	32M-01-14XBR	6/5/2006	241.4	
AOC_32	32M-01-14XBR	6/7/2006	236.4	
AOC_32	32M-01-14XBR	10/17/2006	233.0	
AOC_32	32M-01-14XBR	10/19/2006	232.1	
AOC_32	32M-01-14XBR	5/22/2007	236.4	
AOC_32	32M-01-14XBR	5/23/2007	235.6	
AOC_32	32M-01-14XBR	10/15/2007	230.2	
AOC_32	32M-01-14XBR	10/16/2007	231.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-14XBR	6/25/2008	233.3	
AOC_32	32M-01-14XBR	6/26/2008	234.2	
AOC_32	32M-01-14XBR	10/28/2008	233.5	
AOC_32	32M-01-14XBR	10/29/2008	234.3	
AOC_32	32M-01-14XBR	5/8/2009	235.5	
AOC_32	32M-01-14XBR	5/11/2009	236.4	
AOC_32	32M-01-14XBR	10/26/2009	233.4	
AOC_32	32M-01-14XBR	11/9/2009	234.3	
AOC_32	32M-01-14XBR	5/18/2010	236.3	
AOC_32	32M-01-14XBR	5/20/2010	235.4	
AOC_32	32M-01-14XBR	10/7/2010	233.3	
AOC_32	32M-01-14XBR	10/19/2010	234.1	
AOC_32	32M-01-14XBR	6/30/2011	235.0	
AOC_32	32M-01-14XBR	10/13/2011	235.6	
AOC_32	32M-01-14XBR	5/15/2012	234.1	
AOC_32	32M-01-14XBR	10/22/2012	231.8	
AOC_32	32M-01-14XBR	6/11/2013	235.5	
AOC_32	32M-01-14XBR	10/23/2013	231.3	
AOC_32	32M-01-14XBR	6/17/2014	228.3	
AOC_32	32M-01-14XBR	5/17/2016	233.4	
AOC_32	32M-01-14XBR	7/7/2017	234.3	
AOC_32	32M-01-14XBR	4/9/2018	234.4	
AOC_32	32M-01-14XBR	12/5/2018	236.8	
AOC_32	32M-01-14XBR	4/8/2019	234.3	
AOC_32	32M-01-14XBR	4/29/2020	234.7	
AOC_32	32M-01-14XBR	5/14/2020	235.5	
AOC_32	32M-01-14XOB	1/30/2002	228.9	
AOC_32	32M-01-14XOB	4/11/2002	231.4	
AOC_32	32M-01-14XOB	7/10/2002	231.4	
AOC_32	32M-01-14XOB	10/1/2002	229.8	
AOC_32	32M-01-14XOB	3/27/2003	233.6	
AOC_32	32M-01-14XOB	6/19/2003	232.4	
AOC_32	32M-01-14XOB	9/23/2003	231.2	
AOC_32	32M-01-14XOB	12/1/2003	231.1	
AOC_32	32M-01-14XOB	5/25/2004	232.6	
AOC_32	32M-01-14XOB	10/7/2004	230.9	
AOC_32	32M-01-14XOB	6/13/2005	233.6	
AOC_32	32M-01-14XOB	10/3/2005	230.7	
AOC_32	32M-01-14XOB	6/5/2006	233.6	
AOC_32	32M-01-14XOB	6/7/2006	234.4	
AOC_32	32M-01-14XOB	10/17/2006	231.7	
AOC_32	32M-01-14XOB	10/19/2006	230.8	
AOC_32	32M-01-14XOB	5/22/2007	234.3	
AOC_32	32M-01-14XOB	5/23/2007	233.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-14XOB	10/15/2007	230.3	
AOC_32	32M-01-14XOB	10/16/2007	231.1	
AOC_32	32M-01-14XOB	6/25/2008	231.9	
AOC_32	32M-01-14XOB	6/26/2008	232.8	
AOC_32	32M-01-14XOB	10/28/2008	232.1	
AOC_32	32M-01-14XOB	10/29/2008	233.0	
AOC_32	32M-01-14XOB	5/8/2009	233.3	
AOC_32	32M-01-14XOB	5/11/2009	234.1	
AOC_32	32M-01-14XOB	10/26/2009	231.9	
AOC_32	32M-01-14XOB	11/9/2009	232.7	
AOC_32	32M-01-14XOB	5/18/2010	234.7	
AOC_32	32M-01-14XOB	5/20/2010	233.9	
AOC_32	32M-01-14XOB	10/7/2010	231.1	
AOC_32	32M-01-14XOB	10/19/2010	231.9	
AOC_32	32M-01-14XOB	6/30/2011	232.8	
AOC_32	32M-01-14XOB	10/13/2011	233.8	
AOC_32	32M-01-14XOB	5/15/2012	231.9	
AOC_32	32M-01-14XOB	10/22/2012	230.3	
AOC_32	32M-01-14XOB	6/11/2013	232.6	
AOC_32	32M-01-14XOB	10/23/2013	230.3	
AOC_32	32M-01-14XOB	6/17/2014	231.9	
AOC_32	32M-01-14XOB	6/28/2015	231.8	
AOC_32	32M-01-14XOB	10/8/2015	231.6	
AOC_32	32M-01-14XOB	5/17/2016	231.9	
AOC_32	32M-01-14XOB	6/24/2016	232.6	
AOC_32	32M-01-14XOB	11/15/2016	229.9	
AOC_32	32M-01-14XOB	5/22/2017	235.4	
AOC_32	32M-01-14XOB	7/7/2017	232.7	
AOC_32	32M-01-14XOB	4/9/2018	233.1	
AOC_32	32M-01-14XOB	11/1/2018	232.3	
AOC_32	32M-01-14XOB	12/5/2018	234.5	
AOC_32	32M-01-14XOB	4/8/2019	233.3	
AOC_32	32M-01-14XOB	10/22/2019	230.2	
AOC_32	32M-01-14XOB	4/29/2020	233.4	
AOC_32	32M-01-14XOB	5/14/2020	233.7	
AOC_32	32M-01-15XBR	1/30/2002	235.2	
AOC_32	32M-01-15XBR	4/11/2002	237.4	
AOC_32	32M-01-15XBR	7/10/2002	237.0	
AOC_32	32M-01-15XBR	10/1/2002	237.0	
AOC_32	32M-01-15XBR	3/27/2003	241.8	
AOC_32	32M-01-15XBR	6/19/2003	238.5	
AOC_32	32M-01-15XBR	9/23/2003	236.9	
AOC_32	32M-01-15XBR	12/1/2003	236.5	
AOC_32	32M-01-15XBR	5/25/2004	237.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-15XBR	10/7/2004	237.3	
AOC_32	32M-01-15XBR	6/13/2005	239.0	
AOC_32	32M-01-15XBR	10/3/2005	235.7	
AOC_32	32M-01-15XBR	6/5/2006	238.9	
AOC_32	32M-01-15XBR	6/7/2006	239.6	
AOC_32	32M-01-15XBR	10/17/2006	236.6	
AOC_32	32M-01-15XBR	10/19/2006	236.0	
AOC_32	32M-01-15XBR	5/22/2007	238.3	
AOC_32	32M-01-15XBR	5/23/2007	237.7	
AOC_32	32M-01-15XBR	10/15/2007	235.7	
AOC_32	32M-01-15XBR	10/16/2007	236.3	
AOC_32	32M-01-15XBR	6/25/2008	236.8	
AOC_32	32M-01-15XBR	6/26/2008	237.4	
AOC_32	32M-01-15XBR	10/28/2008	237.3	
AOC_32	32M-01-15XBR	10/29/2008	237.9	
AOC_32	32M-01-15XBR	5/8/2009	239.4	
AOC_32	32M-01-15XBR	5/11/2009	240.1	
AOC_32	32M-01-15XBR	10/26/2009	238.0	
AOC_32	32M-01-15XBR	11/9/2009	238.6	
AOC_32	32M-01-15XBR	5/18/2010	239.5	
AOC_32	32M-01-15XBR	5/20/2010	238.9	
AOC_32	32M-01-15XBR	10/7/2010	238.4	
AOC_32	32M-01-15XBR	10/19/2010	239.1	
AOC_32	32M-01-15XBR	6/30/2011	240.3	
AOC_32	32M-01-15XBR	10/13/2011	240.1	
AOC_32	32M-01-15XBR	5/15/2012	238.2	
AOC_32	32M-01-15XBR	10/22/2012	236.5	
AOC_32	32M-01-15XBR	6/11/2013	240.9	
AOC_32	32M-01-15XBR	10/23/2013	234.9	
AOC_32	32M-01-15XBR	6/17/2014	236.6	
AOC_32	32M-01-15XBR	10/8/2015	233.6	
AOC_32	32M-01-15XBR	5/17/2016	236.7	
AOC_32	32M-01-15XBR	7/7/2017	237.8	
AOC_32	32M-01-15XBR	4/9/2018	238.5	
AOC_32	32M-01-15XBR	12/5/2018	242.4	
AOC_32	32M-01-15XBR	4/8/2019	238.0	
AOC_32	32M-01-15XBR	4/29/2020	239.2	
AOC_32	32M-01-15XBR	5/14/2020	238.8	
AOC_32	32M-01-16XBR	1/30/2002	230.7	
AOC_32	32M-01-16XBR	4/11/2002	233.6	
AOC_32	32M-01-16XBR	7/10/2002	233.9	
AOC_32	32M-01-16XBR	10/1/2002	232.1	
AOC_32	32M-01-16XBR	3/27/2003	236.6	
AOC_32	32M-01-16XBR	6/19/2003	234.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-16XBR	9/23/2003	233.1	
AOC_32	32M-01-16XBR	12/1/2003	232.8	
AOC_32	32M-01-16XBR	5/25/2004	234.1	
AOC_32	32M-01-16XBR	10/7/2004	232.9	
AOC_32	32M-01-16XBR	6/13/2005	235.4	
AOC_32	32M-01-16XBR	10/3/2005	231.8	
AOC_32	32M-01-16XBR	6/5/2006	235.0	
AOC_32	32M-01-16XBR	6/7/2006	235.8	
AOC_32	32M-01-16XBR	10/17/2006	232.8	
AOC_32	32M-01-16XBR	10/19/2006	232.0	
AOC_32	32M-01-16XBR	5/22/2007	236.1	
AOC_32	32M-01-16XBR	5/23/2007	235.3	
AOC_32	32M-01-16XBR	10/15/2007	231.7	
AOC_32	32M-01-16XBR	10/16/2007	232.5	
AOC_32	32M-01-16XBR	6/25/2008	232.4	
AOC_32	32M-01-16XBR	6/26/2008	233.1	
AOC_32	32M-01-16XBR	10/28/2008	233.8	
AOC_32	32M-01-16XBR	10/29/2008	234.5	
AOC_32	32M-01-16XBR	5/8/2009	235.6	
AOC_32	32M-01-16XBR	5/11/2009	236.4	
AOC_32	32M-01-16XBR	10/26/2009	234.3	
AOC_32	32M-01-16XBR	11/9/2009	235.0	
AOC_32	32M-01-16XBR	5/18/2010	236.7	
AOC_32	32M-01-16XBR	5/20/2010	235.9	
AOC_32	32M-01-16XBR	10/7/2010	233.9	
AOC_32	32M-01-16XBR	10/19/2010	234.7	
AOC_32	32M-01-16XBR	6/30/2011	235.6	
AOC_32	32M-01-16XBR	10/13/2011	236.6	
AOC_32	32M-01-16XBR	5/15/2012	234.0	
AOC_32	32M-01-16XBR	10/22/2012	232.3	
AOC_32	32M-01-16XBR	6/11/2013	235.7	
AOC_32	32M-01-16XBR	10/23/2013	231.5	
AOC_32	32M-01-16XBR	6/17/2014	233.1	
AOC_32	32M-01-16XBR	10/8/2015	231.8	
AOC_32	32M-01-16XBR	5/17/2016	234.6	
AOC_32	32M-01-16XBR	7/7/2017	236.2	
AOC_32	32M-01-16XBR	4/9/2018	237.1	
AOC_32	32M-01-16XBR	12/5/2018	238.3	
AOC_32	32M-01-16XBR	4/8/2019	236.9	
AOC_32	32M-01-16XBR	4/29/2020	237.4	
AOC_32	32M-01-16XBR	5/14/2020	237.3	
AOC_32	32M-01-17X	1/30/2002	230.7	
AOC_32	32M-01-17X	4/11/2002	233.0	
AOC_32	32M-01-17X	7/10/2002	229.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-17X	10/1/2002	232.3	
AOC_32	32M-01-17X	3/27/2003	236.0	
AOC_32	32M-01-17X	6/19/2003	234.4	
AOC_32	32M-01-17X	9/23/2003	233.2	
AOC_32	32M-01-17X	12/1/2003	233.0	
AOC_32	32M-01-17X	5/25/2004	234.3	
AOC_32	32M-01-17X	10/7/2004	233.0	
AOC_32	32M-01-17X	6/13/2005	235.6	
AOC_32	32M-01-17X	10/3/2005	232.1	
AOC_32	32M-01-17X	6/5/2006	234.3	
AOC_32	32M-01-17X	10/19/2006	232.3	
AOC_32	32M-01-17X	5/23/2007	235.5	
AOC_32	32M-01-17X	10/15/2007	232.0	
AOC_32	32M-01-17X	6/25/2008	233.6	
AOC_32	32M-01-17X	10/28/2008	234.0	
AOC_32	32M-01-17X	5/8/2009	235.7	
AOC_32	32M-01-17X	10/26/2009	234.3	
AOC_32	32M-01-17X	5/20/2010	236.0	
AOC_32	32M-01-17X	10/7/2010	234.0	
AOC_32	32M-01-17X	6/30/2011	235.6	
AOC_32	32M-01-17X	10/13/2011	236.4	
AOC_32	32M-01-17X	5/15/2012	234.1	
AOC_32	32M-01-17X	10/22/2012	232.5	
AOC_32	32M-01-17XBR	1/30/2002	230.7	
AOC_32	32M-01-17XBR	4/11/2002	233.0	
AOC_32	32M-01-17XBR	7/10/2002	229.7	
AOC_32	32M-01-17XBR	10/1/2002	232.3	
AOC_32	32M-01-17XBR	3/27/2003	236.0	
AOC_32	32M-01-17XBR	6/19/2003	234.4	
AOC_32	32M-01-17XBR	9/23/2003	233.2	
AOC_32	32M-01-17XBR	12/1/2003	233.0	
AOC_32	32M-01-17XBR	5/25/2004	234.3	
AOC_32	32M-01-17XBR	10/7/2004	233.0	
AOC_32	32M-01-17XBR	6/13/2005	235.6	
AOC_32	32M-01-17XBR	10/3/2005	232.1	
AOC_32	32M-01-17XBR	6/5/2006	234.3	
AOC_32	32M-01-17XBR	6/7/2006	234.7	
AOC_32	32M-01-17XBR	10/17/2006	232.7	
AOC_32	32M-01-17XBR	10/19/2006	232.3	
AOC_32	32M-01-17XBR	5/22/2007	235.8	
AOC_32	32M-01-17XBR	5/23/2007	235.5	
AOC_32	32M-01-17XBR	10/15/2007	232.0	
AOC_32	32M-01-17XBR	10/16/2007	232.4	
AOC_32	32M-01-17XBR	6/25/2008	233.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-17XBR	6/26/2008	234.0	
AOC_32	32M-01-17XBR	10/28/2008	234.0	
AOC_32	32M-01-17XBR	10/29/2008	234.4	
AOC_32	32M-01-17XBR	5/8/2009	235.7	
AOC_32	32M-01-17XBR	5/11/2009	236.0	
AOC_32	32M-01-17XBR	10/26/2009	234.3	
AOC_32	32M-01-17XBR	11/9/2009	234.7	
AOC_32	32M-01-17XBR	5/18/2010	236.4	
AOC_32	32M-01-17XBR	5/20/2010	236.0	
AOC_32	32M-01-17XBR	10/7/2010	234.0	
AOC_32	32M-01-17XBR	10/19/2010	234.4	
AOC_32	32M-01-17XBR	6/30/2011	235.6	
AOC_32	32M-01-17XBR	10/13/2011	236.4	
AOC_32	32M-01-17XBR	5/15/2012	234.1	
AOC_32	32M-01-17XBR	10/22/2012	232.5	
AOC_32	32M-01-17XBR	6/11/2013	235.5	
AOC_32	32M-01-17XBR	10/23/2013	231.8	
AOC_32	32M-01-17XBR	6/17/2014	233.4	
AOC_32	32M-01-17XBR	6/28/2015	235.0	
AOC_32	32M-01-17XBR	10/8/2015	232.0	
AOC_32	32M-01-17XBR	5/17/2016	233.3	
AOC_32	32M-01-17XBR	7/7/2017	235.0	
AOC_32	32M-01-17XBR	4/9/2018	235.5	
AOC_32	32M-01-17XBR	12/5/2018	235.9	
AOC_32	32M-01-17XBR	4/8/2019	235.6	
AOC_32	32M-01-17XBR	4/29/2020	235.9	
AOC_32	32M-01-17XBR	5/14/2020	235.9	
AOC_32	32M-01-18XBR	1/30/2002	238.2	
AOC_32	32M-01-18XBR	4/11/2002	240.3	
AOC_32	32M-01-18XBR	7/10/2002	240.8	
AOC_32	32M-01-18XBR	10/1/2002	240.3	
AOC_32	32M-01-18XBR	3/27/2003	245.9	
AOC_32	32M-01-18XBR	6/19/2003	242.8	
AOC_32	32M-01-18XBR	9/23/2003	240.8	
AOC_32	32M-01-18XBR	12/1/2003	240.3	
AOC_32	32M-01-18XBR	5/25/2004	241.7	
AOC_32	32M-01-18XBR	10/7/2004	241.3	
AOC_32	32M-01-18XBR	6/13/2005	242.8	
AOC_32	32M-01-18XBR	10/3/2005	239.0	
AOC_32	32M-01-18XBR	6/5/2006	243.0	
AOC_32	32M-01-18XBR	6/7/2006	243.8	
AOC_32	32M-01-18XBR	10/17/2006	240.5	
AOC_32	32M-01-18XBR	10/19/2006	239.7	
AOC_32	32M-01-18XBR	5/22/2007	244.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-01-18XBR	5/23/2007	243.6	
AOC_32	32M-01-18XBR	10/15/2007	238.6	
AOC_32	32M-01-18XBR	10/16/2007	239.4	
AOC_32	32M-01-18XBR	6/25/2008	239.8	
AOC_32	32M-01-18XBR	6/26/2008	240.6	
AOC_32	32M-01-18XBR	10/28/2008	241.0	
AOC_32	32M-01-18XBR	10/29/2008	241.9	
AOC_32	32M-01-18XBR	5/8/2009	243.9	
AOC_32	32M-01-18XBR	5/11/2009	244.7	
AOC_32	32M-01-18XBR	10/26/2009	242.1	
AOC_32	32M-01-18XBR	11/9/2009	242.9	
AOC_32	32M-01-18XBR	5/18/2010	243.9	
AOC_32	32M-01-18XBR	5/20/2010	243.1	
AOC_32	32M-01-18XBR	10/7/2010	242.5	
AOC_32	32M-01-18XBR	10/19/2010	243.3	
AOC_32	32M-01-18XBR	6/30/2011	244.1	
AOC_32	32M-01-18XBR	10/13/2011	244.2	
AOC_32	32M-01-18XBR	5/15/2012	242.6	
AOC_32	32M-01-18XBR	10/22/2012	240.8	
AOC_32	32M-01-18XBR	6/11/2013	247.3	
AOC_32	32M-01-18XBR	10/23/2013	239.0	
AOC_32	32M-01-18XBR	6/17/2014	241.5	
AOC_32	32M-01-18XBR	6/28/2015	239.8	
AOC_32	32M-01-18XBR	10/8/2015	238.6	
AOC_32	32M-01-18XBR	5/17/2016	241.4	
AOC_32	32M-01-18XBR	7/7/2017	242.1	
AOC_32	32M-01-18XBR	4/9/2018	243.0	
AOC_32	32M-01-18XBR	12/5/2018	243.8	
AOC_32	32M-01-18XBR	4/8/2019	241.9	
AOC_32	32M-01-18XBR	4/29/2020	243.5	
AOC_32	32M-01-18XBR	5/14/2020	243.2	
AOC_32	32M-92-01X	3/30/1993	243.5	
AOC_32	32M-92-01X	6/22/1993	242.4	
AOC_32	32M-92-01X	11/8/1993	241.4	
AOC_32	32M-92-01X	6/28/1994	242.7	
AOC_32	32M-92-01X	10/4/1994	241.9	
AOC_32	32M-92-01X	1/31/1995	244.2	
AOC_32	32M-92-01X	5/9/1995	242.4	
AOC_32	32M-92-01X	12/7/1995	243.4	
AOC_32	32M-92-01X	1/15/1997	244.3	
AOC_32	32M-92-01X	4/23/1998	244.2	
AOC_32	32M-92-01X	6/26/1998	244.6	
AOC_32	32M-92-01X	7/1/1998	244.4	
AOC_32	32M-92-01X	7/17/1998	243.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-92-01X	7/31/1998	242.6	
AOC_32	32M-92-01X	8/28/1998	241.4	
AOC_32	32M-92-01X	10/14/1998	241.7	
AOC_32	32M-92-01X	12/10/1998	240.7	
AOC_32	32M-92-01X	1/6/1999	243.0	
AOC_32	32M-92-01X	2/23/1999	243.2	
AOC_32	32M-92-01X	6/6/1999	241.8	
AOC_32	32M-92-01X	9/8/1999	239.8	
AOC_32	32M-92-01X	1/30/2002	239.5	
AOC_32	32M-92-01X	4/11/2002	243.2	
AOC_32	32M-92-01X	7/10/2002	242.6	
AOC_32	32M-92-01X	10/1/2002	240.6	
AOC_32	32M-92-01X	3/27/2003	245.1	
AOC_32	32M-92-01X	6/19/2003	243.4	
AOC_32	32M-92-01X	9/23/2003	241.1	
AOC_32	32M-92-01X	12/1/2003	241.3	
AOC_32	32M-92-01X	5/25/2004	243.7	
AOC_32	32M-92-01X	10/7/2004	242.1	
AOC_32	32M-92-01X	6/13/2005	243.9	
AOC_32	32M-92-01X	10/3/2005	240.3	
AOC_32	32M-92-01X	6/5/2006	244.8	
AOC_32	32M-92-01X	6/7/2006	245.5	
AOC_32	32M-92-01X	10/17/2006	241.3	
AOC_32	32M-92-01X	10/19/2006	240.6	
AOC_32	32M-92-01X	5/22/2007	245.2	
AOC_32	32M-92-01X	5/23/2007	244.4	
AOC_32	32M-92-01X	10/15/2007	239.7	
AOC_32	32M-92-01X	10/16/2007	240.5	
AOC_32	32M-92-01X	6/25/2008	242.1	
AOC_32	32M-92-01X	6/26/2008	242.9	
AOC_32	32M-92-01X	10/28/2008	241.7	
AOC_32	32M-92-01X	10/29/2008	242.4	
AOC_32	32M-92-01X	5/8/2009	243.7	
AOC_32	32M-92-01X	5/11/2009	244.5	
AOC_32	32M-92-01X	10/26/2009	238.2	
AOC_32	32M-92-01X	11/9/2009	238.9	
AOC_32	32M-92-01X	5/18/2010	244.0	
AOC_32	32M-92-01X	5/20/2010	243.3	
AOC_32	32M-92-01X	10/7/2010	240.3	
AOC_32	32M-92-01X	10/19/2010	241.0	
AOC_32	32M-92-01X	6/30/2011	242.7	
AOC_32	32M-92-01X	10/13/2011	243.0	
AOC_32	32M-92-01X	5/15/2012	242.2	
AOC_32	32M-92-01X	10/22/2012	239.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-92-01X	6/11/2013	243.0	
AOC_32	32M-92-01X	10/23/2013	240.0	
AOC_32	32M-92-01X	6/17/2014	242.8	
AOC_32	32M-92-01X	10/8/2015	239.8	
AOC_32	32M-92-01X	5/17/2016	242.8	
AOC_32	32M-92-01X	6/24/2016	241.7	
AOC_32	32M-92-01X	11/15/2016	239.8	
AOC_32	32M-92-01X	5/22/2017	244.1	
AOC_32	32M-92-01X	7/7/2017	243.1	
AOC_32	32M-92-01X	4/9/2018	244.3	
AOC_32	32M-92-01X	11/1/2018	242.5	
AOC_32	32M-92-01X	12/5/2018	245.5	
AOC_32	32M-92-01X	4/8/2019	243.1	
AOC_32	32M-92-01X	10/22/2019	248.8	
AOC_32	32M-92-01X	4/29/2020	244.5	
AOC_32	32M-92-01X	5/14/2020	244.3	
AOC_32	32M-92-03X	3/30/1993	235.0	
AOC_32	32M-92-03X	11/8/1993	229.6	
AOC_32	32M-92-03X	6/28/1994	232.7	
AOC_32	32M-92-03X	10/4/1994	231.3	
AOC_32	32M-92-03X	1/31/1995	232.3	
AOC_32	32M-92-03X	5/9/1995	231.4	
AOC_32	32M-92-03X	12/7/1995	231.2	
AOC_32	32M-92-03X	1/15/1997	235.4	
AOC_32	32M-92-03X	6/2/1997	234.3	
AOC_32	32M-92-03X	4/23/1998	234.2	
AOC_32	32M-92-03X	10/14/1998	231.7	
AOC_32	32M-92-03X	12/10/1998	230.1	
AOC_32	32M-92-03X	6/6/1999	230.3	
AOC_32	32M-92-03X	9/8/1999	228.4	
AOC_32	32M-92-03X	4/11/2002	230.8	
AOC_32	32M-92-03X	7/10/2002	230.7	
AOC_32	32M-92-03X	10/1/2002	230.1	
AOC_32	32M-92-03X	3/27/2003	233.1	
AOC_32	32M-92-03X	6/19/2003	233.5	
AOC_32	32M-92-03X	9/23/2003	232.1	
AOC_32	32M-92-03X	12/1/2003	231.5	
AOC_32	32M-92-03X	5/25/2004	232.9	
AOC_32	32M-92-03X	10/7/2004	231.8	
AOC_32	32M-92-03X	6/13/2005	234.4	
AOC_32	32M-92-03X	10/3/2005	231.0	
AOC_32	32M-92-03X	6/5/2006	235.0	
AOC_32	32M-92-03X	6/7/2006	236.0	
AOC_32	32M-92-03X	10/17/2006	232.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-92-03X	10/19/2006	231.8	
AOC_32	32M-92-03X	5/22/2007	235.9	
AOC_32	32M-92-03X	5/23/2007	235.0	
AOC_32	32M-92-03X	10/15/2007	230.6	
AOC_32	32M-92-03X	10/16/2007	231.6	
AOC_32	32M-92-03X	6/25/2008	233.1	
AOC_32	32M-92-03X	6/26/2008	234.1	
AOC_32	32M-92-03X	10/28/2008	233.0	
AOC_32	32M-92-03X	10/29/2008	233.9	
AOC_32	32M-92-03X	5/8/2009	234.1	
AOC_32	32M-92-03X	5/11/2009	235.1	
AOC_32	32M-92-03X	10/26/2009	228.7	
AOC_32	32M-92-03X	11/9/2009	229.7	
AOC_32	32M-92-03X	5/18/2010	235.7	
AOC_32	32M-92-03X	5/20/2010	234.7	
AOC_32	32M-92-03X	10/7/2010	231.4	
AOC_32	32M-92-03X	10/19/2010	232.4	
AOC_32	32M-92-03X	6/30/2011	233.2	
AOC_32	32M-92-03X	10/13/2011	233.5	
AOC_32	32M-92-03X	5/15/2012	232.2	
AOC_32	32M-92-03X	6/11/2013	234.7	
AOC_32	32M-92-03X	10/23/2013	230.2	
AOC_32	32M-92-03X	6/17/2014	231.7	
AOC_32	32M-92-03X	10/8/2015	230.3	
AOC_32	32M-92-03X	5/17/2016	231.1	
AOC_32	32M-92-03X	7/7/2017	241.0	
AOC_32	32M-92-03X	4/9/2018	233.2	
AOC_32	32M-92-03X	12/5/2018	236.2	
AOC_32	32M-92-03X	4/8/2019	233.4	
AOC_32	32M-92-03X	4/29/2020	234.1	
AOC_32	32M-92-03X	5/14/2020	233.9	
AOC_32	32M-92-07X	3/30/1993		-12.9
AOC_32	32M-92-07X	6/22/1993		-14.7
AOC_32	32M-92-07X	11/8/1993		-15.5
AOC_32	32M-92-07X	6/28/1994		-14.5
AOC_32	32M-92-07X	10/4/1994		-15.4
AOC_32	32M-92-07X	1/31/1995		-13.2
AOC_32	32M-92-07X	5/9/1995		-14.2
AOC_32	32M-92-07X	12/7/1995		-13.9
AOC_32	32M-92-07X	3/26/1996		-13.0
AOC_32	32M-92-07X	1/15/1997		-13.7
AOC_32	32M-92-07X	6/26/1998		-13.2
AOC_32	32M-92-07X	7/1/1998		-13.4
AOC_32	32M-92-07X	7/17/1998		-14.2

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32M-92-07X	7/31/1998		-14.8
AOC_32	32M-92-07X	8/28/1998		-15.9
AOC_32	32M-92-07X	10/14/1998		-16.3
AOC_32	32M-92-07X	12/10/1998		-16.6
AOC_32	32M-92-07X	2/23/1999		-13.5
AOC_32	32M-92-07X	6/6/1999		-14.8
AOC_32	32M-92-07X	9/8/1999		-17.7
AOC_32	32PZ-19-01	4/29/2020	227.2	
AOC_32	32PZ-19-02	4/29/2020	228.0	
AOC_32	32Z-01-05X	1/30/2002		
AOC_32	32Z-01-05X	4/11/2002		
AOC_32	32Z-01-05X	7/10/2002		
AOC_32	32Z-01-05X	10/1/2002		
AOC_32	32Z-01-05X	3/27/2003		
AOC_32	32Z-01-05X	6/19/2003		
AOC_32	32Z-01-05X	9/23/2003		
AOC_32	32Z-01-05X	12/1/2003		
AOC_32	32Z-01-05X	10/7/2004		
AOC_32	32Z-01-05X	6/13/2005		
AOC_32	32Z-01-05X	10/3/2005		
AOC_32	32Z-01-05X	6/5/2006		
AOC_32	32Z-01-05X	10/19/2006		
AOC_32	32Z-01-05X	5/23/2007		
AOC_32	32Z-01-05X	10/15/2007		
AOC_32	32Z-01-05X	6/25/2008		
AOC_32	32Z-01-05X	10/28/2008		
AOC_32	32Z-01-05X	5/8/2009		
AOC_32	32Z-01-05X	10/26/2009		
AOC_32	32Z-01-05X	5/20/2010		
AOC_32	32Z-01-05X	10/7/2010		
AOC_32	32Z-01-05X	10/13/2011		
AOC_32	32Z-01-05X	5/15/2012		
AOC_32	32Z-01-05X	10/22/2012		
AOC_32	32Z-01-05XOB	1/30/2002	230.6	
AOC_32	32Z-01-05XOB	4/11/2002	227.9	
AOC_32	32Z-01-05XOB	7/10/2002	229.8	
AOC_32	32Z-01-05XOB	10/1/2002	229.4	
AOC_32	32Z-01-05XOB	3/27/2003	231.4	
AOC_32	32Z-01-05XOB	6/19/2003	232.6	
AOC_32	32Z-01-05XOB	9/23/2003	232.2	
AOC_32	32Z-01-05XOB	12/1/2003	231.5	
AOC_32	32Z-01-05XOB	10/7/2004	231.2	
AOC_32	32Z-01-05XOB	6/13/2005	233.8	
AOC_32	32Z-01-05XOB	10/3/2005	231.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-05XOB	6/5/2006	233.8	
AOC_32	32Z-01-05XOB	6/7/2006	234.6	
AOC_32	32Z-01-05XOB	10/17/2006	232.4	
AOC_32	32Z-01-05XOB	10/19/2006	231.6	
AOC_32	32Z-01-05XOB	5/22/2007	234.3	
AOC_32	32Z-01-05XOB	5/23/2007	233.5	
AOC_32	32Z-01-05XOB	10/15/2007	230.3	
AOC_32	32Z-01-05XOB	10/16/2007	231.1	
AOC_32	32Z-01-05XOB	6/25/2008	232.7	
AOC_32	32Z-01-05XOB	6/26/2008	233.5	
AOC_32	32Z-01-05XOB	10/28/2008	232.7	
AOC_32	32Z-01-05XOB	10/29/2008	233.5	
AOC_32	32Z-01-05XOB	5/8/2009	233.0	
AOC_32	32Z-01-05XOB	5/11/2009	233.8	
AOC_32	32Z-01-05XOB	10/26/2009	231.2	
AOC_32	32Z-01-05XOB	11/9/2009	232.0	
AOC_32	32Z-01-05XOB	5/18/2010	235.3	
AOC_32	32Z-01-05XOB	5/20/2010	234.5	
AOC_32	32Z-01-05XOB	10/7/2010	230.5	
AOC_32	32Z-01-05XOB	10/19/2010	231.3	
AOC_32	32Z-01-05XOB	6/30/2011	232.4	
AOC_32	32Z-01-05XOB	10/13/2011	233.0	
AOC_32	32Z-01-05XOB	5/15/2012	231.2	
AOC_32	32Z-01-05XOB	10/17/2012	229.5	
AOC_32	32Z-01-05XOB	10/22/2012	229.5	
AOC_32	32Z-01-05XOB	6/11/2013	231.4	
AOC_32	32Z-01-05XOB	10/23/2013	230.0	
AOC_32	32Z-01-05XOB	6/17/2014	230.9	
AOC_32	32Z-01-05XOB	10/8/2015	229.5	
AOC_32	32Z-01-05XOB	5/17/2016	229.9	
AOC_32	32Z-01-05XOB	7/7/2017	241.5	
AOC_32	32Z-01-05XOB	4/9/2018	231.5	
AOC_32	32Z-01-05XOB	12/5/2018	235.0	
AOC_32	32Z-01-05XOB	4/8/2019	233.0	
AOC_32	32Z-01-05XOB	4/29/2020	232.7	
AOC_32	32Z-01-05XOB	5/14/2020	232.8	
AOC_32	32Z-01-06X	1/30/2002		
AOC_32	32Z-01-06X	4/11/2002		
AOC_32	32Z-01-06X	7/10/2002		
AOC_32	32Z-01-06X	10/1/2002		
AOC_32	32Z-01-06X	3/27/2003		
AOC_32	32Z-01-06X	6/19/2003		
AOC_32	32Z-01-06X	9/23/2003		
AOC_32	32Z-01-06X	12/1/2003		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-06X	10/7/2004		
AOC_32	32Z-01-06X	6/13/2005		
AOC_32	32Z-01-06X	10/3/2005		
AOC_32	32Z-01-06X	6/5/2006		
AOC_32	32Z-01-06X	10/19/2006		
AOC_32	32Z-01-06X	5/23/2007		
AOC_32	32Z-01-06X	10/15/2007		
AOC_32	32Z-01-06X	6/25/2008		
AOC_32	32Z-01-06X	10/28/2008		
AOC_32	32Z-01-06X	5/8/2009		
AOC_32	32Z-01-06X	10/26/2009		
AOC_32	32Z-01-06X	5/20/2010		
AOC_32	32Z-01-06X	10/7/2010		
AOC_32	32Z-01-06X	6/30/2011		
AOC_32	32Z-01-06X	10/13/2011		
AOC_32	32Z-01-06X	5/15/2012		
AOC_32	32Z-01-06X	10/22/2012		
AOC_32	32Z-01-06XBR	1/30/2002	240.8	
AOC_32	32Z-01-06XBR	4/11/2002	244.8	
AOC_32	32Z-01-06XBR	7/10/2002	243.3	
AOC_32	32Z-01-06XBR	10/1/2002	239.7	
AOC_32	32Z-01-06XBR	3/27/2003	248.8	
AOC_32	32Z-01-06XBR	6/19/2003	245.1	
AOC_32	32Z-01-06XBR	9/23/2003	240.1	
AOC_32	32Z-01-06XBR	12/1/2003	242.5	
AOC_32	32Z-01-06XBR	10/7/2004	243.3	
AOC_32	32Z-01-06XBR	6/13/2005	235.1	
AOC_32	32Z-01-06XBR	10/3/2005	237.6	
AOC_32	32Z-01-06XBR	6/5/2006	247.3	
AOC_32	32Z-01-06XBR	6/7/2006	248.2	
AOC_32	32Z-01-06XBR	10/17/2006	241.5	
AOC_32	32Z-01-06XBR	10/19/2006	240.7	
AOC_32	32Z-01-06XBR	5/22/2007	248.2	
AOC_32	32Z-01-06XBR	5/23/2007	247.4	
AOC_32	32Z-01-06XBR	10/15/2007	237.9	
AOC_32	32Z-01-06XBR	10/16/2007	238.7	
AOC_32	32Z-01-06XBR	6/25/2008	242.8	
AOC_32	32Z-01-06XBR	6/26/2008	243.7	
AOC_32	32Z-01-06XBR	10/28/2008	243.3	
AOC_32	32Z-01-06XBR	10/29/2008	244.2	
AOC_32	32Z-01-06XBR	5/8/2009	247.1	
AOC_32	32Z-01-06XBR	5/11/2009	248.0	
AOC_32	32Z-01-06XBR	10/26/2009	242.8	
AOC_32	32Z-01-06XBR	11/9/2009	243.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-06XBR	5/18/2010	245.6	
AOC_32	32Z-01-06XBR	5/20/2010	244.8	
AOC_32	32Z-01-06XBR	10/7/2010	242.9	
AOC_32	32Z-01-06XBR	10/19/2010	243.8	
AOC_32	32Z-01-06XBR	6/30/2011	244.5	
AOC_32	32Z-01-06XBR	10/13/2011	246.8	
AOC_32	32Z-01-06XBR	5/15/2012	245.0	
AOC_32	32Z-01-06XBR	10/22/2012	240.2	
AOC_32	32Z-01-06XBR	6/11/2013	246.1	
AOC_32	32Z-01-06XBR	10/23/2013	239.1	
AOC_32	32Z-01-06XBR	6/17/2014	243.4	
AOC_32	32Z-01-06XBR	10/8/2015	238.4	
AOC_32	32Z-01-06XBR	5/17/2016	244.1	
AOC_32	32Z-01-06XBR	7/7/2017	244.4	
AOC_32	32Z-01-06XBR	12/5/2018	249.0	
AOC_32	32Z-01-06XBR	4/8/2019	245.1	
AOC_32	32Z-01-06XBR	4/29/2020	248.2	
AOC_32	32Z-01-06XBR	5/14/2020	247.5	
AOC_32	32Z-01-07X	1/30/2002		
AOC_32	32Z-01-07X	4/11/2002		
AOC_32	32Z-01-07X	7/10/2002		
AOC_32	32Z-01-07X	10/1/2002		
AOC_32	32Z-01-07X	3/27/2003		
AOC_32	32Z-01-07X	6/19/2003		
AOC_32	32Z-01-07X	9/23/2003		
AOC_32	32Z-01-07X	12/1/2003		
AOC_32	32Z-01-07X	10/7/2004		
AOC_32	32Z-01-07X	6/13/2005		
AOC_32	32Z-01-07X	10/3/2005		
AOC_32	32Z-01-07X	6/5/2006		
AOC_32	32Z-01-07X	10/19/2006		
AOC_32	32Z-01-07X	5/23/2007		
AOC_32	32Z-01-07X	10/15/2007		
AOC_32	32Z-01-07X	6/25/2008		
AOC_32	32Z-01-07X	10/28/2008		
AOC_32	32Z-01-07X	5/8/2009		
AOC_32	32Z-01-07X	10/26/2009		
AOC_32	32Z-01-07X	5/20/2010		
AOC_32	32Z-01-07X	10/7/2010		
AOC_32	32Z-01-07X	6/30/2011		
AOC_32	32Z-01-07X	10/13/2011		
AOC_32	32Z-01-07X	5/15/2012		
AOC_32	32Z-01-07X	10/22/2012		
AOC_32	32Z-01-07XOB	1/30/2002	240.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-07XOB	4/11/2002	243.7	
AOC_32	32Z-01-07XOB	7/10/2002	243.2	
AOC_32	32Z-01-07XOB	10/1/2002	240.7	
AOC_32	32Z-01-07XOB	3/27/2003	246.5	
AOC_32	32Z-01-07XOB	6/19/2003	244.2	
AOC_32	32Z-01-07XOB	9/23/2003	241.6	
AOC_32	32Z-01-07XOB	12/1/2003	242.1	
AOC_32	32Z-01-07XOB	10/7/2004	242.8	
AOC_32	32Z-01-07XOB	6/13/2005	244.5	
AOC_32	32Z-01-07XOB	10/3/2005	240.5	
AOC_32	32Z-01-07XOB	6/5/2006	245.9	
AOC_32	32Z-01-07XOB	6/7/2006	246.7	
AOC_32	32Z-01-07XOB	10/17/2006	242.4	
AOC_32	32Z-01-07XOB	10/19/2006	241.6	
AOC_32	32Z-01-07XOB	5/22/2007	246.7	
AOC_32	32Z-01-07XOB	5/23/2007	245.9	
AOC_32	32Z-01-07XOB	10/15/2007	239.8	
AOC_32	32Z-01-07XOB	10/16/2007	240.7	
AOC_32	32Z-01-07XOB	6/25/2008	242.5	
AOC_32	32Z-01-07XOB	6/26/2008	243.3	
AOC_32	32Z-01-07XOB	10/28/2008	242.9	
AOC_32	32Z-01-07XOB	10/29/2008	243.7	
AOC_32	32Z-01-07XOB	5/8/2009	244.4	
AOC_32	32Z-01-07XOB	5/11/2009	245.2	
AOC_32	32Z-01-07XOB	10/26/2009	237.5	
AOC_32	32Z-01-07XOB	11/9/2009	238.3	
AOC_32	32Z-01-07XOB	5/18/2010	244.8	
AOC_32	32Z-01-07XOB	5/20/2010	244.0	
AOC_32	32Z-01-07XOB	10/7/2010	242.1	
AOC_32	32Z-01-07XOB	10/19/2010	242.9	
AOC_32	32Z-01-07XOB	6/30/2011	243.7	
AOC_32	32Z-01-07XOB	10/13/2011	245.0	
AOC_32	32Z-01-07XOB	5/15/2012	243.7	
AOC_32	32Z-01-07XOB	10/22/2012	240.5	
AOC_32	32Z-01-07XOB	6/11/2013	245.2	
AOC_32	32Z-01-07XOB	10/23/2013	240.3	
AOC_32	32Z-01-07XOB	6/17/2014	243.4	
AOC_32	32Z-01-07XOB	10/8/2015	240.0	
AOC_32	32Z-01-07XOB	5/17/2016	243.6	
AOC_32	32Z-01-07XOB	6/24/2016	242.2	
AOC_32	32Z-01-07XOB	11/15/2016	240.9	
AOC_32	32Z-01-07XOB	5/22/2017	245.5	
AOC_32	32Z-01-07XOB	7/7/2017	241.9	
AOC_32	32Z-01-07XOB	4/9/2018	246.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-07XOB	11/1/2018	244.2	
AOC_32	32Z-01-07XOB	12/5/2018	247.2	
AOC_32	32Z-01-07XOB	4/8/2019	244.4	
AOC_32	32Z-01-07XOB	10/22/2019	240.1	
AOC_32	32Z-01-07XOB	4/29/2020	246.4	
AOC_32	32Z-01-07XOB	5/14/2020	245.8	
AOC_32	32Z-01-08X	1/30/2002	239.1	
AOC_32	32Z-01-08X	4/11/2002	243.5	
AOC_32	32Z-01-08X	7/10/2002	242.1	
AOC_32	32Z-01-08X	10/1/2002	240.5	
AOC_32	32Z-01-08X	3/27/2003	244.2	
AOC_32	32Z-01-08X	6/19/2003	242.9	
AOC_32	32Z-01-08X	9/23/2003	240.9	
AOC_32	32Z-01-08X	12/1/2003	241.1	
AOC_32	32Z-01-08X	10/7/2004	241.7	
AOC_32	32Z-01-08X	6/13/2005	242.7	
AOC_32	32Z-01-08X	10/3/2005	240.2	
AOC_32	32Z-01-08X	6/5/2006	244.2	
AOC_32	32Z-01-08X	10/19/2006	240.5	
AOC_32	32Z-01-08X	5/23/2007	244.0	
AOC_32	32Z-01-08X	10/15/2007	239.7	
AOC_32	32Z-01-08X	6/25/2008	241.9	
AOC_32	32Z-01-08X	10/28/2008	241.4	
AOC_32	32Z-01-08X	5/8/2009	237.9	
AOC_32	32Z-01-08X	10/26/2009	237.5	
AOC_32	32Z-01-08X	5/20/2010	242.3	
AOC_32	32Z-01-08X	10/7/2010	240.1	
AOC_32	32Z-01-08X	10/13/2011	242.6	
AOC_32	32Z-01-08X	5/15/2012	241.9	
AOC_32	32Z-01-08X	10/22/2012	239.8	
AOC_32	32Z-01-08XOB	1/30/2002	239.1	
AOC_32	32Z-01-08XOB	4/11/2002	243.5	
AOC_32	32Z-01-08XOB	7/10/2002	242.1	
AOC_32	32Z-01-08XOB	10/1/2002	240.5	
AOC_32	32Z-01-08XOB	3/27/2003	244.2	
AOC_32	32Z-01-08XOB	6/19/2003	242.9	
AOC_32	32Z-01-08XOB	9/23/2003	240.9	
AOC_32	32Z-01-08XOB	12/1/2003	241.1	
AOC_32	32Z-01-08XOB	10/7/2004	241.7	
AOC_32	32Z-01-08XOB	6/13/2005	242.7	
AOC_32	32Z-01-08XOB	10/3/2005	240.2	
AOC_32	32Z-01-08XOB	6/5/2006	244.2	
AOC_32	32Z-01-08XOB	6/7/2006	245.1	
AOC_32	32Z-01-08XOB	10/17/2006	241.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-08XOB	10/19/2006	240.5	
AOC_32	32Z-01-08XOB	5/22/2007	244.8	
AOC_32	32Z-01-08XOB	5/23/2007	244.0	
AOC_32	32Z-01-08XOB	10/15/2007	239.7	
AOC_32	32Z-01-08XOB	10/16/2007	240.5	
AOC_32	32Z-01-08XOB	6/25/2008	241.9	
AOC_32	32Z-01-08XOB	6/26/2008	242.7	
AOC_32	32Z-01-08XOB	10/28/2008	241.4	
AOC_32	32Z-01-08XOB	10/29/2008	242.3	
AOC_32	32Z-01-08XOB	5/8/2009	237.9	
AOC_32	32Z-01-08XOB	5/11/2009	238.7	
AOC_32	32Z-01-08XOB	10/26/2009	237.5	
AOC_32	32Z-01-08XOB	11/9/2009	238.4	
AOC_32	32Z-01-08XOB	5/18/2010	243.1	
AOC_32	32Z-01-08XOB	5/20/2010	242.3	
AOC_32	32Z-01-08XOB	10/7/2010	240.1	
AOC_32	32Z-01-08XOB	10/19/2010	241.0	
AOC_32	32Z-01-08XOB	6/30/2011	242.4	
AOC_32	32Z-01-08XOB	10/13/2011	242.6	
AOC_32	32Z-01-08XOB	5/15/2012	241.9	
AOC_32	32Z-01-08XOB	10/22/2012	239.8	
AOC_32	32Z-01-08XOB	6/11/2013	242.5	
AOC_32	32Z-01-08XOB	10/23/2013	239.9	
AOC_32	32Z-01-08XOB	6/17/2014	242.6	
AOC_32	32Z-01-08XOB	10/8/2015	239.8	
AOC_32	32Z-01-08XOB	5/17/2016	242.6	
AOC_32	32Z-01-08XOB	7/7/2017	242.7	
AOC_32	32Z-01-08XOB	4/9/2018	243.8	
AOC_32	32Z-01-08XOB	12/5/2018	245.0	
AOC_32	32Z-01-08XOB	4/8/2019	242.8	
AOC_32	32Z-01-08XOB	4/29/2020	244.0	
AOC_32	32Z-01-08XOB	5/14/2020	243.9	
AOC_32	32Z-01-09X	1/30/2002		
AOC_32	32Z-01-09X	4/11/2002		
AOC_32	32Z-01-09X	7/10/2002		
AOC_32	32Z-01-09X	10/1/2002		
AOC_32	32Z-01-09X	3/27/2003		
AOC_32	32Z-01-09X	6/19/2003		
AOC_32	32Z-01-09X	9/23/2003		
AOC_32	32Z-01-09X	12/1/2003		
AOC_32	32Z-01-09X	10/7/2004		
AOC_32	32Z-01-09X	6/13/2005		
AOC_32	32Z-01-09X	10/3/2005		
AOC_32	32Z-01-09X	6/5/2006		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-09X	10/19/2006		
AOC_32	32Z-01-09X	5/23/2007		
AOC_32	32Z-01-09X	10/15/2007		
AOC_32	32Z-01-09X	6/25/2008		
AOC_32	32Z-01-09X	10/28/2008		
AOC_32	32Z-01-09X	5/8/2009		
AOC_32	32Z-01-09X	10/26/2009		
AOC_32	32Z-01-09X	5/20/2010		
AOC_32	32Z-01-09X	10/7/2010		
AOC_32	32Z-01-09X	10/13/2011		
AOC_32	32Z-01-09X	5/15/2012		
AOC_32	32Z-01-09X	10/22/2012		
AOC_32	32Z-01-09XOB	1/30/2002	227.2	
AOC_32	32Z-01-09XOB	4/11/2002	227.8	
AOC_32	32Z-01-09XOB	7/10/2002	229.7	
AOC_32	32Z-01-09XOB	10/1/2002	229.2	
AOC_32	32Z-01-09XOB	3/27/2003	231.3	
AOC_32	32Z-01-09XOB	6/19/2003	232.4	
AOC_32	32Z-01-09XOB	9/23/2003	231.9	
AOC_32	32Z-01-09XOB	12/1/2003	231.3	
AOC_32	32Z-01-09XOB	10/7/2004	230.9	
AOC_32	32Z-01-09XOB	6/13/2005	231.1	
AOC_32	32Z-01-09XOB	10/3/2005	230.7	
AOC_32	32Z-01-09XOB	6/5/2006	233.7	
AOC_32	32Z-01-09XOB	6/7/2006	234.5	
AOC_32	32Z-01-09XOB	10/17/2006	232.0	
AOC_32	32Z-01-09XOB	10/19/2006	231.2	
AOC_32	32Z-01-09XOB	5/22/2007	234.1	
AOC_32	32Z-01-09XOB	5/23/2007	233.3	
AOC_32	32Z-01-09XOB	10/15/2007	229.9	
AOC_32	32Z-01-09XOB	10/16/2007	230.7	
AOC_32	32Z-01-09XOB	6/25/2008	233.3	
AOC_32	32Z-01-09XOB	6/26/2008	233.2	
AOC_32	32Z-01-09XOB	10/28/2008	232.4	
AOC_32	32Z-01-09XOB	10/29/2008	233.2	
AOC_32	32Z-01-09XOB	5/8/2009	232.8	
AOC_32	32Z-01-09XOB	5/11/2009	233.6	
AOC_32	32Z-01-09XOB	10/26/2009	230.8	
AOC_32	32Z-01-09XOB	11/9/2009	231.6	
AOC_32	32Z-01-09XOB	5/18/2010	235.0	
AOC_32	32Z-01-09XOB	5/20/2010	234.2	
AOC_32	32Z-01-09XOB	10/7/2010	230.2	
AOC_32	32Z-01-09XOB	10/19/2010	231.0	
AOC_32	32Z-01-09XOB	6/30/2011	232.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-09XOB	10/13/2011	232.7	
AOC_32	32Z-01-09XOB	5/15/2012	230.9	
AOC_32	32Z-01-09XOB	10/22/2012	229.2	
AOC_32	32Z-01-09XOB	10/23/2013	229.6	
AOC_32	32Z-01-09XOB	6/17/2014	230.7	
AOC_32	32Z-01-09XOB	10/8/2015	229.2	
AOC_32	32Z-01-09XOB	5/17/2016	229.8	
AOC_32	32Z-01-09XOB	7/7/2017	232.2	
AOC_32	32Z-01-09XOB	4/9/2018	231.3	
AOC_32	32Z-01-09XOB	12/5/2018	232.6	
AOC_32	32Z-01-09XOB	4/8/2019	232.7	
AOC_32	32Z-01-09XOB	4/29/2020	232.5	
AOC_32	32Z-01-09XOB	5/14/2020	232.6	
AOC_32	32Z-01-10X	1/30/2002		
AOC_32	32Z-01-10X	4/11/2002		
AOC_32	32Z-01-10X	7/10/2002		
AOC_32	32Z-01-10X	10/1/2002		
AOC_32	32Z-01-10X	3/27/2003		
AOC_32	32Z-01-10X	6/19/2003		
AOC_32	32Z-01-10X	9/23/2003		
AOC_32	32Z-01-10X	12/1/2003		
AOC_32	32Z-01-10X	10/7/2004		
AOC_32	32Z-01-10X	6/13/2005		
AOC_32	32Z-01-10X	10/3/2005		
AOC_32	32Z-01-10X	6/5/2006		
AOC_32	32Z-01-10X	10/19/2006		
AOC_32	32Z-01-10X	5/23/2007		
AOC_32	32Z-01-10X	10/15/2007		
AOC_32	32Z-01-10X	6/25/2008		
AOC_32	32Z-01-10X	10/28/2008		
AOC_32	32Z-01-10X	5/8/2009		
AOC_32	32Z-01-10X	10/26/2009		
AOC_32	32Z-01-10X	5/20/2010		
AOC_32	32Z-01-10X	10/7/2010		
AOC_32	32Z-01-10X	6/30/2011		
AOC_32	32Z-01-10X	10/13/2011		
AOC_32	32Z-01-10X	5/15/2012		
AOC_32	32Z-01-10X	10/22/2012		
AOC_32	32Z-01-10XBR	1/30/2002	239.5	
AOC_32	32Z-01-10XBR	4/11/2002	242.1	
AOC_32	32Z-01-10XBR	7/10/2002	240.5	
AOC_32	32Z-01-10XBR	10/1/2002	241.3	
AOC_32	32Z-01-10XBR	3/27/2003	245.3	
AOC_32	32Z-01-10XBR	6/19/2003	240.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-10XBR	9/23/2003	240.7	
AOC_32	32Z-01-10XBR	12/1/2003	238.9	
AOC_32	32Z-01-10XBR	10/7/2004	240.7	
AOC_32	32Z-01-10XBR	6/13/2005	241.1	
AOC_32	32Z-01-10XBR	10/3/2005	238.1	
AOC_32	32Z-01-10XBR	6/5/2006	235.2	
AOC_32	32Z-01-10XBR	6/7/2006	236.0	
AOC_32	32Z-01-10XBR	10/17/2006	240.2	
AOC_32	32Z-01-10XBR	10/19/2006	239.4	
AOC_32	32Z-01-10XBR	5/22/2007	242.7	
AOC_32	32Z-01-10XBR	5/23/2007	241.9	
AOC_32	32Z-01-10XBR	10/15/2007	238.4	
AOC_32	32Z-01-10XBR	10/16/2007	239.2	
AOC_32	32Z-01-10XBR	6/25/2008	239.6	
AOC_32	32Z-01-10XBR	6/26/2008	240.4	
AOC_32	32Z-01-10XBR	10/28/2008	241.1	
AOC_32	32Z-01-10XBR	10/29/2008	241.9	
AOC_32	32Z-01-10XBR	5/8/2009	242.5	
AOC_32	32Z-01-10XBR	5/11/2009	243.3	
AOC_32	32Z-01-10XBR	10/26/2009	241.2	
AOC_32	32Z-01-10XBR	11/9/2009	242.1	
AOC_32	32Z-01-10XBR	5/18/2010	241.5	
AOC_32	32Z-01-10XBR	5/20/2010	240.7	
AOC_32	32Z-01-10XBR	10/7/2010	242.3	
AOC_32	32Z-01-10XBR	10/19/2010	243.1	
AOC_32	32Z-01-10XBR	6/30/2011	242.3	
AOC_32	32Z-01-10XBR	10/13/2011	242.7	
AOC_32	32Z-01-10XBR	5/15/2012	242.0	
AOC_32	32Z-01-10XBR	10/22/2012	241.3	
AOC_32	32Z-01-10XBR	6/11/2013	245.2	
AOC_32	32Z-01-10XBR	10/23/2013	237.8	
AOC_32	32Z-01-10XBR	6/17/2014	240.0	
AOC_32	32Z-01-10XBR	10/8/2015	238.9	
AOC_32	32Z-01-10XBR	5/17/2016	240.5	
AOC_32	32Z-01-10XBR	7/7/2017	239.7	
AOC_32	32Z-01-10XBR	4/9/2018	243.0	
AOC_32	32Z-01-10XBR	12/5/2018	244.0	
AOC_32	32Z-01-10XBR	4/8/2019	242.0	
AOC_32	32Z-01-10XBR	4/29/2020	243.4	
AOC_32	32Z-01-10XBR	5/14/2020	242.3	
AOC_32	32Z-01-11X	7/10/2002		
AOC_32	32Z-01-11X	3/27/2003		
AOC_32	32Z-01-11X	6/5/2006		
AOC_32	32Z-01-11X	10/13/2011		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-11XBR	7/10/2002	245.2	
AOC_32	32Z-01-11XBR	3/27/2003	244.7	
AOC_32	32Z-01-11XBR	6/5/2006	244.5	
AOC_32	32Z-01-11XBR	6/7/2006	245.3	
AOC_32	32Z-01-11XBR	10/17/2006		
AOC_32	32Z-01-11XBR	5/22/2007		
AOC_32	32Z-01-11XBR	10/16/2007		
AOC_32	32Z-01-11XBR	6/26/2008		
AOC_32	32Z-01-11XBR	10/29/2008		
AOC_32	32Z-01-11XBR	5/11/2009		
AOC_32	32Z-01-11XBR	11/9/2009		
AOC_32	32Z-01-11XBR	5/18/2010		
AOC_32	32Z-01-11XBR	10/19/2010		
AOC_32	32Z-01-11XBR	10/13/2011	244.6	
AOC_32	32Z-01-11XBR	6/11/2013		
AOC_32	32Z-01-11XBR	10/23/2013		
AOC_32	32Z-01-11XBR	6/17/2014		
AOC_32	32Z-01-11XBR	10/8/2015		
AOC_32	32Z-01-11XBR	5/17/2016		
AOC_32	32Z-01-11XBR	7/7/2017		
AOC_32	32Z-01-11XBR	4/9/2018		
AOC_32	32Z-01-11XBR	12/5/2018	245.5	
AOC_32	32Z-01-11XBR	4/8/2019	244.5	
AOC_32	32Z-01-11XBR	4/29/2020	245.7	
AOC_32	32Z-01-11XBR	5/14/2020	245.3	
AOC_32	32Z-01-12X	1/30/2002		
AOC_32	32Z-01-12X	4/11/2002		
AOC_32	32Z-01-12X	7/10/2002		
AOC_32	32Z-01-12X	10/1/2002		
AOC_32	32Z-01-12X	3/27/2003		
AOC_32	32Z-01-12X	6/19/2003		
AOC_32	32Z-01-12X	9/23/2003		
AOC_32	32Z-01-12X	12/1/2003		
AOC_32	32Z-01-12X	10/7/2004		
AOC_32	32Z-01-12X	6/13/2005		
AOC_32	32Z-01-12X	10/3/2005		
AOC_32	32Z-01-12X	6/5/2006		
AOC_32	32Z-01-12X	10/19/2006		
AOC_32	32Z-01-12X	10/15/2007		
AOC_32	32Z-01-12X	6/25/2008		
AOC_32	32Z-01-12X	10/28/2008		
AOC_32	32Z-01-12X	5/8/2009		
AOC_32	32Z-01-12X	10/26/2009		
AOC_32	32Z-01-12X	5/20/2010		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-12X	10/7/2010		
AOC_32	32Z-01-12X	10/13/2011		
AOC_32	32Z-01-12X	10/22/2012		
AOC_32	32Z-01-12XBR	1/30/2002	233.7	
AOC_32	32Z-01-12XBR	4/11/2002	236.0	
AOC_32	32Z-01-12XBR	7/10/2002	238.0	
AOC_32	32Z-01-12XBR	10/1/2002	236.0	
AOC_32	32Z-01-12XBR	3/27/2003	239.2	
AOC_32	32Z-01-12XBR	6/19/2003	238.9	
AOC_32	32Z-01-12XBR	9/23/2003	237.3	
AOC_32	32Z-01-12XBR	12/1/2003	236.8	
AOC_32	32Z-01-12XBR	10/7/2004	236.9	
AOC_32	32Z-01-12XBR	6/13/2005	239.5	
AOC_32	32Z-01-12XBR	10/3/2005	236.0	
AOC_32	32Z-01-12XBR	6/5/2006	239.7	
AOC_32	32Z-01-12XBR	6/7/2006	240.6	
AOC_32	32Z-01-12XBR	10/17/2006	237.0	
AOC_32	32Z-01-12XBR	10/19/2006	236.1	
AOC_32	32Z-01-12XBR	5/22/2007		
AOC_32	32Z-01-12XBR	10/15/2007	235.2	
AOC_32	32Z-01-12XBR	10/16/2007	236.0	
AOC_32	32Z-01-12XBR	6/25/2008	238.1	
AOC_32	32Z-01-12XBR	6/26/2008	238.9	
AOC_32	32Z-01-12XBR	10/28/2008	237.6	
AOC_32	32Z-01-12XBR	10/29/2008	238.4	
AOC_32	32Z-01-12XBR	5/8/2009	239.3	
AOC_32	32Z-01-12XBR	5/11/2009	240.1	
AOC_32	32Z-01-12XBR	10/26/2009	236.7	
AOC_32	32Z-01-12XBR	11/9/2009	237.5	
AOC_32	32Z-01-12XBR	5/18/2010	240.3	
AOC_32	32Z-01-12XBR	5/20/2010	239.5	
AOC_32	32Z-01-12XBR	10/7/2010	235.5	
AOC_32	32Z-01-12XBR	10/19/2010	236.3	
AOC_32	32Z-01-12XBR	6/30/2011	238.6	
AOC_32	32Z-01-12XBR	10/13/2011	238.7	
AOC_32	32Z-01-12XBR	10/22/2012	235.3	
AOC_32	32Z-01-12XBR	6/11/2013	238.7	
AOC_32	32Z-01-12XBR	10/23/2013	235.7	
AOC_32	32Z-01-12XBR	6/17/2014	238.6	
AOC_32	32Z-01-12XBR	10/8/2015	235.5	
AOC_32	32Z-01-12XBR	5/17/2016	238.6	
AOC_32	32Z-01-12XBR	7/7/2017	238.0	
AOC_32	32Z-01-12XBR	4/9/2018	239.6	
AOC_32	32Z-01-12XBR	12/5/2018	238.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-01-12XBR	4/8/2019	238.9	
AOC_32	32Z-01-12XBR	4/29/2020	240.0	
AOC_32	32Z-01-12XBR	5/14/2020	239.9	
AOC_32	32Z-99-02X	1/30/2002	231.7	
AOC_32	32Z-99-02X	4/11/2002	234.3	
AOC_32	32Z-99-02X	7/10/2002	234.5	
AOC_32	32Z-99-02X	10/1/2002	232.6	
AOC_32	32Z-99-02X	3/27/2003	236.5	
AOC_32	32Z-99-02X	6/19/2003	229.6	
AOC_32	32Z-99-02X	9/23/2003	233.9	
AOC_32	32Z-99-02X	12/1/2003	234.3	
AOC_32	32Z-99-02X	5/25/2004	235.7	
AOC_32	32Z-99-02X	10/7/2004	233.6	
AOC_32	32Z-99-02X	6/13/2005	236.6	
AOC_32	32Z-99-02X	10/3/2005	233.2	
AOC_32	32Z-99-02X	6/7/2006	238.1	
AOC_32	32Z-99-02X	10/17/2006	234.1	
AOC_32	32Z-99-02X	10/19/2006	233.1	
AOC_32	32Z-99-02X	5/22/2007	238.0	
AOC_32	32Z-99-02X	5/23/2007	237.0	
AOC_32	32Z-99-02X	10/15/2007	233.5	
AOC_32	32Z-99-02X	10/16/2007	234.6	
AOC_32	32Z-99-02X	6/25/2008	235.2	
AOC_32	32Z-99-02X	6/26/2008	236.3	
AOC_32	32Z-99-02X	10/28/2008	235.5	
AOC_32	32Z-99-02X	10/29/2008	236.6	
AOC_32	32Z-99-02X	5/8/2009	236.5	
AOC_32	32Z-99-02X	5/11/2009	237.3	
AOC_32	32Z-99-02X	10/26/2009	234.3	
AOC_32	32Z-99-02X	11/9/2009	235.4	
AOC_32	32Z-99-02X	5/18/2010	236.9	
AOC_32	32Z-99-02X	5/20/2010	235.8	
AOC_32	32Z-99-02X	10/7/2010	233.9	
AOC_32	32Z-99-02X	10/19/2010	235.0	
AOC_32	32Z-99-02X	6/30/2011	235.5	
AOC_32	32Z-99-02X	10/13/2011	236.4	
AOC_32	32Z-99-02X	5/15/2012	234.7	
AOC_32	32Z-99-02X	10/22/2012	233.1	
AOC_32	32Z-99-02X	6/11/2013	235.2	
AOC_32	32Z-99-02X	10/23/2013		
AOC_32	32Z-99-02X	6/17/2014	235.4	
AOC_32	32Z-99-02X	10/8/2015	233.0	
AOC_32	32Z-99-02X	12/16/2015	232.1	
AOC_32	32Z-99-02X	5/17/2016		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	32Z-99-02X	7/7/2017	236.0	
AOC_32	32Z-99-02X	4/9/2018	236.2	
AOC_32	32Z-99-02X	12/5/2018	238.7	
AOC_32	32Z-99-02X	4/8/2019	236.2	
AOC_32	32Z-99-02X	4/29/2020	237.7	
AOC_32	32Z-99-02X	5/14/2020	237.5	
AOC_32	SHL-12	5/26/1992	225.4	
AOC_32	SHL-12	9/15/1992	225.0	
AOC_32	SHL-12	12/22/1992	224.7	
AOC_32	SHL-12	3/30/1993	226.2	
AOC_32	SHL-12	6/22/1993	225.7	
AOC_32	SHL-12	9/30/1993	224.7	
AOC_32	SHL-12	11/8/1993	224.4	
AOC_32	SHL-12	3/30/1994	226.7	
AOC_32	SHL-12	6/28/1994	226.3	
AOC_32	SHL-12	10/4/1994	225.8	
AOC_32	SHL-12	1/31/1995	226.0	
AOC_32	SHL-12	5/9/1995	225.6	
AOC_32	SHL-12	12/7/1995	225.0	
AOC_32	SHL-12	3/26/1996	226.8	
AOC_32	SHL-12	1/15/1997	227.9	
AOC_32	SHL-12	6/2/1997	227.8	
AOC_32	SHL-12	4/23/1998	227.9	
AOC_32	SHL-12	6/19/1998	229.3	
AOC_32	SHL-12	6/26/1998	229.1	
AOC_32	SHL-12	7/1/1998	229.2	
AOC_32	SHL-12	7/17/1998	228.6	
AOC_32	SHL-12	7/31/1998	228.1	
AOC_32	SHL-12	8/28/1998	227.1	
AOC_32	SHL-12	10/14/1998	226.7	
AOC_32	SHL-12	12/10/1998	225.4	
AOC_32	SHL-12	2/23/1999	225.8	
AOC_32	SHL-12	6/6/1999	224.8	
AOC_32	SHL-12	9/8/1999	223.5	
AOC_32	SHL-12	8/19/2008	228.0	
AOC_32	SHL-12	9/15/2008	228.2	
AOC_32	SHL-12	4/28/2009	227.9	
AOC_32	SHL-12	9/14/2009	227.4	
AOC_32	SHL-12	10/26/2009	226.8	
AOC_32	SHL-12	4/27/2010	229.8	
AOC_32	SHL-12	9/14/2010	226.0	
AOC_32	SHL-12	7/25/2011	226.4	
AOC_32	SHL-12	6/26/2012	226.5	
AOC_32	SHL-12	11/6/2012	225.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	SHL-12	4/25/2013	226.0	
AOC_32	SHL-12	4/22/2014	226.0	
AOC_32	SHL-12	10/6/2014	224.9	
AOC_32	SHL-12	6/8/2015	227.0	
AOC_32	SHL-12	6/9/2015	227.0	
AOC_32	SHL-12	6/17/2015	226.6	
AOC_32	SHL-12	10/7/2015	224.9	
AOC_32	SHL-12	12/16/2015	224.3	
AOC_32	SHL-12	6/9/2016	225.0	
AOC_32	SHL-12	6/24/2016	224.7	
AOC_32	SHL-12	8/16/2016	224.2	
AOC_32	SHL-12	11/15/2016	224.0	
AOC_32	SHL-12	5/22/2017	226.7	
AOC_32	SHL-12	11/1/2018	227.9	
AOC_32	SHL-12	12/5/2018	229.8	
AOC_32	SHL-12	10/22/2019	226.0	
AOC_32	SHL-12	4/29/2020	227.9	
AOC_32	SHL-17	5/26/1992	225.3	
AOC_32	SHL-17	9/15/1992	224.7	
AOC_32	SHL-17	12/22/1992	224.8	
AOC_32	SHL-17	3/30/1993	228.3	
AOC_32	SHL-17	6/22/1993	225.6	
AOC_32	SHL-17	9/30/1993	224.9	
AOC_32	SHL-17	11/8/1993	224.5	
AOC_32	SHL-17	3/30/1994	226.8	
AOC_32	SHL-17	10/4/1994	225.8	
AOC_32	SHL-17	1/31/1995	226.0	
AOC_32	SHL-17	5/9/1995	225.6	
AOC_32	SHL-17	12/7/1995	225.0	
AOC_32	SHL-17	3/26/1996	226.7	
AOC_32	SHL-17	7/23/1996	227.3	
AOC_32	SHL-17	1/15/1997	227.7	
AOC_32	SHL-17	6/2/1997	227.5	
AOC_32	SHL-17	4/23/1998	227.9	
AOC_32	SHL-17	6/19/1998	229.7	
AOC_32	SHL-17	6/26/1998	229.5	
AOC_32	SHL-17	7/1/1998	230.1	
AOC_32	SHL-17	7/17/1998	228.5	
AOC_32	SHL-17	7/31/1998	228.6	
AOC_32	SHL-17	8/28/1998	227.1	
AOC_32	SHL-17	10/14/1998	226.9	
AOC_32	SHL-17	12/10/1998	225.8	
AOC_32	SHL-17	2/23/1999	226.0	
AOC_32	SHL-17	6/6/1999	224.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	SHL-17	9/8/1999	223.5	
AOC_32	SHL-17	9/14/2009	227.3	
AOC_32	SHL-17	10/26/2009	227.0	
AOC_32	SHL-17	4/27/2010	229.7	
AOC_32	SHL-17	9/14/2010	225.9	
AOC_32	SHL-17	7/25/2011	226.3	
AOC_32	SHL-17	6/26/2012	227.0	
AOC_32	SHL-17	11/6/2012	225.7	
AOC_32	SHL-17	4/25/2013	225.9	
AOC_32	SHL-17	4/22/2014	226.0	
AOC_32	SHL-17	6/17/2015	226.6	
AOC_32	SHL-17	10/7/2015	224.9	
AOC_32	SHL-17	10/20/2015		
AOC_32	SHL-17	12/16/2015	224.8	
AOC_32	SHL-17	6/9/2016	225.0	
AOC_32	SHL-17	6/24/2016		
AOC_32	SHL-17	8/16/2016	224.5	
AOC_32	SHL-17	11/15/2016	224.1	
AOC_32	SHL-17	5/22/2017	226.8	
AOC_32	SHL-17	11/1/2018	228.2	
AOC_32	SHL-17	12/5/2018	229.9	
AOC_32	SHL-17	10/22/2019	224.9	
AOC_32	SHL-17	4/29/2020	228.3	
AOC_32	SHL-24	5/26/1992	221.8	
AOC_32	SHL-24	9/15/1992	222.0	
AOC_32	SHL-24	12/22/1992	222.0	
AOC_32	SHL-24	3/30/1993	222.9	
AOC_32	SHL-24	6/22/1993	222.3	
AOC_32	SHL-24	9/30/1993	221.7	
AOC_32	SHL-24	11/8/1993	221.8	
AOC_32	SHL-24	3/30/1994	223.5	
AOC_32	SHL-24	6/28/1994	222.7	
AOC_32	SHL-24	10/4/1994	222.6	
AOC_32	SHL-24	1/31/1995	222.9	
AOC_32	SHL-24	5/9/1995	222.2	
AOC_32	SHL-24	12/7/1995	222.2	
AOC_32	SHL-24	3/26/1996	223.2	
AOC_32	SHL-24	7/23/1996	223.6	
AOC_32	SHL-24	1/15/1997	223.9	
AOC_32	SHL-24	6/2/1997	224.0	
AOC_32	SHL-24	4/23/1998	223.8	
AOC_32	SHL-24	6/19/1998	225.1	
AOC_32	SHL-24	6/26/1998	225.0	
AOC_32	SHL-24	7/1/1998	224.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	SHL-24	7/17/1998	224.3	
AOC_32	SHL-24	7/31/1998	223.9	
AOC_32	SHL-24	8/28/1998	223.2	
AOC_32	SHL-24	10/14/1998	222.9	
AOC_32	SHL-24	12/10/1998	222.1	
AOC_32	SHL-24	2/23/1999	222.4	
AOC_32	SHL-24	6/6/1999	221.7	
AOC_32	SHL-24	9/8/1999	220.7	
AOC_32	SHL-24	8/24/2005	223.1	
AOC_32	SHL-24	8/26/2005	223.1	
AOC_32	SHL-24	6/5/2006	225.3	
AOC_32	SHL-24	9/18/2006	223.5	
AOC_32	SHL-24	12/15/2006	223.6	
AOC_32	SHL-24	4/8/2007	223.3	
AOC_32	SHL-24	4/9/2007	223.3	
AOC_32	SHL-24	10/15/2007	222.6	
AOC_32	SHL-24	2/20/2008	224.7	
AOC_32	SHL-24	2/25/2008	224.4	
AOC_32	SHL-24	3/4/2008	224.2	
AOC_32	SHL-24	4/16/2008	224.5	
AOC_32	SHL-24	9/30/2008	224.7	
AOC_32	SHL-24	4/28/2009	224.1	
AOC_32	SHL-24	9/14/2009	223.7	
AOC_32	SHL-24	10/26/2009	223.2	
AOC_32	SHL-24	11/3/2009	223.3	
AOC_32	SHL-24	4/20/2010	225.7	
AOC_32	SHL-24	4/27/2010	225.4	
AOC_32	SHL-24	9/14/2010	222.6	
AOC_32	SHL-24	10/7/2010	223.1	
AOC_32	SHL-24	4/4/2011	223.7	
AOC_32	SHL-24	7/25/2011	222.9	
AOC_32	SHL-24	11/8/2011	224.6	
AOC_32	SHL-24	4/10/2012	220.9	
AOC_32	SHL-24	6/26/2012	222.9	
AOC_32	SHL-24	11/5/2012	223.0	
AOC_32	SHL-24	11/6/2012	223.0	
AOC_32	SHL-24	5/15/2013	222.5	
AOC_32	SHL-24	6/11/2013	223.8	
AOC_32	SHL-24	10/21/2013	221.8	
AOC_32	SHL-24	4/22/2014	223.0	
AOC_32	SHL-24	6/9/2015	223.5	
AOC_32	SHL-24	6/10/2015	223.5	
AOC_32	SHL-24	6/17/2015	222.8	
AOC_32	SHL-24	10/7/2015	222.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	SHL-24	10/20/2015	221.9	
AOC_32	SHL-24	12/16/2015	221.7	
AOC_32	SHL-24	6/9/2016	222.0	
AOC_32	SHL-24	6/24/2016	221.8	
AOC_32	SHL-24	8/16/2016	221.6	
AOC_32	SHL-24	11/15/2016	221.7	
AOC_32	SHL-24	5/22/2017	223.4	
AOC_32	SHL-24	11/1/2018	224.2	
AOC_32	SHL-24	10/22/2019	223.0	
AOC_32	SHL-24	4/29/2020	224.3	
AOC_32	SHL-25	5/26/1992	233.3	
AOC_32	SHL-25	9/15/1992	231.2	
AOC_32	SHL-25	12/22/1992	231.2	
AOC_32	SHL-25	3/30/1993	233.8	
AOC_32	SHL-25	6/22/1993	233.1	
AOC_32	SHL-25	9/30/1993	229.4	
AOC_32	SHL-25	11/8/1993	231.0	
AOC_32	SHL-25	3/30/1994	236.8	
AOC_32	SHL-25	6/28/1994	234.1	
AOC_32	SHL-25	10/4/1994	232.3	
AOC_32	SHL-25	1/31/1995	235.3	
AOC_32	SHL-25	5/9/1995	232.8	
AOC_32	SHL-25	12/7/1995	234.2	
AOC_32	SHL-25	3/26/1996	236.1	
AOC_32	SHL-25	7/23/1996	234.1	
AOC_32	SHL-25	1/15/1997	236.1	
AOC_32	SHL-25	6/2/1997	235.1	
AOC_32	SHL-25	4/23/1998	235.9	
AOC_32	SHL-25	6/19/1998	237.0	
AOC_32	SHL-25	6/26/1998	237.3	
AOC_32	SHL-25	7/1/1998	237.0	
AOC_32	SHL-25	7/17/1998	235.8	
AOC_32	SHL-25	7/31/1998	234.6	
AOC_32	SHL-25	8/28/1998	232.8	
AOC_32	SHL-25	10/14/1998	230.8	
AOC_32	SHL-25	12/10/1998	230.1	
AOC_32	SHL-25	2/23/1999	233.8	
AOC_32	SHL-25	6/6/1999	231.8	
AOC_32	SHL-25	9/8/1999	228.6	
AOC_32	SHL-25	4/11/2002	229.5	
AOC_32	SHL-25	7/10/2002	231.7	
AOC_32	SHL-25	10/1/2002	229.3	
AOC_32	SHL-25	3/27/2003	231.8	
AOC_32	SHL-25	6/19/2003	232.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	SHL-25	9/23/2003	230.9	
AOC_32	SHL-25	12/1/2003	230.6	
AOC_32	SHL-25	10/7/2004	230.3	
AOC_32	SHL-25	5/18/2005	233.6	
AOC_32	SHL-25	6/13/2005	233.6	
AOC_32	SHL-25	10/3/2005	230.3	
AOC_32	SHL-25	6/5/2006	233.3	
AOC_32	SHL-25	6/7/2006	234.4	
AOC_32	SHL-25	10/17/2006	231.5	
AOC_32	SHL-25	10/19/2006	230.4	
AOC_32	SHL-25	5/22/2007	234.4	
AOC_32	SHL-25	5/23/2007	233.3	
AOC_32	SHL-25	10/15/2007	229.4	
AOC_32	SHL-25	10/16/2007	230.5	
AOC_32	SHL-25	6/25/2008	231.8	
AOC_32	SHL-25	6/26/2008	232.9	
AOC_32	SHL-25	10/28/2008	232.0	
AOC_32	SHL-25	10/29/2008	233.1	
AOC_32	SHL-25	5/8/2009	233.1	
AOC_32	SHL-25	5/11/2009	234.2	
AOC_32	SHL-25	10/26/2009	231.6	
AOC_32	SHL-25	11/9/2009	232.7	
AOC_32	SHL-25	5/18/2010	235.3	
AOC_32	SHL-25	10/7/2010	230.8	
AOC_32	SHL-25	10/19/2010	231.9	
AOC_32	SHL-25	6/30/2011	232.8	
AOC_32	SHL-25	10/13/2011	233.9	
AOC_32	SHL-25	5/15/2012	231.5	
AOC_32	SHL-25	10/22/2012	229.9	
AOC_32	SHL-25	6/11/2013	232.2	
AOC_32	SHL-25	10/23/2013	229.8	
AOC_32	SHL-25	4/22/2014	231.9	
AOC_32	SHL-25	6/17/2014	231.3	
AOC_32	SHL-25	10/6/2014	229.4	
AOC_32	SHL-25	6/17/2015	233.9	
AOC_32	SHL-25	10/7/2015	229.7	
AOC_32	SHL-25	10/8/2015	229.6	
AOC_32	SHL-25	12/16/2015	228.7	
AOC_32	SHL-25	5/17/2016	231.2	
AOC_32	SHL-25	6/9/2016	230.5	
AOC_32	SHL-25	6/24/2016	230.2	
AOC_32	SHL-25	8/16/2016	228.9	
AOC_32	SHL-25	11/15/2016	229.0	
AOC_32	SHL-25	5/22/2017	233.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	SHL-25	7/7/2017	232.6	
AOC_32	SHL-25	4/9/2018	232.6	
AOC_32	SHL-25	11/1/2018	232.0	
AOC_32	SHL-25	12/5/2018	234.2	
AOC_32	SHL-25	4/8/2019	233.3	
AOC_32	SHL-25	10/22/2019	230.3	
AOC_32	SHL-25	4/29/2020	233.3	
AOC_32	SHL-25	5/14/2020	233.4	
AOC_32	SHM-93-24A	3/30/1993	222.5	
AOC_32	SHM-93-24A	6/22/1993	221.4	
AOC_32	SHM-93-24A	9/30/1993	220.9	
AOC_32	SHM-93-24A	11/8/1993	221.0	
AOC_32	SHM-93-24A	3/30/1994	222.8	
AOC_32	SHM-93-24A	6/28/1994	221.8	
AOC_32	SHM-93-24A	10/4/1994	221.8	
AOC_32	SHM-93-24A	1/31/1995	222.2	
AOC_32	SHM-93-24A	5/9/1995	221.5	
AOC_32	SHM-93-24A	12/7/1995	221.5	
AOC_32	SHM-93-24A	3/26/1996	222.5	
AOC_32	SHM-93-24A	7/23/1996	222.8	
AOC_32	SHM-93-24A	1/15/1997	223.1	
AOC_32	SHM-93-24A	6/2/1997	223.0	
AOC_32	SHM-93-24A	4/23/1998	222.9	
AOC_32	SHM-93-24A	6/19/1998	224.2	
AOC_32	SHM-93-24A	6/26/1998	224.0	
AOC_32	SHM-93-24A	7/1/1998	223.8	
AOC_32	SHM-93-24A	7/17/1998	223.4	
AOC_32	SHM-93-24A	7/31/1998	223.0	
AOC_32	SHM-93-24A	8/28/1998	222.3	
AOC_32	SHM-93-24A	10/14/1998	222.0	
AOC_32	SHM-93-24A	12/10/1998	221.4	
AOC_32	SHM-93-24A	2/23/1999	221.7	
AOC_32	SHM-93-24A	6/6/1999	220.9	
AOC_32	SHM-93-24A	9/8/1999	220.0	
AOC_32	SHM-93-24A	11/6/2012	222.4	
AOC_32	SHM-93-24A	4/25/2013	222.0	
AOC_32	SHM-93-24A	5/15/2013	221.8	
AOC_32	SHM-93-24A	6/11/2013	223.4	
AOC_32	SHM-93-24A	10/21/2013	221.0	
AOC_32	SHM-93-24A	4/22/2014	222.4	
AOC_32	SHM-93-24A	6/17/2015	222.1	
AOC_32	SHM-93-24A	10/7/2015	221.3	
AOC_32	SHM-93-24A	12/16/2015	221.1	
AOC_32	SHM-93-24A	6/9/2016	221.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_32	SHM-93-24A	6/24/2016	221.2	
AOC_32	SHM-93-24A	8/16/2016	221.1	
AOC_32	SHM-93-24A	11/15/2016	221.1	
AOC_32	SHM-93-24A	5/22/2017	222.7	
AOC_32	SHM-93-24A	11/1/2018	223.3	
AOC_32	SHM-93-24A	10/22/2019	222.3	
AOC_32	SHM-93-24A	4/29/2020	223.6	
AOC_40	CPSG-01	1/3/2020		-3.7
AOC_40	CPSG-01	3/13/2020	244.3	
AOC_40	CPSG-01	9/1/2020	243.9	
AOC_40	CPSG-02	1/3/2020		-1.9
AOC_40	CPSG-02	3/13/2020	243.7	
AOC_40	CPSG-02	8/31/2020	242.0	
AOC_40	CSBSG-01	1/3/2020		-3.0
AOC_40	CSBSG-01	3/13/2020	235.4	
AOC_40	CSBSG-01	8/31/2020	233.5	
AOC_41	41M-92-01X	9/5/1992	222.7	
AOC_41	41M-92-01X	9/30/1993	221.8	
AOC_41	41M-92-01X	12/7/1995	223.2	
AOC_41	41M-92-01X	7/23/1996	223.7	
AOC_41	41M-92-01X	1/15/1997	225.0	
AOC_41	41M-92-01X	6/2/1997	225.0	
AOC_41	41M-92-01X	4/23/1998	225.2	
AOC_41	41M-92-01X	10/14/1998	222.5	
AOC_41	41M-92-01X	12/6/1999	223.1	
AOC_41	41M-93-02A	12/7/1995	246.1	
AOC_41	41M-93-02A	7/23/1996	245.9	
AOC_41	41M-93-02A	1/15/1997	246.1	
AOC_41	41M-93-02A	6/2/1997	245.6	
AOC_41	41M-93-02A	4/23/1998	246.0	
AOC_41	41M-93-02A	10/14/1998	246.0	
AOC_41	41M-93-02A	12/6/1999	246.1	
AOC_41	41M-93-02B	9/30/1993	221.3	
AOC_41	41M-93-02B	12/7/1995	223.3	
AOC_41	41M-93-02B	7/23/1996	224.2	
AOC_41	41M-93-02B	1/15/1997	225.1	
AOC_41	41M-93-02B	6/2/1997	225.4	
AOC_41	41M-93-02B	4/23/1998	225.4	
AOC_41	41M-93-02B	10/14/1998	223.1	
AOC_41	41M-93-02B	12/6/1999	223.2	
AOC_41	41M-93-04X	9/30/1993	221.4	
AOC_41	41M-93-04X	12/7/1995	223.0	
AOC_41	41M-93-04X	7/23/1996	222.6	
AOC_41	41M-93-04X	1/15/1997	223.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_41	41M-93-04X	6/2/1997	223.1	
AOC_41	41M-93-04X	10/27/1997	222.4	
AOC_41	41M-93-04X	4/23/1998	223.8	
AOC_41	41M-93-04X	10/14/1998	223.0	
AOC_41	41M-93-04X	10/21/1998	222.6	
AOC_41	41M-93-04X	10/18/1999	224.0	
AOC_41	41M-93-04X	12/6/1999	224.0	
AOC_41	41M-93-04X	10/25/2000	225.1	
AOC_41	41M-93-04X	10/15/2001	221.8	
AOC_41	41M-93-04X	10/21/2002	223.7	
AOC_41	41M-93-04X	10/28/2003	222.8	
AOC_41	41M-93-04X	11/1/2004	224.6	
AOC_41	41M-93-04X	11/14/2005	224.8	
AOC_41	41M-93-04X	10/24/2006	222.9	
AOC_41	41M-93-04X	10/23/2007	224.4	
AOC_41	41M-93-04X	10/23/2008	224.0	
AOC_41	41M-93-04X	11/13/2009	224.7	
AOC_41	41M-93-04X	10/26/2010	225.4	
AOC_41	41M-93-05X	9/30/1993	222.4	
AOC_41	41M-93-05X	12/7/1995	223.0	
AOC_41	41M-93-05X	1/15/1997	223.5	
AOC_41	41M-93-05X	6/2/1997	222.8	
AOC_41	41M-93-05X	4/23/1998	223.6	
AOC_41	41M-93-05X	10/14/1998	222.8	
AOC_41	41M-93-05X	12/6/1999	223.9	
AOC_41	41M-94-02C	12/7/1995	221.6	
AOC_41	41M-94-02C	7/23/1996	222.4	
AOC_41	41M-94-02C	1/15/1997	223.4	
AOC_41	41M-94-02C	6/2/1997	223.5	
AOC_41	41M-94-02C	4/23/1998	223.5	
AOC_41	41M-94-02C	10/14/1998	221.5	
AOC_41	41M-94-02C	12/6/1999	221.1	
AOC_41	41M-94-03B	12/7/1995	221.2	
AOC_41	41M-94-03B	7/23/1996	221.9	
AOC_41	41M-94-03B	1/15/1997	223.0	
AOC_41	41M-94-03B	6/2/1997	222.9	
AOC_41	41M-94-03B	4/23/1998	223.0	
AOC_41	41M-94-03B	10/14/1998	221.2	
AOC_41	41M-94-03B	10/21/1998	221.2	
AOC_41	41M-94-03B	12/6/1999	220.7	
AOC_41	41M-94-06X	12/7/1995	224.0	
AOC_41	41M-94-06X	1/15/1997	224.4	
AOC_41	41M-94-06X	6/2/1997	224.1	
AOC_41	41M-94-06X	4/23/1998	224.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_41	41M-94-06X	10/14/1998	223.9	
AOC_41	41M-94-06X	12/6/1999	224.1	
AOC_41	41M-94-07X	12/7/1995	223.7	
AOC_41	41M-94-07X	1/15/1997	224.0	
AOC_41	41M-94-07X	6/2/1997	223.7	
AOC_41	41M-94-07X	4/23/1998	224.0	
AOC_41	41M-94-07X	10/14/1998	223.4	
AOC_41	41M-94-07X	12/6/1999	224.0	
AOC_41	41M-94-08A	12/7/1995	223.6	
AOC_41	41M-94-08A	7/23/1996	223.9	
AOC_41	41M-94-08A	1/15/1997	224.9	
AOC_41	41M-94-08A	6/2/1997	224.8	
AOC_41	41M-94-08A	4/23/1998	225.0	
AOC_41	41M-94-08A	10/14/1998	223.4	
AOC_41	41M-94-08A	12/6/1999	223.8	
AOC_41	41M-94-08B	12/7/1995	223.0	
AOC_41	41M-94-08B	7/23/1996	223.5	
AOC_41	41M-94-08B	1/15/1997	224.5	
AOC_41	41M-94-08B	6/2/1997	224.4	
AOC_41	41M-94-08B	4/23/1998	224.6	
AOC_41	41M-94-08B	10/14/1998	223.0	
AOC_41	41M-94-08B	12/6/1999	222.9	
AOC_41	41M-94-09A	12/7/1995	220.4	
AOC_41	41M-94-09A	1/15/1997	221.9	
AOC_41	41M-94-09A	6/2/1997	221.8	
AOC_41	41M-94-09A	4/23/1998	221.9	
AOC_41	41M-94-09A	10/14/1998	219.9	
AOC_41	41M-94-09A	10/18/1999	219.5	
AOC_41	41M-94-09A	12/6/1999	219.7	
AOC_41	41M-94-09A	10/25/2000	220.1	
AOC_41	41M-94-09A	10/15/2001	219.2	
AOC_41	41M-94-09A	10/21/2002	219.9	
AOC_41	41M-94-09A	10/28/2003	220.6	
AOC_41	41M-94-09A	11/1/2004	221.0	
AOC_41	41M-94-09A	11/14/2005	222.5	
AOC_41	41M-94-09A	10/24/2006	221.5	
AOC_41	41M-94-09B	12/7/1995	220.3	
AOC_41	41M-94-09B	1/15/1997	221.8	
AOC_41	41M-94-09B	6/2/1997	221.6	
AOC_41	41M-94-09B	10/27/1997	218.9	
AOC_41	41M-94-09B	4/23/1998	221.8	
AOC_41	41M-94-09B	10/14/1998	219.9	
AOC_41	41M-94-09B	10/18/1999	219.4	
AOC_41	41M-94-09B	12/6/1999	219.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_41	41M-94-09B	10/25/2000	220.0	
AOC_41	41M-94-09B	10/15/2001	219.1	
AOC_41	41M-94-09B	10/21/2002	219.9	
AOC_41	41M-94-09B	10/28/2003	220.6	
AOC_41	41M-94-09B	11/1/2004	220.9	
AOC_41	41M-94-09B	11/14/2005	222.4	
AOC_41	41M-94-09B	10/24/2006	221.4	
AOC_41	41M-94-10X	12/7/1995	227.0	
AOC_41	41M-94-10X	1/15/1997	230.5	
AOC_41	41M-94-10X	6/2/1997	230.7	
AOC_41	41M-94-10X	4/23/1998	232.6	
AOC_41	41M-94-10X	10/14/1998	228.4	
AOC_41	41M-94-10X	12/6/1999	228.8	
AOC_41	41M-94-11X	12/7/1995	223.1	
AOC_41	41M-94-11X	1/15/1997	225.5	
AOC_41	41M-94-11X	6/2/1997	225.8	
AOC_41	41M-94-11X	10/27/1997	222.6	
AOC_41	41M-94-11X	4/23/1998	225.6	
AOC_41	41M-94-11X	10/14/1998	223.9	
AOC_41	41M-94-11X	10/21/1998	223.9	
AOC_41	41M-94-11X	10/18/1999	222.5	
AOC_41	41M-94-11X	12/6/1999	222.9	
AOC_41	41M-94-11X	10/25/2000	223.8	
AOC_41	41M-94-11X	10/15/2001	222.9	
AOC_41	41M-94-11X	10/21/2002	222.4	
AOC_41	41M-94-11X	10/28/2003	223.9	
AOC_41	41M-94-11X	11/1/2004	224.2	
AOC_41	41M-94-11X	11/14/2005	226.1	
AOC_41	41M-94-11X	10/24/2006	225.2	
AOC_41	41M-94-12X	12/7/1995	221.9	
AOC_41	41M-94-12X	1/15/1997	224.1	
AOC_41	41M-94-12X	6/2/1997	224.1	
AOC_41	41M-94-12X	10/27/1997	219.2	
AOC_41	41M-94-12X	4/23/1998	223.8	
AOC_41	41M-94-12X	10/14/1998	220.4	
AOC_41	41M-94-12X	10/21/1998	220.9	
AOC_41	41M-94-12X	10/18/1999	220.0	
AOC_41	41M-94-12X	12/6/1999	221.6	
AOC_41	41M-94-12X	10/25/2000	220.9	
AOC_41	41M-94-12X	10/15/2001	219.9	
AOC_41	41M-94-12X	10/21/2002	220.1	
AOC_41	41M-94-12X	10/28/2003	221.9	
AOC_41	41M-94-12X	11/1/2004	223.2	
AOC_41	41M-94-12X	11/14/2005	225.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_41	41M-94-12X	10/24/2006	223.9	
AOC_41	41M-94-13X	12/7/1995	221.3	
AOC_41	41M-94-13X	7/23/1996	239.3	
AOC_41	41M-94-13X	1/15/1997	223.2	
AOC_41	41M-94-13X	6/2/1997	223.0	
AOC_41	41M-94-13X	4/23/1998	223.8	
AOC_41	41M-94-13X	10/14/1998	220.6	
AOC_41	41M-94-13X	12/6/1999	220.5	
AOC_41	41M-94-13X	10/15/2001	219.8	
AOC_41	41M-94-13X	10/21/2002	220.4	
AOC_41	41M-94-13X	10/28/2003	221.2	
AOC_41	41M-94-13X	11/1/2004	222.4	
AOC_41	41M-94-13X	11/14/2005	224.0	
AOC_41	41M-94-13X	10/24/2006	222.7	
AOC_41	41M-94-14X	12/7/1995	223.2	
AOC_41	41M-94-14X	1/15/1997	223.6	
AOC_41	41M-94-14X	6/2/1997	223.4	
AOC_41	41M-94-14X	10/27/1997	222.6	
AOC_41	41M-94-14X	4/23/1998	223.7	
AOC_41	41M-94-14X	10/14/1998	223.1	
AOC_41	41M-94-14X	10/21/1998	222.9	
AOC_41	41M-94-14X	10/18/1999	224.0	
AOC_41	41M-94-14X	12/6/1999	223.9	
AOC_41	41M-94-14X	10/25/2000	225.1	
AOC_41	41M-94-14X	10/15/2001	222.1	
AOC_41	41M-94-14X	10/21/2002	223.7	
AOC_41	41M-94-14X	10/28/2003	223.1	
AOC_41	41M-94-14X	11/1/2004	224.4	
AOC_41	41M-94-14X	11/14/2005	224.5	
AOC_41	41M-94-14X	10/24/2006	223.0	
AOC_43A	43M-01-16XBR	1/30/2002	228.0	
AOC_43A	43M-01-16XBR	4/11/2002	228.4	
AOC_43A	43M-01-16XBR	7/10/2002	230.9	
AOC_43A	43M-01-16XBR	10/1/2002	230.2	
AOC_43A	43M-01-16XBR	3/27/2003	232.6	
AOC_43A	43M-01-16XBR	6/19/2003	233.4	
AOC_43A	43M-01-16XBR	9/23/2003	232.4	
AOC_43A	43M-01-16XBR	12/1/2003	231.9	
AOC_43A	43M-01-16XBR	10/7/2004	233.6	
AOC_43A	43M-01-16XBR	6/13/2005	234.6	
AOC_43A	43M-01-16XBR	10/3/2005	231.2	
AOC_43A	43M-01-16XBR	6/5/2006	235.3	
AOC_43A	43M-01-16XBR	6/7/2006	236.0	
AOC_43A	43M-01-16XBR	10/17/2006	232.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43A	43M-01-16XBR	10/19/2006	231.8	
AOC_43A	43M-01-16XBR	5/22/2007	235.0	
AOC_43A	43M-01-16XBR	5/23/2007	234.3	
AOC_43A	43M-01-16XBR	10/15/2007	230.3	
AOC_43A	43M-01-16XBR	10/16/2007	231.1	
AOC_43A	43M-01-16XBR	6/25/2008	233.1	
AOC_43A	43M-01-16XBR	6/26/2008	233.8	
AOC_43A	43M-01-16XBR	10/28/2008	233.0	
AOC_43A	43M-01-16XBR	10/29/2008	233.7	
AOC_43A	43M-01-16XBR	5/8/2009		211.2
AOC_43A	43M-01-16XBR	5/11/2009		211.9
AOC_43A	43M-01-16XBR	10/26/2009		210.1
AOC_43A	43M-01-16XBR	11/9/2009		210.8
AOC_43A	43M-01-16XBR	5/18/2010		214.5
AOC_43A	43M-01-16XBR	5/20/2010		213.8
AOC_43A	43M-01-16XBR	10/7/2010	230.9	
AOC_43A	43M-01-16XBR	10/19/2010	231.6	
AOC_43A	43M-01-16XBR	6/30/2011	233.0	
AOC_43A	43M-01-16XBR	10/13/2011	233.3	
AOC_43A	43M-01-16XBR	10/22/2012	229.8	
AOC_43A	43M-01-16XBR	6/11/2013	232.2	
AOC_43A	43M-01-16XBR	10/23/2013	230.4	
AOC_43A	43M-01-16XBR	6/17/2014	231.5	
AOC_43A	43M-01-16XBR	10/8/2015	231.2	
AOC_43A	43M-01-16XBR	5/17/2016	230.7	
AOC_43A	43M-01-16XBR	7/7/2017	233.1	
AOC_43A	43M-01-16XBR	4/9/2018	232.1	
AOC_43A	43M-01-16XBR	12/5/2018	235.6	
AOC_43A	43M-01-16XBR	4/8/2019	233.7	
AOC_43A	43M-01-16XBR	4/29/2020	232.7	
AOC_43A	43M-01-16XBR	5/14/2020	233.7	
AOC_43A	43M-01-16XOB	1/30/2002	227.9	
AOC_43A	43M-01-16XOB	4/11/2002	228.4	
AOC_43A	43M-01-16XOB	7/10/2002	230.8	
AOC_43A	43M-01-16XOB	10/1/2002	229.9	
AOC_43A	43M-01-16XOB	3/27/2003	232.4	
AOC_43A	43M-01-16XOB	6/19/2003	233.4	
AOC_43A	43M-01-16XOB	9/23/2003	232.4	
AOC_43A	43M-01-16XOB	12/1/2003	231.7	
AOC_43A	43M-01-16XOB	5/25/2004	233.0	
AOC_43A	43M-01-16XOB	10/7/2004	231.6	
AOC_43A	43M-01-16XOB	6/13/2005	234.4	
AOC_43A	43M-01-16XOB	10/3/2005	231.0	
AOC_43A	43M-01-16XOB	6/5/2006	234.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43A	43M-01-16XOB	6/8/2006	235.5	
AOC_43A	43M-01-16XOB	10/17/2006	232.4	
AOC_43A	43M-01-16XOB	10/19/2006	231.6	
AOC_43A	43M-01-16XOB	5/22/2007	235.0	
AOC_43A	43M-01-16XOB	5/23/2007	234.3	
AOC_43A	43M-01-16XOB	10/15/2007	230.2	
AOC_43A	43M-01-16XOB	10/16/2007	231.0	
AOC_43A	43M-01-16XOB	6/25/2008	233.0	
AOC_43A	43M-01-16XOB	6/26/2008	233.7	
AOC_43A	43M-01-16XOB	10/28/2008	232.9	
AOC_43A	43M-01-16XOB	10/29/2008	233.6	
AOC_43A	43M-01-16XOB	5/8/2009	233.6	
AOC_43A	43M-01-16XOB	5/11/2009	234.4	
AOC_43A	43M-01-16XOB	10/26/2009	231.2	
AOC_43A	43M-01-16XOB	11/9/2009	231.9	
AOC_43A	43M-01-16XOB	5/18/2010	235.6	
AOC_43A	43M-01-16XOB	5/20/2010	234.8	
AOC_43A	43M-01-16XOB	10/7/2010	230.5	
AOC_43A	43M-01-16XOB	10/19/2010	231.3	
AOC_43A	43M-01-16XOB	6/30/2011	233.0	
AOC_43A	43M-01-16XOB	10/13/2011	233.2	
AOC_43A	43M-01-16XOB	5/15/2012	231.4	
AOC_43A	43M-01-16XOB	10/22/2012	229.6	
AOC_43A	43M-01-16XOB	6/11/2013	232.6	
AOC_43A	43M-01-16XOB	10/23/2013	230.0	
AOC_43A	43M-01-16XOB	6/17/2014	231.5	
AOC_43A	43M-01-16XOB	10/8/2015	229.6	
AOC_43A	43M-01-16XOB	5/17/2016	230.6	
AOC_43A	43M-01-16XOB	7/7/2017	233.0	
AOC_43A	43M-01-16XOB	4/9/2018	232.3	
AOC_43A	43M-01-16XOB	12/5/2018	235.7	
AOC_43A	43M-01-16XOB	4/8/2019	233.4	
AOC_43A	43M-01-16XOB	4/29/2020	233.5	
AOC_43A	43M-01-16XOB	5/14/2020	233.5	
AOC_43A	43M-01-17XBR	1/30/2002	227.8	
AOC_43A	43M-01-17XBR	4/11/2002	228.2	
AOC_43A	43M-01-17XBR	7/10/2002	230.3	
AOC_43A	43M-01-17XBR	10/1/2002	229.8	
AOC_43A	43M-01-17XBR	3/27/2003	231.9	
AOC_43A	43M-01-17XBR	6/19/2003	233.1	
AOC_43A	43M-01-17XBR	9/23/2003	232.4	
AOC_43A	43M-01-17XBR	12/1/2003	231.7	
AOC_43A	43M-01-17XBR	5/25/2004	232.5	
AOC_43A	43M-01-17XBR	10/7/2004	231.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43A	43M-01-17XBR	6/13/2005	231.8	
AOC_43A	43M-01-17XBR	10/3/2005	231.2	
AOC_43A	43M-01-17XBR	6/5/2006	234.1	
AOC_43A	43M-01-17XBR	6/7/2006	234.8	
AOC_43A	43M-01-17XBR	10/17/2006	232.5	
AOC_43A	43M-01-17XBR	10/19/2006	231.8	
AOC_43A	43M-01-17XBR	5/22/2007	234.8	
AOC_43A	43M-01-17XBR	5/23/2007	234.1	
AOC_43A	43M-01-17XBR	10/15/2007	230.3	
AOC_43A	43M-01-17XBR	10/16/2007	231.1	
AOC_43A	43M-01-17XBR	6/25/2008	232.8	
AOC_43A	43M-01-17XBR	6/26/2008	233.6	
AOC_43A	43M-01-17XBR	10/28/2008	232.8	
AOC_43A	43M-01-17XBR	10/29/2008	233.6	
AOC_43A	43M-01-17XBR	5/8/2009	233.3	
AOC_43A	43M-01-17XBR	5/11/2009	234.1	
AOC_43A	43M-01-17XBR	10/26/2009	231.3	
AOC_43A	43M-01-17XBR	11/9/2009	232.1	
AOC_43A	43M-01-17XBR	5/18/2010		218.9
AOC_43A	43M-01-17XBR	5/20/2010		218.2
AOC_43A	43M-01-17XBR	10/7/2010	230.6	
AOC_43A	43M-01-17XBR	10/19/2010	231.4	
AOC_43A	43M-01-17XBR	6/30/2011	232.8	
AOC_43A	43M-01-17XBR	10/13/2011	233.2	
AOC_43A	43M-01-17XBR	10/22/2012	229.7	
AOC_43A	43M-01-17XBR	6/11/2013	231.9	
AOC_43A	43M-01-17XBR	10/23/2013	230.1	
AOC_43A	43M-01-17XBR	6/17/2014	231.4	
AOC_43A	43M-01-17XBR	10/8/2015	230.5	
AOC_43A	43M-01-17XBR	5/17/2016	230.3	
AOC_43A	43M-01-17XBR	7/7/2017	232.8	
AOC_43A	43M-01-17XBR	4/9/2018	231.8	
AOC_43A	43M-01-17XBR	12/5/2018	235.2	
AOC_43A	43M-01-17XBR	4/8/2019	233.7	
AOC_43A	43M-01-17XBR	4/29/2020	232.6	
AOC_43A	43M-01-17XBR	5/14/2020	233.4	
AOC_43A	43M-01-17XOB	1/30/2002	227.3	
AOC_43A	43M-01-17XOB	4/11/2002	227.8	
AOC_43A	43M-01-17XOB	7/10/2002	230.0	
AOC_43A	43M-01-17XOB	10/1/2002	229.7	
AOC_43A	43M-01-17XOB	3/27/2003	231.8	
AOC_43A	43M-01-17XOB	6/19/2003	233.0	
AOC_43A	43M-01-17XOB	9/23/2003	232.3	
AOC_43A	43M-01-17XOB	12/1/2003	231.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43A	43M-01-17XOB	5/25/2004	232.5	
AOC_43A	43M-01-17XOB	10/7/2004	231.4	
AOC_43A	43M-01-17XOB	6/13/2005	234.2	
AOC_43A	43M-01-17XOB	10/3/2005	231.0	
AOC_43A	43M-01-17XOB	6/5/2006	234.1	
AOC_43A	43M-01-17XOB	6/7/2006	234.9	
AOC_43A	43M-01-17XOB	10/17/2006	232.3	
AOC_43A	43M-01-17XOB	10/19/2006	231.5	
AOC_43A	43M-01-17XOB	5/22/2007	234.5	
AOC_43A	43M-01-17XOB	5/23/2007	233.7	
AOC_43A	43M-01-17XOB	10/15/2007	230.2	
AOC_43A	43M-01-17XOB	10/16/2007	231.0	
AOC_43A	43M-01-17XOB	6/25/2008	232.8	
AOC_43A	43M-01-17XOB	6/26/2008	233.6	
AOC_43A	43M-01-17XOB	10/28/2008	232.7	
AOC_43A	43M-01-17XOB	10/29/2008	233.5	
AOC_43A	43M-01-17XOB	5/8/2009	233.2	
AOC_43A	43M-01-17XOB	5/11/2009	234.0	
AOC_43A	43M-01-17XOB	10/26/2009	231.1	
AOC_43A	43M-01-17XOB	11/9/2009	231.9	
AOC_43A	43M-01-17XOB	5/18/2010	235.5	
AOC_43A	43M-01-17XOB	5/20/2010	234.7	
AOC_43A	43M-01-17XOB	10/7/2010	230.5	
AOC_43A	43M-01-17XOB	10/19/2010	231.3	
AOC_43A	43M-01-17XOB	6/30/2011	232.7	
AOC_43A	43M-01-17XOB	10/13/2011	233.1	
AOC_43A	43M-01-17XOB	5/15/2012	231.2	
AOC_43A	43M-01-17XOB	10/22/2012	229.5	
AOC_43A	43M-01-17XOB	6/11/2013	231.8	
AOC_43A	43M-01-17XOB	10/23/2013	229.9	
AOC_43A	43M-01-17XOB	6/17/2014	231.1	
AOC_43A	43M-01-17XOB	10/8/2015	229.5	
AOC_43A	43M-01-17XOB	5/17/2016	230.2	
AOC_43A	43M-01-17XOB	7/7/2017	232.7	
AOC_43A	43M-01-17XOB	4/9/2018	231.9	
AOC_43A	43M-01-17XOB	12/5/2018	234.2	
AOC_43A	43M-01-17XOB	4/8/2019	233.1	
AOC_43A	43M-01-17XOB	4/29/2020	233.1	
AOC_43A	43M-01-17XOB	5/14/2020	233.1	
AOC_43A	43M-01-20XBR	1/30/2002	226.9	
AOC_43A	43M-01-20XBR	4/11/2002	223.4	
AOC_43A	43M-01-20XBR	7/10/2002	229.5	
AOC_43A	43M-01-20XBR	10/1/2002	229.4	
AOC_43A	43M-01-20XBR	3/27/2003	231.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43A	43M-01-20XBR	6/19/2003	232.5	
AOC_43A	43M-01-20XBR	9/23/2003	231.9	
AOC_43A	43M-01-20XBR	12/1/2003	231.2	
AOC_43A	43M-01-20XBR	5/25/2004	231.9	
AOC_43A	43M-01-20XBR	10/7/2004	231.0	
AOC_43A	43M-01-20XBR	6/13/2005	233.6	
AOC_43A	43M-01-20XBR	10/3/2005	230.6	
AOC_43A	43M-01-20XBR	6/5/2006	233.7	
AOC_43A	43M-01-20XBR	6/7/2006	234.5	
AOC_43A	43M-01-20XBR	10/17/2006	232.0	
AOC_43A	43M-01-20XBR	10/19/2006	231.2	
AOC_43A	43M-01-20XBR	5/22/2007	228.2	
AOC_43A	43M-01-20XBR	5/23/2007	227.4	
AOC_43A	43M-01-20XBR	6/25/2008	223.4	
AOC_43A	43M-01-20XBR	6/26/2008	224.2	
AOC_43A	43M-01-20XBR	10/28/2008	232.4	
AOC_43A	43M-01-20XBR	10/29/2008		
AOC_43A	43M-01-20XBR	5/8/2009	232.8	
AOC_43A	43M-01-20XBR	5/11/2009	233.6	
AOC_43A	43M-01-20XBR	10/26/2009	230.6	
AOC_43A	43M-01-20XBR	11/9/2009	231.6	
AOC_43A	43M-01-20XBR	5/18/2010	235.0	
AOC_43A	43M-01-20XBR	5/20/2010	234.2	
AOC_43A	43M-01-20XBR	10/7/2010	230.2	
AOC_43A	43M-01-20XBR	10/19/2010	231.0	
AOC_43A	43M-01-20XBR	6/30/2011	232.3	
AOC_43A	43M-01-20XBR	10/13/2011	232.7	
AOC_43A	43M-01-20XBR	5/15/2012	230.9	
AOC_43A	43M-01-20XBR	10/22/2012	229.3	
AOC_43A	43M-01-20XBR	6/11/2013	231.6	
AOC_43A	43M-01-20XBR	10/23/2013	229.6	
AOC_43A	43M-01-20XBR	6/17/2014	230.7	
AOC_43A	43M-01-20XBR	10/8/2015	229.2	
AOC_43A	43M-01-20XBR	5/17/2016	229.8	
AOC_43A	43M-01-20XBR	7/7/2017	232.2	
AOC_43A	43M-01-20XBR	4/9/2018	231.4	
AOC_43A	43M-01-20XBR	12/5/2018	232.7	
AOC_43A	43M-01-20XBR	4/8/2019	231.7	
AOC_43A	43M-01-20XBR	4/29/2020	232.6	
AOC_43A	43M-01-20XBR	5/14/2020	232.6	
AOC_43A	43M-01-20XOB	1/30/2002	227.0	
AOC_43A	43M-01-20XOB	4/11/2002	227.6	
AOC_43A	43M-01-20XOB	7/10/2002	229.6	
AOC_43A	43M-01-20XOB	10/1/2002	228.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43A	43M-01-20XOB	3/27/2003	231.1	
AOC_43A	43M-01-20XOB	6/19/2003	232.1	
AOC_43A	43M-01-20XOB	9/23/2003	231.6	
AOC_43A	43M-01-20XOB	12/1/2003	230.9	
AOC_43A	43M-01-20XOB	5/25/2004	231.6	
AOC_43A	43M-01-20XOB	10/7/2004	230.7	
AOC_43A	43M-01-20XOB	6/13/2005	233.2	
AOC_43A	43M-01-20XOB	6/5/2006	233.7	
AOC_43A	43M-01-20XOB	6/7/2006	234.7	
AOC_43A	43M-01-20XOB	10/17/2006	232.2	
AOC_43A	43M-01-20XOB	10/19/2006	231.2	
AOC_43A	43M-01-20XOB	5/22/2007	234.4	
AOC_43A	43M-01-20XOB	5/23/2007	233.3	
AOC_43A	43M-01-20XOB	10/15/2007	229.8	
AOC_43A	43M-01-20XOB	10/16/2007	230.9	
AOC_43A	43M-01-20XOB	6/25/2008	232.3	
AOC_43A	43M-01-20XOB	6/26/2008	233.4	
AOC_43A	43M-01-20XOB	10/28/2008	232.3	
AOC_43A	43M-01-20XOB	10/29/2008	233.4	
AOC_43A	43M-01-20XOB	5/8/2009	232.7	
AOC_43A	43M-01-20XOB	5/11/2009	233.8	
AOC_43A	43M-01-20XOB	10/26/2009	230.9	
AOC_43A	43M-01-20XOB	11/9/2009	231.8	
AOC_43A	43M-01-20XOB	5/18/2010	235.1	
AOC_43A	43M-01-20XOB	5/20/2010	234.1	
AOC_43A	43M-01-20XOB	10/7/2010	230.1	
AOC_43A	43M-01-20XOB	10/19/2010	231.2	
AOC_43A	43M-01-20XOB	6/30/2011	232.2	
AOC_43A	43M-01-20XOB	10/13/2011	232.7	
AOC_43A	43M-01-20XOB	5/15/2012	230.8	
AOC_43A	43M-01-20XOB	10/22/2012	228.9	
AOC_43A	43M-01-20XOB	6/11/2013	231.5	
AOC_43A	43M-01-20XOB	10/23/2013	229.5	
AOC_43A	43M-01-20XOB	6/17/2014	230.7	
AOC_43A	43M-01-20XOB	10/8/2015	229.2	
AOC_43A	43M-01-20XOB	5/17/2016	229.7	
AOC_43A	43M-01-20XOB	7/7/2017	232.2	
AOC_43A	43M-01-20XOB	4/9/2018	231.3	
AOC_43A	43M-01-20XOB	12/5/2018	231.5	
AOC_43A	43M-01-20XOB	4/8/2019	232.7	
AOC_43A	43M-01-20XOB	4/29/2020	232.5	
AOC_43A	43M-01-20XOB	5/14/2020	232.5	
AOC_43A	43MA93-05X	11/8/1993	224.7	
AOC_43A	43MA93-05X	6/28/1994	227.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43A	43MA93-05X	10/4/1994	226.4	
AOC_43A	43MA93-05X	1/31/1995	226.7	
AOC_43A	43MA93-05X	5/9/1995	226.5	
AOC_43A	43MA93-05X	12/7/1995	225.7	
AOC_43A	43MA93-05X	7/23/1996	228.0	
AOC_43A	43MA93-05X	1/15/1997	229.2	
AOC_43A	43MA93-05X	6/2/1997	228.8	
AOC_43A	43MA93-06X	11/8/1993	226.1	
AOC_43A	43MA93-06X	6/28/1994	229.5	
AOC_43A	43MA93-06X	10/4/1994	228.0	
AOC_43A	43MA93-06X	1/31/1995	228.2	
AOC_43A	43MA93-06X	5/9/1995	228.1	
AOC_43A	43MA93-06X	12/7/1995	226.9	
AOC_43A	43MA93-06X	7/23/1996	230.1	
AOC_43A	43MA93-06X	1/15/1997	231.6	
AOC_43A	43MA93-06X	6/2/1997	231.1	
AOC_43A	43MA93-08X	11/8/1993	227.3	
AOC_43A	43MA93-08X	6/28/1994	230.9	
AOC_43A	43MA93-08X	10/4/1994	229.3	
AOC_43A	43MA93-08X	1/31/1995	229.9	
AOC_43A	43MA93-08X	5/9/1995	229.4	
AOC_43A	43MA93-08X	12/7/1995	228.6	
AOC_43A	43MA93-08X	3/26/1996	231.6	
AOC_43G	43GPZ-19-01	6/28/2019	262.0	
AOC_43G	43GPZ-19-01	10/2/2019	262.1	
AOC_43G	43GPZ-19-01	1/2/2020	263.1	
AOC_43G	43GPZ-19-01	2/20/2020	261.9	
AOC_43G	43GPZ-19-01	3/13/2020	262.0	
AOC_43G	43GPZ-19-01	8/31/2020	261.9	
AOC_43G	43GPZ-19-02	6/28/2019	265.9	
AOC_43G	43GPZ-19-02	10/2/2019	261.6	
AOC_43G	43GPZ-19-02	1/2/2020	263.1	
AOC_43G	43GPZ-19-02	2/20/2020	262.2	
AOC_43G	43GPZ-19-02	3/13/2020	262.2	
AOC_43G	43GPZ-19-02	8/31/2020	261.4	
AOC_43G	43GPZ-19-03	6/28/2019	285.0	
AOC_43G	43GPZ-19-03	10/2/2019	283.7	
AOC_43G	43GPZ-19-03	1/2/2020	286.0	
AOC_43G	43GPZ-19-03	2/20/2020	285.4	
AOC_43G	43GPZ-19-03	3/13/2020	285.3	
AOC_43G	43GPZ-19-03	8/31/2020	283.6	
AOC_43G	43GPZ-19-04	6/28/2019	249.7	
AOC_43G	43GPZ-19-04	10/2/2019	247.1	
AOC_43G	43GPZ-19-04	1/2/2020	249.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43G	43GPZ-19-04	2/20/2020	249.6	
AOC_43G	43GPZ-19-04	3/13/2020	249.5	
AOC_43G	43GPZ-19-04	8/31/2020	246.8	
AOC_43G	43GPZ-19-05	6/28/2019	246.9	
AOC_43G	43GPZ-19-05	10/2/2019	245.2	
AOC_43G	43GPZ-19-05	1/2/2020	247.6	
AOC_43G	43GPZ-19-05	2/20/2020	247.4	
AOC_43G	43GPZ-19-05	3/13/2020	247.2	
AOC_43G	43GPZ-19-05	8/31/2020	245.1	
AOC_43G	43GPZ-19-06	6/28/2019	245.2	
AOC_43G	43GPZ-19-06	10/2/2019	244.3	
AOC_43G	43GPZ-19-06	1/2/2020	245.8	
AOC_43G	43GPZ-19-06	2/20/2020	245.8	
AOC_43G	43GPZ-19-06	3/13/2020	245.8	
AOC_43G	43GPZ-19-06	8/31/2020	243.2	
AOC_43G	43GPZ-19-07	1/2/2020	245.2	
AOC_43G	43GPZ-19-07	2/20/2020	245.3	
AOC_43G	43GPZ-19-07	3/12/2020	245.2	
AOC_43G	43GPZ-19-07	3/13/2020	245.4	
AOC_43G	43GPZ-19-07	8/31/2020	243.2	
AOC_43G	43GPZ-19-08	1/2/2020	246.7	
AOC_43G	43GPZ-19-08	2/20/2020	246.4	
AOC_43G	43GPZ-19-08	3/13/2020	246.3	
AOC_43G	43GPZ-19-08	8/31/2020	242.8	
AOC_43G	AAFES-2	10/12/2005	276.8	
AOC_43G	AAFES-2	10/16/2006	277.9	
AOC_43G	AAFES-2	10/18/2007	277.3	
AOC_43G	AAFES-2	10/27/2008	279.1	
AOC_43G	AAFES-2	11/24/2009	280.2	
AOC_43G	AAFES-2	10/20/2010	280.5	
AOC_43G	AAFES-2	10/24/2013	276.3	
AOC_43G	AAFES-2	10/21/2014	277.5	
AOC_43G	AAFES-2	10/8/2015	279.7	
AOC_43G	AAFES-2	10/14/2016	276.8	
AOC_43G	AAFES-2	10/24/2017	276.2	
AOC_43G	AAFES-2	10/10/2018	279.6	
AOC_43G	AAFES-2	6/28/2019	279.1	
AOC_43G	AAFES-2	10/2/2019	276.3	
AOC_43G	AAFES-2	1/2/2020	280.1	
AOC_43G	AAFES-2	2/20/2020	279.1	
AOC_43G	AAFES-5	10/12/2005	276.6	
AOC_43G	AAFES-5	10/16/2006	277.7	
AOC_43G	AAFES-5	10/18/2007	277.2	
AOC_43G	AAFES-5	10/27/2008	278.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43G	AAFES-5	11/24/2009	279.0	
AOC_43G	AAFES-5	10/20/2010	279.1	
AOC_43G	AAFES-5	10/24/2013	276.2	
AOC_43G	AAFES-5	10/21/2014	277.1	
AOC_43G	AAFES-5	10/8/2015	279.1	
AOC_43G	AAFES-5	10/14/2016	276.4	
AOC_43G	AAFES-5	10/24/2017	276.3	
AOC_43G	AAFES-5	10/10/2018	278.2	
AOC_43G	AAFES-5	6/28/2019	277.8	
AOC_43G	AAFES-5	10/2/2019	276.3	
AOC_43G	AAFES-5	1/2/2020	278.3	
AOC_43G	AAFES-5	2/20/2020	277.8	
AOC_43G	AAFES-5	3/13/2020	278.7	
AOC_43G	AAFES-5	8/31/2020	276.2	
AOC_43G	AAFES-6R	10/18/2007		
AOC_43G	AAFES-6R	10/27/2008		
AOC_43G	AAFES-6R	11/24/2009		
AOC_43G	AAFES-6R	10/20/2010		
AOC_43G	AAFES-6R	10/24/2013	276.6	
AOC_43G	AAFES-6R	10/21/2014	278.1	
AOC_43G	AAFES-6R	10/8/2015	280.4	
AOC_43G	AAFES-6R	10/14/2016	276.4	
AOC_43G	AAFES-6R	10/24/2017	276.9	
AOC_43G	AAFES-6R	10/10/2018	280.4	
AOC_43G	AAFES-6R	10/2/2019	277.0	
AOC_43G	AAFES-6R	1/2/2020	281.2	
AOC_43G	AAFES-6R	2/20/2020	279.0	
AOC_43G	AAFES-7	6/27/2008	251.0	
AOC_43G	AAFES-7	10/27/2009	251.4	
AOC_43G	AAFES-7	11/24/2009	251.5	
AOC_43G	AAFES-7	10/20/2010	250.6	
AOC_43G	AAFES-7	10/24/2013	247.4	
AOC_43G	AAFES-7	10/21/2014	247.6	
AOC_43G	AAFES-7	10/8/2015	248.2	
AOC_43G	AAFES-7	10/14/2016	245.5	
AOC_43G	AAFES-7	10/24/2017	247.4	
AOC_43G	AAFES-7	10/10/2018	251.4	
AOC_43G	AAFES-7	6/28/2019	250.8	
AOC_43G	AAFES-7	10/2/2019	248.0	
AOC_43G	AAFES-7	1/2/2020	251.6	
AOC_43G	AAFES-7	2/20/2020	251.0	
AOC_43G	AAFES-7	3/13/2020	250.8	
AOC_43G	AAFES-7	8/31/2020	247.4	
AOC_43G	XGM-20-01A	2/20/2020	250.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43G	XGM-20-01A	3/13/2020	250.0	
AOC_43G	XGM-20-01A	8/31/2020	246.2	
AOC_43G	XGM-20-02A	2/20/2020	253.0	
AOC_43G	XGM-20-02A	3/13/2020	252.7	
AOC_43G	XGM-20-02A	8/31/2020	248.5	
AOC_43G	XGM-20-03A	2/20/2020	254.0	
AOC_43G	XGM-20-03A	3/13/2020	253.9	
AOC_43G	XGM-20-03A	8/31/2020	250.0	
AOC_43G	XGM-93-02X	10/12/2005	279.1	
AOC_43G	XGM-93-02X	10/16/2006	279.2	
AOC_43G	XGM-93-02X	10/18/2007	278.9	
AOC_43G	XGM-93-02X	10/27/2008	279.7	
AOC_43G	XGM-93-02X	11/24/2009	281.0	
AOC_43G	XGM-93-02X	10/20/2010	281.3	
AOC_43G	XGM-93-02X	10/24/2013	278.4	
AOC_43G	XGM-93-02X	10/21/2014	278.9	
AOC_43G	XGM-93-02X	10/8/2015	280.8	
AOC_43G	XGM-93-02X	10/14/2016	278.6	
AOC_43G	XGM-93-02X	10/24/2017	278.3	
AOC_43G	XGM-93-02X	10/10/2018	281.1	
AOC_43G	XGM-93-02X	10/2/2019	279.8	
AOC_43G	XGM-93-02X	1/2/2020	281.7	
AOC_43G	XGM-94-04X	10/12/2005	279.9	
AOC_43G	XGM-94-04X	10/16/2006	280.1	
AOC_43G	XGM-94-04X	10/18/2007	279.7	
AOC_43G	XGM-94-04X	10/27/2008	281.1	
AOC_43G	XGM-94-04X	11/24/2009	282.0	
AOC_43G	XGM-94-04X	10/20/2010	282.2	
AOC_43G	XGM-94-04X	10/24/2013	278.5	
AOC_43G	XGM-94-04X	10/21/2014	279.4	
AOC_43G	XGM-94-04X	10/8/2015	282.0	
AOC_43G	XGM-94-04X	10/14/2016	278.6	
AOC_43G	XGM-94-04X	10/24/2017	278.8	
AOC_43G	XGM-94-04X	10/10/2018	282.0	
AOC_43G	XGM-94-04X	6/28/2019	281.3	
AOC_43G	XGM-94-04X	10/2/2019	279.1	
AOC_43G	XGM-94-04X	1/2/2020	282.3	
AOC_43G	XGM-94-04X	2/20/2020	281.5	
AOC_43G	XGM-94-04X	3/13/2020	281.1	
AOC_43G	XGM-94-04X	8/31/2020	279.1	
AOC_43G	XGM-94-06X	6/27/2008	263.4	
AOC_43G	XGM-94-06X	10/27/2008	263.5	
AOC_43G	XGM-94-06X	6/28/2019	262.9	
AOC_43G	XGM-94-06X	10/2/2019	259.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43G	XGM-94-06X	1/2/2020	265.7	
AOC_43G	XGM-94-06X	2/20/2020	263.8	
AOC_43G	XGM-94-06X	3/13/2020	263.8	
AOC_43G	XGM-94-06X	8/31/2020	259.2	
AOC_43G	XGM-94-07X	10/12/2005	274.0	
AOC_43G	XGM-94-07X	10/16/2006	274.4	
AOC_43G	XGM-94-07X	10/18/2007	274.1	
AOC_43G	XGM-94-07X	10/27/2008	275.5	
AOC_43G	XGM-94-07X	11/24/2009	276.1	
AOC_43G	XGM-94-07X	10/15/2010	276.1	
AOC_43G	XGM-94-07X	10/24/2013		
AOC_43G	XGM-94-07X	10/21/2014	273.9	
AOC_43G	XGM-94-07X	10/8/2015	277.9	
AOC_43G	XGM-94-07X	10/14/2016	273.2	
AOC_43G	XGM-94-07X	10/24/2017	273.1	
AOC_43G	XGM-94-07X	10/10/2018	275.4	
AOC_43G	XGM-94-07X	6/28/2019	280.1	
AOC_43G	XGM-94-07X	10/2/2019	273.3	
AOC_43G	XGM-94-07X	1/2/2020	275.7	
AOC_43G	XGM-94-07X	2/20/2020	275.3	
AOC_43G	XGM-94-07X	8/31/2020	272.9	
AOC_43G	XGM-94-08X	10/12/2005	272.7	
AOC_43G	XGM-94-08X	10/16/2006	272.4	
AOC_43G	XGM-94-08X	10/18/2007	275.5	
AOC_43G	XGM-94-08X	10/27/2008	273.3	
AOC_43G	XGM-94-08X	11/24/2009	274.4	
AOC_43G	XGM-94-08X	10/20/2010	274.4	
AOC_43G	XGM-94-08X	10/24/2013	271.2	
AOC_43G	XGM-94-08X	10/21/2014	272.2	
AOC_43G	XGM-94-08X	10/8/2015	273.4	
AOC_43G	XGM-94-08X	10/14/2016	271.6	
AOC_43G	XGM-94-08X	10/24/2017	271.2	
AOC_43G	XGM-94-08X	10/10/2018	273.9	
AOC_43G	XGM-94-08X	6/28/2019	272.9	
AOC_43G	XGM-94-08X	10/2/2019	271.5	
AOC_43G	XGM-94-08X	1/2/2020	274.8	
AOC_43G	XGM-94-08X	2/20/2020	273.2	
AOC_43G	XGM-94-10X	10/12/2005	278.2	
AOC_43G	XGM-94-10X	10/16/2006	276.8	
AOC_43G	XGM-94-10X	10/18/2007	275.9	
AOC_43G	XGM-94-10X	10/27/2008	277.1	
AOC_43G	XGM-94-10X	11/24/2009		
AOC_43G	XGM-94-10X	10/20/2010	278.2	
AOC_43G	XGM-94-10X	10/24/2013	275.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_43G	XGM-94-10X	10/21/2014	275.8	
AOC_43G	XGM-94-10X	10/8/2015	277.0	
AOC_43G	XGM-94-10X	10/14/2016	275.3	
AOC_43G	XGM-94-10X	10/24/2017	275.3	
AOC_43G	XGM-94-10X	10/10/2018	277.9	
AOC_43G	XGM-94-10X	6/28/2019	276.8	
AOC_43G	XGM-94-10X	10/2/2019	275.3	
AOC_43G	XGM-94-10X	1/2/2020	278.9	
AOC_43G	XGM-94-10X	2/20/2020	277.4	
AOC_43G	XGM-94-10X	3/13/2020	277.4	
AOC_43G	XGM-94-10X	8/31/2020	275.2	
AOC_43G	XGM-97-12X	10/12/2005	282.1	
AOC_43G	XGM-97-12X	10/16/2006	282.1	
AOC_43G	XGM-97-12X	10/18/2007	282.0	
AOC_43G	XGM-97-12X	10/27/2008	284.0	
AOC_43G	XGM-97-12X	11/24/2009	284.3	
AOC_43G	XGM-97-12X	10/20/2010	284.3	
AOC_43G	XGM-97-12X	10/24/2013	281.4	
AOC_43G	XGM-97-12X	10/21/2014	281.8	
AOC_43G	XGM-97-12X	10/8/2015	283.5	
AOC_43G	XGM-97-12X	10/14/2016	281.4	
AOC_43G	XGM-97-12X	10/24/2017	281.5	
AOC_43G	XGM-97-12X	10/10/2018	284.4	
AOC_43G	XGM-97-12X	6/28/2019	283.6	
AOC_43G	XGM-97-12X	10/2/2019	281.5	
AOC_43G	XGM-97-12X	1/2/2020	284.5	
AOC_43G	XGM-97-12X	2/20/2020	284.0	
AOC_43J	2446-03	10/12/2005	361.6	
AOC_43J	HA-3B	3/13/2020	356.9	
AOC_43J	HA-3S	3/13/2020	354.5	
AOC_43J	HA-4B	3/13/2020	359.3	
AOC_43J	HA-4S	3/13/2020	357.7	
AOC_43J	XJM-93-01X	3/13/2020	364.4	
AOC_43J	XJM-93-04X	3/13/2020	364.1	
AOC_43J	XJM-94-07X	3/13/2020	357.1	
AOC_43J	XJM-94-08X	10/12/2005	358.6	
AOC_43J	XJM-94-08X	3/13/2020	358.7	
AOC_43J	XJM-94-10X	10/12/2005	359.8	
AOC_43J	XJM-94-10X	3/13/2020	361.6	
AOC_43J	XJM-97-11X	10/12/2005	361.3	
AOC_43J	XJM-97-11X	3/13/2020	361.9	
AOC_43J	XJM-97-12X	10/12/2005	362.6	
AOC_43J	XJM-97-13X	10/12/2005	359.1	
AOC_43J	XJM-97-13X	3/13/2020	359.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	3-1	4/28/2009	246.4	
AOC_5	3-1	8/5/2009	243.1	
AOC_5	3-1	9/9/2009	239.1	
AOC_5	3-1	3/17/2010	249.1	
AOC_5	3-2	4/28/2009	245.7	
AOC_5	3-2	9/9/2009	238.0	
AOC_5	3-2	3/17/2010	248.5	
AOC_5	3-2	6/24/2016	240.1	
AOC_5	3-2	11/15/2016	231.3	
AOC_5	3-2	11/1/2018	241.1	
AOC_5	3-2	10/22/2019	228.7	
AOC_5	20-1	10/23/2008	263.7	
AOC_5	20-1	4/24/2009	259.6	
AOC_5	20-1	4/28/2009	263.4	
AOC_5	20-1	5/21/2009	261.6	
AOC_5	20-1	8/4/2009	261.9	
AOC_5	20-1	8/5/2009	260.6	
AOC_5	20-1	9/9/2009	250.2	
AOC_5	20-1	9/10/2009	260.2	
AOC_5	20-1	3/17/2010	268.9	
AOC_5	20-1	6/24/2016	250.3	
AOC_5	20-1	11/15/2016	234.4	
AOC_5	20-1	5/22/2017	260.7	
AOC_5	20-1	11/1/2018	260.2	
AOC_5	20-1	10/22/2019	239.0	
AOC_5	20-2	10/23/2008	262.4	
AOC_5	20-2	4/24/2009	254.9	
AOC_5	20-2	4/28/2009	264.0	
AOC_5	20-2	5/21/2009	259.7	
AOC_5	20-2	8/4/2009	259.5	
AOC_5	20-2	8/5/2009	262.2	
AOC_5	20-2	9/9/2009	250.5	
AOC_5	20-2	9/10/2009	249.1	
AOC_5	20-2	3/17/2010	270.5	
AOC_5	27-1	4/28/2009	268.6	
AOC_5	27-1	8/5/2009	264.8	
AOC_5	27-1	9/9/2009	253.3	
AOC_5	27-1	3/17/2010	272.6	
AOC_5	27-1	6/24/2016	239.5	
AOC_5	27-1	11/15/2016	220.4	
AOC_5	27-1	5/22/2017	259.0	
AOC_5	27-1	11/1/2018	258.1	
AOC_5	27-1	10/22/2019	229.5	
AOC_5	27-2	4/28/2009	266.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	27-2	8/5/2009	263.6	
AOC_5	27-2	9/9/2009	252.9	
AOC_5	27-2	3/17/2010	268.9	
AOC_5	27-2	6/24/2016	250.8	
AOC_5	27-2	11/15/2016	232.4	
AOC_5	27-2	5/22/2017	255.8	
AOC_5	27-2	11/1/2018	254.2	
AOC_5	27-2	10/22/2019	227.7	
AOC_5	27-30B-1	10/23/2008	261.1	
AOC_5	27-30B-1	4/24/2009	253.3	
AOC_5	27-30B-1	5/21/2009	258.5	
AOC_5	27-30B-1	8/4/2009	258.1	
AOC_5	27-30B-1	8/5/2009	261.0	
AOC_5	27-30B-1	9/9/2009	250.0	
AOC_5	27-30B-1	9/10/2009	247.2	
AOC_5	27-30B-1	3/17/2010	267.7	
AOC_5	27-30B-2	10/23/2008	261.0	
AOC_5	27-30B-2	4/24/2009	252.8	
AOC_5	27-30B-2	8/4/2009	257.1	
AOC_5	27-30B-2	8/5/2009	261.0	
AOC_5	27-30B-2	3/17/2010	268.7	
AOC_5	3A-1	4/28/2009	245.3	
AOC_5	3A-1	9/9/2009	237.3	
AOC_5	3A-1	3/17/2010	248.4	
AOC_5	3A-2	4/28/2009	245.9	
AOC_5	3A-2	8/5/2009	242.4	
AOC_5	3A-2	9/9/2009	238.2	
AOC_5	3A-2	3/17/2010	248.9	
AOC_5	CAP-1B	4/28/2009	241.7	
AOC_5	CAP-1B	9/9/2009	234.1	
AOC_5	CAP-1B	3/17/2010	242.7	
AOC_5	CAP-2B	4/28/2009	247.0	
AOC_5	CAP-2B	8/5/2009	243.3	
AOC_5	CAP-2B	9/9/2009	238.0	
AOC_5	CAP-2B	3/17/2010	247.7	
AOC_5	CAP-2B	6/24/2016	235.8	
AOC_5	CAP-2B	11/15/2016		
AOC_5	CAP-2B	5/22/2017	242.9	
AOC_5	CAP-2B	11/1/2018	240.9	
AOC_5	CAP-2B	10/22/2019	227.4	
AOC_5	CAP-3	4/28/2009	244.7	
AOC_5	CAP-3	8/5/2009	250.8	
AOC_5	CAP-3	9/9/2009	237.4	
AOC_5	CAP-3	3/17/2010	247.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	CAP-4	4/28/2009	245.2	
AOC_5	CAP-4	3/17/2010	247.4	
AOC_5	CH-1D	10/13/2009	233.4	
AOC_5	CH-1D	11/2/2009	231.7	
AOC_5	CH-1D	3/17/2010	248.7	
AOC_5	CH-1D	10/7/2015	228.6	
AOC_5	CH-1D	12/16/2015	231.8	
AOC_5	CH-1D	6/24/2016	236.4	
AOC_5	CH-1D	11/16/2016	213.7	
AOC_5	CH-1D	5/22/2017	242.5	
AOC_5	CH-1D	11/1/2018	240.9	
AOC_5	CH-1D	10/22/2019	228.8	
AOC_5	CH-1S	10/13/2009	231.8	
AOC_5	CH-1S	11/2/2009	231.6	
AOC_5	CH-1S	3/17/2010	248.4	
AOC_5	CH-1S	6/24/2016		
AOC_5	CH-1S	11/16/2016	216.3	
AOC_5	CH-1S	5/22/2017	242.2	
AOC_5	CH-1S	11/1/2018	240.7	
AOC_5	CH-1S	10/22/2019	228.6	
AOC_5	EPA-PZ-2012-1A	6/19/2012	212.6	
AOC_5	EPA-PZ-2012-1A	9/11/2012	211.4	
AOC_5	EPA-PZ-2012-1A	11/5/2012	212.9	
AOC_5	EPA-PZ-2012-1A	11/6/2012	213.0	
AOC_5	EPA-PZ-2012-1A	3/13/2013	213.4	
AOC_5	EPA-PZ-2012-1A	4/23/2013	212.7	
AOC_5	EPA-PZ-2012-1A	4/25/2013	212.7	
AOC_5	EPA-PZ-2012-1A	5/15/2013	212.2	
AOC_5	EPA-PZ-2012-1A	5/30/2013	213.1	
AOC_5	EPA-PZ-2012-1A	4/22/2014	213.7	
AOC_5	EPA-PZ-2012-1A	10/6/2014	211.4	
AOC_5	EPA-PZ-2012-1A	6/4/2015	212.6	
AOC_5	EPA-PZ-2012-1A	6/17/2015	212.4	
AOC_5	EPA-PZ-2012-1A	10/20/2015	211.3	
AOC_5	EPA-PZ-2012-1A	12/16/2015	211.7	
AOC_5	EPA-PZ-2012-1A	6/9/2016	212.2	
AOC_5	EPA-PZ-2012-1A	6/23/2016	211.7	
AOC_5	EPA-PZ-2012-1A	8/16/2016	211.0	
AOC_5	EPA-PZ-2012-1A	11/16/2016	212.1	
AOC_5	EPA-PZ-2012-1A	5/22/2017	213.4	
AOC_5	EPA-PZ-2012-1A	5/11/2018	213.5	
AOC_5	EPA-PZ-2012-1A	11/1/2018	213.1	
AOC_5	EPA-PZ-2012-1A	4/11/2019	213.0	
AOC_5	EPA-PZ-2012-1A	10/22/2019	211.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-1A	5/18/2020	213.4	
AOC_5	EPA-PZ-2012-1A	5/19/2020	213.5	
AOC_5	EPA-PZ-2012-1B	6/19/2012	212.4	
AOC_5	EPA-PZ-2012-1B	9/11/2012	211.4	
AOC_5	EPA-PZ-2012-1B	11/5/2012	213.0	
AOC_5	EPA-PZ-2012-1B	11/6/2012	212.9	
AOC_5	EPA-PZ-2012-1B	3/13/2013	213.3	
AOC_5	EPA-PZ-2012-1B	4/23/2013	212.7	
AOC_5	EPA-PZ-2012-1B	4/25/2013	212.7	
AOC_5	EPA-PZ-2012-1B	5/15/2013	212.2	
AOC_5	EPA-PZ-2012-1B	5/30/2013	213.1	
AOC_5	EPA-PZ-2012-1B	4/22/2014	213.7	
AOC_5	EPA-PZ-2012-1B	10/6/2014	211.4	
AOC_5	EPA-PZ-2012-1B	6/4/2015	212.7	
AOC_5	EPA-PZ-2012-1B	6/17/2015	212.4	
AOC_5	EPA-PZ-2012-1B	10/20/2015	211.3	
AOC_5	EPA-PZ-2012-1B	12/16/2015	211.7	
AOC_5	EPA-PZ-2012-1B	6/9/2016	212.2	
AOC_5	EPA-PZ-2012-1B	6/23/2016	211.7	
AOC_5	EPA-PZ-2012-1B	8/16/2016	211.0	
AOC_5	EPA-PZ-2012-1B	10/20/2016	210.9	
AOC_5	EPA-PZ-2012-1B	11/16/2016	212.2	
AOC_5	EPA-PZ-2012-1B	5/22/2017	213.4	
AOC_5	EPA-PZ-2012-1B	5/11/2018	213.5	
AOC_5	EPA-PZ-2012-1B	11/1/2018	213.1	
AOC_5	EPA-PZ-2012-1B	4/11/2019	213.0	
AOC_5	EPA-PZ-2012-1B	10/22/2019	211.7	
AOC_5	EPA-PZ-2012-1B	5/18/2020	213.4	
AOC_5	EPA-PZ-2012-1B	5/19/2020	213.4	
AOC_5	EPA-PZ-2012-2A	6/19/2012	212.6	
AOC_5	EPA-PZ-2012-2A	9/11/2012	211.5	
AOC_5	EPA-PZ-2012-2A	11/5/2012	213.0	
AOC_5	EPA-PZ-2012-2A	11/6/2012	213.1	
AOC_5	EPA-PZ-2012-2A	3/13/2013	213.7	
AOC_5	EPA-PZ-2012-2A	4/23/2013	212.8	
AOC_5	EPA-PZ-2012-2A	4/25/2013	212.8	
AOC_5	EPA-PZ-2012-2A	5/15/2013	212.3	
AOC_5	EPA-PZ-2012-2A	5/30/2013	213.4	
AOC_5	EPA-PZ-2012-2A	4/22/2014	213.8	
AOC_5	EPA-PZ-2012-2A	10/6/2014	211.6	
AOC_5	EPA-PZ-2012-2A	6/4/2015	212.9	
AOC_5	EPA-PZ-2012-2A	6/17/2015	212.3	
AOC_5	EPA-PZ-2012-2A	10/20/2015	211.6	
AOC_5	EPA-PZ-2012-2A	12/16/2015	211.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-2A	6/9/2016	212.2	
AOC_5	EPA-PZ-2012-2A	6/23/2016	211.8	
AOC_5	EPA-PZ-2012-2A	8/16/2016	211.2	
AOC_5	EPA-PZ-2012-2A	11/16/2016	212.5	
AOC_5	EPA-PZ-2012-2A	5/22/2017	213.4	
AOC_5	EPA-PZ-2012-2A	5/11/2018	213.5	
AOC_5	EPA-PZ-2012-2A	11/1/2018	213.2	
AOC_5	EPA-PZ-2012-2A	4/11/2019	213.0	
AOC_5	EPA-PZ-2012-2A	10/22/2019	212.0	
AOC_5	EPA-PZ-2012-2A	5/18/2020	213.4	
AOC_5	EPA-PZ-2012-2A	5/19/2020	213.5	
AOC_5	EPA-PZ-2012-2B	6/19/2012	212.6	
AOC_5	EPA-PZ-2012-2B	9/11/2012	211.6	
AOC_5	EPA-PZ-2012-2B	11/5/2012	212.9	
AOC_5	EPA-PZ-2012-2B	11/6/2012	213.0	
AOC_5	EPA-PZ-2012-2B	3/13/2013	213.3	
AOC_5	EPA-PZ-2012-2B	4/23/2013	212.7	
AOC_5	EPA-PZ-2012-2B	4/25/2013	212.7	
AOC_5	EPA-PZ-2012-2B	5/15/2013	212.3	
AOC_5	EPA-PZ-2012-2B	5/30/2013	213.1	
AOC_5	EPA-PZ-2012-2B	4/22/2014	213.7	
AOC_5	EPA-PZ-2012-2B	10/6/2014	211.7	
AOC_5	EPA-PZ-2012-2B	6/4/2015	212.8	
AOC_5	EPA-PZ-2012-2B	6/17/2015	212.4	
AOC_5	EPA-PZ-2012-2B	10/20/2015	211.6	
AOC_5	EPA-PZ-2012-2B	12/16/2015	211.9	
AOC_5	EPA-PZ-2012-2B	6/9/2016	212.3	
AOC_5	EPA-PZ-2012-2B	6/23/2016	211.9	
AOC_5	EPA-PZ-2012-2B	8/16/2016	211.3	
AOC_5	EPA-PZ-2012-2B	10/20/2016	211.2	
AOC_5	EPA-PZ-2012-2B	11/16/2016	212.5	
AOC_5	EPA-PZ-2012-2B	5/22/2017	213.3	
AOC_5	EPA-PZ-2012-2B	5/11/2018	213.4	
AOC_5	EPA-PZ-2012-2B	11/1/2018	213.1	
AOC_5	EPA-PZ-2012-2B	4/11/2019	213.0	
AOC_5	EPA-PZ-2012-2B	10/22/2019	211.9	
AOC_5	EPA-PZ-2012-2B	5/18/2020	213.4	
AOC_5	EPA-PZ-2012-2B	5/20/2020	213.3	
AOC_5	EPA-PZ-2012-3A	6/19/2012	212.0	
AOC_5	EPA-PZ-2012-3A	9/11/2012	210.9	
AOC_5	EPA-PZ-2012-3A	11/5/2012	212.5	
AOC_5	EPA-PZ-2012-3A	11/6/2012	212.4	
AOC_5	EPA-PZ-2012-3A	3/13/2013	212.9	
AOC_5	EPA-PZ-2012-3A	4/23/2013	212.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-3A	4/25/2013	212.2	
AOC_5	EPA-PZ-2012-3A	5/15/2013	211.6	
AOC_5	EPA-PZ-2012-3A	5/30/2013	212.5	
AOC_5	EPA-PZ-2012-3A	4/22/2014	213.3	
AOC_5	EPA-PZ-2012-3A	10/6/2014	210.8	
AOC_5	EPA-PZ-2012-3A	6/4/2015	212.2	
AOC_5	EPA-PZ-2012-3A	6/17/2015	211.9	
AOC_5	EPA-PZ-2012-3A	10/20/2015	210.6	
AOC_5	EPA-PZ-2012-3A	12/16/2015	211.0	
AOC_5	EPA-PZ-2012-3A	6/9/2016	211.7	
AOC_5	EPA-PZ-2012-3A	6/23/2016	211.1	
AOC_5	EPA-PZ-2012-3A	8/16/2016	210.4	
AOC_5	EPA-PZ-2012-3A	11/16/2016	211.5	
AOC_5	EPA-PZ-2012-3A	5/22/2017	212.9	
AOC_5	EPA-PZ-2012-3A	5/11/2018	212.9	
AOC_5	EPA-PZ-2012-3A	11/1/2018	212.5	
AOC_5	EPA-PZ-2012-3A	4/11/2019	212.5	
AOC_5	EPA-PZ-2012-3A	10/22/2019	211.0	
AOC_5	EPA-PZ-2012-3A	5/18/2020	212.8	
AOC_5	EPA-PZ-2012-3A	5/21/2020	212.7	
AOC_5	EPA-PZ-2012-3B	6/19/2012	212.1	
AOC_5	EPA-PZ-2012-3B	9/11/2012	210.8	
AOC_5	EPA-PZ-2012-3B	11/5/2012	212.4	
AOC_5	EPA-PZ-2012-3B	11/6/2012	212.3	
AOC_5	EPA-PZ-2012-3B	3/13/2013	212.8	
AOC_5	EPA-PZ-2012-3B	4/23/2013	212.2	
AOC_5	EPA-PZ-2012-3B	4/25/2013	212.1	
AOC_5	EPA-PZ-2012-3B	5/15/2013	211.6	
AOC_5	EPA-PZ-2012-3B	5/30/2013	212.5	
AOC_5	EPA-PZ-2012-3B	4/22/2014	213.1	
AOC_5	EPA-PZ-2012-3B	10/6/2014	211.4	
AOC_5	EPA-PZ-2012-3B	6/4/2015	212.1	
AOC_5	EPA-PZ-2012-3B	6/17/2015	211.9	
AOC_5	EPA-PZ-2012-3B	10/20/2015	210.6	
AOC_5	EPA-PZ-2012-3B	12/16/2015	211.0	
AOC_5	EPA-PZ-2012-3B	6/9/2016	211.7	
AOC_5	EPA-PZ-2012-3B	6/23/2016	211.1	
AOC_5	EPA-PZ-2012-3B	8/16/2016	210.3	
AOC_5	EPA-PZ-2012-3B	10/20/2016	210.2	
AOC_5	EPA-PZ-2012-3B	11/16/2016	211.4	
AOC_5	EPA-PZ-2012-3B	5/22/2017	212.8	
AOC_5	EPA-PZ-2012-3B	5/11/2018	212.8	
AOC_5	EPA-PZ-2012-3B	11/1/2018	212.4	
AOC_5	EPA-PZ-2012-3B	4/11/2019	212.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-3B	10/22/2019	211.0	
AOC_5	EPA-PZ-2012-3B	5/18/2020	212.9	
AOC_5	EPA-PZ-2012-3B	5/21/2020	212.7	
AOC_5	EPA-PZ-2012-4A	6/19/2012	211.8	
AOC_5	EPA-PZ-2012-4A	9/11/2012	210.6	
AOC_5	EPA-PZ-2012-4A	11/5/2012	212.2	
AOC_5	EPA-PZ-2012-4A	11/6/2012	212.2	
AOC_5	EPA-PZ-2012-4A	3/13/2013	212.7	
AOC_5	EPA-PZ-2012-4A	4/23/2013	212.0	
AOC_5	EPA-PZ-2012-4A	4/25/2013	212.0	
AOC_5	EPA-PZ-2012-4A	5/15/2013	211.4	
AOC_5	EPA-PZ-2012-4A	5/30/2013	212.4	
AOC_5	EPA-PZ-2012-4A	4/22/2014	213.0	
AOC_5	EPA-PZ-2012-4A	10/6/2014	210.5	
AOC_5	EPA-PZ-2012-4A	6/4/2015	211.9	
AOC_5	EPA-PZ-2012-4A	6/17/2015	211.9	
AOC_5	EPA-PZ-2012-4A	10/20/2015	210.4	
AOC_5	EPA-PZ-2012-4A	12/16/2015	210.7	
AOC_5	EPA-PZ-2012-4A	6/9/2016	211.6	
AOC_5	EPA-PZ-2012-4A	6/23/2016	210.8	
AOC_5	EPA-PZ-2012-4A	8/16/2016	210.1	
AOC_5	EPA-PZ-2012-4A	11/16/2016	211.3	
AOC_5	EPA-PZ-2012-4A	5/22/2017	212.6	
AOC_5	EPA-PZ-2012-4A	5/11/2018	212.7	
AOC_5	EPA-PZ-2012-4A	11/1/2018	212.2	
AOC_5	EPA-PZ-2012-4A	4/11/2019	212.2	
AOC_5	EPA-PZ-2012-4A	10/22/2019	210.7	
AOC_5	EPA-PZ-2012-4A	5/18/2020	212.7	
AOC_5	EPA-PZ-2012-4A	5/19/2020	212.7	
AOC_5	EPA-PZ-2012-4B	6/19/2012	211.8	
AOC_5	EPA-PZ-2012-4B	9/11/2012	210.5	
AOC_5	EPA-PZ-2012-4B	11/5/2012	212.0	
AOC_5	EPA-PZ-2012-4B	11/6/2012	212.1	
AOC_5	EPA-PZ-2012-4B	3/13/2013	212.6	
AOC_5	EPA-PZ-2012-4B	4/23/2013	211.9	
AOC_5	EPA-PZ-2012-4B	4/25/2013	211.9	
AOC_5	EPA-PZ-2012-4B	5/15/2013	211.3	
AOC_5	EPA-PZ-2012-4B	5/30/2013	212.2	
AOC_5	EPA-PZ-2012-4B	4/22/2014	213.1	
AOC_5	EPA-PZ-2012-4B	10/6/2014	210.2	
AOC_5	EPA-PZ-2012-4B	6/4/2015	211.7	
AOC_5	EPA-PZ-2012-4B	6/17/2015	211.9	
AOC_5	EPA-PZ-2012-4B	10/20/2015	210.1	
AOC_5	EPA-PZ-2012-4B	12/16/2015	210.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-4B	6/9/2016	211.6	
AOC_5	EPA-PZ-2012-4B	6/23/2016	210.8	
AOC_5	EPA-PZ-2012-4B	8/16/2016	209.9	
AOC_5	EPA-PZ-2012-4B	10/20/2016	209.8	
AOC_5	EPA-PZ-2012-4B	11/16/2016	211.2	
AOC_5	EPA-PZ-2012-4B	5/22/2017	212.5	
AOC_5	EPA-PZ-2012-4B	5/11/2018	212.6	
AOC_5	EPA-PZ-2012-4B	11/1/2018	212.2	
AOC_5	EPA-PZ-2012-4B	4/11/2019	211.2	
AOC_5	EPA-PZ-2012-4B	10/22/2019	210.6	
AOC_5	EPA-PZ-2012-4B	5/18/2020	212.5	
AOC_5	EPA-PZ-2012-4B	5/19/2020	212.5	
AOC_5	EPA-PZ-2012-5A	6/19/2012	212.1	
AOC_5	EPA-PZ-2012-5A	9/11/2012	210.9	
AOC_5	EPA-PZ-2012-5A	11/5/2012	212.5	
AOC_5	EPA-PZ-2012-5A	11/6/2012	212.5	
AOC_5	EPA-PZ-2012-5A	3/13/2013	213.5	
AOC_5	EPA-PZ-2012-5A	4/23/2013	212.3	
AOC_5	EPA-PZ-2012-5A	4/25/2013	212.2	
AOC_5	EPA-PZ-2012-5A	5/30/2013	212.7	
AOC_5	EPA-PZ-2012-5A	4/22/2014	213.3	
AOC_5	EPA-PZ-2012-5A	10/6/2014	210.9	
AOC_5	EPA-PZ-2012-5A	6/4/2015	212.3	
AOC_5	EPA-PZ-2012-5A	6/17/2015	211.8	
AOC_5	EPA-PZ-2012-5A	10/20/2015	210.7	
AOC_5	EPA-PZ-2012-5A	12/16/2015	211.2	
AOC_5	EPA-PZ-2012-5A	6/9/2016	211.6	
AOC_5	EPA-PZ-2012-5A	6/23/2016	211.2	
AOC_5	EPA-PZ-2012-5A	8/16/2016	210.5	
AOC_5	EPA-PZ-2012-5A	11/16/2016	211.8	
AOC_5	EPA-PZ-2012-5A	5/22/2017	212.9	
AOC_5	EPA-PZ-2012-5A	5/11/2018	212.9	
AOC_5	EPA-PZ-2012-5A	11/1/2018	212.6	
AOC_5	EPA-PZ-2012-5A	4/11/2019	212.5	
AOC_5	EPA-PZ-2012-5A	10/22/2019	211.1	
AOC_5	EPA-PZ-2012-5A	5/18/2020	208.7	
AOC_5	EPA-PZ-2012-5A	5/22/2020	212.6	
AOC_5	EPA-PZ-2012-5B	6/19/2012	212.1	
AOC_5	EPA-PZ-2012-5B	9/11/2012	211.0	
AOC_5	EPA-PZ-2012-5B	11/5/2012	212.5	
AOC_5	EPA-PZ-2012-5B	11/6/2012	212.4	
AOC_5	EPA-PZ-2012-5B	3/13/2013	212.9	
AOC_5	EPA-PZ-2012-5B	4/23/2013	212.2	
AOC_5	EPA-PZ-2012-5B	4/25/2013	212.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-5B	5/15/2013	211.7	
AOC_5	EPA-PZ-2012-5B	5/30/2013	212.5	
AOC_5	EPA-PZ-2012-5B	4/22/2014	213.3	
AOC_5	EPA-PZ-2012-5B	10/6/2014	211.0	
AOC_5	EPA-PZ-2012-5B	6/4/2015	212.3	
AOC_5	EPA-PZ-2012-5B	10/20/2015	210.9	
AOC_5	EPA-PZ-2012-5B	12/16/2015	211.2	
AOC_5	EPA-PZ-2012-5B	6/9/2016	211.7	
AOC_5	EPA-PZ-2012-5B	6/23/2016	211.2	
AOC_5	EPA-PZ-2012-5B	8/16/2016	210.6	
AOC_5	EPA-PZ-2012-5B	10/20/2016	210.5	
AOC_5	EPA-PZ-2012-5B	11/16/2016	211.7	
AOC_5	EPA-PZ-2012-5B	5/22/2017	212.9	
AOC_5	EPA-PZ-2012-5B	5/11/2018	212.9	
AOC_5	EPA-PZ-2012-5B	11/1/2018	212.6	
AOC_5	EPA-PZ-2012-5B	4/11/2019	212.5	
AOC_5	EPA-PZ-2012-5B	10/22/2019	211.1	
AOC_5	EPA-PZ-2012-5B	5/18/2020	212.8	
AOC_5	EPA-PZ-2012-5B	5/22/2020	212.7	
AOC_5	EPA-PZ-2012-6A	6/19/2012	211.9	
AOC_5	EPA-PZ-2012-6A	9/11/2012	210.6	
AOC_5	EPA-PZ-2012-6A	11/5/2012	212.2	
AOC_5	EPA-PZ-2012-6A	11/6/2012	212.1	
AOC_5	EPA-PZ-2012-6A	3/13/2013	212.7	
AOC_5	EPA-PZ-2012-6A	4/23/2013	212.0	
AOC_5	EPA-PZ-2012-6A	4/25/2013	212.0	
AOC_5	EPA-PZ-2012-6A	5/15/2013	211.4	
AOC_5	EPA-PZ-2012-6A	5/30/2013	212.4	
AOC_5	EPA-PZ-2012-6A	4/22/2014	213.0	
AOC_5	EPA-PZ-2012-6A	10/6/2014	210.4	
AOC_5	EPA-PZ-2012-6A	6/4/2015	212.1	
AOC_5	EPA-PZ-2012-6A	6/17/2015	211.6	
AOC_5	EPA-PZ-2012-6A	10/20/2015	210.1	
AOC_5	EPA-PZ-2012-6A	12/16/2015	210.7	
AOC_5	EPA-PZ-2012-6A	6/9/2016	211.3	
AOC_5	EPA-PZ-2012-6A	6/23/2016		
AOC_5	EPA-PZ-2012-6A	8/16/2016	210.0	
AOC_5	EPA-PZ-2012-6A	11/16/2016	211.1	
AOC_5	EPA-PZ-2012-6A	5/22/2017	212.7	
AOC_5	EPA-PZ-2012-6A	5/11/2018	212.8	
AOC_5	EPA-PZ-2012-6A	11/1/2018	212.3	
AOC_5	EPA-PZ-2012-6A	4/11/2019	212.4	
AOC_5	EPA-PZ-2012-6A	10/22/2019	210.6	
AOC_5	EPA-PZ-2012-6A	5/18/2020	212.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-6A	5/22/2020	212.5	
AOC_5	EPA-PZ-2012-6B	6/19/2012	211.1	
AOC_5	EPA-PZ-2012-6B	9/11/2012	210.6	
AOC_5	EPA-PZ-2012-6B	11/5/2012	212.0	
AOC_5	EPA-PZ-2012-6B	11/6/2012	212.0	
AOC_5	EPA-PZ-2012-6B	3/13/2013	212.5	
AOC_5	EPA-PZ-2012-6B	4/23/2013	211.9	
AOC_5	EPA-PZ-2012-6B	4/25/2013	211.9	
AOC_5	EPA-PZ-2012-6B	5/15/2013	211.3	
AOC_5	EPA-PZ-2012-6B	5/30/2013	212.2	
AOC_5	EPA-PZ-2012-6B	4/22/2014	212.8	
AOC_5	EPA-PZ-2012-6B	10/6/2014	210.4	
AOC_5	EPA-PZ-2012-6B	6/4/2015	211.8	
AOC_5	EPA-PZ-2012-6B	6/17/2015	211.7	
AOC_5	EPA-PZ-2012-6B	10/7/2015	210.6	
AOC_5	EPA-PZ-2012-6B	10/20/2015	210.0	
AOC_5	EPA-PZ-2012-6B	12/16/2015	210.6	
AOC_5	EPA-PZ-2012-6B	6/9/2016	211.5	
AOC_5	EPA-PZ-2012-6B	6/23/2016	210.7	
AOC_5	EPA-PZ-2012-6B	8/16/2016	209.9	
AOC_5	EPA-PZ-2012-6B	10/20/2016	209.8	
AOC_5	EPA-PZ-2012-6B	11/16/2016	211.1	
AOC_5	EPA-PZ-2012-6B	5/22/2017	211.5	
AOC_5	EPA-PZ-2012-6B	5/11/2018	212.6	
AOC_5	EPA-PZ-2012-6B	11/1/2018	212.2	
AOC_5	EPA-PZ-2012-6B	4/11/2019	212.2	
AOC_5	EPA-PZ-2012-6B	10/22/2019	210.5	
AOC_5	EPA-PZ-2012-6B	5/18/2020	212.7	
AOC_5	EPA-PZ-2012-6B	5/22/2020	212.3	
AOC_5	EPA-PZ-2012-7A	6/19/2012	211.9	
AOC_5	EPA-PZ-2012-7A	9/11/2012	210.7	
AOC_5	EPA-PZ-2012-7A	11/5/2012	212.2	
AOC_5	EPA-PZ-2012-7A	11/6/2012	212.1	
AOC_5	EPA-PZ-2012-7A	3/13/2013	212.5	
AOC_5	EPA-PZ-2012-7A	4/23/2013	212.1	
AOC_5	EPA-PZ-2012-7A	4/25/2013	212.1	
AOC_5	EPA-PZ-2012-7A	5/30/2013	212.3	
AOC_5	EPA-PZ-2012-7A	4/22/2014	213.2	
AOC_5	EPA-PZ-2012-7A	10/6/2014	210.5	
AOC_5	EPA-PZ-2012-7A	6/4/2015	211.9	
AOC_5	EPA-PZ-2012-7A	6/17/2015	211.5	
AOC_5	EPA-PZ-2012-7A	10/20/2015	210.1	
AOC_5	EPA-PZ-2012-7A	12/16/2015	210.7	
AOC_5	EPA-PZ-2012-7A	6/9/2016	211.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EPA-PZ-2012-7A	6/23/2016	210.9	
AOC_5	EPA-PZ-2012-7A	8/16/2016	210.0	
AOC_5	EPA-PZ-2012-7A	11/16/2016	211.1	
AOC_5	EPA-PZ-2012-7A	5/22/2017	212.8	
AOC_5	EPA-PZ-2012-7A	5/11/2018	212.8	
AOC_5	EPA-PZ-2012-7A	11/1/2018	212.0	
AOC_5	EPA-PZ-2012-7A	4/11/2019	211.2	
AOC_5	EPA-PZ-2012-7A	10/22/2019	206.4	
AOC_5	EPA-PZ-2012-7A	5/18/2020	212.8	
AOC_5	EPA-PZ-2012-7A	5/22/2020	212.6	
AOC_5	EPA-PZ-2012-7B	6/19/2012	211.8	
AOC_5	EPA-PZ-2012-7B	9/11/2012	210.6	
AOC_5	EPA-PZ-2012-7B	11/5/2012	212.1	
AOC_5	EPA-PZ-2012-7B	11/6/2012	212.0	
AOC_5	EPA-PZ-2012-7B	3/13/2013	212.5	
AOC_5	EPA-PZ-2012-7B	4/23/2013	212.0	
AOC_5	EPA-PZ-2012-7B	4/25/2013	211.9	
AOC_5	EPA-PZ-2012-7B	5/15/2013	211.3	
AOC_5	EPA-PZ-2012-7B	5/30/2013	212.2	
AOC_5	EPA-PZ-2012-7B	4/22/2014	213.0	
AOC_5	EPA-PZ-2012-7B	10/6/2014	210.4	
AOC_5	EPA-PZ-2012-7B	6/4/2015	211.9	
AOC_5	EPA-PZ-2012-7B	6/17/2015	211.7	
AOC_5	EPA-PZ-2012-7B	10/20/2015	210.1	
AOC_5	EPA-PZ-2012-7B	12/16/2015	210.7	
AOC_5	EPA-PZ-2012-7B	6/9/2016	211.4	
AOC_5	EPA-PZ-2012-7B	6/23/2016	210.8	
AOC_5	EPA-PZ-2012-7B	8/16/2016	210.0	
AOC_5	EPA-PZ-2012-7B	10/20/2016	209.9	
AOC_5	EPA-PZ-2012-7B	11/16/2016	211.2	
AOC_5	EPA-PZ-2012-7B	5/22/2017	212.7	
AOC_5	EPA-PZ-2012-7B	5/11/2018	212.7	
AOC_5	EPA-PZ-2012-7B	11/1/2018	212.0	
AOC_5	EPA-PZ-2012-7B	4/11/2019	212.2	
AOC_5	EPA-PZ-2012-7B	10/22/2019	210.6	
AOC_5	EPA-PZ-2012-7B	5/18/2020	212.7	
AOC_5	EPA-PZ-2012-7B	5/22/2020	212.4	
AOC_5	EW-01	8/4/2005	212.9	
AOC_5	EW-01	8/24/2005	212.6	
AOC_5	EW-01	8/26/2005	212.0	
AOC_5	EW-01	4/10/2006	213.0	
AOC_5	EW-01	6/5/2006	214.7	
AOC_5	EW-01	9/18/2006	212.8	
AOC_5	EW-01	12/15/2006	213.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	EW-01	2/20/2008	213.8	
AOC_5	EW-01	2/25/2008	214.9	
AOC_5	EW-01	3/4/2008	213.4	
AOC_5	EW-01	2/14/2013	212.7	
AOC_5	EW-01	4/22/2013	199.6	
AOC_5	EW-01	5/15/2013	198.9	
AOC_5	EW-01	6/11/2013	212.6	
AOC_5	EW-01	10/21/2013	211.3	
AOC_5	EW-01	4/22/2014	213.0	
AOC_5	EW-01	10/6/2014	210.2	
AOC_5	EW-01	10/20/2015	191.6	
AOC_5	EW-01	6/23/2016	210.6	
AOC_5	EW-01	5/22/2017	212.6	
AOC_5	EW-01	5/18/2020	200.2	
AOC_5	EW-04	8/24/2005	212.4	
AOC_5	EW-04	8/26/2005	212.2	
AOC_5	EW-04	4/10/2006	212.9	
AOC_5	EW-04	6/5/2006	214.9	
AOC_5	EW-04	9/18/2006	212.6	
AOC_5	EW-04	12/15/2006	213.8	
AOC_5	EW-04	2/20/2008	214.5	
AOC_5	EW-04	2/25/2008	215.0	
AOC_5	EW-04	3/4/2008	213.9	
AOC_5	EW-04	2/14/2013	212.6	
AOC_5	EW-04	3/12/2013	191.2	
AOC_5	EW-04	4/22/2013	190.6	
AOC_5	EW-04	5/15/2013	189.5	
AOC_5	EW-04	6/11/2013	212.8	
AOC_5	EW-04	10/21/2013	211.2	
AOC_5	EW-04	4/22/2014	213.2	
AOC_5	EW-04	10/6/2014	210.4	
AOC_5	EW-04	6/23/2016	193.6	
AOC_5	EW-04	5/22/2017	212.8	
AOC_5	EW-04	5/18/2020	182.7	
AOC_5	MW 4-1	10/22/2019		
AOC_5	MW 7	10/22/2019		
AOC_5	MW-1	10/12/2015		187.2
AOC_5	MW-1	6/24/2016		
AOC_5	MW-1	11/15/2016		
AOC_5	MW-1	5/22/2017	243.5	
AOC_5	MW-1	11/1/2018	242.5	
AOC_5	MW-1	10/22/2019		
AOC_5	MW-11A	6/24/2016	249.7	
AOC_5	MW-11A	11/16/2016	249.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	MW-11A	5/22/2017		
AOC_5	MW-11A	11/1/2018		
AOC_5	MW-11A	10/22/2019	249.7	
AOC_5	MW-14	6/24/2016		
AOC_5	MW-14	11/16/2016		
AOC_5	MW-14	5/22/2017	250.1	
AOC_5	MW-14	11/1/2018	249.8	
AOC_5	MW-14	10/22/2019		
AOC_5	MW-16	6/24/2016	260.6	
AOC_5	MW-16	11/15/2016		
AOC_5	MW-16	5/22/2017		
AOC_5	MW-16	11/1/2018	260.7	
AOC_5	MW-16	10/22/2019	260.7	
AOC_5	MW-22	6/24/2016		
AOC_5	MW-22	11/15/2016		
AOC_5	MW-22	5/22/2017	261.5	
AOC_5	MW-22	11/1/2018	261.3	
AOC_5	MW-22	10/22/2019		
AOC_5	MW-4-1	6/24/2016	239.6	
AOC_5	MW-4-1	11/15/2016		
AOC_5	MW-4-1	5/22/2017	244.1	
AOC_5	MW-4-1	11/1/2018	243.6	
AOC_5	MW-9	6/24/2016	232.0	
AOC_5	MW-9	11/15/2016	232.1	
AOC_5	MW-9	5/22/2017	234.7	
AOC_5	MW-9	11/1/2018		
AOC_5	MW-9	10/22/2019		
AOC_5	N1-P1	12/7/1995	215.5	
AOC_5	N1-P1	3/26/1996	215.9	
AOC_5	N1-P1	6/2/1997	214.7	
AOC_5	N1-P1	4/23/1998	215.8	
AOC_5	N1-P1	6/19/1998	216.3	
AOC_5	N1-P1	6/26/1998	216.1	
AOC_5	N1-P1	7/1/1998	215.9	
AOC_5	N1-P1	7/17/1998	215.5	
AOC_5	N1-P1	7/31/1998	215.4	
AOC_5	N1-P1	8/28/1998	215.1	
AOC_5	N1-P1	10/14/1998	215.2	
AOC_5	N1-P1	12/10/1998	215.1	
AOC_5	N1-P1	2/23/1999	215.4	
AOC_5	N1-P1	6/6/1999	214.9	
AOC_5	N1-P1	9/8/1999	214.5	
AOC_5	N1-P1	11/16/2001	215.1	
AOC_5	N1-P1	8/4/2005	215.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N1-P1	8/24/2005	215.0	
AOC_5	N1-P1	8/26/2005	215.0	
AOC_5	N1-P1	4/10/2006	215.2	
AOC_5	N1-P1	6/5/2006	215.9	
AOC_5	N1-P1	9/18/2006	215.2	
AOC_5	N1-P1	10/19/2006	215.4	
AOC_5	N1-P1	12/15/2006	215.4	
AOC_5	N1-P1	4/8/2007	215.2	
AOC_5	N1-P1	4/9/2007	215.2	
AOC_5	N1-P1	4/26/2007	216.3	
AOC_5	N1-P1	10/15/2007	215.8	
AOC_5	N1-P1	11/7/2007	215.8	
AOC_5	N1-P1	2/20/2008	216.5	
AOC_5	N1-P1	2/25/2008	216.0	
AOC_5	N1-P1	3/4/2008	216.2	
AOC_5	N1-P1	4/16/2008	215.7	
AOC_5	N1-P1	4/28/2008	214.7	
AOC_5	N1-P1	6/10/2008	215.4	
AOC_5	N1-P1	8/19/2008	215.8	
AOC_5	N1-P1	9/15/2008	215.8	
AOC_5	N1-P1	9/30/2008	215.6	
AOC_5	N1-P1	4/28/2009	215.6	
AOC_5	N1-P1	9/14/2009	215.2	
AOC_5	N1-P1	10/26/2009	215.4	
AOC_5	N1-P1	11/3/2009	215.3	
AOC_5	N1-P1	4/20/2010	216.1	
AOC_5	N1-P1	9/14/2010	214.7	
AOC_5	N1-P1	10/7/2010	215.4	
AOC_5	N1-P1	4/4/2011	215.8	
AOC_5	N1-P1	11/8/2011	215.9	
AOC_5	N1-P1	4/10/2012	214.9	
AOC_5	N1-P1	11/5/2012	215.7	
AOC_5	N1-P1	11/6/2012	216.0	
AOC_5	N1-P1	5/15/2013	215.5	
AOC_5	N1-P1	6/11/2013	216.6	
AOC_5	N1-P1	10/21/2013		212.5
AOC_5	N1-P1	4/22/2014	216.0	
AOC_5	N1-P1	10/6/2014	215.9	
AOC_5	N1-P1	6/2/2015	216.0	
AOC_5	N1-P1	6/17/2015	215.4	
AOC_5	N1-P1	8/18/2015	215.3	
AOC_5	N1-P1	10/7/2015	215.3	
AOC_5	N1-P1	10/20/2015	216.1	
AOC_5	N1-P1	12/16/2015	215.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N1-P1	6/9/2016	215.5	
AOC_5	N1-P1	6/24/2016	215.4	
AOC_5	N1-P1	8/16/2016	215.1	
AOC_5	N1-P1	11/15/2016	215.9	
AOC_5	N1-P1	5/22/2017	215.5	
AOC_5	N1-P1	11/1/2018	215.7	
AOC_5	N1-P1	10/22/2019	216.9	
AOC_5	N1-P2	12/7/1995	215.6	
AOC_5	N1-P2	3/26/1996	216.0	
AOC_5	N1-P2	6/2/1997	215.6	
AOC_5	N1-P2	4/23/1998	215.8	
AOC_5	N1-P2	6/19/1998	216.4	
AOC_5	N1-P2	6/26/1998	216.1	
AOC_5	N1-P2	7/1/1998	216.0	
AOC_5	N1-P2	7/17/1998	215.6	
AOC_5	N1-P2	7/31/1998	215.5	
AOC_5	N1-P2	8/28/1998	215.2	
AOC_5	N1-P2	10/14/1998	215.3	
AOC_5	N1-P2	12/10/1998	215.2	
AOC_5	N1-P2	2/23/1999	215.5	
AOC_5	N1-P2	6/6/1999	215.0	
AOC_5	N1-P2	9/8/1999	215.6	
AOC_5	N1-P2	11/16/2001	215.3	
AOC_5	N1-P2	8/4/2005	215.4	
AOC_5	N1-P2	8/24/2005	215.1	
AOC_5	N1-P2	8/26/2005	215.1	
AOC_5	N1-P2	4/10/2006	215.4	
AOC_5	N1-P2	6/5/2006	216.3	
AOC_5	N1-P2	9/18/2006	215.3	
AOC_5	N1-P2	10/19/2006	215.5	
AOC_5	N1-P2	12/15/2006	215.8	
AOC_5	N1-P2	4/8/2007	215.4	
AOC_5	N1-P2	4/9/2007	215.4	
AOC_5	N1-P2	4/26/2007	216.4	
AOC_5	N1-P2	10/15/2007	216.2	
AOC_5	N1-P2	11/7/2007	215.9	
AOC_5	N1-P2	2/20/2008	216.6	
AOC_5	N1-P2	2/25/2008	216.4	
AOC_5	N1-P2	3/4/2008	216.2	
AOC_5	N1-P2	4/16/2008	216.1	
AOC_5	N1-P2	6/10/2008	215.5	
AOC_5	N1-P2	8/19/2008	215.9	
AOC_5	N1-P2	9/15/2008	215.9	
AOC_5	N1-P2	9/30/2008	215.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N1-P2	4/28/2009	215.9	
AOC_5	N1-P2	9/14/2009	215.4	
AOC_5	N1-P2	10/26/2009	215.5	
AOC_5	N1-P2	11/3/2009	215.5	
AOC_5	N1-P2	4/20/2010	216.3	
AOC_5	N1-P2	9/14/2010	214.9	
AOC_5	N1-P2	10/7/2010	215.1	
AOC_5	N1-P2	4/4/2011	216.0	
AOC_5	N1-P2	11/8/2011	216.0	
AOC_5	N1-P2	4/10/2012	215.3	
AOC_5	N1-P2	11/5/2012	216.0	
AOC_5	N1-P2	11/6/2012	216.1	
AOC_5	N1-P2	5/15/2013	215.6	
AOC_5	N1-P2	6/11/2013	216.7	
AOC_5	N1-P2	10/21/2013		212.5
AOC_5	N1-P2	4/22/2014	216.1	
AOC_5	N1-P2	10/6/2014	216.0	
AOC_5	N1-P2	6/2/2015	216.1	
AOC_5	N1-P2	10/7/2015	215.4	
AOC_5	N1-P2	10/20/2015	216.2	
AOC_5	N1-P2	6/24/2016	215.5	
AOC_5	N1-P2	11/15/2016	216.1	
AOC_5	N1-P2	5/22/2017	216.0	
AOC_5	N1-P2	11/1/2018	215.8	
AOC_5	N1-P2	10/22/2019	216.9	
AOC_5	N1-P3	12/7/1995	216.0	
AOC_5	N1-P3	3/26/1996	216.3	
AOC_5	N1-P3	4/23/1998	216.1	
AOC_5	N1-P3	6/19/1998	216.6	
AOC_5	N1-P3	7/1/1998	216.2	
AOC_5	N1-P3	7/17/1998	215.9	
AOC_5	N1-P3	7/31/1998	215.4	
AOC_5	N1-P3	8/28/1998	215.7	
AOC_5	N1-P3	10/14/1998	215.8	
AOC_5	N1-P3	12/10/1998	215.8	
AOC_5	N1-P3	2/23/1999	216.0	
AOC_5	N1-P3	6/6/1999	215.6	
AOC_5	N1-P3	9/8/1999	215.3	
AOC_5	N1-P3	11/16/2001	215.8	
AOC_5	N1-P3	8/4/2005	215.8	
AOC_5	N1-P3	8/24/2005	215.6	
AOC_5	N1-P3	8/26/2005	215.7	
AOC_5	N1-P3	4/10/2006	215.8	
AOC_5	N1-P3	6/5/2006	214.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N1-P3	9/18/2006	215.7	
AOC_5	N1-P3	10/19/2006	216.0	
AOC_5	N1-P3	12/15/2006	216.1	
AOC_5	N1-P3	4/8/2007	214.7	
AOC_5	N1-P3	4/9/2007	214.7	
AOC_5	N1-P3	4/26/2007	216.5	
AOC_5	N1-P3	10/15/2007	217.0	
AOC_5	N1-P3	11/7/2007	216.5	
AOC_5	N1-P3	2/20/2008	217.1	
AOC_5	N1-P3	2/25/2008	216.7	
AOC_5	N1-P3	3/4/2008	216.6	
AOC_5	N1-P3	4/16/2008	216.4	
AOC_5	N1-P3	6/10/2008	215.9	
AOC_5	N1-P3	8/19/2008	216.3	
AOC_5	N1-P3	9/15/2008	216.3	
AOC_5	N1-P3	9/30/2008	216.3	
AOC_5	N1-P3	4/28/2009	216.3	
AOC_5	N1-P3	7/5/2009	216.0	
AOC_5	N1-P3	9/14/2009	215.9	
AOC_5	N1-P3	10/26/2009	216.1	
AOC_5	N1-P3	11/3/2009	216.0	
AOC_5	N1-P3	4/20/2010	216.3	
AOC_5	N1-P3	4/27/2010	216.2	
AOC_5	N1-P3	9/14/2010	215.6	
AOC_5	N1-P3	10/7/2010	216.2	
AOC_5	N1-P3	4/4/2011	216.3	
AOC_5	N1-P3	7/25/2011	215.8	
AOC_5	N1-P3	11/8/2011	216.4	
AOC_5	N1-P3	4/10/2012	215.8	
AOC_5	N1-P3	6/26/2012	216.0	
AOC_5	N1-P3	11/5/2012	216.6	
AOC_5	N1-P3	11/6/2012	216.6	
AOC_5	N1-P3	4/25/2013	216.1	
AOC_5	N1-P3	5/15/2013	216.3	
AOC_5	N1-P3	6/11/2013	216.3	
AOC_5	N1-P3	10/21/2013		212.6
AOC_5	N1-P3	4/22/2014	216.5	
AOC_5	N1-P3	10/6/2014	216.9	
AOC_5	N1-P3	6/2/2015	216.8	
AOC_5	N1-P3	6/17/2015	216.2	
AOC_5	N1-P3	8/18/2015	216.1	
AOC_5	N1-P3	10/7/2015	216.1	
AOC_5	N1-P3	10/20/2015	217.1	
AOC_5	N1-P3	12/16/2015	216.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N1-P3	6/9/2016	216.4	
AOC_5	N1-P3	6/24/2016	216.2	
AOC_5	N1-P3	8/16/2016	215.9	
AOC_5	N1-P3	11/15/2016	216.8	
AOC_5	N1-P3	5/22/2017	216.4	
AOC_5	N1-P3	11/1/2018	216.2	
AOC_5	N1-P3	10/22/2019	217.1	
AOC_5	N2-P1	12/7/1995	216.4	
AOC_5	N2-P1	3/26/1996	216.6	
AOC_5	N2-P1	4/23/1998	216.5	
AOC_5	N2-P1	6/19/1998	217.0	
AOC_5	N2-P1	6/26/1998	216.6	
AOC_5	N2-P1	7/1/1998	216.6	
AOC_5	N2-P1	7/17/1998	216.3	
AOC_5	N2-P1	7/31/1998	216.3	
AOC_5	N2-P1	8/28/1998	216.2	
AOC_5	N2-P1	10/14/1998	216.3	
AOC_5	N2-P1	12/10/1998	216.2	
AOC_5	N2-P1	2/23/1999	216.3	
AOC_5	N2-P1	6/6/1999	216.0	
AOC_5	N2-P1	9/8/1999	215.8	
AOC_5	N2-P1	11/16/2001	216.3	
AOC_5	N2-P1	8/4/2005	216.2	
AOC_5	N2-P1	8/24/2005	216.1	
AOC_5	N2-P1	8/26/2005	216.2	
AOC_5	N2-P1	4/10/2006	216.3	
AOC_5	N2-P1	6/5/2006	216.9	
AOC_5	N2-P1	8/2/2006	216.0	
AOC_5	N2-P1	9/18/2006	216.0	
AOC_5	N2-P1	10/19/2006	216.3	
AOC_5	N2-P1	12/15/2006	216.3	
AOC_5	N2-P1	4/8/2007	216.1	
AOC_5	N2-P1	4/9/2007	216.1	
AOC_5	N2-P1	4/26/2007	216.7	
AOC_5	N2-P1	9/10/2007	216.2	
AOC_5	N2-P1	10/15/2007	217.3	
AOC_5	N2-P1	11/7/2007	216.9	
AOC_5	N2-P1	2/20/2008	217.3	
AOC_5	N2-P1	2/25/2008	216.9	
AOC_5	N2-P1	3/4/2008	217.0	
AOC_5	N2-P1	4/16/2008	216.8	
AOC_5	N2-P1	6/10/2008	216.1	
AOC_5	N2-P1	8/19/2008	216.7	
AOC_5	N2-P1	9/15/2008	216.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N2-P1	9/30/2008	216.7	
AOC_5	N2-P1	4/28/2009	216.7	
AOC_5	N2-P1	9/14/2009	216.4	
AOC_5	N2-P1	10/26/2009	216.5	
AOC_5	N2-P1	11/3/2009	216.3	
AOC_5	N2-P1	4/20/2010	216.6	
AOC_5	N2-P1	4/27/2010	216.2	
AOC_5	N2-P1	9/14/2010	216.1	
AOC_5	N2-P1	10/7/2010	216.7	
AOC_5	N2-P1	4/4/2011	216.7	
AOC_5	N2-P1	7/25/2011	216.2	
AOC_5	N2-P1	11/8/2011	216.7	
AOC_5	N2-P1	4/10/2012	216.3	
AOC_5	N2-P1	11/5/2012	216.7	
AOC_5	N2-P1	11/6/2012	216.8	
AOC_5	N2-P1	5/15/2013	216.4	
AOC_5	N2-P1	6/11/2013	217.5	
AOC_5	N2-P1	10/21/2013		212.9
AOC_5	N2-P1	4/22/2014	216.6	
AOC_5	N2-P1	10/6/2014	217.0	
AOC_5	N2-P1	6/2/2015	217.1	
AOC_5	N2-P1	6/17/2015	216.5	
AOC_5	N2-P1	8/18/2015	216.4	
AOC_5	N2-P1	10/20/2015	217.2	
AOC_5	N2-P1	12/16/2015	216.5	
AOC_5	N2-P1	8/16/2016	216.2	
AOC_5	N2-P1	11/15/2016	217.0	
AOC_5	N2-P1	11/1/2018	216.6	
AOC_5	N2-P1	10/22/2019	217.4	
AOC_5	N2-P2	12/7/1995	216.3	
AOC_5	N2-P2	3/26/1996	216.5	
AOC_5	N2-P2	6/2/1997	216.3	
AOC_5	N2-P2	4/23/1998	216.4	
AOC_5	N2-P2	6/19/1998	216.9	
AOC_5	N2-P2	6/26/1998	216.5	
AOC_5	N2-P2	7/1/1998	216.5	
AOC_5	N2-P2	7/17/1998	216.2	
AOC_5	N2-P2	7/31/1998	216.2	
AOC_5	N2-P2	8/28/1998	216.1	
AOC_5	N2-P2	10/14/1998	216.2	
AOC_5	N2-P2	12/10/1998	216.2	
AOC_5	N2-P2	6/6/1999	216.0	
AOC_5	N2-P2	9/8/1999	215.8	
AOC_5	N2-P2	11/16/2001	216.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N2-P2	8/4/2005	216.2	
AOC_5	N2-P2	8/24/2005	216.0	
AOC_5	N2-P2	8/26/2005	216.1	
AOC_5	N2-P2	4/10/2006	216.3	
AOC_5	N2-P2	6/5/2006	216.8	
AOC_5	N2-P2	8/2/2006	216.4	
AOC_5	N2-P2	9/18/2006	216.4	
AOC_5	N2-P2	10/19/2006	216.6	
AOC_5	N2-P2	12/15/2006	216.7	
AOC_5	N2-P2	4/8/2007	216.0	
AOC_5	N2-P2	4/9/2007	216.0	
AOC_5	N2-P2	4/26/2007	216.6	
AOC_5	N2-P2	9/10/2007	216.2	
AOC_5	N2-P2	10/15/2007	217.3	
AOC_5	N2-P2	11/7/2007	216.9	
AOC_5	N2-P2	2/12/2008	216.9	
AOC_5	N2-P2	2/20/2008	217.3	
AOC_5	N2-P2	2/25/2008	216.8	
AOC_5	N2-P2	3/4/2008	216.9	
AOC_5	N2-P2	4/16/2008	216.6	
AOC_5	N2-P2	4/28/2008	216.4	
AOC_5	N2-P2	6/10/2008	216.3	
AOC_5	N2-P2	8/19/2008	216.6	
AOC_5	N2-P2	9/15/2008	216.6	
AOC_5	N2-P2	9/30/2008	216.6	
AOC_5	N2-P2	4/28/2009	216.5	
AOC_5	N2-P2	7/5/2009	216.4	
AOC_5	N2-P2	9/14/2009	216.3	
AOC_5	N2-P2	10/26/2009	216.5	
AOC_5	N2-P2	11/3/2009	216.6	
AOC_5	N2-P2	4/20/2010	216.5	
AOC_5	N2-P2	9/14/2010	216.1	
AOC_5	N2-P2	10/7/2010	216.6	
AOC_5	N2-P2	4/4/2011	216.6	
AOC_5	N2-P2	7/25/2011	216.2	
AOC_5	N2-P2	11/8/2011	216.6	
AOC_5	N2-P2	4/10/2012	216.2	
AOC_5	N2-P2	6/26/2012	216.4	
AOC_5	N2-P2	11/5/2012	217.0	
AOC_5	N2-P2	11/6/2012	217.1	
AOC_5	N2-P2	4/25/2013	216.4	
AOC_5	N2-P2	5/15/2013	216.8	
AOC_5	N2-P2	5/30/2013	217.4	
AOC_5	N2-P2	6/11/2013	217.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N2-P2	10/21/2013	214.1	
AOC_5	N2-P2	4/22/2014	217.0	
AOC_5	N2-P2	10/6/2014	217.3	
AOC_5	N2-P2	6/2/2015	217.0	
AOC_5	N2-P2	6/17/2015	216.5	
AOC_5	N2-P2	8/18/2015	216.4	
AOC_5	N2-P2	10/7/2015	216.5	
AOC_5	N2-P2	10/20/2015	217.6	
AOC_5	N2-P2	12/16/2015	216.5	
AOC_5	N2-P2	4/6/2016	216.6	
AOC_5	N2-P2	8/16/2016	216.2	
AOC_5	N2-P2	10/20/2016	216.3	
AOC_5	N2-P2	11/15/2016	217.2	
AOC_5	N2-P2	11/1/2018	216.7	
AOC_5	N2-P2	10/22/2019	217.2	
AOC_5	N3-P1	12/7/1995	216.3	
AOC_5	N3-P1	3/26/1996	216.4	
AOC_5	N3-P1	7/23/1996	216.1	
AOC_5	N3-P1	6/2/1997	216.3	
AOC_5	N3-P1	4/23/1998	216.4	
AOC_5	N3-P1	6/19/1998	216.9	
AOC_5	N3-P1	6/26/1998	216.6	
AOC_5	N3-P1	7/1/1998	216.5	
AOC_5	N3-P1	7/17/1998	216.3	
AOC_5	N3-P1	7/31/1998	216.2	
AOC_5	N3-P1	8/28/1998	216.2	
AOC_5	N3-P1	10/14/1998	216.2	
AOC_5	N3-P1	12/10/1998	216.2	
AOC_5	N3-P1	2/23/1999	216.4	
AOC_5	N3-P1	6/6/1999	216.0	
AOC_5	N3-P1	9/8/1999	215.8	
AOC_5	N3-P1	11/16/2001	216.2	
AOC_5	N3-P1	8/4/2005	216.1	
AOC_5	N3-P1	8/24/2005	216.1	
AOC_5	N3-P1	8/26/2005	216.1	
AOC_5	N3-P1	4/10/2006	215.8	
AOC_5	N3-P1	6/5/2006	216.0	
AOC_5	N3-P1	8/2/2006	216.2	
AOC_5	N3-P1	9/18/2006	216.1	
AOC_5	N3-P1	12/15/2006	215.9	
AOC_5	N3-P1	4/8/2007	215.7	
AOC_5	N3-P1	4/9/2007	215.7	
AOC_5	N3-P1	4/26/2007	216.7	
AOC_5	N3-P1	9/10/2007	216.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N3-P1	10/15/2007	216.6	
AOC_5	N3-P1	11/7/2007	216.9	
AOC_5	N3-P1	2/20/2008	217.4	
AOC_5	N3-P1	2/25/2008	216.6	
AOC_5	N3-P1	3/4/2008	216.9	
AOC_5	N3-P1	4/16/2008	216.4	
AOC_5	N3-P1	6/10/2008	216.3	
AOC_5	N3-P1	8/19/2008	216.7	
AOC_5	N3-P1	9/15/2008	216.6	
AOC_5	N3-P1	9/30/2008	216.3	
AOC_5	N3-P1	4/28/2009	216.2	
AOC_5	N3-P1	7/5/2009	216.4	
AOC_5	N3-P1	9/14/2009	216.3	
AOC_5	N3-P1	10/26/2009	216.5	
AOC_5	N3-P1	11/3/2009	215.6	
AOC_5	N3-P1	4/20/2010	216.4	
AOC_5	N3-P1	9/14/2010	216.1	
AOC_5	N3-P1	10/7/2010	216.6	
AOC_5	N3-P1	4/4/2011	216.6	
AOC_5	N3-P1	7/25/2011	216.1	
AOC_5	N3-P1	11/8/2011	216.6	
AOC_5	N3-P1	4/10/2012	215.7	
AOC_5	N3-P1	11/5/2012	216.9	
AOC_5	N3-P1	11/6/2012	217.0	
AOC_5	N3-P1	5/15/2013	216.6	
AOC_5	N3-P1	6/11/2013	217.7	
AOC_5	N3-P1	10/21/2013		213.1
AOC_5	N3-P1	4/22/2014	216.8	
AOC_5	N3-P1	10/6/2014	217.2	
AOC_5	N3-P1	6/2/2015	217.1	
AOC_5	N3-P1	6/17/2015	216.4	
AOC_5	N3-P1	8/18/2015	216.4	
AOC_5	N3-P1	10/20/2015	217.4	
AOC_5	N3-P1	12/16/2015	216.5	
AOC_5	N3-P1	6/9/2016	216.6	
AOC_5	N3-P1	8/16/2016	216.2	
AOC_5	N3-P1	11/15/2016	217.1	
AOC_5	N3-P1	11/1/2018	216.4	
AOC_5	N3-P1	10/22/2019	216.7	
AOC_5	N3-P2	12/7/1995	216.3	
AOC_5	N3-P2	3/26/1996	216.5	
AOC_5	N3-P2	7/23/1996	216.2	
AOC_5	N3-P2	4/23/1998	216.4	
AOC_5	N3-P2	6/19/1998	216.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N3-P2	6/26/1998	216.5	
AOC_5	N3-P2	7/1/1998	216.5	
AOC_5	N3-P2	7/17/1998	216.2	
AOC_5	N3-P2	7/31/1998	216.2	
AOC_5	N3-P2	8/28/1998	216.1	
AOC_5	N3-P2	10/14/1998	216.2	
AOC_5	N3-P2	12/10/1998	216.2	
AOC_5	N3-P2	6/6/1999	216.0	
AOC_5	N3-P2	9/8/1999	215.8	
AOC_5	N3-P2	11/16/2001	216.2	
AOC_5	N3-P2	8/4/2005	216.0	
AOC_5	N3-P2	8/24/2005	216.1	
AOC_5	N3-P2	8/26/2005	216.0	
AOC_5	N3-P2	4/10/2006	216.3	
AOC_5	N3-P2	6/5/2006		213.0
AOC_5	N3-P2	9/18/2006	216.2	
AOC_5	N3-P2	12/15/2006	216.4	
AOC_5	N3-P2	4/8/2007		212.6
AOC_5	N3-P2	4/9/2007		212.6
AOC_5	N3-P2	4/26/2007	216.6	
AOC_5	N3-P2	9/10/2007	216.2	
AOC_5	N3-P2	10/15/2007	217.3	
AOC_5	N3-P2	11/7/2007	216.9	
AOC_5	N3-P2	2/12/2008	216.9	
AOC_5	N3-P2	2/20/2008	217.3	
AOC_5	N3-P2	2/25/2008	216.9	
AOC_5	N3-P2	3/4/2008	217.0	
AOC_5	N3-P2	4/16/2008	216.6	
AOC_5	N3-P2	4/28/2008	216.4	
AOC_5	N3-P2	6/10/2008	216.3	
AOC_5	N3-P2	8/19/2008	216.6	
AOC_5	N3-P2	9/15/2008	216.6	
AOC_5	N3-P2	9/30/2008	216.7	
AOC_5	N3-P2	4/28/2009	216.6	
AOC_5	N3-P2	7/5/2009	216.4	
AOC_5	N3-P2	9/14/2009	216.3	
AOC_5	N3-P2	10/26/2009	216.5	
AOC_5	N3-P2	11/3/2009	216.4	
AOC_5	N3-P2	4/20/2010	216.5	
AOC_5	N3-P2	4/27/2010	216.4	
AOC_5	N3-P2	9/14/2010	216.1	
AOC_5	N3-P2	10/7/2010	216.6	
AOC_5	N3-P2	4/4/2011	216.6	
AOC_5	N3-P2	7/25/2011	216.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N3-P2	11/8/2011	216.6	
AOC_5	N3-P2	4/10/2012	216.2	
AOC_5	N3-P2	6/26/2012	216.4	
AOC_5	N3-P2	11/5/2012	216.9	
AOC_5	N3-P2	11/6/2012	217.0	
AOC_5	N3-P2	4/25/2013	216.4	
AOC_5	N3-P2	5/15/2013	216.6	
AOC_5	N3-P2	5/30/2013	217.2	
AOC_5	N3-P2	6/11/2013	217.7	
AOC_5	N3-P2	10/21/2013		212.1
AOC_5	N3-P2	4/22/2014	216.8	
AOC_5	N3-P2	10/6/2014	217.2	
AOC_5	N3-P2	6/2/2015	217.0	
AOC_5	N3-P2	6/17/2015	216.5	
AOC_5	N3-P2	8/18/2015	216.4	
AOC_5	N3-P2	10/7/2015	216.5	
AOC_5	N3-P2	10/20/2015	217.4	
AOC_5	N3-P2	12/16/2015	216.5	
AOC_5	N3-P2	6/9/2016	216.6	
AOC_5	N3-P2	8/16/2016	216.2	
AOC_5	N3-P2	10/20/2016	217.0	
AOC_5	N3-P2	11/15/2016	217.2	
AOC_5	N3-P2	11/1/2018	216.6	
AOC_5	N3-P2	10/22/2019	217.0	
AOC_5	N4-P1	12/7/1995	216.0	
AOC_5	N4-P1	7/23/1996	215.7	
AOC_5	N4-P1	6/2/1997	215.5	
AOC_5	N4-P1	4/23/1998	215.9	
AOC_5	N4-P1	6/19/1998	216.6	
AOC_5	N4-P1	6/26/1998	216.2	
AOC_5	N4-P1	7/1/1998	216.2	
AOC_5	N4-P1	7/17/1998	215.8	
AOC_5	N4-P1	7/31/1998	215.7	
AOC_5	N4-P1	8/28/1998	215.6	
AOC_5	N4-P1	10/14/1998	215.6	
AOC_5	N4-P1	12/10/1998	215.6	
AOC_5	N4-P1	6/6/1999	215.4	
AOC_5	N4-P1	9/8/1999	215.1	
AOC_5	N4-P1	6/24/2016		
AOC_5	N4-P2	12/7/1995	215.7	
AOC_5	N4-P2	7/23/1996	215.4	
AOC_5	N4-P2	6/2/1997	215.5	
AOC_5	N4-P2	4/23/1998	215.6	
AOC_5	N4-P2	6/19/1998	216.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N4-P2	6/26/1998	215.9	
AOC_5	N4-P2	7/1/1998	215.8	
AOC_5	N4-P2	7/17/1998	215.5	
AOC_5	N4-P2	7/31/1998	215.4	
AOC_5	N4-P2	8/28/1998	215.3	
AOC_5	N4-P2	10/14/1998	215.4	
AOC_5	N4-P2	12/10/1998	215.3	
AOC_5	N4-P2	6/6/1999	215.1	
AOC_5	N4-P2	9/8/1999	214.9	
AOC_5	N4-P2	8/4/2005	215.4	
AOC_5	N4-P2	8/24/2005	215.3	
AOC_5	N4-P2	8/26/2005	215.3	
AOC_5	N4-P2	6/24/2016		
AOC_5	N4-P3	12/7/1995	215.7	
AOC_5	N4-P3	7/23/1996	215.5	
AOC_5	N4-P3	6/2/1997	215.5	
AOC_5	N4-P3	4/23/1998	215.7	
AOC_5	N4-P3	6/19/1998	216.2	
AOC_5	N4-P3	6/26/1998	215.9	
AOC_5	N4-P3	7/1/1998	215.8	
AOC_5	N4-P3	7/17/1998	215.5	
AOC_5	N4-P3	7/31/1998	215.4	
AOC_5	N4-P3	8/28/1998	215.4	
AOC_5	N4-P3	10/14/1998	215.4	
AOC_5	N4-P3	12/10/1998	215.4	
AOC_5	N4-P3	6/6/1999	215.2	
AOC_5	N4-P3	9/8/1999	215.0	
AOC_5	N4-P3	6/24/2016		
AOC_5	N5-P1	12/7/1995	218.5	
AOC_5	N5-P1	7/23/1996	219.7	
AOC_5	N5-P1	6/2/1997	220.6	
AOC_5	N5-P1	4/23/1998	220.3	
AOC_5	N5-P1	6/19/1998	220.6	
AOC_5	N5-P1	6/26/1998	220.7	
AOC_5	N5-P1	7/1/1998	220.7	
AOC_5	N5-P1	7/17/1998	220.6	
AOC_5	N5-P1	7/31/1998	220.2	
AOC_5	N5-P1	8/28/1998	219.6	
AOC_5	N5-P1	10/14/1998	218.8	
AOC_5	N5-P1	12/10/1998	218.4	
AOC_5	N5-P1	2/23/1999	218.3	
AOC_5	N5-P1	6/6/1999	218.4	
AOC_5	N5-P1	9/8/1999	217.3	
AOC_5	N5-P1	11/16/2001	217.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N5-P1	8/4/2005	219.8	
AOC_5	N5-P1	8/24/2005	219.3	
AOC_5	N5-P1	8/26/2005	219.4	
AOC_5	N5-P1	4/10/2006	220.2	
AOC_5	N5-P1	6/5/2006	220.7	
AOC_5	N5-P1	8/2/2006	220.4	
AOC_5	N5-P1	9/18/2006	219.3	
AOC_5	N5-P1	10/19/2006	219.0	
AOC_5	N5-P1	12/15/2006	219.5	
AOC_5	N5-P1	4/8/2007	219.0	
AOC_5	N5-P1	4/9/2007	219.0	
AOC_5	N5-P1	4/26/2007	220.1	
AOC_5	N5-P1	10/15/2007	218.4	
AOC_5	N5-P1	2/20/2008	219.3	
AOC_5	N5-P1	2/25/2008	219.5	
AOC_5	N5-P1	3/4/2008	219.6	
AOC_5	N5-P1	4/16/2008	220.7	
AOC_5	N5-P1	4/28/2008	220.5	
AOC_5	N5-P1	6/10/2008	220.0	
AOC_5	N5-P1	8/19/2008	219.4	
AOC_5	N5-P1	9/15/2008	219.3	
AOC_5	N5-P1	9/30/2008	219.3	
AOC_5	N5-P1	10/3/2008	219.4	
AOC_5	N5-P1	4/28/2009	220.5	
AOC_5	N5-P1	9/14/2009	219.3	
AOC_5	N5-P1	10/22/2009	218.7	
AOC_5	N5-P1	10/26/2009	218.7	
AOC_5	N5-P1	11/3/2009	218.8	
AOC_5	N5-P1	4/20/2010	221.0	
AOC_5	N5-P1	9/14/2010	218.2	
AOC_5	N5-P1	10/7/2010	218.0	
AOC_5	N5-P1	4/4/2011	219.3	
AOC_5	N5-P1	7/25/2011	219.1	
AOC_5	N5-P1	11/8/2011	219.9	
AOC_5	N5-P1	4/10/2012	219.5	
AOC_5	N5-P1	11/5/2012	218.3	
AOC_5	N5-P1	5/15/2013	219.1	
AOC_5	N5-P1	6/11/2013	219.4	
AOC_5	N5-P1	10/21/2013	218.0	
AOC_5	N5-P1	10/22/2013	217.8	
AOC_5	N5-P1	4/22/2014	218.8	
AOC_5	N5-P1	10/6/2014	218.4	
AOC_5	N5-P1	6/3/2015	219.4	
AOC_5	N5-P1	6/17/2015	219.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N5-P1	10/7/2015	218.0	
AOC_5	N5-P1	10/20/2015	217.9	
AOC_5	N5-P1	12/16/2015	217.8	
AOC_5	N5-P1	6/9/2016	218.7	
AOC_5	N5-P1	6/24/2016	218.6	
AOC_5	N5-P1	8/16/2016	217.8	
AOC_5	N5-P1	11/16/2016	217.6	
AOC_5	N5-P1	5/22/2017	220.0	
AOC_5	N5-P1	11/1/2018	219.6	
AOC_5	N5-P1	10/22/2019	218.7	
AOC_5	N5-P2	12/7/1995	218.0	
AOC_5	N5-P2	7/23/1996	219.9	
AOC_5	N5-P2	6/2/1997	220.8	
AOC_5	N5-P2	4/23/1998	220.0	
AOC_5	N5-P2	6/19/1998	220.4	
AOC_5	N5-P2	6/26/1998	220.7	
AOC_5	N5-P2	7/1/1998	220.7	
AOC_5	N5-P2	7/17/1998	220.7	
AOC_5	N5-P2	7/31/1998	220.3	
AOC_5	N5-P2	8/28/1998	219.8	
AOC_5	N5-P2	10/14/1998	218.9	
AOC_5	N5-P2	12/10/1998	218.3	
AOC_5	N5-P2	2/23/1999	218.0	
AOC_5	N5-P2	6/6/1999	218.5	
AOC_5	N5-P2	9/8/1999	217.6	
AOC_5	N5-P2	11/16/2001	218.0	
AOC_5	N5-P2	8/4/2005	220.0	
AOC_5	N5-P2	8/24/2005	219.4	
AOC_5	N5-P2	8/26/2005	219.5	
AOC_5	N5-P2	8/2/2006	220.7	
AOC_5	N5-P2	10/19/2006	219.2	
AOC_5	N5-P2	4/8/2007	222.7	
AOC_5	N5-P2	4/9/2007	222.7	
AOC_5	N5-P2	4/26/2007	219.4	
AOC_5	N5-P2	10/15/2007	218.3	
AOC_5	N5-P2	2/12/2008	218.2	
AOC_5	N5-P2	2/20/2008	218.5	
AOC_5	N5-P2	2/25/2008	218.8	
AOC_5	N5-P2	3/4/2008	218.9	
AOC_5	N5-P2	4/16/2008	220.2	
AOC_5	N5-P2	4/28/2008	220.6	
AOC_5	N5-P2	6/10/2008	220.2	
AOC_5	N5-P2	8/19/2008	219.2	
AOC_5	N5-P2	9/15/2008	219.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N5-P2	9/30/2008	219.1	
AOC_5	N5-P2	10/3/2008	219.0	
AOC_5	N5-P2	4/28/2009	220.4	
AOC_5	N5-P2	9/14/2009	219.5	
AOC_5	N5-P2	10/22/2009	218.9	
AOC_5	N5-P2	10/26/2009	218.7	
AOC_5	N5-P2	11/3/2009	220.3	
AOC_5	N5-P2	4/20/2010	220.6	
AOC_5	N5-P2	4/27/2010	220.9	
AOC_5	N5-P2	9/14/2010	218.4	
AOC_5	N5-P2	10/7/2010	218.3	
AOC_5	N5-P2	4/4/2011	218.7	
AOC_5	N5-P2	7/25/2011	219.3	
AOC_5	N5-P2	11/8/2011	219.4	
AOC_5	N5-P2	4/10/2012	219.6	
AOC_5	N5-P2	6/26/2012	219.3	
AOC_5	N5-P2	11/5/2012	217.8	
AOC_5	N5-P2	11/6/2012	217.9	
AOC_5	N5-P2	4/25/2013	218.9	
AOC_5	N5-P2	5/15/2013	219.0	
AOC_5	N5-P2	6/11/2013	219.2	
AOC_5	N5-P2	10/21/2013	218.3	
AOC_5	N5-P2	10/22/2013	218.4	
AOC_5	N5-P2	4/22/2014	218.1	
AOC_5	N5-P2	10/6/2014	218.0	
AOC_5	N5-P2	6/3/2015	219.4	
AOC_5	N5-P2	6/17/2015	219.2	
AOC_5	N5-P2	10/7/2015	218.2	
AOC_5	N5-P2	10/20/2015	217.9	
AOC_5	N5-P2	12/16/2015	217.6	
AOC_5	N5-P2	6/9/2016	218.8	
AOC_5	N5-P2	6/24/2016	218.7	
AOC_5	N5-P2	8/16/2016	218.0	
AOC_5	N5-P2	5/22/2017	219.6	
AOC_5	N5-P2	11/1/2018	219.3	
AOC_5	N5-P2	10/22/2019	218.4	
AOC_5	N6-P1	12/7/1995	220.6	
AOC_5	N6-P1	3/26/1996	221.9	
AOC_5	N6-P1	6/2/1997	223.4	
AOC_5	N6-P1	4/23/1998	222.9	
AOC_5	N6-P1	6/19/1998	223.2	
AOC_5	N6-P1	6/26/1998	223.4	
AOC_5	N6-P1	7/1/1998	223.4	
AOC_5	N6-P1	7/17/1998	223.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N6-P1	7/31/1998	223.1	
AOC_5	N6-P1	8/28/1998	222.5	
AOC_5	N6-P1	10/14/1998	221.5	
AOC_5	N6-P1	12/10/1998	220.9	
AOC_5	N6-P1	2/23/1999	220.6	
AOC_5	N6-P1	6/6/1999	220.8	
AOC_5	N6-P1	9/8/1999	219.6	
AOC_5	N6-P1	8/4/2005	222.5	
AOC_5	N6-P1	8/24/2005	222.1	
AOC_5	N6-P1	8/26/2005	222.6	
AOC_5	N6-P1	4/10/2006	223.0	
AOC_5	N6-P1	6/5/2006	223.3	
AOC_5	N6-P1	9/18/2006	222.4	
AOC_5	N6-P1	12/15/2006	222.0	
AOC_5	N6-P1	4/8/2007	221.7	
AOC_5	N6-P1	4/9/2007	221.7	
AOC_5	N6-P1	10/15/2007	221.0	
AOC_5	N6-P1	2/20/2008	221.4	
AOC_5	N6-P1	2/25/2008	221.7	
AOC_5	N6-P1	3/4/2008	221.8	
AOC_5	N6-P1	4/16/2008	223.2	
AOC_5	N6-P1	9/15/2008	222.1	
AOC_5	N6-P1	9/30/2008	221.9	
AOC_5	N6-P1	4/28/2009	223.0	
AOC_5	N6-P1	9/14/2009	222.3	
AOC_5	N6-P1	10/26/2009	221.5	
AOC_5	N6-P1	11/3/2009	221.5	
AOC_5	N6-P1	4/20/2010	223.9	
AOC_5	N6-P1	4/27/2010	224.0	
AOC_5	N6-P1	9/14/2010	221.2	
AOC_5	N6-P1	10/7/2010	220.8	
AOC_5	N6-P1	4/4/2011	221.8	
AOC_5	N6-P1	7/25/2011	221.9	
AOC_5	N6-P1	11/8/2011	222.5	
AOC_5	N6-P1	4/10/2012	222.1	
AOC_5	N6-P1	6/26/2012	221.8	
AOC_5	N6-P1	11/5/2012	220.7	
AOC_5	N6-P1	11/6/2012	220.8	
AOC_5	N6-P1	4/25/2013	221.6	
AOC_5	N6-P1	5/15/2013	221.6	
AOC_5	N6-P1	6/11/2013	221.7	
AOC_5	N6-P1	10/21/2013	220.7	
AOC_5	N6-P1	4/22/2014	220.9	
AOC_5	N6-P1	10/6/2014	220.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N6-P1	6/3/2015	222.0	
AOC_5	N6-P1	6/17/2015	221.9	
AOC_5	N6-P1	10/7/2015	220.7	
AOC_5	N6-P1	10/20/2015	220.5	
AOC_5	N6-P1	12/16/2015	220.1	
AOC_5	N6-P1	6/9/2016	221.1	
AOC_5	N6-P1	8/16/2016	220.3	
AOC_5	N6-P1	11/15/2016	219.7	
AOC_5	N6-P1	5/11/2018	222.7	
AOC_5	N6-P1	11/1/2018	222.8	
AOC_5	N6-P1	4/11/2019	224.0	
AOC_5	N6-P1	10/22/2019	221.9	
AOC_5	N6-P1	4/29/2020	223.7	
AOC_5	N7-P1	12/7/1995	223.5	
AOC_5	N7-P1	6/2/1997	226.5	
AOC_5	N7-P1	4/23/1998	226.4	
AOC_5	N7-P1	6/19/1998	227.1	
AOC_5	N7-P1	6/26/1998	227.2	
AOC_5	N7-P1	7/1/1998	227.3	
AOC_5	N7-P1	7/17/1998	227.0	
AOC_5	N7-P1	7/31/1998	226.6	
AOC_5	N7-P1	8/28/1998	225.8	
AOC_5	N7-P1	10/14/1998	225.0	
AOC_5	N7-P1	12/10/1998	224.0	
AOC_5	N7-P1	2/23/1999	224.1	
AOC_5	N7-P1	6/6/1999	223.6	
AOC_5	N7-P1	9/8/1999	222.3	
AOC_5	N7-P1	8/4/2005	225.7	
AOC_5	N7-P1	8/24/2005	225.2	
AOC_5	N7-P1	8/26/2005	225.3	
AOC_5	N7-P1	4/10/2006	226.2	
AOC_5	N7-P1	6/5/2006	227.0	
AOC_5	N7-P1	9/18/2006	225.7	
AOC_5	N7-P1	12/15/2006	225.7	
AOC_5	N7-P1	4/8/2007	225.0	
AOC_5	N7-P1	4/9/2007	225.0	
AOC_5	N7-P1	10/15/2007	224.1	
AOC_5	N7-P1	2/20/2008	225.3	
AOC_5	N7-P1	2/25/2008	225.5	
AOC_5	N7-P1	3/4/2008	225.7	
AOC_5	N7-P1	4/16/2008	226.9	
AOC_5	N7-P1	8/19/2008	225.9	
AOC_5	N7-P1	9/15/2008	226.0	
AOC_5	N7-P1	9/30/2008	226.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N7-P1	4/28/2009	226.2	
AOC_5	N7-P1	9/14/2009	225.8	
AOC_5	N7-P1	10/26/2009	225.0	
AOC_5	N7-P1	11/3/2009	225.0	
AOC_5	N7-P1	4/20/2010	228.1	
AOC_5	N7-P1	9/14/2010	224.5	
AOC_5	N7-P1	10/7/2010	224.4	
AOC_5	N7-P1	4/4/2011	225.4	
AOC_5	N7-P1	7/25/2011	225.0	
AOC_5	N7-P1	11/8/2011	226.3	
AOC_5	N7-P1	4/10/2012	225.2	
AOC_5	N7-P1	6/26/2012	224.9	
AOC_5	N7-P1	11/5/2012	223.9	
AOC_5	N7-P1	11/6/2012	224.0	
AOC_5	N7-P1	5/15/2013	224.3	
AOC_5	N7-P1	6/11/2013	224.8	
AOC_5	N7-P1	10/21/2013	223.8	
AOC_5	N7-P1	4/22/2014	224.1	
AOC_5	N7-P1	10/6/2014	223.4	
AOC_5	N7-P1	6/3/2015	225.3	
AOC_5	N7-P1	6/17/2015	225.0	
AOC_5	N7-P1	10/7/2015	223.5	
AOC_5	N7-P1	10/20/2015	223.3	
AOC_5	N7-P1	12/16/2015	222.9	
AOC_5	N7-P1	6/9/2016	223.7	
AOC_5	N7-P1	6/24/2016		
AOC_5	N7-P1	8/16/2016	222.9	
AOC_5	N7-P1	11/15/2016	222.6	
AOC_5	N7-P1	5/22/2017	225.3	
AOC_5	N7-P1	11/1/2018	226.1	
AOC_5	N7-P1	12/5/2018	227.6	
AOC_5	N7-P1	10/22/2019	224.4	
AOC_5	N7-P1	4/29/2020	226.2	
AOC_5	N7-P2	12/7/1995	223.7	
AOC_5	N7-P2	6/2/1997	226.8	
AOC_5	N7-P2	4/23/1998	226.8	
AOC_5	N7-P2	6/19/1998	227.5	
AOC_5	N7-P2	6/26/1998	227.6	
AOC_5	N7-P2	7/1/1998	227.7	
AOC_5	N7-P2	7/17/1998	227.4	
AOC_5	N7-P2	7/31/1998	227.0	
AOC_5	N7-P2	8/28/1998	226.1	
AOC_5	N7-P2	10/14/1998	225.4	
AOC_5	N7-P2	12/10/1998	224.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N7-P2	2/23/1999	224.5	
AOC_5	N7-P2	6/6/1999	223.9	
AOC_5	N7-P2	9/8/1999	222.6	
AOC_5	N7-P2	8/4/2005	226.0	
AOC_5	N7-P2	8/24/2005	225.6	
AOC_5	N7-P2	8/26/2005	225.6	
AOC_5	N7-P2	4/10/2006	226.6	
AOC_5	N7-P2	6/5/2006	226.3	
AOC_5	N7-P2	9/18/2006	226.1	
AOC_5	N7-P2	12/15/2006	226.0	
AOC_5	N7-P2	4/8/2007	225.3	
AOC_5	N7-P2	4/9/2007	225.3	
AOC_5	N7-P2	10/15/2007	224.4	
AOC_5	N7-P2	2/20/2008	225.6	
AOC_5	N7-P2	2/25/2008	225.9	
AOC_5	N7-P2	3/4/2008	226.1	
AOC_5	N7-P2	4/16/2008	227.3	
AOC_5	N7-P2	6/10/2008	226.5	
AOC_5	N7-P2	8/19/2008	226.3	
AOC_5	N7-P2	9/15/2008	226.4	
AOC_5	N7-P2	9/30/2008	226.5	
AOC_5	N7-P2	4/28/2009	226.7	
AOC_5	N7-P2	9/14/2009	226.2	
AOC_5	N7-P2	10/26/2009	225.4	
AOC_5	N7-P2	11/3/2009	225.4	
AOC_5	N7-P2	4/20/2010	228.6	
AOC_5	N7-P2	4/27/2010	228.5	
AOC_5	N7-P2	9/14/2010	224.8	
AOC_5	N7-P2	10/7/2010	224.6	
AOC_5	N7-P2	4/4/2011	225.7	
AOC_5	N7-P2	7/25/2011	225.3	
AOC_5	N7-P2	11/8/2011	226.8	
AOC_5	N7-P2	4/10/2012	225.4	
AOC_5	N7-P2	6/26/2012	225.2	
AOC_5	N7-P2	11/5/2012	224.2	
AOC_5	N7-P2	11/6/2012	224.3	
AOC_5	N7-P2	4/25/2013	224.8	
AOC_5	N7-P2	5/15/2013	224.6	
AOC_5	N7-P2	6/11/2013	225.0	
AOC_5	N7-P2	10/21/2013	224.0	
AOC_5	N7-P2	4/22/2014	224.4	
AOC_5	N7-P2	10/6/2014	223.6	
AOC_5	N7-P2	6/3/2015	225.6	
AOC_5	N7-P2	6/17/2015	225.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	N7-P2	10/7/2015	223.8	
AOC_5	N7-P2	10/20/2015	223.6	
AOC_5	N7-P2	10/21/2015	223.6	
AOC_5	N7-P2	12/16/2015	223.2	
AOC_5	N7-P2	6/9/2016	223.9	
AOC_5	N7-P2	6/24/2016	223.8	
AOC_5	N7-P2	8/16/2016	223.1	
AOC_5	N7-P2	11/15/2016	222.8	
AOC_5	N7-P2	5/22/2017	225.5	
AOC_5	N7-P2	11/1/2018	226.0	
AOC_5	N7-P2	12/5/2018	228.1	
AOC_5	N7-P2	10/22/2019	224.8	
AOC_5	N7-P2	4/29/2020	226.5	
AOC_5	PSP-01	8/4/2005		
AOC_5	PSP-01	8/24/2005		
AOC_5	PSP-01	8/26/2005		
AOC_5	PSP-01	4/10/2006		
AOC_5	PSP-01	6/5/2006		
AOC_5	PSP-01	9/18/2006		
AOC_5	PSP-01	12/15/2006		
AOC_5	PSP-01	4/8/2007		
AOC_5	PSP-01	4/9/2007		
AOC_5	PSP-01	10/15/2007		
AOC_5	PSP-01	2/20/2008		
AOC_5	PSP-01	2/25/2008		
AOC_5	PSP-01	3/4/2008		
AOC_5	PSP-01	4/16/2008		
AOC_5	PSP-01	4/28/2008		
AOC_5	PSP-01	6/10/2008		
AOC_5	PSP-01	9/30/2008		
AOC_5	PSP-01	4/28/2009		
AOC_5	PSP-01	7/5/2009		
AOC_5	PSP-01	11/3/2009		
AOC_5	PSP-01	4/20/2010		
AOC_5	PSP-01	10/7/2010		
AOC_5	PSP-01	4/4/2011		
AOC_5	PSP-01	11/8/2011		
AOC_5	PSP-01	4/10/2012		
AOC_5	PSP-01	11/5/2012	212.8	
AOC_5	PSP-01	5/15/2013	213.1	
AOC_5	PSP-01	6/11/2013	211.0	
AOC_5	PSP-01	7/20/2013	213.3	
AOC_5	PSP-01	4/22/2014	213.0	
AOC_5	PSP-01	6/2/2015	212.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PSP-01	10/20/2015		
AOC_5	PSP-01	5/11/2018	216.3	
AOC_5	PSP-01	4/11/2019	216.3	
AOC_5	PSP-01	10/22/2019	217.1	
AOC_5	PZ-12-01	11/5/2012	217.0	
AOC_5	PZ-12-01	11/6/2012	217.1	
AOC_5	PZ-12-01	11/16/2012	216.9	
AOC_5	PZ-12-01	11/21/2012	217.0	
AOC_5	PZ-12-01	11/28/2012	216.8	
AOC_5	PZ-12-01	12/13/2012	216.6	
AOC_5	PZ-12-01	1/16/2013	216.9	
AOC_5	PZ-12-01	2/14/2013	216.7	
AOC_5	PZ-12-01	3/12/2013	217.0	
AOC_5	PZ-12-01	4/22/2013	216.8	
AOC_5	PZ-12-01	4/25/2013	216.8	
AOC_5	PZ-12-01	5/15/2013	216.9	
AOC_5	PZ-12-01	5/28/2013		203.6
AOC_5	PZ-12-01	5/30/2013	217.3	
AOC_5	PZ-12-01	6/11/2013	217.7	
AOC_5	PZ-12-01	10/21/2013	214.1	
AOC_5	PZ-12-01	11/19/2013	216.0	
AOC_5	PZ-12-01	4/22/2014	217.0	
AOC_5	PZ-12-01	10/6/2014	216.9	
AOC_5	PZ-12-01	6/3/2015	217.0	
AOC_5	PZ-12-01	6/17/2015	216.8	
AOC_5	PZ-12-01	8/18/2015	216.6	
AOC_5	PZ-12-01	10/7/2015	216.5	
AOC_5	PZ-12-01	10/20/2015	218.2	
AOC_5	PZ-12-01	12/16/2015	216.5	
AOC_5	PZ-12-01	4/6/2016	216.9	
AOC_5	PZ-12-01	6/9/2016	216.8	
AOC_5	PZ-12-01	6/23/2016	216.7	
AOC_5	PZ-12-01	8/16/2016	216.3	
AOC_5	PZ-12-01	10/20/2016	216.3	
AOC_5	PZ-12-01	11/15/2016	217.0	
AOC_5	PZ-12-01	5/22/2017	217.2	
AOC_5	PZ-12-01	5/11/2018	217.3	
AOC_5	PZ-12-01	11/1/2018	217.1	
AOC_5	PZ-12-01	4/11/2019	217.1	
AOC_5	PZ-12-01	10/22/2019	217.4	
AOC_5	PZ-12-01	5/18/2020	217.4	
AOC_5	PZ-12-02	11/5/2012	217.3	
AOC_5	PZ-12-02	11/6/2012	217.4	
AOC_5	PZ-12-02	11/16/2012	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-02	11/21/2012	217.3	
AOC_5	PZ-12-02	11/28/2012	217.2	
AOC_5	PZ-12-02	12/13/2012	217.0	
AOC_5	PZ-12-02	1/16/2013	217.2	
AOC_5	PZ-12-02	2/14/2013	217.1	
AOC_5	PZ-12-02	3/12/2013	217.3	
AOC_5	PZ-12-02	4/22/2013	217.4	
AOC_5	PZ-12-02	4/25/2013	217.4	
AOC_5	PZ-12-02	5/15/2013	217.4	
AOC_5	PZ-12-02	5/21/2013	217.4	
AOC_5	PZ-12-02	5/30/2013	217.7	
AOC_5	PZ-12-02	6/11/2013	217.9	
AOC_5	PZ-12-02	10/21/2013	215.3	
AOC_5	PZ-12-02	11/19/2013	216.3	
AOC_5	PZ-12-02	4/22/2014	217.4	
AOC_5	PZ-12-02	10/6/2014	217.0	
AOC_5	PZ-12-02	6/3/2015	215.8	
AOC_5	PZ-12-02	6/17/2015	217.4	
AOC_5	PZ-12-02	8/18/2015	217.2	
AOC_5	PZ-12-02	10/7/2015	216.8	
AOC_5	PZ-12-02	10/20/2015	217.1	
AOC_5	PZ-12-02	12/16/2015	216.8	
AOC_5	PZ-12-02	4/6/2016	217.4	
AOC_5	PZ-12-02	6/9/2016	217.3	
AOC_5	PZ-12-02	6/23/2016	217.1	
AOC_5	PZ-12-02	8/16/2016	216.7	
AOC_5	PZ-12-02	11/15/2016	217.0	
AOC_5	PZ-12-02	5/22/2017	218.0	
AOC_5	PZ-12-02	5/11/2018	218.0	
AOC_5	PZ-12-02	11/1/2018	217.8	
AOC_5	PZ-12-02	4/11/2019	218.2	
AOC_5	PZ-12-02	10/22/2019	217.7	
AOC_5	PZ-12-02	5/15/2020	218.5	
AOC_5	PZ-12-02	5/18/2020	218.5	
AOC_5	PZ-12-03	11/5/2012	217.0	
AOC_5	PZ-12-03	11/6/2012	217.0	
AOC_5	PZ-12-03	11/16/2012	216.9	
AOC_5	PZ-12-03	11/21/2012	217.0	
AOC_5	PZ-12-03	11/28/2012	216.8	
AOC_5	PZ-12-03	12/13/2012	216.5	
AOC_5	PZ-12-03	1/16/2013	217.0	
AOC_5	PZ-12-03	2/14/2013	216.6	
AOC_5	PZ-12-03	3/12/2013	217.0	
AOC_5	PZ-12-03	4/22/2013	216.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-03	4/25/2013	216.6	
AOC_5	PZ-12-03	5/15/2013	216.8	
AOC_5	PZ-12-03	5/24/2013	217.2	
AOC_5	PZ-12-03	5/30/2013	217.4	
AOC_5	PZ-12-03	6/11/2013	216.9	
AOC_5	PZ-12-03	10/21/2013		213.6
AOC_5	PZ-12-03	11/19/2013	216.1	
AOC_5	PZ-12-03	4/22/2014	216.9	
AOC_5	PZ-12-03	10/6/2014	217.1	
AOC_5	PZ-12-03	6/3/2015	217.0	
AOC_5	PZ-12-03	6/17/2015	216.7	
AOC_5	PZ-12-03	8/18/2015	216.5	
AOC_5	PZ-12-03	10/7/2015	216.5	
AOC_5	PZ-12-03	10/20/2015	217.3	
AOC_5	PZ-12-03	12/16/2015	216.6	
AOC_5	PZ-12-03	4/6/2016	216.8	
AOC_5	PZ-12-03	6/9/2016	216.8	
AOC_5	PZ-12-03	6/23/2016	216.6	
AOC_5	PZ-12-03	8/16/2016	216.3	
AOC_5	PZ-12-03	10/20/2016	216.4	
AOC_5	PZ-12-03	11/15/2016	217.2	
AOC_5	PZ-12-03	5/22/2017	216.9	
AOC_5	PZ-12-03	5/11/2018	217.1	
AOC_5	PZ-12-03	11/1/2018	216.9	
AOC_5	PZ-12-03	4/11/2019	216.9	
AOC_5	PZ-12-03	10/22/2019	216.5	
AOC_5	PZ-12-03	5/18/2020	217.0	
AOC_5	PZ-12-04	11/5/2012	217.8	
AOC_5	PZ-12-04	11/6/2012	217.9	
AOC_5	PZ-12-04	11/16/2012	217.8	
AOC_5	PZ-12-04	11/21/2012	217.8	
AOC_5	PZ-12-04	11/28/2012	217.8	
AOC_5	PZ-12-04	12/13/2012	217.5	
AOC_5	PZ-12-04	1/16/2013	217.7	
AOC_5	PZ-12-04	2/14/2013	217.6	
AOC_5	PZ-12-04	3/12/2013	217.8	
AOC_5	PZ-12-04	3/13/2013	217.9	
AOC_5	PZ-12-04	4/22/2013	218.1	
AOC_5	PZ-12-04	4/25/2013	218.1	
AOC_5	PZ-12-04	5/15/2013	218.1	
AOC_5	PZ-12-04	5/24/2013	218.1	
AOC_5	PZ-12-04	5/30/2013	218.3	
AOC_5	PZ-12-04	6/11/2013	218.5	
AOC_5	PZ-12-04	10/21/2013	216.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-04	11/19/2013	215.9	
AOC_5	PZ-12-04	4/22/2014	217.9	
AOC_5	PZ-12-04	10/6/2014	217.5	
AOC_5	PZ-12-04	6/3/2015	218.4	
AOC_5	PZ-12-04	6/17/2015	218.2	
AOC_5	PZ-12-04	8/18/2015	217.9	
AOC_5	PZ-12-04	10/7/2015	217.5	
AOC_5	PZ-12-04	10/20/2015		211.6
AOC_5	PZ-12-04	12/16/2015	217.3	
AOC_5	PZ-12-04	4/6/2016	218.0	
AOC_5	PZ-12-04	6/9/2016	217.9	
AOC_5	PZ-12-04	6/23/2016	217.9	
AOC_5	PZ-12-04	8/16/2016	217.3	
AOC_5	PZ-12-04	11/15/2016	217.4	
AOC_5	PZ-12-04	5/22/2017	218.7	
AOC_5	PZ-12-04	5/11/2018	218.8	
AOC_5	PZ-12-04	11/1/2018	218.6	
AOC_5	PZ-12-04	4/11/2019	219.2	
AOC_5	PZ-12-04	10/22/2019	218.3	
AOC_5	PZ-12-04	5/18/2020	219.5	
AOC_5	PZ-12-05	11/5/2012	217.2	
AOC_5	PZ-12-05	11/16/2012	217.1	
AOC_5	PZ-12-05	11/21/2012	217.1	
AOC_5	PZ-12-05	11/28/2012	217.0	
AOC_5	PZ-12-05	12/13/2012	216.7	
AOC_5	PZ-12-05	1/16/2013	217.2	
AOC_5	PZ-12-05	2/14/2013	216.8	
AOC_5	PZ-12-05	3/12/2013	217.2	
AOC_5	PZ-12-05	4/22/2013	216.8	
AOC_5	PZ-12-05	4/25/2013	216.9	
AOC_5	PZ-12-05	5/15/2013	217.0	
AOC_5	PZ-12-05	5/22/2013	217.1	
AOC_5	PZ-12-05	5/30/2013	217.5	
AOC_5	PZ-12-05	6/11/2013	218.0	
AOC_5	PZ-12-05	10/21/2013		214.0
AOC_5	PZ-12-05	11/19/2013	216.3	
AOC_5	PZ-12-05	4/22/2014	217.1	
AOC_5	PZ-12-05	10/6/2014	218.3	
AOC_5	PZ-12-05	6/3/2015	217.2	
AOC_5	PZ-12-05	6/17/2015	217.0	
AOC_5	PZ-12-05	8/18/2015	216.7	
AOC_5	PZ-12-05	10/7/2015	216.7	
AOC_5	PZ-12-05	10/20/2015	217.5	
AOC_5	PZ-12-05	12/16/2015	216.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-05	4/6/2016	217.0	
AOC_5	PZ-12-05	6/9/2016	217.0	
AOC_5	PZ-12-05	6/23/2016	216.6	
AOC_5	PZ-12-05	8/16/2016	216.5	
AOC_5	PZ-12-05	10/20/2016	216.6	
AOC_5	PZ-12-05	11/15/2016	217.5	
AOC_5	PZ-12-05	11/16/2016	217.5	
AOC_5	PZ-12-05	5/22/2017	217.2	
AOC_5	PZ-12-05	5/11/2018	217.3	
AOC_5	PZ-12-05	11/1/2018	217.2	
AOC_5	PZ-12-05	4/11/2019	217.1	
AOC_5	PZ-12-05	10/22/2019	217.6	
AOC_5	PZ-12-05	5/18/2020	218.3	
AOC_5	PZ-12-06	11/5/2012	217.9	
AOC_5	PZ-12-06	11/6/2012	218.0	
AOC_5	PZ-12-06	11/16/2012	217.9	
AOC_5	PZ-12-06	11/21/2012	218.0	
AOC_5	PZ-12-06	11/28/2012	217.9	
AOC_5	PZ-12-06	12/13/2012	217.7	
AOC_5	PZ-12-06	1/16/2013	217.9	
AOC_5	PZ-12-06	2/14/2013	217.8	
AOC_5	PZ-12-06	3/12/2013	218.0	
AOC_5	PZ-12-06	3/13/2013	218.0	
AOC_5	PZ-12-06	4/22/2013	218.2	
AOC_5	PZ-12-06	4/25/2013	218.3	
AOC_5	PZ-12-06	5/15/2013	218.3	
AOC_5	PZ-12-06	5/24/2013	218.3	
AOC_5	PZ-12-06	5/30/2013	218.4	
AOC_5	PZ-12-06	6/11/2013	218.6	
AOC_5	PZ-12-06	10/21/2013	216.5	
AOC_5	PZ-12-06	11/19/2013	216.7	
AOC_5	PZ-12-06	4/22/2014	218.0	
AOC_5	PZ-12-06	10/6/2014	217.7	
AOC_5	PZ-12-06	6/3/2015	218.5	
AOC_5	PZ-12-06	6/17/2015	218.4	
AOC_5	PZ-12-06	8/18/2015	218.1	
AOC_5	PZ-12-06	10/7/2015	217.6	
AOC_5	PZ-12-06	10/20/2015	217.8	
AOC_5	PZ-12-06	12/16/2015	217.5	
AOC_5	PZ-12-06	4/6/2016	218.2	
AOC_5	PZ-12-06	6/9/2016	218.1	
AOC_5	PZ-12-06	6/23/2016	218.0	
AOC_5	PZ-12-06	8/16/2016	217.5	
AOC_5	PZ-12-06	11/15/2016	217.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-06	11/16/2016	217.6	
AOC_5	PZ-12-06	5/22/2017	218.9	
AOC_5	PZ-12-06	5/11/2018	219.0	
AOC_5	PZ-12-06	11/1/2018	218.9	
AOC_5	PZ-12-06	4/11/2019	219.5	
AOC_5	PZ-12-06	10/22/2019	218.5	
AOC_5	PZ-12-06	5/18/2020	219.8	
AOC_5	PZ-12-07	11/5/2012	217.7	
AOC_5	PZ-12-07	11/6/2012	217.6	
AOC_5	PZ-12-07	11/16/2012	217.3	
AOC_5	PZ-12-07	11/21/2012	217.3	
AOC_5	PZ-12-07	11/28/2012	217.2	
AOC_5	PZ-12-07	12/13/2012	216.8	
AOC_5	PZ-12-07	1/16/2013	217.3	
AOC_5	PZ-12-07	2/14/2013	216.9	
AOC_5	PZ-12-07	3/12/2013	217.3	
AOC_5	PZ-12-07	4/22/2013	217.0	
AOC_5	PZ-12-07	4/25/2013	217.0	
AOC_5	PZ-12-07	5/15/2013	217.1	
AOC_5	PZ-12-07	5/24/2013	217.2	
AOC_5	PZ-12-07	5/30/2013	217.7	
AOC_5	PZ-12-07	6/11/2013	217.6	
AOC_5	PZ-12-07	10/21/2013		214.2
AOC_5	PZ-12-07	11/19/2013	216.1	
AOC_5	PZ-12-07	4/22/2014	217.4	
AOC_5	PZ-12-07	10/6/2014	217.0	
AOC_5	PZ-12-07	6/3/2015	217.5	
AOC_5	PZ-12-07	6/17/2015	216.8	
AOC_5	PZ-12-07	8/18/2015	216.7	
AOC_5	PZ-12-07	10/7/2015	216.6	
AOC_5	PZ-12-07	10/20/2015	217.3	
AOC_5	PZ-12-07	12/16/2015	216.7	
AOC_5	PZ-12-07	4/6/2016	217.1	
AOC_5	PZ-12-07	6/9/2016	216.9	
AOC_5	PZ-12-07	6/23/2016	216.8	
AOC_5	PZ-12-07	8/16/2016	216.4	
AOC_5	PZ-12-07	10/20/2016	216.5	
AOC_5	PZ-12-07	11/15/2016	217.3	
AOC_5	PZ-12-07	5/22/2017	217.3	
AOC_5	PZ-12-07	5/11/2018	217.4	
AOC_5	PZ-12-07	11/1/2018	217.2	
AOC_5	PZ-12-07	4/11/2019	216.9	
AOC_5	PZ-12-07	10/22/2019	217.5	
AOC_5	PZ-12-07	5/15/2020	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-07	5/18/2020	217.2	
AOC_5	PZ-12-08	11/5/2012	218.6	
AOC_5	PZ-12-08	11/6/2012	218.6	
AOC_5	PZ-12-08	11/16/2012	218.5	
AOC_5	PZ-12-08	11/21/2012	218.5	
AOC_5	PZ-12-08	11/28/2012	218.5	
AOC_5	PZ-12-08	12/13/2012	218.2	
AOC_5	PZ-12-08	1/16/2013	218.4	
AOC_5	PZ-12-08	2/14/2013	218.3	
AOC_5	PZ-12-08	3/12/2013	218.6	
AOC_5	PZ-12-08	4/22/2013	218.8	
AOC_5	PZ-12-08	4/25/2013	218.9	
AOC_5	PZ-12-08	5/15/2013	218.8	
AOC_5	PZ-12-08	5/24/2013	218.8	
AOC_5	PZ-12-08	5/30/2013	219.0	
AOC_5	PZ-12-08	6/11/2013	219.2	
AOC_5	PZ-12-08	10/21/2013	217.3	
AOC_5	PZ-12-08	11/19/2013	217.6	
AOC_5	PZ-12-08	4/22/2014	218.7	
AOC_5	PZ-12-08	10/6/2014	218.3	
AOC_5	PZ-12-08	6/3/2015	219.3	
AOC_5	PZ-12-08	6/17/2015	219.3	
AOC_5	PZ-12-08	8/18/2015	218.9	
AOC_5	PZ-12-08	10/7/2015	218.4	
AOC_5	PZ-12-08	10/20/2015	218.4	
AOC_5	PZ-12-08	12/16/2015	218.3	
AOC_5	PZ-12-08	4/6/2016	219.2	
AOC_5	PZ-12-08	6/9/2016	218.9	
AOC_5	PZ-12-08	6/23/2016	218.9	
AOC_5	PZ-12-08	8/16/2016	218.2	
AOC_5	PZ-12-08	11/15/2016	218.3	
AOC_5	PZ-12-08	5/22/2017	220.1	
AOC_5	PZ-12-08	5/11/2018	220.3	
AOC_5	PZ-12-08	11/1/2018	218.1	
AOC_5	PZ-12-08	4/11/2019	220.8	
AOC_5	PZ-12-08	10/22/2019	218.4	
AOC_5	PZ-12-08	5/18/2020	221.0	
AOC_5	PZ-12-08	5/19/2020	220.9	
AOC_5	PZ-12-09	11/5/2012	218.9	
AOC_5	PZ-12-09	11/6/2012	218.7	
AOC_5	PZ-12-09	11/16/2012	218.2	
AOC_5	PZ-12-09	11/21/2012	218.0	
AOC_5	PZ-12-09	11/28/2012	217.9	
AOC_5	PZ-12-09	12/13/2012	217.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-09	1/16/2013	218.8	
AOC_5	PZ-12-09	2/14/2013	217.7	
AOC_5	PZ-12-09	3/12/2013	218.3	
AOC_5	PZ-12-09	4/22/2013	217.8	
AOC_5	PZ-12-09	4/25/2013	217.8	
AOC_5	PZ-12-09	5/15/2013	217.6	
AOC_5	PZ-12-09	5/21/2013	217.5	
AOC_5	PZ-12-09	6/11/2013	219.1	
AOC_5	PZ-12-09	10/21/2013	216.7	
AOC_5	PZ-12-09	11/19/2013	217.2	
AOC_5	PZ-12-09	4/22/2014	218.4	
AOC_5	PZ-12-09	10/6/2014	217.3	
AOC_5	PZ-12-09	6/3/2015	217.7	
AOC_5	PZ-12-09	6/17/2015	217.7	
AOC_5	PZ-12-09	8/18/2015	217.5	
AOC_5	PZ-12-09	10/7/2015	217.3	
AOC_5	PZ-12-09	10/20/2015	217.5	
AOC_5	PZ-12-09	12/16/2015	217.4	
AOC_5	PZ-12-09	4/6/2016	218.1	
AOC_5	PZ-12-09	6/9/2016	217.6	
AOC_5	PZ-12-09	6/23/2016	218.6	
AOC_5	PZ-12-09	8/16/2016	217.1	
AOC_5	PZ-12-09	10/20/2016	217.1	
AOC_5	PZ-12-09	11/16/2016	218.0	
AOC_5	PZ-12-09	5/22/2017	218.3	
AOC_5	PZ-12-09	5/11/2018	218.5	
AOC_5	PZ-12-09	11/1/2018	218.4	
AOC_5	PZ-12-09	4/11/2019	218.0	
AOC_5	PZ-12-09	10/22/2019	218.0	
AOC_5	PZ-12-09	5/15/2020	218.7	
AOC_5	PZ-12-09	5/18/2020	218.6	
AOC_5	PZ-12-10	11/5/2012	219.9	
AOC_5	PZ-12-10	11/6/2012	220.0	
AOC_5	PZ-12-10	11/16/2012	219.7	
AOC_5	PZ-12-10	11/21/2012	219.6	
AOC_5	PZ-12-10	11/28/2012	219.5	
AOC_5	PZ-12-10	12/13/2012	219.2	
AOC_5	PZ-12-10	1/16/2013	219.7	
AOC_5	PZ-12-10	2/14/2013	219.5	
AOC_5	PZ-12-10	3/12/2013	220.1	
AOC_5	PZ-12-10	4/22/2013	219.6	
AOC_5	PZ-12-10	4/25/2013	219.6	
AOC_5	PZ-12-10	5/15/2013	219.4	
AOC_5	PZ-12-10	5/22/2013	219.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	PZ-12-10	6/11/2013	219.1	
AOC_5	PZ-12-10	10/21/2013	218.7	
AOC_5	PZ-12-10	11/19/2013	218.5	
AOC_5	PZ-12-10	4/22/2014	219.9	
AOC_5	PZ-12-10	10/6/2014	218.7	
AOC_5	PZ-12-10	6/3/2015	219.4	
AOC_5	PZ-12-10	6/17/2015	219.5	
AOC_5	PZ-12-10	8/18/2015	219.3	
AOC_5	PZ-12-10	10/7/2015	218.9	
AOC_5	PZ-12-10	10/20/2015	218.8	
AOC_5	PZ-12-10	12/16/2015	218.8	
AOC_5	PZ-12-10	4/6/2016	219.9	
AOC_5	PZ-12-10	6/9/2016	219.4	
AOC_5	PZ-12-10	6/24/2016	219.2	
AOC_5	PZ-12-10	8/16/2016	218.8	
AOC_5	PZ-12-10	11/16/2016	219.2	
AOC_5	PZ-12-10	5/22/2017	220.6	
AOC_5	PZ-12-10	5/11/2018	220.7	
AOC_5	PZ-12-10	11/1/2018	220.5	
AOC_5	PZ-12-10	4/11/2019	220.6	
AOC_5	PZ-12-10	10/22/2019	219.5	
AOC_5	PZ-12-10	5/15/2020	221.4	
AOC_5	PZ-12-10	5/18/2020	221.3	
AOC_5	Q4-1	4/28/2009	263.1	
AOC_5	Q4-1	9/9/2009	251.5	
AOC_5	Q4-1	3/17/2010	266.6	
AOC_5	Q4-1	6/24/2016	249.5	
AOC_5	Q4-1	11/15/2016	233.7	
AOC_5	Q4-1	5/22/2017	258.6	
AOC_5	Q4-1	11/1/2018	258.3	
AOC_5	Q4-1	10/22/2019	235.7	
AOC_5	Q4-2	4/28/2009	264.4	
AOC_5	Q4-2	8/5/2009	264.0	
AOC_5	Q4-2	9/9/2009	248.4	
AOC_5	Q4-2	3/17/2010	269.3	
AOC_5	Q5-1	4/28/2009	258.5	
AOC_5	Q5-1	8/5/2009	256.7	
AOC_5	Q5-1	9/9/2009	248.1	
AOC_5	Q5-1	3/17/2010	261.5	
AOC_5	Q5-1	6/24/2016	247.1	
AOC_5	Q5-1	11/15/2016	230.2	
AOC_5	Q5-1	5/22/2017	255.7	
AOC_5	Q5-1	11/1/2018	255.4	
AOC_5	Q5-1	10/22/2019	232.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	Q5-2	4/28/2009	258.5	
AOC_5	Q5-2	8/5/2009	256.4	
AOC_5	Q5-2	9/9/2009	247.2	
AOC_5	Q5-2	3/17/2010	261.6	
AOC_5	RSK 7	11/1/2018	216.6	
AOC_5	RSK 7	10/22/2019	217.4	
AOC_5	RSK1	9/15/2005	216.2	
AOC_5	RSK1	8/2/2006	216.4	
AOC_5	RSK1	8/10/2006	216.4	
AOC_5	RSK1	10/19/2006	216.5	
AOC_5	RSK1	4/26/2007	216.7	
AOC_5	RSK1	8/21/2007	216.2	
AOC_5	RSK1	11/7/2007	217.0	
AOC_5	RSK1	4/28/2008	216.5	
AOC_5	RSK1	6/10/2008	216.4	
AOC_5	RSK1	8/19/2008	216.7	
AOC_5	RSK1	4/28/2009	216.8	
AOC_5	RSK1	9/14/2009	216.4	
AOC_5	RSK1	10/26/2009	216.6	
AOC_5	RSK1	11/6/2012	217.5	
AOC_5	RSK1	5/30/2013	217.2	
AOC_5	RSK1	6/17/2015	216.5	
AOC_5	RSK1	8/18/2015	216.4	
AOC_5	RSK1	12/16/2015	216.5	
AOC_5	RSK1	6/9/2016	216.7	
AOC_5	RSK1	8/16/2016	216.3	
AOC_5	RSK10	9/15/2005	216.7	
AOC_5	RSK10	10/19/2006	216.9	
AOC_5	RSK10	4/25/2007	217.5	
AOC_5	RSK10	9/11/2007	216.7	
AOC_5	RSK10	11/6/2012	217.1	
AOC_5	RSK11	9/15/2005	216.7	
AOC_5	RSK11	8/2/2006	217.1	
AOC_5	RSK11	10/19/2006	217.0	
AOC_5	RSK11	4/25/2007	217.5	
AOC_5	RSK11	9/11/2007	216.7	
AOC_5	RSK11	11/6/2012	217.1	
AOC_5	RSK12	9/15/2005	216.7	
AOC_5	RSK12	10/19/2006	217.0	
AOC_5	RSK12	4/25/2007	217.5	
AOC_5	RSK12	4/26/2007	217.5	
AOC_5	RSK12	9/10/2007	216.7	
AOC_5	RSK12	9/11/2007	216.7	
AOC_5	RSK12	11/7/2007	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK12	2/12/2008	217.6	
AOC_5	RSK12	4/28/2008	217.3	
AOC_5	RSK12	6/10/2008	217.1	
AOC_5	RSK12	8/19/2008	217.4	
AOC_5	RSK12	9/15/2008	217.3	
AOC_5	RSK12	4/28/2009	217.5	
AOC_5	RSK12	7/5/2009	217.2	
AOC_5	RSK12	9/14/2009	216.9	
AOC_5	RSK12	10/26/2009	217.0	
AOC_5	RSK12	4/27/2010	217.5	
AOC_5	RSK12	9/14/2010	216.5	
AOC_5	RSK12	7/25/2011	216.8	
AOC_5	RSK12	6/26/2012	217.0	
AOC_5	RSK12	11/6/2012	217.2	
AOC_5	RSK12	4/25/2013	216.7	
AOC_5	RSK12	5/30/2013	217.4	
AOC_5	RSK12	6/17/2015	216.8	
AOC_5	RSK12	8/18/2015	216.6	
AOC_5	RSK12	10/7/2015	216.6	
AOC_5	RSK12	12/16/2015	216.7	
AOC_5	RSK12	4/6/2016	216.9	
AOC_5	RSK12	6/9/2016	216.9	
AOC_5	RSK12	8/16/2016	216.4	
AOC_5	RSK12	10/20/2016	216.4	
AOC_5	RSK13	9/15/2005	216.6	
AOC_5	RSK13	5/18/2006	218.2	
AOC_5	RSK13	8/2/2006	217.0	
AOC_5	RSK13	10/19/2006	216.9	
AOC_5	RSK13	4/26/2007	217.5	
AOC_5	RSK13	9/12/2007	216.8	
AOC_5	RSK13	11/7/2007	217.2	
AOC_5	RSK13	4/28/2008	217.1	
AOC_5	RSK13	6/10/2008	220.0	
AOC_5	RSK13	8/19/2008	217.3	
AOC_5	RSK13	4/28/2009	217.3	
AOC_5	RSK13	9/14/2009	216.8	
AOC_5	RSK13	10/26/2009	217.0	
AOC_5	RSK13	6/26/2012	216.9	
AOC_5	RSK13	11/6/2012	217.2	
AOC_5	RSK13	5/30/2013	217.4	
AOC_5	RSK13	6/17/2015	216.7	
AOC_5	RSK13	8/18/2015	216.6	
AOC_5	RSK13	10/7/2015	216.6	
AOC_5	RSK13	6/9/2016	216.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK14	9/15/2005	216.6	
AOC_5	RSK14	5/18/2006	218.3	
AOC_5	RSK14	8/2/2006	217.0	
AOC_5	RSK14	10/19/2006	216.9	
AOC_5	RSK14	9/12/2007	216.8	
AOC_5	RSK15	9/15/2005	216.6	
AOC_5	RSK15	5/18/2006	218.3	
AOC_5	RSK15	8/2/2006	217.0	
AOC_5	RSK15	10/19/2006	216.9	
AOC_5	RSK15	4/26/2007	217.6	
AOC_5	RSK15	9/10/2007	216.6	
AOC_5	RSK15	9/12/2007	216.8	
AOC_5	RSK15	11/7/2007	217.3	
AOC_5	RSK15	2/12/2008	217.6	
AOC_5	RSK15	4/28/2008	217.2	
AOC_5	RSK15	6/10/2008	220.0	
AOC_5	RSK15	8/19/2008	217.4	
AOC_5	RSK15	9/15/2008	217.3	
AOC_5	RSK15	4/28/2009	217.4	
AOC_5	RSK15	7/5/2009	217.1	
AOC_5	RSK15	9/14/2009	216.9	
AOC_5	RSK15	10/26/2009	217.0	
AOC_5	RSK15	4/27/2010	217.3	
AOC_5	RSK15	9/14/2010	216.5	
AOC_5	RSK15	7/25/2011	216.8	
AOC_5	RSK15	6/26/2012	216.9	
AOC_5	RSK15	11/6/2012	217.2	
AOC_5	RSK15	4/25/2013	216.7	
AOC_5	RSK15	5/30/2013	217.4	
AOC_5	RSK15	6/17/2015	216.7	
AOC_5	RSK15	8/18/2015	216.5	
AOC_5	RSK15	10/7/2015	216.6	
AOC_5	RSK15	12/16/2015	216.6	
AOC_5	RSK15	4/6/2016	216.8	
AOC_5	RSK15	6/9/2016	216.8	
AOC_5	RSK15	8/16/2016	216.4	
AOC_5	RSK15	10/20/2016	216.4	
AOC_5	RSK15	11/1/2018	216.9	
AOC_5	RSK15	10/22/2019	217.5	
AOC_5	RSK16	9/15/2005	216.4	
AOC_5	RSK16	8/2/2006	216.7	
AOC_5	RSK16	10/19/2006	216.7	
AOC_5	RSK16	4/24/2007	217.1	
AOC_5	RSK16	4/26/2007	217.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK16	11/7/2007	217.1	
AOC_5	RSK16	4/28/2008	216.8	
AOC_5	RSK16	6/10/2008	216.7	
AOC_5	RSK16	8/19/2008	217.0	
AOC_5	RSK16	10/26/2009	216.8	
AOC_5	RSK16	11/6/2012	217.1	
AOC_5	RSK16	5/30/2013	217.3	
AOC_5	RSK16	6/17/2015	216.6	
AOC_5	RSK16	8/18/2015	216.5	
AOC_5	RSK16	12/16/2015	216.5	
AOC_5	RSK16	6/9/2016	216.7	
AOC_5	RSK16	8/16/2016	216.3	
AOC_5	RSK17	9/15/2005	216.4	
AOC_5	RSK17	8/2/2006	216.7	
AOC_5	RSK17	10/19/2006	216.7	
AOC_5	RSK17	4/24/2007	217.1	
AOC_5	RSK17	11/6/2012	217.1	
AOC_5	RSK18	9/15/2005	216.4	
AOC_5	RSK18	8/2/2006	216.6	
AOC_5	RSK18	10/19/2006	216.7	
AOC_5	RSK18	4/24/2007	217.0	
AOC_5	RSK18	11/6/2012	217.0	
AOC_5	RSK19	9/15/2005	216.4	
AOC_5	RSK19	8/2/2006	216.6	
AOC_5	RSK19	10/19/2006	216.7	
AOC_5	RSK19	4/24/2007	217.0	
AOC_5	RSK19	4/26/2007	217.0	
AOC_5	RSK19	9/10/2007	216.4	
AOC_5	RSK19	11/7/2007	217.1	
AOC_5	RSK19	2/12/2008	217.1	
AOC_5	RSK19	4/28/2008	216.8	
AOC_5	RSK19	6/10/2008	216.6	
AOC_5	RSK19	8/19/2008	216.9	
AOC_5	RSK19	9/15/2008	216.9	
AOC_5	RSK19	4/28/2009	217.0	
AOC_5	RSK19	7/5/2009	216.7	
AOC_5	RSK19	9/14/2009	216.6	
AOC_5	RSK19	10/26/2009	216.8	
AOC_5	RSK19	4/27/2010	216.9	
AOC_5	RSK19	9/14/2010	216.2	
AOC_5	RSK19	7/25/2011	216.4	
AOC_5	RSK19	6/26/2012	216.6	
AOC_5	RSK19	11/6/2012	217.0	
AOC_5	RSK19	4/25/2013	216.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK19	5/30/2013	217.2	
AOC_5	RSK19	6/17/2015	216.6	
AOC_5	RSK19	8/18/2015	216.5	
AOC_5	RSK19	10/7/2015	216.5	
AOC_5	RSK19	12/16/2015	216.5	
AOC_5	RSK19	4/6/2016	216.7	
AOC_5	RSK19	6/9/2016	216.7	
AOC_5	RSK19	8/16/2016	216.3	
AOC_5	RSK19	10/20/2016	216.3	
AOC_5	RSK19	11/1/2018	216.8	
AOC_5	RSK19	10/22/2019	217.4	
AOC_5	RSK2	9/15/2005	215.7	
AOC_5	RSK2	8/2/2006	215.9	
AOC_5	RSK2	8/8/2006	216.1	
AOC_5	RSK2	11/6/2012	216.5	
AOC_5	RSK20	9/15/2005	216.4	
AOC_5	RSK20	8/2/2006	216.7	
AOC_5	RSK20	10/19/2006	216.7	
AOC_5	RSK20	4/24/2007	217.1	
AOC_5	RSK20	11/6/2012	217.1	
AOC_5	RSK21	8/2/2006	216.6	
AOC_5	RSK21	10/19/2006	216.7	
AOC_5	RSK21	11/7/2007	217.1	
AOC_5	RSK23	9/10/2007	216.7	
AOC_5	RSK23	11/7/2007	217.3	
AOC_5	RSK23	4/28/2009	217.5	
AOC_5	RSK24	4/26/2007	219.3	
AOC_5	RSK24	9/10/2007	217.8	
AOC_5	RSK24	11/7/2007	219.5	
AOC_5	RSK24	4/28/2008	218.7	
AOC_5	RSK24	6/10/2008	218.4	
AOC_5	RSK24	8/19/2008	219.0	
AOC_5	RSK24	9/15/2008	219.5	
AOC_5	RSK24	4/28/2009	219.0	
AOC_5	RSK24	7/5/2009	218.7	
AOC_5	RSK24	9/14/2009	218.1	
AOC_5	RSK24	10/26/2009	218.8	
AOC_5	RSK24	6/26/2012	218.2	
AOC_5	RSK24	4/25/2013	219.3	
AOC_5	RSK24	6/17/2015	219.6	
AOC_5	RSK24	8/18/2015	219.2	
AOC_5	RSK24	6/9/2016	219.2	
AOC_5	RSK24	8/16/2016	218.5	
AOC_5	RSK25	4/26/2007	218.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK25	9/10/2007	217.0	
AOC_5	RSK25	11/7/2007	217.6	
AOC_5	RSK25	4/28/2008	217.8	
AOC_5	RSK25	6/10/2008	217.5	
AOC_5	RSK25	8/19/2008	218.1	
AOC_5	RSK25	9/15/2008	218.1	
AOC_5	RSK25	4/28/2009	218.0	
AOC_5	RSK25	7/5/2009	217.8	
AOC_5	RSK25	9/14/2009	217.3	
AOC_5	RSK25	10/26/2009	217.3	
AOC_5	RSK25	4/27/2010	218.1	
AOC_5	RSK25	9/14/2010	216.8	
AOC_5	RSK25	7/25/2011	217.1	
AOC_5	RSK25	6/26/2012	217.3	
AOC_5	RSK25	4/25/2013	217.0	
AOC_5	RSK25	5/30/2013	217.7	
AOC_5	RSK25	6/17/2015	216.8	
AOC_5	RSK25	8/18/2015	216.7	
AOC_5	RSK25	10/7/2015	216.6	
AOC_5	RSK25	12/16/2015	216.7	
AOC_5	RSK25	4/6/2016	217.1	
AOC_5	RSK25	6/9/2016	216.9	
AOC_5	RSK25	8/16/2016	216.4	
AOC_5	RSK25	10/20/2016	216.5	
AOC_5	RSK25	11/1/2018	217.3	
AOC_5	RSK25	10/22/2019	217.5	
AOC_5	RSK26	4/26/2007		-20.8
AOC_5	RSK26	9/10/2007		-21.8
AOC_5	RSK26	11/7/2007		-21.3
AOC_5	RSK26	2/12/2008		-20.9
AOC_5	RSK26	4/28/2008		-21.2
AOC_5	RSK26	6/10/2008		-21.3
AOC_5	RSK26	8/19/2008		-21.0
AOC_5	RSK26	9/15/2008		-21.1
AOC_5	RSK26	4/28/2009		-20.9
AOC_5	RSK26	7/5/2009		-21.2
AOC_5	RSK26	9/14/2009		-21.6
AOC_5	RSK26	10/26/2009		-21.5
AOC_5	RSK26	4/27/2010		-20.9
AOC_5	RSK26	9/14/2010		-22.1
AOC_5	RSK26	7/25/2011		-21.7
AOC_5	RSK26	6/26/2012		-21.6
AOC_5	RSK27	4/26/2007	219.8	
AOC_5	RSK27	9/10/2007	218.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK27	11/7/2007	219.3	
AOC_5	RSK27	4/28/2008	219.7	
AOC_5	RSK27	6/10/2008	219.5	
AOC_5	RSK27	8/19/2008	219.6	
AOC_5	RSK27	9/15/2008	219.6	
AOC_5	RSK27	4/28/2009	219.8	
AOC_5	RSK27	7/5/2009	219.6	
AOC_5	RSK27	9/14/2009	219.2	
AOC_5	RSK27	10/26/2009	219.2	
AOC_5	RSK27	4/27/2010	220.0	
AOC_5	RSK27	9/14/2010	218.7	
AOC_5	RSK27	7/25/2011	219.1	
AOC_5	RSK27	6/26/2012	219.2	
AOC_5	RSK27	4/25/2013	220.2	
AOC_5	RSK27	5/30/2013	218.5	
AOC_5	RSK27	6/17/2015	218.5	
AOC_5	RSK27	8/18/2015	218.2	
AOC_5	RSK27	10/7/2015	217.7	
AOC_5	RSK27	12/16/2015	217.6	
AOC_5	RSK27	4/6/2016	218.3	
AOC_5	RSK27	6/9/2016	218.2	
AOC_5	RSK27	8/16/2016	217.6	
AOC_5	RSK27	11/1/2018	219.0	
AOC_5	RSK27	10/22/2019	219.1	
AOC_5	RSK28	4/26/2007	219.6	
AOC_5	RSK28	9/10/2007	218.8	
AOC_5	RSK28	11/7/2007	219.2	
AOC_5	RSK28	2/12/2008	219.5	
AOC_5	RSK28	4/28/2008	219.5	
AOC_5	RSK28	6/10/2008	219.3	
AOC_5	RSK28	8/19/2008	219.4	
AOC_5	RSK28	9/15/2008	219.3	
AOC_5	RSK28	4/28/2009	219.6	
AOC_5	RSK28	7/5/2009	219.3	
AOC_5	RSK28	9/14/2009	219.0	
AOC_5	RSK28	10/26/2009	219.0	
AOC_5	RSK28	4/27/2010	219.7	
AOC_5	RSK28	9/14/2010	218.5	
AOC_5	RSK28	7/25/2011	218.9	
AOC_5	RSK28	6/26/2012	219.0	
AOC_5	RSK28	4/25/2013	220.0	
AOC_5	RSK28	5/30/2013	218.5	
AOC_5	RSK28	6/17/2015	218.4	
AOC_5	RSK28	8/18/2015	218.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK28	10/7/2015	217.6	
AOC_5	RSK28	12/16/2015	217.4	
AOC_5	RSK28	4/6/2016	218.2	
AOC_5	RSK28	6/9/2016	218.1	
AOC_5	RSK28	8/16/2016	217.4	
AOC_5	RSK28	11/1/2018	218.8	
AOC_5	RSK28	10/22/2019	218.5	
AOC_5	RSK29	4/26/2007		-16.9
AOC_5	RSK29	9/10/2007		-17.7
AOC_5	RSK29	11/7/2007		-17.2
AOC_5	RSK29	2/12/2008		-16.9
AOC_5	RSK29	4/28/2008		-17.0
AOC_5	RSK29	6/10/2008		-17.2
AOC_5	RSK29	8/19/2008		-17.0
AOC_5	RSK29	9/15/2008		-17.1
AOC_5	RSK29	4/28/2009		-16.9
AOC_5	RSK29	7/5/2009		-17.2
AOC_5	RSK29	9/14/2009		-17.4
AOC_5	RSK29	10/26/2009		-17.4
AOC_5	RSK29	4/27/2010		-16.8
AOC_5	RSK29	9/14/2010		-17.9
AOC_5	RSK29	7/25/2011		-17.6
AOC_5	RSK29	6/26/2012		-17.4
AOC_5	RSK3	9/15/2005	216.1	
AOC_5	RSK3	8/2/2006	216.3	
AOC_5	RSK3	8/10/2006	216.4	
AOC_5	RSK3	10/19/2006	216.4	
AOC_5	RSK3	8/21/2007	216.2	
AOC_5	RSK3	11/6/2012	216.9	
AOC_5	RSK30	4/26/2007		-13.5
AOC_5	RSK30	9/10/2007		-14.3
AOC_5	RSK30	11/7/2007		-13.8
AOC_5	RSK30	4/28/2008		-13.7
AOC_5	RSK30	6/10/2008		-13.9
AOC_5	RSK30	8/19/2008		-13.7
AOC_5	RSK30	9/15/2008		-13.7
AOC_5	RSK30	4/28/2009		-13.5
AOC_5	RSK30	7/5/2009		-13.8
AOC_5	RSK30	9/14/2009		-14.1
AOC_5	RSK30	10/26/2009		-14.0
AOC_5	RSK30	4/27/2010		-13.5
AOC_5	RSK30	9/14/2010		-14.5
AOC_5	RSK30	7/25/2011		-14.2
AOC_5	RSK30	6/26/2012		-14.0

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK32	11/7/2007	219.1	
AOC_5	RSK32	2/12/2008	219.4	
AOC_5	RSK32	4/28/2008	219.3	
AOC_5	RSK32	6/10/2008	219.1	
AOC_5	RSK32	8/19/2008	219.3	
AOC_5	RSK32	9/15/2008	219.2	
AOC_5	RSK32	4/28/2009	219.5	
AOC_5	RSK32	7/5/2009	219.2	
AOC_5	RSK32	9/14/2009	218.9	
AOC_5	RSK32	10/26/2009	218.9	
AOC_5	RSK32	4/27/2010	219.6	
AOC_5	RSK32	9/14/2010	217.4	
AOC_5	RSK32	7/25/2011	218.8	
AOC_5	RSK32	6/26/2012	218.9	
AOC_5	RSK32	4/25/2013	219.9	
AOC_5	RSK32	5/30/2013	218.3	
AOC_5	RSK32	6/17/2015	218.2	
AOC_5	RSK32	8/18/2015	217.9	
AOC_5	RSK32	10/7/2015	217.4	
AOC_5	RSK32	12/16/2015	217.3	
AOC_5	RSK32	4/6/2016	218.0	
AOC_5	RSK32	6/9/2016	217.9	
AOC_5	RSK32	8/16/2016	217.2	
AOC_5	RSK32	11/1/2018	218.6	
AOC_5	RSK32	10/22/2019	218.3	
AOC_5	RSK33	4/26/2007		-16.4
AOC_5	RSK33	9/10/2007		-17.5
AOC_5	RSK33	11/7/2007		-16.9
AOC_5	RSK33	4/28/2008		-16.7
AOC_5	RSK33	6/10/2008		-16.9
AOC_5	RSK33	8/19/2008		-16.7
AOC_5	RSK33	9/15/2008		-16.7
AOC_5	RSK33	4/28/2009		-16.5
AOC_5	RSK33	7/5/2009		-16.8
AOC_5	RSK33	9/14/2009		-17.2
AOC_5	RSK33	10/26/2009		-17.2
AOC_5	RSK33	4/27/2010		-16.4
AOC_5	RSK33	9/14/2010		-17.7
AOC_5	RSK33	7/25/2011		-17.3
AOC_5	RSK33	6/26/2012		-17.2
AOC_5	RSK34	4/26/2007	217.6	
AOC_5	RSK34	9/10/2007	216.1	
AOC_5	RSK34	11/7/2007	216.6	
AOC_5	RSK34	4/28/2008	217.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK34	6/10/2008	216.9	
AOC_5	RSK34	8/19/2008	217.1	
AOC_5	RSK34	9/15/2008	217.0	
AOC_5	RSK34	4/28/2009	217.4	
AOC_5	RSK34	7/5/2009	217.0	
AOC_5	RSK34	9/14/2009	216.5	
AOC_5	RSK34	10/26/2009	216.4	
AOC_5	RSK34	4/27/2010	217.7	
AOC_5	RSK34	9/14/2010	215.9	
AOC_5	RSK34	7/25/2011	216.4	
AOC_5	RSK34	6/26/2012	216.5	
AOC_5	RSK34	4/25/2013	217.1	
AOC_5	RSK34	5/30/2013	217.3	
AOC_5	RSK34	6/17/2015	217.0	
AOC_5	RSK34	8/18/2015	216.7	
AOC_5	RSK34	10/7/2015	216.2	
AOC_5	RSK34	12/16/2015	216.3	
AOC_5	RSK34	4/6/2016	217.1	
AOC_5	RSK34	6/9/2016	216.7	
AOC_5	RSK34	8/16/2016	216.1	
AOC_5	RSK34	11/1/2018	217.7	
AOC_5	RSK34	10/22/2019	217.1	
AOC_5	RSK35	4/26/2007	219.9	
AOC_5	RSK35	9/10/2007	218.3	
AOC_5	RSK35	11/7/2007	218.9	
AOC_5	RSK35	4/28/2008	219.4	
AOC_5	RSK35	6/10/2008	219.1	
AOC_5	RSK35	8/19/2008	219.4	
AOC_5	RSK35	9/15/2008	219.3	
AOC_5	RSK35	4/28/2009	219.6	
AOC_5	RSK35	7/5/2009	219.3	
AOC_5	RSK35	9/14/2009	218.6	
AOC_5	RSK35	10/26/2009	218.7	
AOC_5	RSK35	4/27/2010	220.0	
AOC_5	RSK35	9/14/2010	218.0	
AOC_5	RSK35	7/25/2011	218.6	
AOC_5	RSK35	6/26/2012	218.7	
AOC_5	RSK35	4/25/2013	219.1	
AOC_5	RSK35	5/30/2013	216.9	
AOC_5	RSK35	6/17/2015	216.4	
AOC_5	RSK35	8/18/2015	216.1	
AOC_5	RSK35	10/7/2015	215.8	
AOC_5	RSK35	12/16/2015	215.9	
AOC_5	RSK35	4/6/2016	216.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK35	6/9/2016	216.3	
AOC_5	RSK35	8/16/2016	215.6	
AOC_5	RSK35	10/20/2016	215.4	
AOC_5	RSK35	11/1/2018	216.9	
AOC_5	RSK35	10/22/2019	216.6	
AOC_5	RSK37	4/26/2007	216.7	
AOC_5	RSK37	8/22/2007	216.2	
AOC_5	RSK37	9/10/2007	216.2	
AOC_5	RSK37	11/7/2007	217.0	
AOC_5	RSK37	2/12/2008	217.0	
AOC_5	RSK37	4/28/2008	216.4	
AOC_5	RSK37	6/10/2008	216.4	
AOC_5	RSK37	8/19/2008	216.7	
AOC_5	RSK37	9/15/2008	216.7	
AOC_5	RSK37	4/28/2009	216.7	
AOC_5	RSK37	7/5/2009	216.4	
AOC_5	RSK37	9/14/2009	216.4	
AOC_5	RSK37	10/26/2009	216.6	
AOC_5	RSK37	4/27/2010	216.5	
AOC_5	RSK37	9/14/2010	216.1	
AOC_5	RSK37	7/25/2011	216.2	
AOC_5	RSK37	6/26/2012	216.4	
AOC_5	RSK37	11/6/2012	217.0	
AOC_5	RSK37	4/25/2013	216.4	
AOC_5	RSK37	5/30/2013	217.2	
AOC_5	RSK37	6/17/2015	216.5	
AOC_5	RSK37	8/18/2015	216.4	
AOC_5	RSK37	10/7/2015	216.5	
AOC_5	RSK37	12/16/2015	216.5	
AOC_5	RSK37	4/6/2016	216.6	
AOC_5	RSK37	6/9/2016	216.7	
AOC_5	RSK37	8/16/2016	216.3	
AOC_5	RSK37	10/20/2016	216.4	
AOC_5	RSK37	11/1/2018	211.8	
AOC_5	RSK37	10/22/2019	217.5	
AOC_5	RSK38	8/22/2007	216.2	
AOC_5	RSK38	11/6/2012	217.0	
AOC_5	RSK39	8/22/2007	216.2	
AOC_5	RSK39	11/6/2012	217.0	
AOC_5	RSK39	10/7/2015	216.5	
AOC_5	RSK4	9/15/2005	215.9	
AOC_5	RSK4	8/2/2006	216.1	
AOC_5	RSK4	8/10/2006	216.8	
AOC_5	RSK4	10/19/2006	216.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK4	8/21/2007	216.0	
AOC_5	RSK4	11/6/2012	216.7	
AOC_5	RSK40	8/22/2007	216.2	
AOC_5	RSK40	11/6/2012	217.0	
AOC_5	RSK41	4/26/2007	216.8	
AOC_5	RSK41	8/22/2007	216.2	
AOC_5	RSK41	11/7/2007	217.0	
AOC_5	RSK41	4/28/2008	216.5	
AOC_5	RSK41	6/10/2008	216.4	
AOC_5	RSK41	8/19/2008	216.8	
AOC_5	RSK41	9/14/2009	216.4	
AOC_5	RSK41	10/26/2009	216.6	
AOC_5	RSK41	11/6/2012	217.1	
AOC_5	RSK41	6/17/2015	216.5	
AOC_5	RSK41	8/18/2015	216.4	
AOC_5	RSK41	6/9/2016	216.7	
AOC_5	RSK41	8/16/2016	216.3	
AOC_5	RSK42	8/22/2007	216.2	
AOC_5	RSK42	11/6/2012	217.0	
AOC_5	RSK42	10/7/2015	216.5	
AOC_5	RSK43	11/7/2007	217.0	
AOC_5	RSK43	8/19/2008	216.7	
AOC_5	RSK43	10/26/2009	216.6	
AOC_5	RSK47	9/10/2007	216.8	
AOC_5	RSK47	11/7/2007	217.3	
AOC_5	RSK48	9/10/2007		-3.7
AOC_5	RSK48	11/7/2007		-3.1
AOC_5	RSK48	2/12/2008		-3.0
AOC_5	RSK48	4/28/2008		-3.4
AOC_5	RSK48	6/10/2008		-3.5
AOC_5	RSK48	8/19/2008		-3.3
AOC_5	RSK48	9/15/2008		-3.2
AOC_5	RSK48	4/28/2009		-3.2
AOC_5	RSK48	7/5/2009		-3.4
AOC_5	RSK48	9/14/2009		-3.5
AOC_5	RSK48	10/26/2009		-3.4
AOC_5	RSK48	4/27/2010		-3.3
AOC_5	RSK48	9/14/2010		-3.9
AOC_5	RSK48	7/25/2011		-3.7
AOC_5	RSK48	6/26/2012		-3.5
AOC_5	RSK48	11/6/2012		-3.1
AOC_5	RSK48	4/25/2013		-3.6
AOC_5	RSK48	5/30/2013		-2.9
AOC_5	RSK49	4/26/2007		-4.7

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK49	9/10/2007		-5.6
AOC_5	RSK49	11/7/2007		-4.9
AOC_5	RSK49	4/28/2008		-5.2
AOC_5	RSK49	6/10/2008		-5.4
AOC_5	RSK49	8/19/2008		-5.1
AOC_5	RSK49	9/15/2008		-5.0
AOC_5	RSK49	4/28/2009		-5.0
AOC_5	RSK49	7/5/2009		-5.3
AOC_5	RSK49	9/14/2009		-5.4
AOC_5	RSK49	10/26/2009		-5.3
AOC_5	RSK49	4/27/2010		-5.1
AOC_5	RSK49	9/14/2010		-5.4
AOC_5	RSK49	7/25/2011		-5.3
AOC_5	RSK49	6/26/2012		-5.4
AOC_5	RSK49	11/6/2012		-4.9
AOC_5	RSK49	4/25/2013		-5.6
AOC_5	RSK49	5/30/2013		-3.8
AOC_5	RSK5	9/15/2005	216.1	
AOC_5	RSK5	8/2/2006	216.2	
AOC_5	RSK5	8/10/2006	216.3	
AOC_5	RSK5	10/19/2006	216.4	
AOC_5	RSK5	8/21/2007	216.2	
AOC_5	RSK5	11/6/2012	216.9	
AOC_5	RSK50	7/5/2009	215.9	
AOC_5	RSK50	9/14/2009	215.8	
AOC_5	RSK50	10/26/2009	215.9	
AOC_5	RSK50	4/27/2010	216.0	
AOC_5	RSK50	9/14/2010	215.4	
AOC_5	RSK50	7/25/2011	215.6	
AOC_5	RSK50	6/26/2012	215.8	
AOC_5	RSK50	11/6/2012	216.2	
AOC_5	RSK50	4/25/2013	215.7	
AOC_5	RSK50	6/17/2015	216.6	
AOC_5	RSK50	8/18/2015	216.4	
AOC_5	RSK50	10/7/2015	216.5	
AOC_5	RSK50	12/16/2015	216.5	
AOC_5	RSK50	4/6/2016	216.7	
AOC_5	RSK50	6/9/2016	216.7	
AOC_5	RSK50	8/16/2016	216.3	
AOC_5	RSK50	10/20/2016	216.3	
AOC_5	RSK6	9/15/2005	216.2	
AOC_5	RSK6	8/2/2006	216.3	
AOC_5	RSK6	8/8/2006	216.5	
AOC_5	RSK6	10/19/2006	216.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK6	8/21/2007	216.2	
AOC_5	RSK6	11/6/2012	216.9	
AOC_5	RSK7	9/15/2005	215.7	
AOC_5	RSK7	8/2/2006	215.9	
AOC_5	RSK7	8/10/2006	215.9	
AOC_5	RSK7	10/19/2006	216.0	
AOC_5	RSK7	4/26/2007	216.2	
AOC_5	RSK7	8/21/2007	215.9	
AOC_5	RSK7	9/10/2007	215.8	
AOC_5	RSK7	11/7/2007	216.5	
AOC_5	RSK7	2/12/2008	216.6	
AOC_5	RSK7	4/28/2008	216.1	
AOC_5	RSK7	6/10/2008	215.9	
AOC_5	RSK7	8/19/2008	216.2	
AOC_5	RSK7	9/15/2008	216.2	
AOC_5	RSK7	4/28/2009	216.3	
AOC_5	RSK7	7/5/2009	216.0	
AOC_5	RSK7	9/14/2009	215.9	
AOC_5	RSK7	10/26/2009	216.1	
AOC_5	RSK7	4/27/2010	216.0	
AOC_5	RSK7	9/14/2010	215.7	
AOC_5	RSK7	7/25/2011	215.8	
AOC_5	RSK7	6/26/2012	216.0	
AOC_5	RSK7	11/6/2012	216.5	
AOC_5	RSK7	4/25/2013	216.0	
AOC_5	RSK7	5/30/2013	216.8	
AOC_5	RSK7	6/17/2015	216.5	
AOC_5	RSK7	8/18/2015	216.4	
AOC_5	RSK7	10/7/2015	216.5	
AOC_5	RSK7	12/16/2015	216.5	
AOC_5	RSK7	4/6/2016	216.6	
AOC_5	RSK7	6/9/2016	216.7	
AOC_5	RSK7	8/16/2016	216.3	
AOC_5	RSK7	10/20/2016	216.3	
AOC_5	RSK8	9/15/2005	216.6	
AOC_5	RSK8	8/2/2006	217.1	
AOC_5	RSK8	10/19/2006	216.9	
AOC_5	RSK8	4/25/2007	217.5	
AOC_5	RSK8	4/26/2007	217.5	
AOC_5	RSK8	9/11/2007	216.7	
AOC_5	RSK8	11/7/2007	217.2	
AOC_5	RSK8	4/28/2008	217.2	
AOC_5	RSK8	6/10/2008	217.1	
AOC_5	RSK8	8/19/2008	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	RSK8	4/28/2009	217.4	
AOC_5	RSK8	9/14/2009	216.9	
AOC_5	RSK8	10/26/2009	217.0	
AOC_5	RSK8	6/26/2012	216.9	
AOC_5	RSK8	11/6/2012	217.1	
AOC_5	RSK8	5/30/2013	217.4	
AOC_5	RSK8	6/17/2015	216.8	
AOC_5	RSK8	8/18/2015	216.7	
AOC_5	RSK8	10/7/2015	216.7	
AOC_5	RSK8	6/9/2016	216.9	
AOC_5	RSK9	9/15/2005	216.7	
AOC_5	RSK9	5/18/2006	218.1	
AOC_5	RSK9	8/2/2006	217.1	
AOC_5	RSK9	10/19/2006	217.0	
AOC_5	RSK9	4/25/2007	217.5	
AOC_5	RSK9	9/12/2007	216.7	
AOC_5	RSK9	11/6/2012	217.1	
AOC_5	SHL-1	3/30/1993	269.8	
AOC_5	SHL-1	9/30/1993	266.3	
AOC_5	SHL-1	3/30/1994	270.2	
AOC_5	SHL-1	12/7/1995	269.7	
AOC_5	SHL-1	3/26/1996	270.1	
AOC_5	SHL-1	4/23/1998	268.8	
AOC_5	SHL-1	6/19/1998	269.9	
AOC_5	SHL-1	6/26/1998	269.6	
AOC_5	SHL-1	7/1/1998	269.8	
AOC_5	SHL-1	10/14/1998	264.6	
AOC_5	SHL-1	4/26/2007	269.9	
AOC_5	SHL-1	4/28/2008	269.1	
AOC_5	SHL-1	6/10/2008	264.3	
AOC_5	SHL-1	9/15/2008	264.3	
AOC_5	SHL-1	4/28/2009	267.8	
AOC_5	SHL-1	9/14/2009	264.3	
AOC_5	SHL-1	10/26/2009	264.2	
AOC_5	SHL-1	4/22/2014	270.0	
AOC_5	SHL-1	6/24/2016	264.3	
AOC_5	SHL-1	11/15/2016		
AOC_5	SHL-1	5/22/2017	269.6	
AOC_5	SHL-1	11/1/2018	269.0	
AOC_5	SHL-1	10/22/2019	264.5	
AOC_5	SHL-10	5/26/1992	216.8	
AOC_5	SHL-10	9/15/1992	216.6	
AOC_5	SHL-10	12/22/1992	217.2	
AOC_5	SHL-10	3/30/1993	217.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-10	6/22/1993	216.6	
AOC_5	SHL-10	9/30/1993	216.7	
AOC_5	SHL-10	11/8/1993	216.9	
AOC_5	SHL-10	3/30/1994	217.8	
AOC_5	SHL-10	6/28/1994	216.7	
AOC_5	SHL-10	10/4/1994	217.0	
AOC_5	SHL-10	1/31/1995	217.4	
AOC_5	SHL-10	5/9/1995	216.7	
AOC_5	SHL-10	12/7/1995	217.2	
AOC_5	SHL-10	3/26/1996	217.6	
AOC_5	SHL-10	7/23/1996	217.0	
AOC_5	SHL-10	6/2/1997	216.8	
AOC_5	SHL-10	4/23/1998	217.3	
AOC_5	SHL-10	6/19/1998	218.2	
AOC_5	SHL-10	6/26/1998	218.0	
AOC_5	SHL-10	7/1/1998	217.8	
AOC_5	SHL-10	7/17/1998	217.2	
AOC_5	SHL-10	8/28/1998	216.7	
AOC_5	SHL-10	10/14/1998	216.7	
AOC_5	SHL-10	12/10/1998	216.7	
AOC_5	SHL-10	2/23/1999	216.8	
AOC_5	SHL-10	6/6/1999	216.5	
AOC_5	SHL-10	9/8/1999	216.5	
AOC_5	SHL-10	11/16/2001	216.6	
AOC_5	SHL-10	8/24/2005	218.3	
AOC_5	SHL-10	4/10/2006	218.5	
AOC_5	SHL-10	6/5/2006	219.9	
AOC_5	SHL-10	9/18/2006	218.4	
AOC_5	SHL-10	12/15/2006	219.3	
AOC_5	SHL-10	4/8/2007	217.2	
AOC_5	SHL-10	4/9/2007	217.2	
AOC_5	SHL-10	4/26/2007	218.3	
AOC_5	SHL-10	9/10/2007	216.5	
AOC_5	SHL-10	10/15/2007	217.5	
AOC_5	SHL-10	2/20/2008	218.8	
AOC_5	SHL-10	2/25/2008	218.4	
AOC_5	SHL-10	3/4/2008	218.0	
AOC_5	SHL-10	4/16/2008	217.6	
AOC_5	SHL-10	8/19/2008	217.6	
AOC_5	SHL-10	9/15/2008	217.7	
AOC_5	SHL-10	9/30/2008	217.4	
AOC_5	SHL-10	10/3/2008	217.4	
AOC_5	SHL-10	4/28/2009	217.5	
AOC_5	SHL-10	7/5/2009	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-10	9/14/2009	216.9	
AOC_5	SHL-10	10/20/2009	216.9	
AOC_5	SHL-10	10/26/2009	216.9	
AOC_5	SHL-10	11/3/2009	217.0	
AOC_5	SHL-10	4/20/2010	217.9	
AOC_5	SHL-10	4/27/2010	217.6	
AOC_5	SHL-10	9/14/2010	216.4	
AOC_5	SHL-10	10/7/2010	216.8	
AOC_5	SHL-10	4/4/2011	217.6	
AOC_5	SHL-10	7/25/2011	216.7	
AOC_5	SHL-10	11/8/2011	217.6	
AOC_5	SHL-10	4/10/2012	216.8	
AOC_5	SHL-10	6/26/2012	216.9	
AOC_5	SHL-10	11/5/2012	217.7	
AOC_5	SHL-10	11/6/2012	217.5	
AOC_5	SHL-10	2/14/2013	216.9	
AOC_5	SHL-10	3/12/2013	217.4	
AOC_5	SHL-10	4/22/2013	217.0	
AOC_5	SHL-10	4/25/2013	217.0	
AOC_5	SHL-10	5/15/2013	217.0	
AOC_5	SHL-10	5/22/2013	217.0	
AOC_5	SHL-10	6/11/2013	218.0	
AOC_5	SHL-10	10/21/2013	214.3	
AOC_5	SHL-10	4/22/2014	217.5	
AOC_5	SHL-10	10/6/2014	216.9	
AOC_5	SHL-10	6/2/2015	214.1	
AOC_5	SHL-10	6/17/2015	216.8	
AOC_5	SHL-10	8/18/2015	216.7	
AOC_5	SHL-10	10/7/2015	216.6	
AOC_5	SHL-10	10/20/2015	217.2	
AOC_5	SHL-10	12/16/2015	216.7	
AOC_5	SHL-10	6/9/2016	216.9	
AOC_5	SHL-10	8/16/2016	216.4	
AOC_5	SHL-10	5/22/2017	217.3	
AOC_5	SHL-10	5/11/2018	217.3	
AOC_5	SHL-10	11/1/2018	210.6	
AOC_5	SHL-10	4/11/2019	216.9	
AOC_5	SHL-10	10/22/2019	217.5	
AOC_5	SHL-10	5/15/2020	227.1	
AOC_5	SHL-10	5/18/2020	217.4	
AOC_5	SHL-11	5/26/1992	216.6	
AOC_5	SHL-11	9/15/1992	216.5	
AOC_5	SHL-11	12/22/1992	216.8	
AOC_5	SHL-11	3/30/1993	217.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-11	6/22/1993	216.5	
AOC_5	SHL-11	9/30/1993	216.5	
AOC_5	SHL-11	11/8/1993	216.4	
AOC_5	SHL-11	3/30/1994	217.2	
AOC_5	SHL-11	6/28/1994	216.6	
AOC_5	SHL-11	10/4/1994	216.6	
AOC_5	SHL-11	1/31/1995	216.8	
AOC_5	SHL-11	5/9/1995	216.6	
AOC_5	SHL-11	12/7/1995	216.6	
AOC_5	SHL-11	3/26/1996	217.1	
AOC_5	SHL-11	7/23/1996	216.8	
AOC_5	SHL-11	1/15/1997	217.0	
AOC_5	SHL-11	6/2/1997	217.0	
AOC_5	SHL-11	4/23/1998	217.0	
AOC_5	SHL-11	6/19/1998	217.5	
AOC_5	SHL-11	6/26/1998	217.3	
AOC_5	SHL-11	7/1/1998	217.2	
AOC_5	SHL-11	7/17/1998	217.0	
AOC_5	SHL-11	7/31/1998	216.8	
AOC_5	SHL-11	8/28/1998	216.6	
AOC_5	SHL-11	10/14/1998	216.7	
AOC_5	SHL-11	12/10/1998	216.5	
AOC_5	SHL-11	2/23/1999	216.6	
AOC_5	SHL-11	6/6/1999	216.3	
AOC_5	SHL-11	9/8/1999	215.9	
AOC_5	SHL-11	11/16/2001	216.5	
AOC_5	SHL-11	8/4/2005	216.7	
AOC_5	SHL-11	8/24/2005	216.5	
AOC_5	SHL-11	8/26/2005	216.6	
AOC_5	SHL-11	4/10/2006	216.9	
AOC_5	SHL-11	6/5/2006	217.5	
AOC_5	SHL-11	9/18/2006	216.7	
AOC_5	SHL-11	10/19/2006	216.8	
AOC_5	SHL-11	12/15/2006	216.9	
AOC_5	SHL-11	4/8/2007	216.9	
AOC_5	SHL-11	4/9/2007	216.9	
AOC_5	SHL-11	4/26/2007	217.3	
AOC_5	SHL-11	9/10/2007	216.5	
AOC_5	SHL-11	10/15/2007	217.3	
AOC_5	SHL-11	11/7/2007	217.0	
AOC_5	SHL-11	2/12/2008	217.3	
AOC_5	SHL-11	2/20/2008	217.7	
AOC_5	SHL-11	2/25/2008	217.4	
AOC_5	SHL-11	3/4/2008	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-11	4/16/2008	217.3	
AOC_5	SHL-11	4/28/2008	217.1	
AOC_5	SHL-11	6/10/2008	216.9	
AOC_5	SHL-11	9/15/2008	217.1	
AOC_5	SHL-11	9/30/2008	217.1	
AOC_5	SHL-11	10/3/2008	217.1	
AOC_5	SHL-11	4/28/2009	217.2	
AOC_5	SHL-11	7/5/2009	217.0	
AOC_5	SHL-11	9/14/2009	216.7	
AOC_5	SHL-11	10/21/2009	216.7	
AOC_5	SHL-11	10/26/2009	216.8	
AOC_5	SHL-11	11/3/2009	216.8	
AOC_5	SHL-11	4/20/2010	217.4	
AOC_5	SHL-11	4/27/2010	217.3	
AOC_5	SHL-11	9/14/2010	216.3	
AOC_5	SHL-11	10/7/2010	216.7	
AOC_5	SHL-11	4/4/2011	217.0	
AOC_5	SHL-11	7/25/2011	216.6	
AOC_5	SHL-11	11/8/2011	217.2	
AOC_5	SHL-11	4/10/2012	216.6	
AOC_5	SHL-11	6/26/2012	216.7	
AOC_5	SHL-11	11/5/2012	216.9	
AOC_5	SHL-11	11/6/2012	217.0	
AOC_5	SHL-11	2/14/2013	216.6	
AOC_5	SHL-11	3/12/2013	216.9	
AOC_5	SHL-11	4/22/2013	216.6	
AOC_5	SHL-11	4/25/2013	216.6	
AOC_5	SHL-11	5/15/2013	216.8	
AOC_5	SHL-11	5/23/2013	217.0	
AOC_5	SHL-11	5/30/2013	217.3	
AOC_5	SHL-11	6/11/2013	217.7	
AOC_5	SHL-11	10/21/2013	213.8	
AOC_5	SHL-11	10/22/2013	213.7	
AOC_5	SHL-11	4/22/2014	217.0	
AOC_5	SHL-11	4/23/2014	216.9	
AOC_5	SHL-11	10/6/2014	217.0	
AOC_5	SHL-11	6/4/2015	217.1	
AOC_5	SHL-11	6/17/2015	216.7	
AOC_5	SHL-11	8/18/2015	216.5	
AOC_5	SHL-11	10/7/2015	216.5	
AOC_5	SHL-11	10/20/2015	215.8	
AOC_5	SHL-11	12/16/2015	216.5	
AOC_5	SHL-11	4/6/2016	216.8	
AOC_5	SHL-11	6/9/2016	216.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-11	6/23/2016	216.6	
AOC_5	SHL-11	8/16/2016	216.3	
AOC_5	SHL-11	10/20/2016	216.3	
AOC_5	SHL-11	11/15/2016	217.0	
AOC_5	SHL-11	5/22/2017	217.0	
AOC_5	SHL-11	5/11/2018	217.1	
AOC_5	SHL-11	11/1/2018	216.9	
AOC_5	SHL-11	4/11/2019	216.9	
AOC_5	SHL-11	10/22/2019	217.4	
AOC_5	SHL-11	5/18/2020	217.1	
AOC_5	SHL-12	5/26/1992	225.4	
AOC_5	SHL-12	9/15/1992	225.0	
AOC_5	SHL-12	12/22/1992	224.7	
AOC_5	SHL-12	3/30/1993	226.2	
AOC_5	SHL-12	6/22/1993	225.7	
AOC_5	SHL-12	9/30/1993	224.7	
AOC_5	SHL-12	11/8/1993	224.4	
AOC_5	SHL-12	3/30/1994	226.7	
AOC_5	SHL-12	6/28/1994	226.3	
AOC_5	SHL-12	10/4/1994	225.8	
AOC_5	SHL-12	1/31/1995	226.0	
AOC_5	SHL-12	5/9/1995	225.6	
AOC_5	SHL-12	12/7/1995	225.0	
AOC_5	SHL-12	3/26/1996	226.8	
AOC_5	SHL-12	1/15/1997	227.9	
AOC_5	SHL-12	6/2/1997	227.8	
AOC_5	SHL-12	4/23/1998	227.9	
AOC_5	SHL-12	6/19/1998	229.3	
AOC_5	SHL-12	6/26/1998	229.1	
AOC_5	SHL-12	7/1/1998	229.2	
AOC_5	SHL-12	7/17/1998	228.6	
AOC_5	SHL-12	7/31/1998	228.1	
AOC_5	SHL-12	8/28/1998	227.1	
AOC_5	SHL-12	10/14/1998	226.7	
AOC_5	SHL-12	12/10/1998	225.4	
AOC_5	SHL-12	2/23/1999	225.8	
AOC_5	SHL-12	6/6/1999	224.8	
AOC_5	SHL-12	9/8/1999	223.5	
AOC_5	SHL-12	8/19/2008	228.0	
AOC_5	SHL-12	9/15/2008	228.2	
AOC_5	SHL-12	4/28/2009	227.9	
AOC_5	SHL-12	9/14/2009	227.4	
AOC_5	SHL-12	10/26/2009	226.8	
AOC_5	SHL-12	4/27/2010	229.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-12	9/14/2010	226.0	
AOC_5	SHL-12	7/25/2011	226.4	
AOC_5	SHL-12	6/26/2012	226.5	
AOC_5	SHL-12	11/6/2012	225.7	
AOC_5	SHL-12	4/25/2013	226.0	
AOC_5	SHL-12	4/22/2014	226.0	
AOC_5	SHL-12	10/6/2014	224.9	
AOC_5	SHL-12	6/8/2015	227.0	
AOC_5	SHL-12	6/9/2015	227.0	
AOC_5	SHL-12	6/17/2015	226.6	
AOC_5	SHL-12	10/7/2015	224.9	
AOC_5	SHL-12	12/16/2015	224.3	
AOC_5	SHL-12	6/9/2016	225.0	
AOC_5	SHL-12	6/24/2016	224.7	
AOC_5	SHL-12	8/16/2016	224.2	
AOC_5	SHL-12	11/15/2016	224.0	
AOC_5	SHL-12	5/22/2017	226.7	
AOC_5	SHL-12	11/1/2018	227.9	
AOC_5	SHL-12	12/5/2018	229.8	
AOC_5	SHL-12	10/22/2019	226.0	
AOC_5	SHL-12	4/29/2020	227.9	
AOC_5	SHL-13	5/26/1992	213.7	
AOC_5	SHL-13	9/15/1992	213.1	
AOC_5	SHL-13	12/22/1992	214.1	
AOC_5	SHL-13	3/30/1993	213.1	
AOC_5	SHL-13	6/22/1993	213.4	
AOC_5	SHL-13	9/30/1993	213.5	
AOC_5	SHL-13	11/8/1993	213.6	
AOC_5	SHL-13	3/30/1994	215.0	
AOC_5	SHL-13	6/28/1994	213.5	
AOC_5	SHL-13	10/4/1994	213.7	
AOC_5	SHL-13	1/31/1995	214.3	
AOC_5	SHL-13	5/9/1995	213.5	
AOC_5	SHL-13	12/7/1995	214.0	
AOC_5	SHL-13	3/26/1996	214.7	
AOC_5	SHL-13	7/23/1996	213.8	
AOC_5	SHL-13	6/2/1997	214.1	
AOC_5	SHL-13	4/23/1998	214.4	
AOC_5	SHL-13	6/19/1998	215.1	
AOC_5	SHL-13	6/26/1998	214.9	
AOC_5	SHL-13	7/1/1998	214.7	
AOC_5	SHL-13	7/17/1998	214.0	
AOC_5	SHL-13	7/31/1998	213.7	
AOC_5	SHL-13	8/28/1998	213.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-13	10/14/1998	213.5	
AOC_5	SHL-13	12/10/1998	213.4	
AOC_5	SHL-13	2/23/1999	213.9	
AOC_5	SHL-13	6/6/1999	213.1	
AOC_5	SHL-13	9/8/1999	212.5	
AOC_5	SHL-13	11/16/2001	213.2	
AOC_5	SHL-13	8/4/2005	213.7	
AOC_5	SHL-13	8/24/2005	213.1	
AOC_5	SHL-13	8/26/2005	213.2	
AOC_5	SHL-13	4/10/2006	213.8	
AOC_5	SHL-13	6/5/2006	215.0	
AOC_5	SHL-13	9/18/2006	213.4	
AOC_5	SHL-13	10/19/2006	213.7	
AOC_5	SHL-13	12/15/2006	214.3	
AOC_5	SHL-13	4/8/2007	214.1	
AOC_5	SHL-13	4/9/2007	214.1	
AOC_5	SHL-13	10/15/2007	214.0	
AOC_5	SHL-13	2/20/2008	215.2	
AOC_5	SHL-13	2/25/2008	214.9	
AOC_5	SHL-13	3/4/2008	214.7	
AOC_5	SHL-13	4/16/2008	214.6	
AOC_5	SHL-13	8/19/2008	214.2	
AOC_5	SHL-13	9/15/2008	214.2	
AOC_5	SHL-13	9/30/2008	214.2	
AOC_5	SHL-13	10/1/2008	214.3	
AOC_5	SHL-13	4/28/2009	214.4	
AOC_5	SHL-13	7/5/2009	213.8	
AOC_5	SHL-13	9/14/2009	213.3	
AOC_5	SHL-13	10/19/2009	213.3	
AOC_5	SHL-13	10/26/2009	213.5	
AOC_5	SHL-13	11/3/2009	213.6	
AOC_5	SHL-13	4/20/2010	215.0	
AOC_5	SHL-13	9/14/2010	212.6	
AOC_5	SHL-13	10/7/2010	213.4	
AOC_5	SHL-13	4/4/2011	214.5	
AOC_5	SHL-13	7/25/2011	213.0	
AOC_5	SHL-13	11/8/2011	214.4	
AOC_5	SHL-13	4/10/2012	213.3	
AOC_5	SHL-13	6/26/2012	213.5	
AOC_5	SHL-13	11/5/2012	214.1	
AOC_5	SHL-13	11/6/2012	214.0	
AOC_5	SHL-13	4/25/2013	213.6	
AOC_5	SHL-13	5/15/2013	213.4	
AOC_5	SHL-13	5/30/2013	214.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-13	6/11/2013	215.1	
AOC_5	SHL-13	10/21/2013	211.5	
AOC_5	SHL-13	10/22/2013	211.3	
AOC_5	SHL-13	4/22/2014	214.7	
AOC_5	SHL-13	10/6/2014	213.8	
AOC_5	SHL-13	6/2/2015	214.4	
AOC_5	SHL-13	6/17/2015	213.5	
AOC_5	SHL-13	8/18/2015	213.2	
AOC_5	SHL-13	10/7/2015	213.0	
AOC_5	SHL-13	10/20/2015	213.9	
AOC_5	SHL-13	12/16/2015	213.3	
AOC_5	SHL-13	6/9/2016	213.6	
AOC_5	SHL-13	8/16/2016	212.9	
AOC_5	SHL-13	10/20/2016	212.8	
AOC_5	SHL-13	11/15/2016	214.0	
AOC_5	SHL-13	11/1/2018	214.1	
AOC_5	SHL-13	10/22/2019	214.1	
AOC_5	SHL-15	5/26/1992	242.0	
AOC_5	SHL-15	9/15/1992	240.5	
AOC_5	SHL-15	12/22/1992	240.8	
AOC_5	SHL-15	3/30/1993	242.8	
AOC_5	SHL-15	6/22/1993	241.7	
AOC_5	SHL-15	9/30/1993	240.8	
AOC_5	SHL-15	11/8/1993	241.0	
AOC_5	SHL-15	3/30/1994	244.4	
AOC_5	SHL-15	6/28/1994	242.1	
AOC_5	SHL-15	10/4/1994	241.5	
AOC_5	SHL-15	1/31/1995	243.3	
AOC_5	SHL-15	5/9/1995	241.9	
AOC_5	SHL-15	12/7/1995	242.6	
AOC_5	SHL-15	3/26/1996	243.7	
AOC_5	SHL-15	7/23/1996	242.3	
AOC_5	SHL-15	1/15/1997	243.4	
AOC_5	SHL-15	6/2/1997	242.7	
AOC_5	SHL-15	4/23/1998	243.3	
AOC_5	SHL-15	6/19/1998	243.8	
AOC_5	SHL-15	6/26/1998	243.6	
AOC_5	SHL-15	7/1/1998	243.4	
AOC_5	SHL-15	7/17/1998	242.8	
AOC_5	SHL-15	7/31/1998	242.1	
AOC_5	SHL-15	8/28/1998	241.1	
AOC_5	SHL-15	10/14/1998	241.2	
AOC_5	SHL-15	12/10/1998	240.3	
AOC_5	SHL-15	2/23/1999	242.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-15	6/6/1999	241.5	
AOC_5	SHL-15	9/8/1999	239.5	
AOC_5	SHL-15	1/30/2002	239.3	
AOC_5	SHL-15	4/11/2002	242.1	
AOC_5	SHL-15	7/10/2002	242.1	
AOC_5	SHL-15	10/1/2002	239.8	
AOC_5	SHL-15	6/19/2003	241.8	
AOC_5	SHL-15	9/23/2003	240.5	
AOC_5	SHL-15	12/1/2003	240.7	
AOC_5	SHL-15	5/25/2004	243.7	
AOC_5	SHL-15	10/7/2004	241.9	
AOC_5	SHL-15	5/18/2005	243.2	
AOC_5	SHL-15	6/13/2005	243.2	
AOC_5	SHL-15	8/4/2005	241.7	
AOC_5	SHL-15	8/24/2005	241.0	
AOC_5	SHL-15	8/26/2005	240.9	
AOC_5	SHL-15	10/3/2005	239.9	
AOC_5	SHL-15	4/10/2006	241.8	
AOC_5	SHL-15	6/5/2006	243.9	
AOC_5	SHL-15	6/7/2006	244.2	
AOC_5	SHL-15	9/18/2006	240.6	
AOC_5	SHL-15	10/17/2006	240.6	
AOC_5	SHL-15	10/19/2006	240.2	
AOC_5	SHL-15	12/15/2006	242.5	
AOC_5	SHL-15	4/8/2007	243.0	
AOC_5	SHL-15	4/9/2007	243.0	
AOC_5	SHL-15	5/22/2007	247.0	
AOC_5	SHL-15	10/15/2007	239.3	
AOC_5	SHL-15	10/16/2007	239.3	
AOC_5	SHL-15	2/20/2008	244.6	
AOC_5	SHL-15	2/25/2008	244.4	
AOC_5	SHL-15	3/4/2008	244.1	
AOC_5	SHL-15	4/16/2008	243.9	
AOC_5	SHL-15	6/25/2008	241.7	
AOC_5	SHL-15	6/26/2008	242.1	
AOC_5	SHL-15	9/30/2008	241.8	
AOC_5	SHL-15	10/3/2008	241.9	
AOC_5	SHL-15	10/28/2008	241.4	
AOC_5	SHL-15	10/29/2008	241.7	
AOC_5	SHL-15	4/28/2009	243.2	
AOC_5	SHL-15	5/8/2009	243.1	
AOC_5	SHL-15	5/11/2009	243.5	
AOC_5	SHL-15	9/14/2009	241.4	
AOC_5	SHL-15	10/22/2009	240.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-15	10/26/2009	240.3	
AOC_5	SHL-15	11/3/2009	240.8	
AOC_5	SHL-15	11/9/2009	241.0	
AOC_5	SHL-15	4/20/2010	244.3	
AOC_5	SHL-15	5/18/2010	243.1	
AOC_5	SHL-15	10/7/2010	239.4	
AOC_5	SHL-15	10/19/2010	240.7	
AOC_5	SHL-15	4/4/2011	244.1	
AOC_5	SHL-15	6/30/2011	242.3	
AOC_5	SHL-15	10/13/2011	242.6	
AOC_5	SHL-15	11/8/2011	243.1	
AOC_5	SHL-15	4/10/2012	241.6	
AOC_5	SHL-15	5/15/2012	241.8	
AOC_5	SHL-15	10/22/2012	239.6	
AOC_5	SHL-15	11/5/2012	241.1	
AOC_5	SHL-15	11/6/2012	241.0	
AOC_5	SHL-15	5/15/2013	242.3	
AOC_5	SHL-15	6/11/2013	242.5	
AOC_5	SHL-15	10/21/2013	239.6	
AOC_5	SHL-15	10/22/2013	239.2	
AOC_5	SHL-15	10/23/2013	239.6	
AOC_5	SHL-15	4/22/2014	243.8	
AOC_5	SHL-15	6/17/2014	242.5	
AOC_5	SHL-15	10/6/2014	239.7	
AOC_5	SHL-15	6/8/2015	242.1	
AOC_5	SHL-15	6/9/2015	242.1	
AOC_5	SHL-15	6/17/2015	242.0	
AOC_5	SHL-15	10/7/2015	239.5	
AOC_5	SHL-15	10/8/2015	239.5	
AOC_5	SHL-15	12/16/2015	239.1	
AOC_5	SHL-15	5/17/2016	242.5	
AOC_5	SHL-15	6/9/2016	241.8	
AOC_5	SHL-15	6/24/2016	241.4	
AOC_5	SHL-15	8/16/2016	239.9	
AOC_5	SHL-15	11/15/2016	239.5	
AOC_5	SHL-15	5/22/2017	243.3	
AOC_5	SHL-15	7/7/2017	242.6	
AOC_5	SHL-15	4/9/2018	243.6	
AOC_5	SHL-15	11/1/2018	242.2	
AOC_5	SHL-15	12/5/2018	244.4	
AOC_5	SHL-15	4/8/2019	242.7	
AOC_5	SHL-15	10/22/2019	239.5	
AOC_5	SHL-15	4/29/2020	243.8	
AOC_5	SHL-15	5/14/2020	243.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-17	5/26/1992	225.3	
AOC_5	SHL-17	9/15/1992	224.7	
AOC_5	SHL-17	12/22/1992	224.8	
AOC_5	SHL-17	3/30/1993	228.3	
AOC_5	SHL-17	6/22/1993	225.6	
AOC_5	SHL-17	9/30/1993	224.9	
AOC_5	SHL-17	11/8/1993	224.5	
AOC_5	SHL-17	3/30/1994	226.8	
AOC_5	SHL-17	10/4/1994	225.8	
AOC_5	SHL-17	1/31/1995	226.0	
AOC_5	SHL-17	5/9/1995	225.6	
AOC_5	SHL-17	12/7/1995	225.0	
AOC_5	SHL-17	3/26/1996	226.7	
AOC_5	SHL-17	7/23/1996	227.3	
AOC_5	SHL-17	1/15/1997	227.7	
AOC_5	SHL-17	6/2/1997	227.5	
AOC_5	SHL-17	4/23/1998	227.9	
AOC_5	SHL-17	6/19/1998	229.7	
AOC_5	SHL-17	6/26/1998	229.5	
AOC_5	SHL-17	7/1/1998	230.1	
AOC_5	SHL-17	7/17/1998	228.5	
AOC_5	SHL-17	7/31/1998	228.6	
AOC_5	SHL-17	8/28/1998	227.1	
AOC_5	SHL-17	10/14/1998	226.9	
AOC_5	SHL-17	12/10/1998	225.8	
AOC_5	SHL-17	2/23/1999	226.0	
AOC_5	SHL-17	6/6/1999	224.8	
AOC_5	SHL-17	9/8/1999	223.5	
AOC_5	SHL-17	9/14/2009	227.3	
AOC_5	SHL-17	10/26/2009	227.0	
AOC_5	SHL-17	4/27/2010	229.7	
AOC_5	SHL-17	9/14/2010	225.9	
AOC_5	SHL-17	7/25/2011	226.3	
AOC_5	SHL-17	6/26/2012	227.0	
AOC_5	SHL-17	11/6/2012	225.7	
AOC_5	SHL-17	4/25/2013	225.9	
AOC_5	SHL-17	4/22/2014	226.0	
AOC_5	SHL-17	6/17/2015	226.6	
AOC_5	SHL-17	10/7/2015	224.9	
AOC_5	SHL-17	10/20/2015		
AOC_5	SHL-17	12/16/2015	224.8	
AOC_5	SHL-17	6/9/2016	225.0	
AOC_5	SHL-17	6/24/2016		
AOC_5	SHL-17	8/16/2016	224.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-17	11/15/2016	224.1	
AOC_5	SHL-17	5/22/2017	226.8	
AOC_5	SHL-17	11/1/2018	228.2	
AOC_5	SHL-17	12/5/2018	229.9	
AOC_5	SHL-17	10/22/2019	224.9	
AOC_5	SHL-17	4/29/2020	228.3	
AOC_5	SHL-18	5/26/1992	217.9	
AOC_5	SHL-18	9/15/1992	217.7	
AOC_5	SHL-18	12/22/1992	218.3	
AOC_5	SHL-18	3/30/1993	218.1	
AOC_5	SHL-18	6/22/1993	217.7	
AOC_5	SHL-18	9/30/1993	217.8	
AOC_5	SHL-18	11/8/1993	217.9	
AOC_5	SHL-18	3/30/1994	219.0	
AOC_5	SHL-18	6/28/1994	217.9	
AOC_5	SHL-18	10/4/1994	218.2	
AOC_5	SHL-18	1/31/1995	218.6	
AOC_5	SHL-18	5/9/1995	217.8	
AOC_5	SHL-18	12/7/1995	218.3	
AOC_5	SHL-18	3/26/1996	218.8	
AOC_5	SHL-18	7/23/1996	218.4	
AOC_5	SHL-18	1/15/1997	218.8	
AOC_5	SHL-18	6/2/1997	218.7	
AOC_5	SHL-18	4/23/1998	218.6	
AOC_5	SHL-18	6/19/1998	220.0	
AOC_5	SHL-18	6/26/1998	219.6	
AOC_5	SHL-18	7/1/1998	219.4	
AOC_5	SHL-18	7/17/1998	218.7	
AOC_5	SHL-18	7/31/1998	218.3	
AOC_5	SHL-18	8/28/1998	217.9	
AOC_5	SHL-18	10/14/1998	218.0	
AOC_5	SHL-18	12/10/1998	217.7	
AOC_5	SHL-18	2/23/1999	218.0	
AOC_5	SHL-18	6/6/1999	217.4	
AOC_5	SHL-18	9/8/1999	216.9	
AOC_5	SHL-18	11/16/2001	217.5	
AOC_5	SHL-18	8/4/2005	218.3	
AOC_5	SHL-18	8/24/2005	218.0	
AOC_5	SHL-18	8/26/2005	218.0	
AOC_5	SHL-18	4/10/2006	218.2	
AOC_5	SHL-18	6/5/2006	219.8	
AOC_5	SHL-18	9/18/2006	218.1	
AOC_5	SHL-18	10/19/2006	218.1	
AOC_5	SHL-18	12/15/2006	219.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-18	4/8/2007	218.7	
AOC_5	SHL-18	4/9/2007	218.7	
AOC_5	SHL-18	10/15/2007	218.4	
AOC_5	SHL-18	2/20/2008	220.0	
AOC_5	SHL-18	2/25/2008	219.7	
AOC_5	SHL-18	3/4/2008	219.4	
AOC_5	SHL-18	4/16/2008	219.1	
AOC_5	SHL-18	8/19/2008	219.2	
AOC_5	SHL-18	9/15/2008	219.4	
AOC_5	SHL-18	9/30/2008	219.3	
AOC_5	SHL-18	4/28/2009	219.0	
AOC_5	SHL-18	7/5/2009	218.9	
AOC_5	SHL-18	9/14/2009	218.3	
AOC_5	SHL-18	10/26/2009	218.2	
AOC_5	SHL-18	11/3/2009	218.3	
AOC_5	SHL-18	4/20/2010	219.9	
AOC_5	SHL-18	4/27/2010	219.5	
AOC_5	SHL-18	9/14/2010	217.7	
AOC_5	SHL-18	10/7/2010	218.1	
AOC_5	SHL-18	4/4/2011	219.1	
AOC_5	SHL-18	7/25/2011	218.0	
AOC_5	SHL-18	11/8/2011	219.3	
AOC_5	SHL-18	4/10/2012	218.0	
AOC_5	SHL-18	6/26/2012	218.3	
AOC_5	SHL-18	11/5/2012	219.0	
AOC_5	SHL-18	11/6/2012	219.0	
AOC_5	SHL-18	4/25/2013	218.3	
AOC_5	SHL-18	5/15/2013	218.2	
AOC_5	SHL-18	6/11/2013	219.3	
AOC_5	SHL-18	10/21/2013	216.0	
AOC_5	SHL-18	4/22/2014	218.9	
AOC_5	SHL-18	10/6/2014	218.0	
AOC_5	SHL-18	6/2/2015	218.6	
AOC_5	SHL-18	6/17/2015	218.1	
AOC_5	SHL-18	8/18/2015	217.9	
AOC_5	SHL-18	10/7/2015	217.7	
AOC_5	SHL-18	10/20/2015	218.2	
AOC_5	SHL-18	12/16/2015	217.7	
AOC_5	SHL-18	6/9/2016	218.0	
AOC_5	SHL-18	6/24/2016	217.8	
AOC_5	SHL-18	8/16/2016	217.6	
AOC_5	SHL-18	11/15/2016	218.2	
AOC_5	SHL-18	5/22/2017	218.8	
AOC_5	SHL-18	11/1/2018	218.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-18	10/22/2019	212.4	
AOC_5	SHL-18	4/29/2020	219.3	
AOC_5	SHL-19	5/26/1992	217.2	
AOC_5	SHL-19	9/15/1992	217.0	
AOC_5	SHL-19	12/22/1992	218.1	
AOC_5	SHL-19	3/30/1993	217.4	
AOC_5	SHL-19	6/22/1993	217.0	
AOC_5	SHL-19	9/30/1993	217.3	
AOC_5	SHL-19	11/8/1993	217.2	
AOC_5	SHL-19	3/30/1994	218.0	
AOC_5	SHL-19	6/28/1994	217.3	
AOC_5	SHL-19	10/4/1994	217.6	
AOC_5	SHL-19	1/31/1995	217.8	
AOC_5	SHL-19	5/9/1995	217.2	
AOC_5	SHL-19	12/7/1995	218.1	
AOC_5	SHL-19	3/26/1996	218.2	
AOC_5	SHL-19	7/23/1996	218.7	
AOC_5	SHL-19	1/15/1997	218.3	
AOC_5	SHL-19	6/2/1997	217.7	
AOC_5	SHL-19	4/23/1998	217.7	
AOC_5	SHL-19	6/19/1998	218.9	
AOC_5	SHL-19	6/26/1998	218.5	
AOC_5	SHL-19	7/1/1998	218.3	
AOC_5	SHL-19	7/17/1998	217.8	
AOC_5	SHL-19	7/31/1998	217.6	
AOC_5	SHL-19	8/28/1998	217.2	
AOC_5	SHL-19	10/14/1998	217.5	
AOC_5	SHL-19	12/10/1998	217.0	
AOC_5	SHL-19	2/23/1999	217.2	
AOC_5	SHL-19	6/6/1999	215.8	
AOC_5	SHL-19	9/8/1999	216.4	
AOC_5	SHL-19	11/16/2001	216.8	
AOC_5	SHL-19	8/4/2005	217.4	
AOC_5	SHL-19	8/24/2005	217.1	
AOC_5	SHL-19	8/26/2005	217.1	
AOC_5	SHL-19	4/10/2006	217.6	
AOC_5	SHL-19	6/5/2006	219.1	
AOC_5	SHL-19	8/2/2006	217.4	
AOC_5	SHL-19	9/18/2006	217.2	
AOC_5	SHL-19	10/19/2006	217.2	
AOC_5	SHL-19	12/15/2006	217.9	
AOC_5	SHL-19	4/8/2007	218.0	
AOC_5	SHL-19	4/9/2007	218.0	
AOC_5	SHL-19	4/26/2007	218.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-19	9/10/2007	216.9	
AOC_5	SHL-19	10/15/2007	217.7	
AOC_5	SHL-19	11/7/2007	217.6	
AOC_5	SHL-19	2/12/2008	218.8	
AOC_5	SHL-19	2/20/2008	219.0	
AOC_5	SHL-19	2/25/2008	218.6	
AOC_5	SHL-19	3/4/2008	218.2	
AOC_5	SHL-19	4/16/2008	218.1	
AOC_5	SHL-19	4/28/2008	217.8	
AOC_5	SHL-19	6/10/2008	217.5	
AOC_5	SHL-19	8/19/2008	218.1	
AOC_5	SHL-19	9/15/2008	218.1	
AOC_5	SHL-19	9/30/2008	218.1	
AOC_5	SHL-19	10/3/2008	218.1	
AOC_5	SHL-19	4/28/2009	218.0	
AOC_5	SHL-19	9/14/2009	217.3	
AOC_5	SHL-19	10/22/2009	217.2	
AOC_5	SHL-19	10/26/2009	217.3	
AOC_5	SHL-19	11/3/2009	217.4	
AOC_5	SHL-19	4/20/2010	218.4	
AOC_5	SHL-19	4/27/2010	218.1	
AOC_5	SHL-19	9/14/2010	217.3	
AOC_5	SHL-19	10/7/2010	217.0	
AOC_5	SHL-19	4/4/2011	218.0	
AOC_5	SHL-19	7/25/2011	217.1	
AOC_5	SHL-19	11/8/2011	218.1	
AOC_5	SHL-19	4/10/2012	217.3	
AOC_5	SHL-19	6/26/2012	217.3	
AOC_5	SHL-19	11/5/2012	217.9	
AOC_5	SHL-19	11/6/2012	217.7	
AOC_5	SHL-19	2/14/2013	217.0	
AOC_5	SHL-19	3/12/2013	217.4	
AOC_5	SHL-19	4/22/2013	217.1	
AOC_5	SHL-19	4/25/2013	217.1	
AOC_5	SHL-19	5/15/2013	217.1	
AOC_5	SHL-19	5/24/2013	217.2	
AOC_5	SHL-19	5/30/2013	217.8	
AOC_5	SHL-19	6/11/2013	218.4	
AOC_5	SHL-19	10/21/2013	214.3	
AOC_5	SHL-19	10/24/2013	214.2	
AOC_5	SHL-19	4/22/2014	217.5	
AOC_5	SHL-19	10/6/2014	217.0	
AOC_5	SHL-19	6/4/2015	217.0	
AOC_5	SHL-19	6/17/2015	216.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-19	8/18/2015	216.7	
AOC_5	SHL-19	10/7/2015	216.6	
AOC_5	SHL-19	10/20/2015	217.3	
AOC_5	SHL-19	12/16/2015	216.7	
AOC_5	SHL-19	4/6/2016	217.2	
AOC_5	SHL-19	6/9/2016	216.9	
AOC_5	SHL-19	8/16/2016	216.4	
AOC_5	SHL-19	11/15/2016	217.3	
AOC_5	SHL-19	5/22/2017	217.4	
AOC_5	SHL-19	5/11/2018	217.5	
AOC_5	SHL-19	11/1/2018	217.3	
AOC_5	SHL-19	4/11/2019	216.9	
AOC_5	SHL-19	10/22/2019	217.5	
AOC_5	SHL-19	5/18/2020	217.4	
AOC_5	SHL-19	5/19/2020	218.2	
AOC_5	SHL-20	5/26/1992	216.7	
AOC_5	SHL-20	9/15/1992	216.5	
AOC_5	SHL-20	12/22/1992	216.9	
AOC_5	SHL-20	3/30/1993	217.1	
AOC_5	SHL-20	6/22/1993	216.6	
AOC_5	SHL-20	9/30/1993	216.5	
AOC_5	SHL-20	11/8/1993	216.5	
AOC_5	SHL-20	3/30/1994	217.3	
AOC_5	SHL-20	6/28/1994	216.7	
AOC_5	SHL-20	10/4/1994	216.7	
AOC_5	SHL-20	1/31/1995	216.9	
AOC_5	SHL-20	5/9/1995	216.6	
AOC_5	SHL-20	12/7/1995	216.7	
AOC_5	SHL-20	3/26/1996	217.2	
AOC_5	SHL-20	7/23/1996	216.9	
AOC_5	SHL-20	1/15/1997	217.2	
AOC_5	SHL-20	6/2/1997	217.1	
AOC_5	SHL-20	4/23/1998	217.1	
AOC_5	SHL-20	6/19/1998	217.7	
AOC_5	SHL-20	6/26/1998	217.4	
AOC_5	SHL-20	7/1/1998	217.3	
AOC_5	SHL-20	7/17/1998	217.1	
AOC_5	SHL-20	7/31/1998	217.0	
AOC_5	SHL-20	8/28/1998	216.8	
AOC_5	SHL-20	10/14/1998	216.7	
AOC_5	SHL-20	12/10/1998	216.6	
AOC_5	SHL-20	2/23/1999	216.6	
AOC_5	SHL-20	6/6/1999	216.4	
AOC_5	SHL-20	9/8/1999	215.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-20	11/16/2001	216.5	
AOC_5	SHL-20	8/4/2005	216.9	
AOC_5	SHL-20	8/24/2005	216.6	
AOC_5	SHL-20	8/26/2005	216.7	
AOC_5	SHL-20	4/10/2006	217.0	
AOC_5	SHL-20	6/5/2006	217.6	
AOC_5	SHL-20	8/2/2006	217.1	
AOC_5	SHL-20	9/18/2006	216.7	
AOC_5	SHL-20	10/19/2006	216.8	
AOC_5	SHL-20	12/15/2006	217.1	
AOC_5	SHL-20	4/8/2007	217.0	
AOC_5	SHL-20	4/9/2007	217.0	
AOC_5	SHL-20	4/26/2007	217.4	
AOC_5	SHL-20	9/10/2007	216.5	
AOC_5	SHL-20	10/15/2007	217.3	
AOC_5	SHL-20	11/7/2007	217.0	
AOC_5	SHL-20	2/20/2008	217.7	
AOC_5	SHL-20	2/25/2008	217.5	
AOC_5	SHL-20	3/4/2008	217.4	
AOC_5	SHL-20	4/16/2008	217.4	
AOC_5	SHL-20	4/28/2008	217.2	
AOC_5	SHL-20	6/10/2008	217.0	
AOC_5	SHL-20	9/30/2008	217.2	
AOC_5	SHL-20	10/3/2008	217.2	
AOC_5	SHL-20	4/28/2009	217.3	
AOC_5	SHL-20	9/14/2009	216.8	
AOC_5	SHL-20	10/21/2009	216.8	
AOC_5	SHL-20	10/26/2009	216.9	
AOC_5	SHL-20	11/3/2009	216.9	
AOC_5	SHL-20	4/20/2010	217.5	
AOC_5	SHL-20	10/7/2010	216.7	
AOC_5	SHL-20	4/4/2011	217.1	
AOC_5	SHL-20	11/8/2011	217.3	
AOC_5	SHL-20	4/10/2012	216.7	
AOC_5	SHL-20	6/26/2012	216.8	
AOC_5	SHL-20	11/5/2012	217.5	
AOC_5	SHL-20	11/6/2012	217.5	
AOC_5	SHL-20	2/14/2013	217.3	
AOC_5	SHL-20	3/12/2013	217.5	
AOC_5	SHL-20	4/22/2013	217.6	
AOC_5	SHL-20	5/15/2013	217.7	
AOC_5	SHL-20	5/22/2013	217.7	
AOC_5	SHL-20	5/30/2013	217.9	
AOC_5	SHL-20	6/11/2013	218.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-20	10/21/2013	215.7	
AOC_5	SHL-20	10/22/2013	215.6	
AOC_5	SHL-20	4/22/2014	217.6	
AOC_5	SHL-20	4/23/2014	217.5	
AOC_5	SHL-20	10/6/2014	217.2	
AOC_5	SHL-20	6/4/2015	217.9	
AOC_5	SHL-20	6/5/2015	217.9	
AOC_5	SHL-20	6/17/2015	217.7	
AOC_5	SHL-20	8/18/2015	217.4	
AOC_5	SHL-20	10/7/2015	217.1	
AOC_5	SHL-20	10/20/2015	217.4	
AOC_5	SHL-20	12/16/2015	217.0	
AOC_5	SHL-20	4/6/2016	217.6	
AOC_5	SHL-20	6/9/2016	217.5	
AOC_5	SHL-20	6/23/2016	217.4	
AOC_5	SHL-20	8/16/2016	216.9	
AOC_5	SHL-20	11/15/2016	217.2	
AOC_5	SHL-20	5/22/2017	218.3	
AOC_5	SHL-20	5/11/2018	218.3	
AOC_5	SHL-20	11/1/2018	217.0	
AOC_5	SHL-20	4/11/2019	218.6	
AOC_5	SHL-20	10/22/2019	218.0	
AOC_5	SHL-20	5/18/2020	218.8	
AOC_5	SHL-21	5/26/1992	214.7	
AOC_5	SHL-21	9/15/1992	214.0	
AOC_5	SHL-21	12/22/1992	215.2	
AOC_5	SHL-21	3/30/1993	214.9	
AOC_5	SHL-21	6/22/1993	214.4	
AOC_5	SHL-21	9/30/1993	213.9	
AOC_5	SHL-21	11/8/1993	214.5	
AOC_5	SHL-21	3/30/1994	215.4	
AOC_5	SHL-21	6/28/1994	214.7	
AOC_5	SHL-21	10/4/1994	214.7	
AOC_5	SHL-21	1/31/1995	215.5	
AOC_5	SHL-21	5/9/1995	214.5	
AOC_5	SHL-21	12/7/1995	215.0	
AOC_5	SHL-21	3/26/1996	215.9	
AOC_5	SHL-21	7/23/1996	214.9	
AOC_5	SHL-21	4/23/1998	215.7	
AOC_5	SHL-21	6/19/1998	216.3	
AOC_5	SHL-21	6/26/1998	216.3	
AOC_5	SHL-21	7/1/1998	216.1	
AOC_5	SHL-21	7/17/1998	215.5	
AOC_5	SHL-21	7/31/1998	215.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-21	8/28/1998	214.2	
AOC_5	SHL-21	10/14/1998	214.0	
AOC_5	SHL-21	12/10/1998	214.1	
AOC_5	SHL-21	2/23/1999	214.6	
AOC_5	SHL-21	6/6/1999	213.9	
AOC_5	SHL-21	9/8/1999	213.0	
AOC_5	SHL-21	11/16/2001	213.7	
AOC_5	SHL-21	8/24/2005	214.2	
AOC_5	SHL-21	4/10/2006	215.0	
AOC_5	SHL-21	6/5/2006	216.3	
AOC_5	SHL-21	9/18/2006	214.3	
AOC_5	SHL-21	12/15/2006	215.5	
AOC_5	SHL-21	4/8/2007	214.9	
AOC_5	SHL-21	4/9/2007	214.9	
AOC_5	SHL-21	4/26/2007	216.6	
AOC_5	SHL-21	10/15/2007		210.9
AOC_5	SHL-21	2/20/2008	216.0	
AOC_5	SHL-21	2/25/2008	216.1	
AOC_5	SHL-21	3/4/2008	215.8	
AOC_5	SHL-21	4/16/2008	216.0	
AOC_5	SHL-21	6/10/2008	214.9	
AOC_5	SHL-21	7/16/2008	214.1	
AOC_5	SHL-21	8/19/2008	215.2	
AOC_5	SHL-21	9/15/2008	215.0	
AOC_5	SHL-21	9/30/2008	214.9	
AOC_5	SHL-21	10/6/2008	215.1	
AOC_5	SHL-21	1/22/2009	215.3	
AOC_5	SHL-21	4/28/2009	215.6	
AOC_5	SHL-21	7/5/2009	215.2	
AOC_5	SHL-21	7/16/2009	215.1	
AOC_5	SHL-21	9/14/2009	214.0	
AOC_5	SHL-21	10/26/2009	213.9	
AOC_5	SHL-21	11/3/2009	214.4	
AOC_5	SHL-21	4/20/2010	217.0	
AOC_5	SHL-21	4/27/2010	216.5	
AOC_5	SHL-21	9/14/2010	213.1	
AOC_5	SHL-21	10/7/2010	213.3	
AOC_5	SHL-21	4/4/2011	215.6	
AOC_5	SHL-21	7/25/2011	213.9	
AOC_5	SHL-21	11/8/2011	215.9	
AOC_5	SHL-21	4/10/2012	214.2	
AOC_5	SHL-21	6/26/2012	214.2	
AOC_5	SHL-21	9/11/2012	213.4	
AOC_5	SHL-21	11/5/2012	214.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-21	11/6/2012	214.8	
AOC_5	SHL-21	3/13/2013	214.7	
AOC_5	SHL-21	4/23/2013	214.6	
AOC_5	SHL-21	4/25/2013	214.6	
AOC_5	SHL-21	5/15/2013	214.1	
AOC_5	SHL-21	5/30/2013	214.8	
AOC_5	SHL-21	6/11/2013	215.1	
AOC_5	SHL-21	10/21/2013	212.2	
AOC_5	SHL-21	4/22/2014	215.3	
AOC_5	SHL-21	10/6/2014	213.3	
AOC_5	SHL-21	6/17/2015	214.2	
AOC_5	SHL-21	10/7/2015	213.1	
AOC_5	SHL-21	10/20/2015	213.6	
AOC_5	SHL-21	12/16/2015	213.6	
AOC_5	SHL-21	6/9/2016	214.9	
AOC_5	SHL-21	8/16/2016	213.0	
AOC_5	SHL-21	10/20/2016	212.9	
AOC_5	SHL-22	5/26/1992	212.9	
AOC_5	SHL-22	9/15/1992	212.0	
AOC_5	SHL-22	12/22/1992	213.7	
AOC_5	SHL-22	3/30/1993	213.7	
AOC_5	SHL-22	6/22/1993	212.3	
AOC_5	SHL-22	9/30/1993	212.2	
AOC_5	SHL-22	11/8/1993	212.8	
AOC_5	SHL-22	3/30/1994	214.4	
AOC_5	SHL-22	6/28/1994	212.6	
AOC_5	SHL-22	10/4/1994	212.0	
AOC_5	SHL-22	1/31/1995	213.7	
AOC_5	SHL-22	5/9/1995	212.5	
AOC_5	SHL-22	12/7/1995	213.2	
AOC_5	SHL-22	3/26/1996	214.1	
AOC_5	SHL-22	7/23/1996	213.0	
AOC_5	SHL-22	1/15/1997	213.8	
AOC_5	SHL-22	6/2/1997	213.4	
AOC_5	SHL-22	4/23/1998	213.8	
AOC_5	SHL-22	6/19/1998	215.0	
AOC_5	SHL-22	6/26/1998	214.6	
AOC_5	SHL-22	7/1/1998	214.5	
AOC_5	SHL-22	7/17/1998	213.5	
AOC_5	SHL-22	7/31/1998	212.9	
AOC_5	SHL-22	8/28/1998	212.1	
AOC_5	SHL-22	10/14/1998	212.3	
AOC_5	SHL-22	12/10/1998	212.3	
AOC_5	SHL-22	2/23/1999	212.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-22	6/6/1999	211.9	
AOC_5	SHL-22	9/8/1999	211.1	
AOC_5	SHL-22	11/16/2001	211.9	
AOC_5	SHL-22	8/4/2005	212.8	
AOC_5	SHL-22	8/24/2005	212.2	
AOC_5	SHL-22	8/26/2005	212.0	
AOC_5	SHL-22	4/10/2006	212.8	
AOC_5	SHL-22	6/5/2006	214.5	
AOC_5	SHL-22	9/18/2006	212.4	
AOC_5	SHL-22	10/19/2006	212.3	
AOC_5	SHL-22	12/15/2006	213.5	
AOC_5	SHL-22	4/8/2007	213.6	
AOC_5	SHL-22	4/9/2007	213.6	
AOC_5	SHL-22	10/15/2007	211.3	
AOC_5	SHL-22	10/19/2007	211.1	
AOC_5	SHL-22	2/20/2008	214.2	
AOC_5	SHL-22	2/25/2008	214.5	
AOC_5	SHL-22	3/4/2008	213.6	
AOC_5	SHL-22	4/16/2008	213.7	
AOC_5	SHL-22	7/15/2008	211.6	
AOC_5	SHL-22	9/30/2008	212.9	
AOC_5	SHL-22	1/20/2009	212.9	
AOC_5	SHL-22	4/28/2009	213.2	
AOC_5	SHL-22	7/15/2009	212.6	
AOC_5	SHL-22	11/3/2009	211.8	
AOC_5	SHL-22	4/20/2010	214.2	
AOC_5	SHL-22	10/7/2010	210.9	
AOC_5	SHL-22	4/4/2011	213.4	
AOC_5	SHL-22	11/8/2011	213.4	
AOC_5	SHL-22	4/10/2012	211.5	
AOC_5	SHL-22	6/26/2012	211.9	
AOC_5	SHL-22	9/11/2012	210.8	
AOC_5	SHL-22	11/5/2012	212.3	
AOC_5	SHL-22	11/6/2012	212.3	
AOC_5	SHL-22	3/13/2013	212.8	
AOC_5	SHL-22	4/23/2013	212.1	
AOC_5	SHL-22	5/15/2013	211.5	
AOC_5	SHL-22	5/28/2013	212.7	
AOC_5	SHL-22	5/30/2013	212.4	
AOC_5	SHL-22	6/11/2013	212.9	
AOC_5	SHL-22	10/21/2013	210.9	
AOC_5	SHL-22	10/23/2013	210.3	
AOC_5	SHL-22	4/22/2014	213.1	
AOC_5	SHL-22	4/24/2014	212.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-22	10/6/2014	210.7	
AOC_5	SHL-22	6/4/2015	212.1	
AOC_5	SHL-22	6/17/2015	211.8	
AOC_5	SHL-22	10/20/2015	210.5	
AOC_5	SHL-22	12/16/2015	211.0	
AOC_5	SHL-22	6/9/2016	211.6	
AOC_5	SHL-22	8/16/2016	210.3	
AOC_5	SHL-22	11/16/2016	211.4	
AOC_5	SHL-22	11/1/2018	212.4	
AOC_5	SHL-22	10/22/2019	210.9	
AOC_5	SHL-23	5/26/1992	214.0	
AOC_5	SHL-23	9/15/1992	212.8	
AOC_5	SHL-23	12/22/1992	214.8	
AOC_5	SHL-23	3/30/1993	213.8	
AOC_5	SHL-23	6/22/1993	213.3	
AOC_5	SHL-23	9/30/1993	212.6	
AOC_5	SHL-23	11/8/1993	213.8	
AOC_5	SHL-23	3/30/1994	215.4	
AOC_5	SHL-23	6/28/1994	214.0	
AOC_5	SHL-23	10/4/1994	213.9	
AOC_5	SHL-23	1/31/1995	215.3	
AOC_5	SHL-23	5/9/1995	213.5	
AOC_5	SHL-23	12/7/1995	214.9	
AOC_5	SHL-23	3/26/1996	215.8	
AOC_5	SHL-23	7/23/1996	214.0	
AOC_5	SHL-23	6/2/1997	214.9	
AOC_5	SHL-23	4/23/1998	215.4	
AOC_5	SHL-23	6/19/1998	216.4	
AOC_5	SHL-23	6/26/1998	216.6	
AOC_5	SHL-23	7/1/1998	216.3	
AOC_5	SHL-23	7/17/1998	215.2	
AOC_5	SHL-23	7/31/1998	214.3	
AOC_5	SHL-23	8/28/1998	213.1	
AOC_5	SHL-23	10/14/1998	212.8	
AOC_5	SHL-23	12/10/1998	212.9	
AOC_5	SHL-23	2/23/1999	213.7	
AOC_5	SHL-23	6/6/1999	212.8	
AOC_5	SHL-23	9/8/1999	211.6	
AOC_5	SHL-23	11/16/2001	212.3	
AOC_5	SHL-23	8/4/2005	213.9	
AOC_5	SHL-23	8/24/2005	213.1	
AOC_5	SHL-23	8/26/2005	213.1	
AOC_5	SHL-23	4/10/2006	214.0	
AOC_5	SHL-23	6/5/2006	216.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-23	9/18/2006	213.1	
AOC_5	SHL-23	12/15/2006	215.0	
AOC_5	SHL-23	4/8/2007	214.9	
AOC_5	SHL-23	4/9/2007	214.9	
AOC_5	SHL-23	4/26/2007	217.5	
AOC_5	SHL-23	10/15/2007	211.6	
AOC_5	SHL-23	2/20/2008	215.7	
AOC_5	SHL-23	2/25/2008	216.3	
AOC_5	SHL-23	3/4/2008	215.7	
AOC_5	SHL-23	4/16/2008	215.7	
AOC_5	SHL-23	6/10/2008	213.8	
AOC_5	SHL-23	7/16/2008	212.5	
AOC_5	SHL-23	8/19/2008	214.2	
AOC_5	SHL-23	9/15/2008	213.8	
AOC_5	SHL-23	9/30/2008	213.6	
AOC_5	SHL-23	10/6/2008	214.2	
AOC_5	SHL-23	1/20/2009	214.7	
AOC_5	SHL-23	4/28/2009	215.1	
AOC_5	SHL-23	9/14/2009	212.4	
AOC_5	SHL-23	10/26/2009	211.9	
AOC_5	SHL-23	11/3/2009	212.5	
AOC_5	SHL-23	4/20/2010	216.6	
AOC_5	SHL-23	4/27/2010	215.7	
AOC_5	SHL-23	9/14/2010	211.3	
AOC_5	SHL-23	10/7/2010	211.1	
AOC_5	SHL-23	4/4/2011	215.6	
AOC_5	SHL-23	7/25/2011	212.3	
AOC_5	SHL-23	11/8/2011	215.0	
AOC_5	SHL-23	4/10/2012	213.0	
AOC_5	SHL-23	6/26/2012	212.8	
AOC_5	SHL-23	9/11/2012	211.4	
AOC_5	SHL-23	11/5/2012	212.9	
AOC_5	SHL-23	11/6/2012	212.9	
AOC_5	SHL-23	3/13/2013	213.2	
AOC_5	SHL-23	4/23/2013	213.6	
AOC_5	SHL-23	4/25/2013	213.6	
AOC_5	SHL-23	5/15/2013	212.6	
AOC_5	SHL-23	5/30/2013	213.4	
AOC_5	SHL-23	6/11/2013	213.6	
AOC_5	SHL-23	10/21/2013	211.6	
AOC_5	SHL-23	4/22/2014	215.0	
AOC_5	SHL-23	10/6/2014	210.9	
AOC_5	SHL-23	6/9/2015	212.7	
AOC_5	SHL-23	6/10/2015	212.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-23	6/17/2015	212.3	
AOC_5	SHL-23	10/20/2015	210.6	
AOC_5	SHL-23	12/16/2015	211.4	
AOC_5	SHL-23	6/9/2016	212.0	
AOC_5	SHL-23	6/24/2016	211.6	
AOC_5	SHL-23	8/16/2016	210.6	
AOC_5	SHL-23	10/20/2016	210.4	
AOC_5	SHL-23	11/16/2016	211.7	
AOC_5	SHL-23	5/22/2017	214.5	
AOC_5	SHL-23	11/1/2018	213.4	
AOC_5	SHL-23	10/22/2019	211.1	
AOC_5	SHL-24	5/26/1992	221.8	
AOC_5	SHL-24	9/15/1992	222.0	
AOC_5	SHL-24	12/22/1992	222.0	
AOC_5	SHL-24	3/30/1993	222.9	
AOC_5	SHL-24	6/22/1993	222.3	
AOC_5	SHL-24	9/30/1993	221.7	
AOC_5	SHL-24	11/8/1993	221.8	
AOC_5	SHL-24	3/30/1994	223.5	
AOC_5	SHL-24	6/28/1994	222.7	
AOC_5	SHL-24	10/4/1994	222.6	
AOC_5	SHL-24	1/31/1995	222.9	
AOC_5	SHL-24	5/9/1995	222.2	
AOC_5	SHL-24	12/7/1995	222.2	
AOC_5	SHL-24	3/26/1996	223.2	
AOC_5	SHL-24	7/23/1996	223.6	
AOC_5	SHL-24	1/15/1997	223.9	
AOC_5	SHL-24	6/2/1997	224.0	
AOC_5	SHL-24	4/23/1998	223.8	
AOC_5	SHL-24	6/19/1998	225.1	
AOC_5	SHL-24	6/26/1998	225.0	
AOC_5	SHL-24	7/1/1998	224.8	
AOC_5	SHL-24	7/17/1998	224.3	
AOC_5	SHL-24	7/31/1998	223.9	
AOC_5	SHL-24	8/28/1998	223.2	
AOC_5	SHL-24	10/14/1998	222.9	
AOC_5	SHL-24	12/10/1998	222.1	
AOC_5	SHL-24	2/23/1999	222.4	
AOC_5	SHL-24	6/6/1999	221.7	
AOC_5	SHL-24	9/8/1999	220.7	
AOC_5	SHL-24	8/24/2005	223.1	
AOC_5	SHL-24	8/26/2005	223.1	
AOC_5	SHL-24	6/5/2006	225.3	
AOC_5	SHL-24	9/18/2006	223.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-24	12/15/2006	223.6	
AOC_5	SHL-24	4/8/2007	223.3	
AOC_5	SHL-24	4/9/2007	223.3	
AOC_5	SHL-24	10/15/2007	222.6	
AOC_5	SHL-24	2/20/2008	224.7	
AOC_5	SHL-24	2/25/2008	224.4	
AOC_5	SHL-24	3/4/2008	224.2	
AOC_5	SHL-24	4/16/2008	224.5	
AOC_5	SHL-24	9/30/2008	224.7	
AOC_5	SHL-24	4/28/2009	224.1	
AOC_5	SHL-24	9/14/2009	223.7	
AOC_5	SHL-24	10/26/2009	223.2	
AOC_5	SHL-24	11/3/2009	223.3	
AOC_5	SHL-24	4/20/2010	225.7	
AOC_5	SHL-24	4/27/2010	225.4	
AOC_5	SHL-24	9/14/2010	222.6	
AOC_5	SHL-24	10/7/2010	223.1	
AOC_5	SHL-24	4/4/2011	223.7	
AOC_5	SHL-24	7/25/2011	222.9	
AOC_5	SHL-24	11/8/2011	224.6	
AOC_5	SHL-24	4/10/2012	220.9	
AOC_5	SHL-24	6/26/2012	222.9	
AOC_5	SHL-24	11/5/2012	223.0	
AOC_5	SHL-24	11/6/2012	223.0	
AOC_5	SHL-24	5/15/2013	222.5	
AOC_5	SHL-24	6/11/2013	223.8	
AOC_5	SHL-24	10/21/2013	221.8	
AOC_5	SHL-24	4/22/2014	223.0	
AOC_5	SHL-24	6/9/2015	223.5	
AOC_5	SHL-24	6/10/2015	223.5	
AOC_5	SHL-24	6/17/2015	222.8	
AOC_5	SHL-24	10/7/2015	222.0	
AOC_5	SHL-24	10/20/2015	221.9	
AOC_5	SHL-24	12/16/2015	221.7	
AOC_5	SHL-24	6/9/2016	222.0	
AOC_5	SHL-24	6/24/2016	221.8	
AOC_5	SHL-24	8/16/2016	221.6	
AOC_5	SHL-24	11/15/2016	221.7	
AOC_5	SHL-24	5/22/2017	223.4	
AOC_5	SHL-24	11/1/2018	224.2	
AOC_5	SHL-24	10/22/2019	223.0	
AOC_5	SHL-24	4/29/2020	224.3	
AOC_5	SHL-25	5/26/1992	233.3	
AOC_5	SHL-25	9/15/1992	231.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-25	12/22/1992	231.2	
AOC_5	SHL-25	3/30/1993	233.8	
AOC_5	SHL-25	6/22/1993	233.1	
AOC_5	SHL-25	9/30/1993	229.4	
AOC_5	SHL-25	11/8/1993	231.0	
AOC_5	SHL-25	3/30/1994	236.8	
AOC_5	SHL-25	6/28/1994	234.1	
AOC_5	SHL-25	10/4/1994	232.3	
AOC_5	SHL-25	1/31/1995	235.3	
AOC_5	SHL-25	5/9/1995	232.8	
AOC_5	SHL-25	12/7/1995	234.2	
AOC_5	SHL-25	3/26/1996	236.1	
AOC_5	SHL-25	7/23/1996	234.1	
AOC_5	SHL-25	1/15/1997	236.1	
AOC_5	SHL-25	6/2/1997	235.1	
AOC_5	SHL-25	4/23/1998	235.9	
AOC_5	SHL-25	6/19/1998	237.0	
AOC_5	SHL-25	6/26/1998	237.3	
AOC_5	SHL-25	7/1/1998	237.0	
AOC_5	SHL-25	7/17/1998	235.8	
AOC_5	SHL-25	7/31/1998	234.6	
AOC_5	SHL-25	8/28/1998	232.8	
AOC_5	SHL-25	10/14/1998	230.8	
AOC_5	SHL-25	12/10/1998	230.1	
AOC_5	SHL-25	2/23/1999	233.8	
AOC_5	SHL-25	6/6/1999	231.8	
AOC_5	SHL-25	9/8/1999	228.6	
AOC_5	SHL-25	4/11/2002	229.5	
AOC_5	SHL-25	7/10/2002	231.7	
AOC_5	SHL-25	10/1/2002	229.3	
AOC_5	SHL-25	3/27/2003	231.8	
AOC_5	SHL-25	6/19/2003	232.3	
AOC_5	SHL-25	9/23/2003	230.9	
AOC_5	SHL-25	12/1/2003	230.6	
AOC_5	SHL-25	10/7/2004	230.3	
AOC_5	SHL-25	5/18/2005	233.6	
AOC_5	SHL-25	6/13/2005	233.6	
AOC_5	SHL-25	10/3/2005	230.3	
AOC_5	SHL-25	6/5/2006	233.3	
AOC_5	SHL-25	6/7/2006	234.4	
AOC_5	SHL-25	10/17/2006	231.5	
AOC_5	SHL-25	10/19/2006	230.4	
AOC_5	SHL-25	5/22/2007	234.4	
AOC_5	SHL-25	5/23/2007	233.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-25	10/15/2007	229.4	
AOC_5	SHL-25	10/16/2007	230.5	
AOC_5	SHL-25	6/25/2008	231.8	
AOC_5	SHL-25	6/26/2008	232.9	
AOC_5	SHL-25	10/28/2008	232.0	
AOC_5	SHL-25	10/29/2008	233.1	
AOC_5	SHL-25	5/8/2009	233.1	
AOC_5	SHL-25	5/11/2009	234.2	
AOC_5	SHL-25	10/26/2009	231.6	
AOC_5	SHL-25	11/9/2009	232.7	
AOC_5	SHL-25	5/18/2010	235.3	
AOC_5	SHL-25	10/7/2010	230.8	
AOC_5	SHL-25	10/19/2010	231.9	
AOC_5	SHL-25	6/30/2011	232.8	
AOC_5	SHL-25	10/13/2011	233.9	
AOC_5	SHL-25	5/15/2012	231.5	
AOC_5	SHL-25	10/22/2012	229.9	
AOC_5	SHL-25	6/11/2013	232.2	
AOC_5	SHL-25	10/23/2013	229.8	
AOC_5	SHL-25	4/22/2014	231.9	
AOC_5	SHL-25	6/17/2014	231.3	
AOC_5	SHL-25	10/6/2014	229.4	
AOC_5	SHL-25	6/17/2015	233.9	
AOC_5	SHL-25	10/7/2015	229.7	
AOC_5	SHL-25	10/8/2015	229.6	
AOC_5	SHL-25	12/16/2015	228.7	
AOC_5	SHL-25	5/17/2016	231.2	
AOC_5	SHL-25	6/9/2016	230.5	
AOC_5	SHL-25	6/24/2016	230.2	
AOC_5	SHL-25	8/16/2016	228.9	
AOC_5	SHL-25	11/15/2016	229.0	
AOC_5	SHL-25	5/22/2017	233.0	
AOC_5	SHL-25	7/7/2017	232.6	
AOC_5	SHL-25	4/9/2018	232.6	
AOC_5	SHL-25	11/1/2018	232.0	
AOC_5	SHL-25	12/5/2018	234.2	
AOC_5	SHL-25	4/8/2019	233.3	
AOC_5	SHL-25	10/22/2019	230.3	
AOC_5	SHL-25	4/29/2020	233.3	
AOC_5	SHL-25	5/14/2020	233.4	
AOC_5	SHL-3	5/26/1992	217.1	
AOC_5	SHL-3	9/15/1992	216.9	
AOC_5	SHL-3	12/22/1992	217.5	
AOC_5	SHL-3	3/30/1993	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-3	6/22/1993	216.9	
AOC_5	SHL-3	9/30/1993	217.0	
AOC_5	SHL-3	11/8/1993	217.1	
AOC_5	SHL-3	3/30/1994	218.0	
AOC_5	SHL-3	6/28/1994	217.0	
AOC_5	SHL-3	10/4/1994	217.3	
AOC_5	SHL-3	1/31/1995	217.6	
AOC_5	SHL-3	5/9/1995	216.9	
AOC_5	SHL-3	12/7/1995	217.5	
AOC_5	SHL-3	3/26/1996	217.7	
AOC_5	SHL-3	7/23/1996	218.1	
AOC_5	SHL-3	1/15/1997	217.7	
AOC_5	SHL-3	4/23/1998	218.3	
AOC_5	SHL-3	6/19/1998	218.5	
AOC_5	SHL-3	6/26/1998	218.4	
AOC_5	SHL-3	7/1/1998	218.2	
AOC_5	SHL-3	7/17/1998	217.6	
AOC_5	SHL-3	7/31/1998	217.3	
AOC_5	SHL-3	8/28/1998	217.0	
AOC_5	SHL-3	10/14/1998	217.0	
AOC_5	SHL-3	12/10/1998	216.7	
AOC_5	SHL-3	2/23/1999	217.1	
AOC_5	SHL-3	6/6/1999	216.7	
AOC_5	SHL-3	9/8/1999	216.3	
AOC_5	SHL-3	11/16/2001	216.8	
AOC_5	SHL-3	8/4/2005	216.5	
AOC_5	SHL-3	8/24/2005	216.2	
AOC_5	SHL-3	8/26/2005	216.2	
AOC_5	SHL-3	4/10/2006	217.2	
AOC_5	SHL-3	6/5/2006	217.5	
AOC_5	SHL-3	9/18/2006	216.3	
AOC_5	SHL-3	10/19/2006	217.2	
AOC_5	SHL-3	12/15/2006	217.4	
AOC_5	SHL-3	4/8/2007	217.5	
AOC_5	SHL-3	4/9/2007	217.5	
AOC_5	SHL-3	4/26/2007	218.5	
AOC_5	SHL-3	10/15/2007	217.8	
AOC_5	SHL-3	2/20/2008	218.1	
AOC_5	SHL-3	2/25/2008	217.7	
AOC_5	SHL-3	3/4/2008	217.4	
AOC_5	SHL-3	4/16/2008	217.1	
AOC_5	SHL-3	6/10/2008	217.3	
AOC_5	SHL-3	8/19/2008	217.8	
AOC_5	SHL-3	9/15/2008	217.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-3	9/30/2008	217.0	
AOC_5	SHL-3	4/28/2009	217.0	
AOC_5	SHL-3	7/5/2009	216.9	
AOC_5	SHL-3	9/14/2009	217.2	
AOC_5	SHL-3	10/26/2009	217.2	
AOC_5	SHL-3	11/3/2009	216.1	
AOC_5	SHL-3	4/20/2010	217.6	
AOC_5	SHL-3	4/27/2010	218.0	
AOC_5	SHL-3	9/14/2010	216.8	
AOC_5	SHL-3	10/7/2010	216.4	
AOC_5	SHL-3	4/4/2011	217.2	
AOC_5	SHL-3	7/25/2011	217.0	
AOC_5	SHL-3	11/8/2011	217.2	
AOC_5	SHL-3	4/10/2012	216.3	
AOC_5	SHL-3	6/26/2012	216.5	
AOC_5	SHL-3	11/5/2012	217.9	
AOC_5	SHL-3	11/6/2012	216.2	
AOC_5	SHL-3	2/14/2013	217.2	
AOC_5	SHL-3	3/12/2013	217.7	
AOC_5	SHL-3	4/22/2013	217.4	
AOC_5	SHL-3	4/25/2013	216.6	
AOC_5	SHL-3	5/15/2013	217.3	
AOC_5	SHL-3	6/11/2013	218.2	
AOC_5	SHL-3	10/21/2013	215.0	
AOC_5	SHL-3	4/22/2014	217.8	
AOC_5	SHL-3	10/6/2014	217.4	
AOC_5	SHL-3	6/2/2015	216.6	
AOC_5	SHL-3	6/17/2015	217.2	
AOC_5	SHL-3	8/18/2015	217.1	
AOC_5	SHL-3	10/7/2015	217.0	
AOC_5	SHL-3	10/20/2015	217.8	
AOC_5	SHL-3	12/16/2015	217.0	
AOC_5	SHL-3	6/9/2016	217.2	
AOC_5	SHL-3	8/16/2016	216.8	
AOC_5	SHL-3	11/15/2016	217.7	
AOC_5	SHL-3	11/1/2018	216.8	
AOC_5	SHL-3	10/22/2019	217.6	
AOC_5	SHL-3	4/29/2020	217.3	
AOC_5	SHL-4	5/26/1992	216.4	
AOC_5	SHL-4	9/15/1992	216.3	
AOC_5	SHL-4	12/22/1992	216.9	
AOC_5	SHL-4	3/30/1993	217.1	
AOC_5	SHL-4	6/22/1993	216.3	
AOC_5	SHL-4	9/30/1993	216.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-4	11/8/1993	216.4	
AOC_5	SHL-4	3/30/1994	217.1	
AOC_5	SHL-4	10/4/1994	216.5	
AOC_5	SHL-4	1/31/1995	216.7	
AOC_5	SHL-4	5/9/1995	216.4	
AOC_5	SHL-4	12/7/1995	216.8	
AOC_5	SHL-4	3/26/1996	217.3	
AOC_5	SHL-4	7/23/1996	217.0	
AOC_5	SHL-4	1/15/1997	217.3	
AOC_5	SHL-4	6/2/1997	217.0	
AOC_5	SHL-4	4/23/1998	217.1	
AOC_5	SHL-4	6/19/1998	217.8	
AOC_5	SHL-4	6/26/1998	217.5	
AOC_5	SHL-4	7/1/1998	217.4	
AOC_5	SHL-4	7/17/1998	217.1	
AOC_5	SHL-4	7/31/1998	217.0	
AOC_5	SHL-4	8/28/1998	216.8	
AOC_5	SHL-4	10/14/1998	216.9	
AOC_5	SHL-4	12/10/1998	216.7	
AOC_5	SHL-4	2/23/1999	216.7	
AOC_5	SHL-4	6/6/1999	216.4	
AOC_5	SHL-4	9/8/1999	216.1	
AOC_5	SHL-4	11/16/2001	216.6	
AOC_5	SHL-4	8/4/2005	216.9	
AOC_5	SHL-4	8/24/2005	216.7	
AOC_5	SHL-4	8/26/2005	216.4	
AOC_5	SHL-4	4/10/2006	217.0	
AOC_5	SHL-4	6/5/2006	218.0	
AOC_5	SHL-4	9/18/2006	216.8	
AOC_5	SHL-4	10/19/2006	216.9	
AOC_5	SHL-4	12/15/2006	217.2	
AOC_5	SHL-4	4/8/2007	217.3	
AOC_5	SHL-4	4/9/2007	217.3	
AOC_5	SHL-4	10/15/2007	217.5	
AOC_5	SHL-4	2/20/2008	218.0	
AOC_5	SHL-4	2/25/2008	217.6	
AOC_5	SHL-4	3/4/2008	217.6	
AOC_5	SHL-4	4/16/2008	217.4	
AOC_5	SHL-4	9/30/2008	217.5	
AOC_5	SHL-4	10/3/2008	217.4	
AOC_5	SHL-4	4/28/2009	217.4	
AOC_5	SHL-4	9/14/2009	216.9	
AOC_5	SHL-4	10/22/2009	216.9	
AOC_5	SHL-4	11/3/2009	217.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-4	4/20/2010	217.5	
AOC_5	SHL-4	10/7/2010	216.9	
AOC_5	SHL-4	4/4/2011	217.3	
AOC_5	SHL-4	11/8/2011	217.4	
AOC_5	SHL-4	4/10/2012	216.8	
AOC_5	SHL-4	6/26/2012	216.9	
AOC_5	SHL-4	11/5/2012	217.2	
AOC_5	SHL-4	11/6/2012	217.2	
AOC_5	SHL-4	2/14/2013	216.7	
AOC_5	SHL-4	3/12/2013	217.0	
AOC_5	SHL-4	4/22/2013	216.7	
AOC_5	SHL-4	5/15/2013	216.9	
AOC_5	SHL-4	5/24/2013	217.1	
AOC_5	SHL-4	6/11/2013	217.6	
AOC_5	SHL-4	10/21/2013	213.7	
AOC_5	SHL-4	11/19/2013	216.1	
AOC_5	SHL-4	4/22/2014	217.0	
AOC_5	SHL-4	10/6/2014	217.1	
AOC_5	SHL-4	6/2/2015	217.1	
AOC_5	SHL-4	6/17/2015	216.6	
AOC_5	SHL-4	8/18/2015	216.5	
AOC_5	SHL-4	10/7/2015	216.6	
AOC_5	SHL-4	10/20/2015	217.4	
AOC_5	SHL-4	12/16/2015	216.6	
AOC_5	SHL-4	4/6/2016	216.8	
AOC_5	SHL-4	6/9/2016	216.8	
AOC_5	SHL-4	8/16/2016	216.3	
AOC_5	SHL-4	11/15/2016	218.2	
AOC_5	SHL-4	5/22/2017	217.0	
AOC_5	SHL-4	5/11/2018	217.1	
AOC_5	SHL-4	11/1/2018	216.8	
AOC_5	SHL-4	4/11/2019	216.8	
AOC_5	SHL-4	10/22/2019	217.5	
AOC_5	SHL-4	5/18/2020	217.4	
AOC_5	SHL-4	5/20/2020	216.9	
AOC_5	SHL-5	5/26/1992	213.5	
AOC_5	SHL-5	9/15/1992	212.5	
AOC_5	SHL-5	12/22/1992	215.2	
AOC_5	SHL-5	3/30/1993	215.8	
AOC_5	SHL-5	6/22/1993	212.7	
AOC_5	SHL-5	9/30/1993	214.4	
AOC_5	SHL-5	11/8/1993	214.5	
AOC_5	SHL-5	3/30/1994	215.9	
AOC_5	SHL-5	6/28/1994	212.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-5	10/4/1994	214.3	
AOC_5	SHL-5	1/31/1995	214.7	
AOC_5	SHL-5	5/9/1995	213.3	
AOC_5	SHL-5	12/7/1995	214.4	
AOC_5	SHL-5	3/26/1996	215.3	
AOC_5	SHL-5	7/23/1996	213.7	
AOC_5	SHL-5	1/15/1997	211.8	
AOC_5	SHL-5	6/2/1997	214.1	
AOC_5	SHL-5	4/23/1998	214.9	
AOC_5	SHL-5	6/19/1998	215.7	
AOC_5	SHL-5	6/26/1998	215.3	
AOC_5	SHL-5	7/1/1998	215.2	
AOC_5	SHL-5	7/17/1998	213.7	
AOC_5	SHL-5	7/31/1998	213.0	
AOC_5	SHL-5	8/28/1998	212.0	
AOC_5	SHL-5	12/10/1998	213.7	
AOC_5	SHL-5	2/23/1999	213.0	
AOC_5	SHL-5	6/6/1999	212.0	
AOC_5	SHL-5	9/8/1999	211.0	
AOC_5	SHL-5	11/16/2001	212.2	
AOC_5	SHL-5	8/4/2005	213.1	
AOC_5	SHL-5	8/24/2005	212.3	
AOC_5	SHL-5	8/26/2005	212.2	
AOC_5	SHL-5	4/10/2006	214.5	
AOC_5	SHL-5	6/5/2006	215.7	
AOC_5	SHL-5	9/18/2006	212.7	
AOC_5	SHL-5	12/15/2006	214.8	
AOC_5	SHL-5	4/8/2007	215.4	
AOC_5	SHL-5	4/9/2007	215.4	
AOC_5	SHL-5	4/26/2007	215.7	
AOC_5	SHL-5	10/15/2007	211.8	
AOC_5	SHL-5	2/20/2008	216.0	
AOC_5	SHL-5	2/25/2008	215.4	
AOC_5	SHL-5	3/4/2008	215.4	
AOC_5	SHL-5	4/16/2008	215.0	
AOC_5	SHL-5	6/10/2008	213.1	
AOC_5	SHL-5	7/15/2008	212.2	
AOC_5	SHL-5	8/19/2008	214.8	
AOC_5	SHL-5	9/30/2008	215.4	
AOC_5	SHL-5	10/1/2008	215.6	
AOC_5	SHL-5	1/21/2009	214.4	
AOC_5	SHL-5	4/28/2009	215.0	
AOC_5	SHL-5	7/15/2009	214.1	
AOC_5	SHL-5	10/19/2009	212.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-5	10/26/2009	214.4	
AOC_5	SHL-5	11/3/2009	214.4	
AOC_5	SHL-5	4/20/2010	215.4	
AOC_5	SHL-5	9/14/2010	210.9	
AOC_5	SHL-5	10/7/2010	211.5	
AOC_5	SHL-5	4/4/2011	215.3	
AOC_5	SHL-5	11/8/2011	215.2	
AOC_5	SHL-5	4/10/2012	213.1	
AOC_5	SHL-5	6/26/2012	213.3	
AOC_5	SHL-5	9/11/2012	211.3	
AOC_5	SHL-5	11/5/2012	214.7	
AOC_5	SHL-5	11/6/2012	214.7	
AOC_5	SHL-5	2/14/2013	213.7	
AOC_5	SHL-5	3/12/2013	216.0	
AOC_5	SHL-5	3/13/2013	216.0	
AOC_5	SHL-5	4/22/2013	214.0	
AOC_5	SHL-5	4/23/2013	214.0	
AOC_5	SHL-5	5/15/2013	212.8	
AOC_5	SHL-5	5/21/2013	212.7	
AOC_5	SHL-5	5/30/2013	216.0	
AOC_5	SHL-5	6/11/2013	216.1	
AOC_5	SHL-5	10/21/2013	211.0	
AOC_5	SHL-5	10/22/2013	209.8	
AOC_5	SHL-5	4/22/2014	215.1	
AOC_5	SHL-5	10/6/2014	211.2	
AOC_5	SHL-5	6/2/2015	214.8	
AOC_5	SHL-5	6/17/2015	212.6	
AOC_5	SHL-5	10/20/2015	211.0	
AOC_5	SHL-5	12/16/2015	212.1	
AOC_5	SHL-5	6/9/2016	212.2	
AOC_5	SHL-5	8/16/2016	210.6	
AOC_5	SHL-5	11/15/2016	213.3	
AOC_5	SHL-5	11/1/2018	214.9	
AOC_5	SHL-5	10/22/2019	212.0	
AOC_5	SHL-5+WT-5	11/1/2018	214.9	
AOC_5	SHL-6	5/26/1992	224.7	
AOC_5	SHL-6	9/15/1992	225.4	
AOC_5	SHL-6	12/22/1992	224.1	
AOC_5	SHL-6	3/30/1993	224.7	
AOC_5	SHL-6	6/22/1993	224.8	
AOC_5	SHL-6	9/30/1993	224.0	
AOC_5	SHL-6	11/8/1993	223.9	
AOC_5	SHL-6	3/30/1994	225.7	
AOC_5	SHL-6	6/28/1994	225.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-6	10/4/1994	225.2	
AOC_5	SHL-6	1/31/1995	225.3	
AOC_5	SHL-6	5/9/1995	224.8	
AOC_5	SHL-6	12/7/1995	224.5	
AOC_5	SHL-6	3/26/1996	225.9	
AOC_5	SHL-6	7/23/1996	226.6	
AOC_5	SHL-6	1/15/1997	226.9	
AOC_5	SHL-6	6/2/1997	227.0	
AOC_5	SHL-6	4/23/1998	226.7	
AOC_5	SHL-6	6/19/1998	228.0	
AOC_5	SHL-6	6/26/1998	228.0	
AOC_5	SHL-6	7/1/1998	227.9	
AOC_5	SHL-6	7/17/1998	227.5	
AOC_5	SHL-6	7/31/1998	226.9	
AOC_5	SHL-6	8/28/1998	226.2	
AOC_5	SHL-6	2/23/1999	225.0	
AOC_5	SHL-7	5/26/1992	217.8	
AOC_5	SHL-7	9/15/1992	218.4	
AOC_5	SHL-7	12/22/1992	217.9	
AOC_5	SHL-7	3/30/1993	220.0	
AOC_5	SHL-7	6/22/1993	218.5	
AOC_5	SHL-7	9/30/1993	217.2	
AOC_5	SHL-7	11/8/1993	217.5	
AOC_5	SHL-7	3/30/1994	219.1	
AOC_5	SHL-7	6/28/1994	218.8	
AOC_5	SHL-7	10/4/1994	218.0	
AOC_5	SHL-7	1/31/1995	218.5	
AOC_5	SHL-7	5/9/1995	217.5	
AOC_5	SHL-7	12/7/1995	218.2	
AOC_5	SHL-7	3/26/1996	218.6	
AOC_5	SHL-7	7/23/1996	219.4	
AOC_5	SHL-7	1/15/1997	218.8	
AOC_5	SHL-7	6/2/1997	218.9	
AOC_5	SHL-7	4/23/1998	218.6	
AOC_5	SHL-7	6/19/1998	220.1	
AOC_5	SHL-7	6/26/1998	219.9	
AOC_5	SHL-7	7/1/1998	219.6	
AOC_5	SHL-7	7/17/1998	218.9	
AOC_5	SHL-7	7/31/1998	218.4	
AOC_5	SHL-7	8/28/1998	217.8	
AOC_5	SHL-7	10/14/1998	217.8	
AOC_5	SHL-7	12/10/1998	217.4	
AOC_5	SHL-7	2/23/1999	217.8	
AOC_5	SHL-7	6/6/1999	217.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-7	9/8/1999	216.5	
AOC_5	SHL-7	4/25/2013	219.2	
AOC_5	SHL-7	6/17/2015	219.0	
AOC_5	SHL-7	8/18/2015	218.8	
AOC_5	SHL-7	10/7/2015	218.5	
AOC_5	SHL-7	12/16/2015	218.4	
AOC_5	SHL-7	6/9/2016	218.8	
AOC_5	SHL-7	6/24/2016	218.4	
AOC_5	SHL-7	8/16/2016	218.4	
AOC_5	SHL-7	11/15/2016		
AOC_5	SHL-7	5/22/2017	220.5	
AOC_5	SHL-7	11/1/2018	219.8	
AOC_5	SHL-7	10/22/2019	218.2	
AOC_5	SHL-7	4/29/2020	219.3	
AOC_5	SHL-8D	5/26/1992	213.3	
AOC_5	SHL-8D	9/15/1992	212.8	
AOC_5	SHL-8D	12/22/1992	213.7	
AOC_5	SHL-8D	6/22/1993	212.9	
AOC_5	SHL-8D	9/30/1993	212.9	
AOC_5	SHL-8D	11/8/1993	213.3	
AOC_5	SHL-8D	3/30/1994	214.6	
AOC_5	SHL-8D	6/28/1994	213.1	
AOC_5	SHL-8D	10/4/1994	213.3	
AOC_5	SHL-8D	1/31/1995	214.0	
AOC_5	SHL-8D	5/9/1995	213.8	
AOC_5	SHL-8D	12/7/1995	213.8	
AOC_5	SHL-8D	3/26/1996	214.4	
AOC_5	SHL-8D	7/23/1996	213.5	
AOC_5	SHL-8D	6/2/1997	213.7	
AOC_5	SHL-8D	4/23/1998	214.1	
AOC_5	SHL-8D	6/19/1998	215.0	
AOC_5	SHL-8D	6/26/1998	214.7	
AOC_5	SHL-8D	7/1/1998	214.6	
AOC_5	SHL-8D	7/17/1998	213.8	
AOC_5	SHL-8D	7/31/1998	213.3	
AOC_5	SHL-8D	8/28/1998	212.7	
AOC_5	SHL-8D	10/14/1998	212.9	
AOC_5	SHL-8D	12/10/1998	212.8	
AOC_5	SHL-8D	2/23/1999	213.4	
AOC_5	SHL-8D	6/6/1999	212.6	
AOC_5	SHL-8D	9/8/1999	211.9	
AOC_5	SHL-8D	11/16/2001	212.6	
AOC_5	SHL-8D	8/4/2005	213.3	
AOC_5	SHL-8D	8/24/2005	212.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-8D	8/26/2005	212.8	
AOC_5	SHL-8D	4/10/2006	213.4	
AOC_5	SHL-8D	6/5/2006	214.8	
AOC_5	SHL-8D	9/18/2006	212.9	
AOC_5	SHL-8D	10/19/2006	213.1	
AOC_5	SHL-8D	12/15/2006	213.9	
AOC_5	SHL-8D	4/8/2007	213.6	
AOC_5	SHL-8D	4/9/2007	213.6	
AOC_5	SHL-8D	10/15/2007	212.8	
AOC_5	SHL-8D	2/20/2008	214.8	
AOC_5	SHL-8D	2/25/2008	214.7	
AOC_5	SHL-8D	3/4/2008	214.3	
AOC_5	SHL-8D	4/16/2008	214.3	
AOC_5	SHL-8D	7/15/2008	212.7	
AOC_5	SHL-8D	9/30/2008	213.7	
AOC_5	SHL-8D	10/1/2008	213.8	
AOC_5	SHL-8D	1/21/2009	213.6	
AOC_5	SHL-8D	4/28/2009	213.9	
AOC_5	SHL-8D	7/15/2009	213.4	
AOC_5	SHL-8D	10/19/2009	212.4	
AOC_5	SHL-8D	10/26/2009	212.9	
AOC_5	SHL-8D	11/3/2009	212.9	
AOC_5	SHL-8D	4/20/2010	214.8	
AOC_5	SHL-8D	10/7/2010	212.3	
AOC_5	SHL-8D	4/4/2011	214.0	
AOC_5	SHL-8D	11/8/2011	214.0	
AOC_5	SHL-8D	4/10/2012	212.7	
AOC_5	SHL-8D	9/11/2012	212.1	
AOC_5	SHL-8D	11/5/2012	213.3	
AOC_5	SHL-8D	11/6/2012	213.3	
AOC_5	SHL-8D	3/13/2013	213.6	
AOC_5	SHL-8D	4/23/2013	213.0	
AOC_5	SHL-8D	4/25/2013	213.0	
AOC_5	SHL-8D	5/15/2013	212.7	
AOC_5	SHL-8D	5/21/2013	212.7	
AOC_5	SHL-8D	5/30/2013	213.5	
AOC_5	SHL-8D	6/11/2013	214.0	
AOC_5	SHL-8D	10/21/2013	211.2	
AOC_5	SHL-8D	10/22/2013	210.8	
AOC_5	SHL-8D	4/22/2014	213.9	
AOC_5	SHL-8D	10/6/2014	212.2	
AOC_5	SHL-8D	6/2/2015	213.3	
AOC_5	SHL-8D	6/17/2015	212.8	
AOC_5	SHL-8D	8/18/2015	212.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-8D	10/20/2015	212.3	
AOC_5	SHL-8D	12/16/2015	212.4	
AOC_5	SHL-8D	6/9/2016	212.7	
AOC_5	SHL-8D	8/16/2016	211.8	
AOC_5	SHL-8D	10/20/2016	211.8	
AOC_5	SHL-8D	11/15/2016	212.8	
AOC_5	SHL-8D	11/1/2018	213.4	
AOC_5	SHL-8D	10/22/2019	212.6	
AOC_5	SHL-8S	5/26/1992	213.3	
AOC_5	SHL-8S	9/15/1992	212.4	
AOC_5	SHL-8S	12/22/1992	214.1	
AOC_5	SHL-8S	3/30/1993	214.2	
AOC_5	SHL-8S	6/22/1993	212.9	
AOC_5	SHL-8S	9/30/1993	212.9	
AOC_5	SHL-8S	11/8/1993	213.3	
AOC_5	SHL-8S	3/30/1994	214.7	
AOC_5	SHL-8S	6/28/1994	213.1	
AOC_5	SHL-8S	10/4/1994	213.9	
AOC_5	SHL-8S	1/31/1995	214.0	
AOC_5	SHL-8S	5/9/1995	213.1	
AOC_5	SHL-8S	12/7/1995	213.7	
AOC_5	SHL-8S	3/26/1996	214.4	
AOC_5	SHL-8S	7/23/1996	213.4	
AOC_5	SHL-8S	6/2/1997	213.7	
AOC_5	SHL-8S	4/23/1998	214.1	
AOC_5	SHL-8S	6/19/1998	215.0	
AOC_5	SHL-8S	6/26/1998	214.7	
AOC_5	SHL-8S	7/1/1998	214.5	
AOC_5	SHL-8S	7/17/1998	213.7	
AOC_5	SHL-8S	7/31/1998	213.3	
AOC_5	SHL-8S	8/28/1998	212.7	
AOC_5	SHL-8S	10/14/1998	213.0	
AOC_5	SHL-8S	12/10/1998	212.8	
AOC_5	SHL-8S	2/23/1999	213.4	
AOC_5	SHL-8S	6/6/1999	212.6	
AOC_5	SHL-8S	9/8/1999	211.9	
AOC_5	SHL-8S	11/16/2001	212.7	
AOC_5	SHL-8S	8/4/2005	213.3	
AOC_5	SHL-8S	8/24/2005	212.8	
AOC_5	SHL-8S	8/26/2005	212.7	
AOC_5	SHL-8S	4/10/2006	213.5	
AOC_5	SHL-8S	6/5/2006	214.8	
AOC_5	SHL-8S	9/18/2006	213.2	
AOC_5	SHL-8S	10/19/2006	213.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-8S	12/15/2006	214.0	
AOC_5	SHL-8S	4/8/2007	213.5	
AOC_5	SHL-8S	4/9/2007	213.5	
AOC_5	SHL-8S	4/26/2007	215.1	
AOC_5	SHL-8S	10/15/2007	212.8	
AOC_5	SHL-8S	2/20/2008	214.8	
AOC_5	SHL-8S	2/25/2008	214.7	
AOC_5	SHL-8S	3/4/2008	214.3	
AOC_5	SHL-8S	4/16/2008	214.3	
AOC_5	SHL-8S	6/10/2008		190.0
AOC_5	SHL-8S	7/15/2008	212.7	
AOC_5	SHL-8S	9/30/2008	213.8	
AOC_5	SHL-8S	10/1/2008	213.8	
AOC_5	SHL-8S	1/21/2009	213.6	
AOC_5	SHL-8S	4/28/2009	214.0	
AOC_5	SHL-8S	7/5/2009	213.5	
AOC_5	SHL-8S	7/15/2009	213.4	
AOC_5	SHL-8S	10/19/2009	212.6	
AOC_5	SHL-8S	10/26/2009	213.0	
AOC_5	SHL-8S	11/3/2009	213.1	
AOC_5	SHL-8S	4/20/2010	214.8	
AOC_5	SHL-8S	10/7/2010	212.4	
AOC_5	SHL-8S	4/4/2011	214.1	
AOC_5	SHL-8S	11/8/2011	214.1	
AOC_5	SHL-8S	4/10/2012	212.8	
AOC_5	SHL-8S	6/26/2012	213.0	
AOC_5	SHL-8S	9/11/2012	212.1	
AOC_5	SHL-8S	11/5/2012	213.4	
AOC_5	SHL-8S	11/6/2012	213.4	
AOC_5	SHL-8S	3/13/2013	213.7	
AOC_5	SHL-8S	4/23/2013	213.2	
AOC_5	SHL-8S	4/25/2013	213.1	
AOC_5	SHL-8S	5/15/2013	212.8	
AOC_5	SHL-8S	5/28/2013	213.6	
AOC_5	SHL-8S	5/30/2013	213.6	
AOC_5	SHL-8S	6/11/2013	214.2	
AOC_5	SHL-8S	10/21/2013	211.3	
AOC_5	SHL-8S	10/22/2013	209.8	
AOC_5	SHL-8S	4/22/2014	213.9	
AOC_5	SHL-8S	10/6/2014	212.4	
AOC_5	SHL-8S	6/2/2015	213.4	
AOC_5	SHL-8S	6/17/2015	212.8	
AOC_5	SHL-8S	8/18/2015	212.3	
AOC_5	SHL-8S	10/20/2015	212.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-8S	12/16/2015	212.5	
AOC_5	SHL-8S	6/9/2016	212.8	
AOC_5	SHL-8S	8/16/2016	212.0	
AOC_5	SHL-8S	11/15/2016	213.0	
AOC_5	SHL-8S	11/1/2018	213.5	
AOC_5	SHL-8S	10/22/2019	212.6	
AOC_5	SHL-9	5/26/1992	212.8	
AOC_5	SHL-9	9/15/1992	211.9	
AOC_5	SHL-9	12/22/1992	213.7	
AOC_5	SHL-9	3/30/1993	213.9	
AOC_5	SHL-9	6/22/1993	212.3	
AOC_5	SHL-9	9/30/1993	212.1	
AOC_5	SHL-9	11/8/1993	212.9	
AOC_5	SHL-9	3/30/1994	214.9	
AOC_5	SHL-9	6/28/1994	212.7	
AOC_5	SHL-9	1/31/1995	213.9	
AOC_5	SHL-9	5/9/1995	212.6	
AOC_5	SHL-9	12/7/1995	213.4	
AOC_5	SHL-9	3/26/1996	214.4	
AOC_5	SHL-9	7/23/1996	213.0	
AOC_5	SHL-9	6/2/1997	213.4	
AOC_5	SHL-9	4/23/1998	214.0	
AOC_5	SHL-9	6/19/1998	215.2	
AOC_5	SHL-9	7/1/1998	214.7	
AOC_5	SHL-9	7/17/1998	213.6	
AOC_5	SHL-9	8/28/1998	212.0	
AOC_5	SHL-9	10/14/1998	212.3	
AOC_5	SHL-9	12/10/1998	212.2	
AOC_5	SHL-9	2/23/1999	213.2	
AOC_5	SHL-9	6/6/1999	211.7	
AOC_5	SHL-9	9/8/1999	211.0	
AOC_5	SHL-9	11/16/2001	211.8	
AOC_5	SHL-9	8/4/2005	212.8	
AOC_5	SHL-9	8/24/2005	212.1	
AOC_5	SHL-9	8/26/2005	212.1	
AOC_5	SHL-9	4/10/2006	212.9	
AOC_5	SHL-9	6/5/2006	214.8	
AOC_5	SHL-9	9/18/2006	212.4	
AOC_5	SHL-9	12/15/2006	213.6	
AOC_5	SHL-9	4/8/2007	213.9	
AOC_5	SHL-9	4/9/2007	213.9	
AOC_5	SHL-9	10/15/2007	211.2	
AOC_5	SHL-9	2/20/2008	214.9	
AOC_5	SHL-9	2/25/2008	214.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHL-9	3/4/2008	213.9	
AOC_5	SHL-9	4/16/2008	213.8	
AOC_5	SHL-9	7/15/2008	211.8	
AOC_5	SHL-9	9/30/2008	213.0	
AOC_5	SHL-9	10/1/2008		203.1
AOC_5	SHL-9	1/20/2009	213.1	
AOC_5	SHL-9	4/28/2009	213.5	
AOC_5	SHL-9	7/15/2009	215.6	
AOC_5	SHL-9	10/19/2009	211.0	
AOC_5	SHL-9	11/3/2009	211.8	
AOC_5	SHL-9	4/20/2010	214.3	
AOC_5	SHL-9	9/14/2010	210.8	
AOC_5	SHL-9	10/7/2010	210.8	
AOC_5	SHL-9	4/4/2011	213.8	
AOC_5	SHL-9	11/8/2011	213.6	
AOC_5	SHL-9	4/10/2012	211.9	
AOC_5	SHL-9	6/26/2012	211.8	
AOC_5	SHL-9	9/11/2012	210.7	
AOC_5	SHL-9	11/5/2012	212.3	
AOC_5	SHL-9	11/6/2012	212.3	
AOC_5	SHL-9	2/14/2013	212.4	
AOC_5	SHL-9	3/12/2013	216.1	
AOC_5	SHL-9	3/13/2013	213.6	
AOC_5	SHL-9	4/22/2013	212.2	
AOC_5	SHL-9	4/23/2013	212.3	
AOC_5	SHL-9	4/25/2013	212.3	
AOC_5	SHL-9	5/15/2013	211.6	
AOC_5	SHL-9	5/28/2013	212.9	
AOC_5	SHL-9	5/30/2013	212.6	
AOC_5	SHL-9	6/11/2013		205.9
AOC_5	SHL-9	10/21/2013	210.9	
AOC_5	SHL-9	10/23/2013	210.6	
AOC_5	SHL-9	4/22/2014	213.3	
AOC_5	SHL-9	4/23/2014	213.2	
AOC_5	SHL-9	10/6/2014	210.6	
AOC_5	SHL-9	6/2/2015	212.4	
AOC_5	SHL-9	6/17/2015	211.8	
AOC_5	SHL-9	10/20/2015	210.5	
AOC_5	SHL-9	12/16/2015	211.0	
AOC_5	SHL-9	6/9/2016	211.5	
AOC_5	SHL-9	8/16/2016	210.2	
AOC_5	SHL-9	10/16/2016	211.5	
AOC_5	SHL-9	11/1/2018	212.5	
AOC_5	SHL-9	10/22/2019	209.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-39A	8/4/2005	210.0	
AOC_5	SHM-05-39A	8/24/2005	209.6	
AOC_5	SHM-05-39A	8/26/2005	209.6	
AOC_5	SHM-05-39A	4/10/2006	210.3	
AOC_5	SHM-05-39A	6/5/2006	211.7	
AOC_5	SHM-05-39A	9/18/2006	210.1	
AOC_5	SHM-05-39A	12/15/2006	211.0	
AOC_5	SHM-05-39A	4/8/2007	211.0	
AOC_5	SHM-05-39A	4/9/2007	211.0	
AOC_5	SHM-05-39A	10/15/2007	209.5	
AOC_5	SHM-05-39A	2/20/2008	211.8	
AOC_5	SHM-05-39A	2/25/2008	211.7	
AOC_5	SHM-05-39A	4/16/2008	211.2	
AOC_5	SHM-05-39A	9/30/2008	210.5	
AOC_5	SHM-05-39A	10/2/2008	210.7	
AOC_5	SHM-05-39A	4/28/2009	213.4	
AOC_5	SHM-05-39A	10/20/2009	209.4	
AOC_5	SHM-05-39A	11/3/2009	209.9	
AOC_5	SHM-05-39A	4/20/2010	211.7	
AOC_5	SHM-05-39A	10/7/2010	209.2	
AOC_5	SHM-05-39A	4/4/2011	211.0	
AOC_5	SHM-05-39A	11/8/2011	210.9	
AOC_5	SHM-05-39A	4/10/2012	209.1	
AOC_5	SHM-05-39A	11/5/2012	210.1	
AOC_5	SHM-05-39A	4/25/2013	209.9	
AOC_5	SHM-05-39A	5/15/2013	209.6	
AOC_5	SHM-05-39A	5/30/2013	210.1	
AOC_5	SHM-05-39A	6/11/2013	210.6	
AOC_5	SHM-05-39A	10/21/2013	209.0	
AOC_5	SHM-05-39A	10/24/2013	208.8	
AOC_5	SHM-05-39A	4/22/2014	211.0	
AOC_5	SHM-05-39A	10/6/2014	209.2	
AOC_5	SHM-05-39A	6/2/2015	209.9	
AOC_5	SHM-05-39A	6/17/2015	209.6	
AOC_5	SHM-05-39A	10/20/2015	209.0	
AOC_5	SHM-05-39A	6/9/2016	209.6	
AOC_5	SHM-05-39A	8/16/2016	208.8	
AOC_5	SHM-05-39A	11/1/2018	210.2	
AOC_5	SHM-05-39A	10/22/2019	209.1	
AOC_5	SHM-05-39B	8/4/2005	209.2	
AOC_5	SHM-05-39B	8/24/2005	208.8	
AOC_5	SHM-05-39B	8/26/2005	208.8	
AOC_5	SHM-05-39B	4/10/2006	209.5	
AOC_5	SHM-05-39B	6/5/2006	210.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-39B	9/18/2006	209.3	
AOC_5	SHM-05-39B	12/15/2006	205.9	
AOC_5	SHM-05-39B	4/8/2007	210.1	
AOC_5	SHM-05-39B	4/9/2007	210.1	
AOC_5	SHM-05-39B	10/15/2007	208.9	
AOC_5	SHM-05-39B	2/20/2008	211.0	
AOC_5	SHM-05-39B	2/25/2008	210.9	
AOC_5	SHM-05-39B	4/16/2008	210.4	
AOC_5	SHM-05-39B	9/30/2008	209.6	
AOC_5	SHM-05-39B	10/2/2008	208.0	
AOC_5	SHM-05-39B	4/28/2009	210.0	
AOC_5	SHM-05-39B	10/20/2009	208.4	
AOC_5	SHM-05-39B	11/3/2009	209.1	
AOC_5	SHM-05-39B	4/20/2010	210.8	
AOC_5	SHM-05-39B	10/7/2010	208.1	
AOC_5	SHM-05-39B	4/4/2011	210.2	
AOC_5	SHM-05-39B	11/8/2011	210.0	
AOC_5	SHM-05-39B	4/10/2012	209.6	
AOC_5	SHM-05-39B	11/5/2012	209.2	
AOC_5	SHM-05-39B	4/25/2013	209.1	
AOC_5	SHM-05-39B	5/15/2013	208.8	
AOC_5	SHM-05-39B	5/30/2013	209.3	
AOC_5	SHM-05-39B	6/11/2013	209.7	
AOC_5	SHM-05-39B	10/21/2013	208.4	
AOC_5	SHM-05-39B	4/22/2014	210.2	
AOC_5	SHM-05-39B	10/6/2014	208.5	
AOC_5	SHM-05-39B	6/2/2015	209.1	
AOC_5	SHM-05-39B	6/17/2015	208.9	
AOC_5	SHM-05-39B	10/20/2015	208.4	
AOC_5	SHM-05-39B	6/9/2016	208.9	
AOC_5	SHM-05-39B	8/16/2016	208.2	
AOC_5	SHM-05-39B	10/20/2016	208.3	
AOC_5	SHM-05-39B	11/1/2018	209.4	
AOC_5	SHM-05-39B	10/22/2019		
AOC_5	SHM-05-40X	8/4/2005	209.0	
AOC_5	SHM-05-40X	8/24/2005	208.6	
AOC_5	SHM-05-40X	8/26/2005	208.6	
AOC_5	SHM-05-40X	4/10/2006	209.2	
AOC_5	SHM-05-40X	6/5/2006	210.7	
AOC_5	SHM-05-40X	9/18/2006	209.1	
AOC_5	SHM-05-40X	12/15/2006	210.0	
AOC_5	SHM-05-40X	4/8/2007	210.0	
AOC_5	SHM-05-40X	4/9/2007	210.0	
AOC_5	SHM-05-40X	10/15/2007	208.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-40X	2/20/2008	210.9	
AOC_5	SHM-05-40X	2/25/2008	210.9	
AOC_5	SHM-05-40X	3/4/2008	210.4	
AOC_5	SHM-05-40X	4/16/2008	210.3	
AOC_5	SHM-05-40X	9/30/2008	209.4	
AOC_5	SHM-05-40X	4/28/2009	209.8	
AOC_5	SHM-05-40X	10/20/2009	208.4	
AOC_5	SHM-05-40X	11/3/2009	208.8	
AOC_5	SHM-05-40X	4/20/2010	211.0	
AOC_5	SHM-05-40X	10/7/2010	208.0	
AOC_5	SHM-05-40X	4/4/2011	210.1	
AOC_5	SHM-05-40X	11/8/2011	209.9	
AOC_5	SHM-05-40X	4/10/2012	208.6	
AOC_5	SHM-05-40X	11/5/2012	209.0	
AOC_5	SHM-05-40X	4/25/2013	208.9	
AOC_5	SHM-05-40X	5/15/2013	208.5	
AOC_5	SHM-05-40X	5/30/2013	209.0	
AOC_5	SHM-05-40X	6/11/2013	209.3	
AOC_5	SHM-05-40X	10/21/2013	208.1	
AOC_5	SHM-05-40X	10/24/2013	208.0	
AOC_5	SHM-05-40X	4/22/2014	210.1	
AOC_5	SHM-05-40X	10/6/2014	208.1	
AOC_5	SHM-05-40X	6/2/2015	208.7	
AOC_5	SHM-05-40X	6/17/2015	208.6	
AOC_5	SHM-05-40X	10/20/2015	208.0	
AOC_5	SHM-05-40X	12/16/2015	208.3	
AOC_5	SHM-05-40X	6/9/2016	208.5	
AOC_5	SHM-05-40X	6/23/2016	208.4	
AOC_5	SHM-05-40X	8/16/2016	207.8	
AOC_5	SHM-05-40X	10/20/2016	207.9	
AOC_5	SHM-05-40X	11/16/2016	208.7	
AOC_5	SHM-05-40X	5/22/2017	209.5	
AOC_5	SHM-05-40X	5/11/2018	212.8	
AOC_5	SHM-05-40X	11/1/2018	209.3	
AOC_5	SHM-05-40X	4/11/2019	209.3	
AOC_5	SHM-05-40X	10/22/2019	208.2	
AOC_5	SHM-05-40X	5/18/2020	209.5	
AOC_5	SHM-05-40X	5/19/2020	209.5	
AOC_5	SHM-05-41A	8/4/2005	212.3	
AOC_5	SHM-05-41A	8/24/2005	211.8	
AOC_5	SHM-05-41A	8/26/2005	211.7	
AOC_5	SHM-05-41A	4/10/2006	212.4	
AOC_5	SHM-05-41A	6/5/2006	214.0	
AOC_5	SHM-05-41A	9/18/2006	212.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-41A	12/15/2006	213.2	
AOC_5	SHM-05-41A	4/8/2007	213.3	
AOC_5	SHM-05-41A	4/9/2007	213.3	
AOC_5	SHM-05-41A	10/15/2007	210.9	
AOC_5	SHM-05-41A	2/20/2008	213.9	
AOC_5	SHM-05-41A	2/25/2008	214.2	
AOC_5	SHM-05-41A	3/4/2008	213.4	
AOC_5	SHM-05-41A	4/16/2008	213.4	
AOC_5	SHM-05-41A	9/30/2008	212.5	
AOC_5	SHM-05-41A	10/2/2008	212.6	
AOC_5	SHM-05-41A	4/28/2009	212.9	
AOC_5	SHM-05-41A	10/20/2009	210.8	
AOC_5	SHM-05-41A	11/3/2009	211.5	
AOC_5	SHM-05-41A	4/20/2010	213.9	
AOC_5	SHM-05-41A	10/7/2010	210.5	
AOC_5	SHM-05-41A	4/4/2011	213.2	
AOC_5	SHM-05-41A	11/8/2011	213.1	
AOC_5	SHM-05-41A	4/10/2012	211.5	
AOC_5	SHM-05-41A	9/11/2012	210.5	
AOC_5	SHM-05-41A	11/5/2012	211.9	
AOC_5	SHM-05-41A	11/6/2012	211.9	
AOC_5	SHM-05-41A	3/13/2013	212.3	
AOC_5	SHM-05-41A	4/23/2013	211.8	
AOC_5	SHM-05-41A	4/25/2013	211.8	
AOC_5	SHM-05-41A	5/15/2013	211.2	
AOC_5	SHM-05-41A	5/22/2013	211.2	
AOC_5	SHM-05-41A	5/30/2013	212.0	
AOC_5	SHM-05-41A	6/11/2013	212.5	
AOC_5	SHM-05-41A	10/21/2013	210.6	
AOC_5	SHM-05-41A	10/23/2013	210.5	
AOC_5	SHM-05-41A	4/22/2014	212.8	
AOC_5	SHM-05-41A	4/23/2014	212.8	
AOC_5	SHM-05-41A	10/6/2014	210.4	
AOC_5	SHM-05-41A	6/2/2015	211.6	
AOC_5	SHM-05-41A	6/17/2015	211.3	
AOC_5	SHM-05-41A	10/20/2015	210.1	
AOC_5	SHM-05-41A	12/16/2015	210.6	
AOC_5	SHM-05-41A	6/9/2016	211.1	
AOC_5	SHM-05-41A	8/16/2016	210.0	
AOC_5	SHM-05-41A	11/16/2016	211.1	
AOC_5	SHM-05-41A	11/1/2018	212.0	
AOC_5	SHM-05-41A	10/22/2019	210.5	
AOC_5	SHM-05-41B	8/4/2005	212.3	
AOC_5	SHM-05-41B	8/24/2005	211.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-41B	8/26/2005	211.7	
AOC_5	SHM-05-41B	4/10/2006	212.4	
AOC_5	SHM-05-41B	6/5/2006	214.1	
AOC_5	SHM-05-41B	9/18/2006	212.0	
AOC_5	SHM-05-41B	12/15/2006	213.2	
AOC_5	SHM-05-41B	4/8/2007	213.3	
AOC_5	SHM-05-41B	4/9/2007	213.3	
AOC_5	SHM-05-41B	10/15/2007	211.0	
AOC_5	SHM-05-41B	2/20/2008	214.0	
AOC_5	SHM-05-41B	2/25/2008	214.2	
AOC_5	SHM-05-41B	3/4/2008	213.3	
AOC_5	SHM-05-41B	4/16/2008	213.4	
AOC_5	SHM-05-41B	9/30/2008	212.5	
AOC_5	SHM-05-41B	10/1/2008	212.6	
AOC_5	SHM-05-41B	4/28/2009	213.0	
AOC_5	SHM-05-41B	10/20/2009	210.8	
AOC_5	SHM-05-41B	11/3/2009	211.5	
AOC_5	SHM-05-41B	4/20/2010	214.0	
AOC_5	SHM-05-41B	9/14/2010	210.5	
AOC_5	SHM-05-41B	10/7/2010	210.6	
AOC_5	SHM-05-41B	4/4/2011	213.2	
AOC_5	SHM-05-41B	11/8/2011	213.1	
AOC_5	SHM-05-41B	4/10/2012	211.5	
AOC_5	SHM-05-41B	9/11/2012	210.5	
AOC_5	SHM-05-41B	11/5/2012	211.9	
AOC_5	SHM-05-41B	11/6/2012	211.9	
AOC_5	SHM-05-41B	3/13/2013	212.4	
AOC_5	SHM-05-41B	4/23/2013	211.8	
AOC_5	SHM-05-41B	4/25/2013	211.8	
AOC_5	SHM-05-41B	5/15/2013	211.2	
AOC_5	SHM-05-41B	5/22/2013	211.2	
AOC_5	SHM-05-41B	5/30/2013	212.1	
AOC_5	SHM-05-41B	6/11/2013	212.5	
AOC_5	SHM-05-41B	10/21/2013	210.6	
AOC_5	SHM-05-41B	10/23/2013	210.5	
AOC_5	SHM-05-41B	4/22/2014	212.9	
AOC_5	SHM-05-41B	4/23/2014	212.8	
AOC_5	SHM-05-41B	10/6/2014	210.4	
AOC_5	SHM-05-41B	6/2/2015	211.9	
AOC_5	SHM-05-41B	6/8/2015	211.4	
AOC_5	SHM-05-41B	6/17/2015	211.3	
AOC_5	SHM-05-41B	10/20/2015	210.1	
AOC_5	SHM-05-41B	12/16/2015	210.6	
AOC_5	SHM-05-41B	6/9/2016	211.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-41B	6/23/2016	210.7	
AOC_5	SHM-05-41B	8/16/2016	210.0	
AOC_5	SHM-05-41B	10/20/2016	209.9	
AOC_5	SHM-05-41B	11/16/2016	211.1	
AOC_5	SHM-05-41B	5/22/2017	212.3	
AOC_5	SHM-05-41B	5/11/2018	212.4	
AOC_5	SHM-05-41B	11/1/2018	212.0	
AOC_5	SHM-05-41B	4/11/2019	210.7	
AOC_5	SHM-05-41B	10/22/2019		182.2
AOC_5	SHM-05-41B	5/18/2020	212.4	
AOC_5	SHM-05-41B	5/21/2020	212.2	
AOC_5	SHM-05-41C	8/4/2005	212.3	
AOC_5	SHM-05-41C	8/24/2005	211.8	
AOC_5	SHM-05-41C	8/26/2005	211.7	
AOC_5	SHM-05-41C	4/10/2006	212.4	
AOC_5	SHM-05-41C	6/5/2006	214.1	
AOC_5	SHM-05-41C	9/18/2006	212.0	
AOC_5	SHM-05-41C	12/15/2006	213.2	
AOC_5	SHM-05-41C	4/8/2007	213.3	
AOC_5	SHM-05-41C	4/9/2007	213.3	
AOC_5	SHM-05-41C	10/15/2007	211.0	
AOC_5	SHM-05-41C	2/20/2008	213.9	
AOC_5	SHM-05-41C	2/25/2008	214.2	
AOC_5	SHM-05-41C	3/4/2008	213.6	
AOC_5	SHM-05-41C	4/16/2008	213.4	
AOC_5	SHM-05-41C	9/30/2008	212.5	
AOC_5	SHM-05-41C	10/2/2008	212.7	
AOC_5	SHM-05-41C	4/28/2009	213.0	
AOC_5	SHM-05-41C	10/20/2009	210.8	
AOC_5	SHM-05-41C	11/3/2009	211.5	
AOC_5	SHM-05-41C	4/20/2010	213.9	
AOC_5	SHM-05-41C	9/14/2010	210.5	
AOC_5	SHM-05-41C	10/7/2010	210.6	
AOC_5	SHM-05-41C	4/4/2011	213.1	
AOC_5	SHM-05-41C	11/8/2011	213.1	
AOC_5	SHM-05-41C	4/10/2012	211.5	
AOC_5	SHM-05-41C	9/11/2012	210.5	
AOC_5	SHM-05-41C	11/5/2012	211.9	
AOC_5	SHM-05-41C	11/6/2012	211.9	
AOC_5	SHM-05-41C	3/13/2013	212.3	
AOC_5	SHM-05-41C	4/23/2013	211.7	
AOC_5	SHM-05-41C	5/15/2013	211.2	
AOC_5	SHM-05-41C	5/21/2013	211.3	
AOC_5	SHM-05-41C	5/30/2013	212.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-41C	6/11/2013	212.5	
AOC_5	SHM-05-41C	10/21/2013	210.6	
AOC_5	SHM-05-41C	10/23/2013	210.4	
AOC_5	SHM-05-41C	4/22/2014	212.8	
AOC_5	SHM-05-41C	4/23/2014	212.7	
AOC_5	SHM-05-41C	10/6/2014	210.2	
AOC_5	SHM-05-41C	6/2/2015	211.7	
AOC_5	SHM-05-41C	6/8/2015	211.4	
AOC_5	SHM-05-41C	6/17/2015	211.4	
AOC_5	SHM-05-41C	10/20/2015	210.2	
AOC_5	SHM-05-41C	12/16/2015	210.7	
AOC_5	SHM-05-41C	6/9/2016	211.2	
AOC_5	SHM-05-41C	6/23/2016	210.7	
AOC_5	SHM-05-41C	11/16/2016	211.1	
AOC_5	SHM-05-41C	5/22/2017	212.4	
AOC_5	SHM-05-41C	5/11/2018	212.5	
AOC_5	SHM-05-41C	11/1/2018	212.0	
AOC_5	SHM-05-41C	4/11/2019	211.8	
AOC_5	SHM-05-41C	10/22/2019	210.4	
AOC_5	SHM-05-41C	5/18/2020	212.3	
AOC_5	SHM-05-41C	5/21/2020	211.9	
AOC_5	SHM-05-42A	8/4/2005	212.3	
AOC_5	SHM-05-42A	8/24/2005	211.8	
AOC_5	SHM-05-42A	8/26/2005	211.7	
AOC_5	SHM-05-42A	4/10/2006	212.5	
AOC_5	SHM-05-42A	6/5/2006	214.0	
AOC_5	SHM-05-42A	8/2/2006	212.4	
AOC_5	SHM-05-42A	9/18/2006	212.0	
AOC_5	SHM-05-42A	12/15/2006	213.2	
AOC_5	SHM-05-42A	4/8/2007	213.3	
AOC_5	SHM-05-42A	4/9/2007	213.3	
AOC_5	SHM-05-42A	10/15/2007	211.2	
AOC_5	SHM-05-42A	2/25/2008	214.3	
AOC_5	SHM-05-42A	3/4/2008	213.6	
AOC_5	SHM-05-42A	4/16/2008	213.3	
AOC_5	SHM-05-42A	9/30/2008	212.6	
AOC_5	SHM-05-42A	10/2/2008	212.3	
AOC_5	SHM-05-42A	4/28/2009	213.0	
AOC_5	SHM-05-42A	10/21/2009	211.1	
AOC_5	SHM-05-42A	11/3/2009	211.7	
AOC_5	SHM-05-42A	4/20/2010	214.5	
AOC_5	SHM-05-42A	9/14/2010	210.6	
AOC_5	SHM-05-42A	10/7/2010	210.9	
AOC_5	SHM-05-42A	4/4/2011	213.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-42A	11/8/2011	213.1	
AOC_5	SHM-05-42A	4/10/2012	211.6	
AOC_5	SHM-05-42A	6/26/2012	211.7	
AOC_5	SHM-05-42A	9/11/2012	210.6	
AOC_5	SHM-05-42A	11/5/2012	212.1	
AOC_5	SHM-05-42A	11/6/2012	212.1	
AOC_5	SHM-05-42A	3/13/2013	212.6	
AOC_5	SHM-05-42A	4/23/2013	211.9	
AOC_5	SHM-05-42A	4/25/2013	211.9	
AOC_5	SHM-05-42A	5/15/2013	211.4	
AOC_5	SHM-05-42A	5/22/2013	211.4	
AOC_5	SHM-05-42A	5/30/2013	212.2	
AOC_5	SHM-05-42A	6/11/2013	212.8	
AOC_5	SHM-05-42A	10/21/2013	210.7	
AOC_5	SHM-05-42A	10/23/2013	210.4	
AOC_5	SHM-05-42A	4/22/2014	212.9	
AOC_5	SHM-05-42A	4/23/2014	212.9	
AOC_5	SHM-05-42A	10/6/2014	210.7	
AOC_5	SHM-05-42A	6/2/2015	212.0	
AOC_5	SHM-05-42A	6/17/2015	211.5	
AOC_5	SHM-05-42A	10/20/2015	210.5	
AOC_5	SHM-05-42A	12/16/2015	210.9	
AOC_5	SHM-05-42A	6/9/2016	211.3	
AOC_5	SHM-05-42A	8/16/2016	210.3	
AOC_5	SHM-05-42A	11/16/2016	211.4	
AOC_5	SHM-05-42A	11/1/2018	212.3	
AOC_5	SHM-05-42A	10/22/2019	208.8	
AOC_5	SHM-05-42B	8/4/2005	212.4	
AOC_5	SHM-05-42B	8/24/2005	211.9	
AOC_5	SHM-05-42B	8/26/2005	211.7	
AOC_5	SHM-05-42B	4/10/2006	212.5	
AOC_5	SHM-05-42B	6/5/2006	214.1	
AOC_5	SHM-05-42B	8/2/2006	212.5	
AOC_5	SHM-05-42B	9/18/2006	212.1	
AOC_5	SHM-05-42B	12/15/2006	213.2	
AOC_5	SHM-05-42B	4/8/2007	213.4	
AOC_5	SHM-05-42B	4/9/2007	213.4	
AOC_5	SHM-05-42B	10/15/2007	211.2	
AOC_5	SHM-05-42B	2/25/2008	214.2	
AOC_5	SHM-05-42B	3/4/2008	213.7	
AOC_5	SHM-05-42B	4/16/2008	213.3	
AOC_5	SHM-05-42B	9/30/2008	212.6	
AOC_5	SHM-05-42B	10/2/2008	212.7	
AOC_5	SHM-05-42B	4/28/2009	213.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-05-42B	10/21/2009	211.0	
AOC_5	SHM-05-42B	11/3/2009	211.7	
AOC_5	SHM-05-42B	4/20/2010	213.9	
AOC_5	SHM-05-42B	9/14/2010	210.6	
AOC_5	SHM-05-42B	10/7/2010	210.8	
AOC_5	SHM-05-42B	4/4/2011	213.1	
AOC_5	SHM-05-42B	11/8/2011	213.1	
AOC_5	SHM-05-42B	4/10/2012	211.6	
AOC_5	SHM-05-42B	9/11/2012	210.6	
AOC_5	SHM-05-42B	11/5/2012	212.1	
AOC_5	SHM-05-42B	11/6/2012	212.0	
AOC_5	SHM-05-42B	3/13/2013	212.5	
AOC_5	SHM-05-42B	4/23/2013	211.9	
AOC_5	SHM-05-42B	5/15/2013	211.4	
AOC_5	SHM-05-42B	5/22/2013	211.4	
AOC_5	SHM-05-42B	5/30/2013	212.2	
AOC_5	SHM-05-42B	6/11/2013	212.8	
AOC_5	SHM-05-42B	10/21/2013	210.7	
AOC_5	SHM-05-42B	10/23/2013	210.5	
AOC_5	SHM-05-42B	4/22/2014	212.9	
AOC_5	SHM-05-42B	4/23/2014	212.9	
AOC_5	SHM-05-42B	10/6/2014	210.6	
AOC_5	SHM-05-42B	6/2/2015	211.9	
AOC_5	SHM-05-42B	6/17/2015	211.5	
AOC_5	SHM-05-42B	10/20/2015	210.5	
AOC_5	SHM-05-42B	12/16/2015	210.9	
AOC_5	SHM-05-42B	6/9/2016	211.3	
AOC_5	SHM-05-42B	8/16/2016	210.2	
AOC_5	SHM-05-42B	10/20/2016	210.1	
AOC_5	SHM-05-42B	11/16/2016	211.3	
AOC_5	SHM-05-42B	11/1/2018	212.1	
AOC_5	SHM-05-42B	10/22/2019	209.3	
AOC_5	SHM-07-03	2/20/2008	208.0	
AOC_5	SHM-07-03	5/15/2013	208.1	
AOC_5	SHM-07-03	5/28/2013	208.2	
AOC_5	SHM-07-03	6/11/2013	208.7	
AOC_5	SHM-07-03	10/21/2013	207.4	
AOC_5	SHM-07-03	4/22/2014	209.7	
AOC_5	SHM-07-03	10/6/2014	207.4	
AOC_5	SHM-07-03	6/9/2015	208.2	
AOC_5	SHM-07-03	6/10/2015	208.2	
AOC_5	SHM-07-03	6/17/2015	207.9	
AOC_5	SHM-07-03	12/16/2015	207.6	
AOC_5	SHM-07-03	6/9/2016	207.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-07-03	6/23/2016	207.7	
AOC_5	SHM-07-03	8/16/2016	207.0	
AOC_5	SHM-07-03	10/20/2016	207.2	
AOC_5	SHM-07-03	11/16/2016	207.8	
AOC_5	SHM-07-03	5/22/2017	208.9	
AOC_5	SHM-07-03	5/11/2018	208.8	
AOC_5	SHM-07-03	11/1/2018	208.5	
AOC_5	SHM-07-03	4/11/2019	208.4	
AOC_5	SHM-07-03	10/22/2019	203.9	
AOC_5	SHM-07-03	5/15/2020	208.9	
AOC_5	SHM-07-03	5/18/2020	208.9	
AOC_5	SHM-07-05	2/20/2008	209.3	
AOC_5	SHM-07-05	5/15/2013	209.1	
AOC_5	SHM-07-05	6/11/2013	209.2	
AOC_5	SHM-07-05	10/21/2013	208.8	
AOC_5	SHM-07-05	4/22/2014	208.4	
AOC_5	SHM-07-05	10/6/2014	208.8	
AOC_5	SHM-07-05	6/8/2015	209.1	
AOC_5	SHM-07-05	6/9/2015	209.1	
AOC_5	SHM-07-05	6/17/2015	208.9	
AOC_5	SHM-07-05	12/16/2015	208.8	
AOC_5	SHM-07-05	6/9/2016	208.9	
AOC_5	SHM-07-05	6/23/2016	208.7	
AOC_5	SHM-07-05	11/16/2016	209.2	
AOC_5	SHM-07-05	5/22/2017	207.5	
AOC_5	SHM-07-05	5/11/2018	209.6	
AOC_5	SHM-07-05X	11/1/2018	208.9	
AOC_5	SHM-07-05X	4/11/2019	209.2	
AOC_5	SHM-07-05X	10/22/2019	208.1	
AOC_5	SHM-07-05X	5/18/2020	220.7	
AOC_5	SHM-10-01	11/5/2012	205.5	
AOC_5	SHM-10-01	5/15/2013	206.1	
AOC_5	SHM-10-01	5/29/2013	206.4	
AOC_5	SHM-10-01	6/11/2013	207.2	
AOC_5	SHM-10-01	10/21/2013	205.6	
AOC_5	SHM-10-01	4/22/2014	206.7	
AOC_5	SHM-10-01	10/6/2014	205.6	
AOC_5	SHM-10-01	6/1/2015	206.0	
AOC_5	SHM-10-01	6/9/2015	205.7	
AOC_5	SHM-10-01	6/17/2015	205.5	
AOC_5	SHM-10-01	10/20/2015	205.3	
AOC_5	SHM-10-01	12/16/2015	205.6	
AOC_5	SHM-10-01	6/9/2016	205.5	
AOC_5	SHM-10-01	11/1/2018	206.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-10-01	10/22/2019	205.5	
AOC_5	SHM-10-02	11/5/2012	205.8	
AOC_5	SHM-10-02	5/15/2013	204.4	
AOC_5	SHM-10-02	5/29/2013	205.6	
AOC_5	SHM-10-02	6/11/2013	206.5	
AOC_5	SHM-10-02	10/21/2013	204.7	
AOC_5	SHM-10-02	4/22/2014	205.8	
AOC_5	SHM-10-02	10/6/2014	204.6	
AOC_5	SHM-10-02	6/8/2015	205.0	
AOC_5	SHM-10-02	6/9/2015	205.0	
AOC_5	SHM-10-02	11/1/2018	206.3	
AOC_5	SHM-10-02	10/22/2019	204.8	
AOC_5	SHM-10-03	11/5/2012	205.9	
AOC_5	SHM-10-03	5/15/2013	205.7	
AOC_5	SHM-10-03	5/24/2013	205.6	
AOC_5	SHM-10-03	6/11/2013	206.6	
AOC_5	SHM-10-03	10/21/2013	205.1	
AOC_5	SHM-10-03	4/22/2014	206.4	
AOC_5	SHM-10-03	10/6/2014	205.0	
AOC_5	SHM-10-03	6/9/2015	205.5	
AOC_5	SHM-10-03	6/10/2015	205.5	
AOC_5	SHM-10-03	11/1/2018	206.4	
AOC_5	SHM-10-03	10/22/2019	205.2	
AOC_5	SHM-10-04	11/5/2012	206.4	
AOC_5	SHM-10-04	5/15/2013	206.5	
AOC_5	SHM-10-04	5/29/2013	206.7	
AOC_5	SHM-10-04	6/11/2013	207.4	
AOC_5	SHM-10-04	10/21/2013	206.4	
AOC_5	SHM-10-04	4/22/2014	207.5	
AOC_5	SHM-10-04	10/6/2014	206.4	
AOC_5	SHM-10-04	6/8/2015	206.8	
AOC_5	SHM-10-04	6/9/2015	206.8	
AOC_5	SHM-10-04	11/1/2018	207.9	
AOC_5	SHM-10-04	10/22/2019	205.9	
AOC_5	SHM-10-05A	11/5/2012	209.9	
AOC_5	SHM-10-05A	5/15/2013	209.5	
AOC_5	SHM-10-05A	5/22/2013	209.5	
AOC_5	SHM-10-05A	6/11/2013	210.4	
AOC_5	SHM-10-05A	10/21/2013	209.0	
AOC_5	SHM-10-05A	4/22/2014	210.9	
AOC_5	SHM-10-05A	10/6/2014	209.7	
AOC_5	SHM-10-05A	6/9/2015	209.9	
AOC_5	SHM-10-05A	6/10/2015	209.9	
AOC_5	SHM-10-05A	6/17/2015	209.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-10-05A	12/16/2015	209.7	
AOC_5	SHM-10-05A	6/9/2016	209.9	
AOC_5	SHM-10-05A	11/16/2016	210.1	
AOC_5	SHM-10-05A	11/1/2018	210.1	
AOC_5	SHM-10-05A	10/22/2019	209.4	
AOC_5	SHM-10-06	6/26/2012	213.7	
AOC_5	SHM-10-06	9/11/2012	212.6	
AOC_5	SHM-10-06	11/5/2012	214.1	
AOC_5	SHM-10-06	11/6/2012	214.0	
AOC_5	SHM-10-06	3/13/2013	214.3	
AOC_5	SHM-10-06	4/23/2013	213.9	
AOC_5	SHM-10-06	4/25/2013	213.9	
AOC_5	SHM-10-06	5/15/2013	213.5	
AOC_5	SHM-10-06	5/23/2013	213.8	
AOC_5	SHM-10-06	5/30/2013	214.2	
AOC_5	SHM-10-06	6/11/2013	213.7	
AOC_5	SHM-10-06	10/21/2013	212.1	
AOC_5	SHM-10-06	4/22/2014	214.7	
AOC_5	SHM-10-06	5/21/2014	214.1	
AOC_5	SHM-10-06	9/30/2014	212.5	
AOC_5	SHM-10-06	10/6/2014	212.6	
AOC_5	SHM-10-06	6/2/2015	213.9	
AOC_5	SHM-10-06	6/17/2015	213.6	
AOC_5	SHM-10-06	10/20/2015	212.5	
AOC_5	SHM-10-06	12/16/2015	212.8	
AOC_5	SHM-10-06	6/9/2016	213.4	
AOC_5	SHM-10-06	8/16/2016	212.2	
AOC_5	SHM-10-06	10/20/2016	212.0	
AOC_5	SHM-10-06	11/16/2016	213.4	
AOC_5	SHM-10-06	11/1/2018	214.4	
AOC_5	SHM-10-06	10/22/2019	212.9	
AOC_5	SHM-10-06A	6/26/2012	213.8	
AOC_5	SHM-10-06A	9/11/2012	212.9	
AOC_5	SHM-10-06A	11/5/2012	214.3	
AOC_5	SHM-10-06A	11/6/2012	214.2	
AOC_5	SHM-10-06A	2/14/2013	213.9	
AOC_5	SHM-10-06A	3/12/2013	214.3	
AOC_5	SHM-10-06A	3/13/2013	214.5	
AOC_5	SHM-10-06A	4/22/2013	214.0	
AOC_5	SHM-10-06A	4/23/2013	214.1	
AOC_5	SHM-10-06A	4/25/2013	214.0	
AOC_5	SHM-10-06A	5/15/2013	213.6	
AOC_5	SHM-10-06A	5/22/2013	213.6	
AOC_5	SHM-10-06A	5/30/2013	214.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-10-06A	6/11/2013	214.9	
AOC_5	SHM-10-06A	10/21/2013	212.0	
AOC_5	SHM-10-06A	11/20/2013	212.6	
AOC_5	SHM-10-06A	4/22/2014	214.8	
AOC_5	SHM-10-06A	5/21/2014	214.3	
AOC_5	SHM-10-06A	9/30/2014	212.8	
AOC_5	SHM-10-06A	10/6/2014	212.9	
AOC_5	SHM-10-06A	6/2/2015	214.0	
AOC_5	SHM-10-06A	6/17/2015	213.7	
AOC_5	SHM-10-06A	10/20/2015	212.8	
AOC_5	SHM-10-06A	12/16/2015	213.1	
AOC_5	SHM-10-06A	6/9/2016	213.5	
AOC_5	SHM-10-06A	8/16/2016	212.5	
AOC_5	SHM-10-06A	10/20/2016	212.4	
AOC_5	SHM-10-06A	11/16/2016	213.7	
AOC_5	SHM-10-06A	11/1/2018	214.6	
AOC_5	SHM-10-06A	10/22/2019	213.2	
AOC_5	SHM-10-07	9/14/2010	218.9	
AOC_5	SHM-10-07	6/26/2012	219.4	
AOC_5	SHM-10-07	11/5/2012	218.1	
AOC_5	SHM-10-07	11/6/2012	219.1	
AOC_5	SHM-10-07	2/14/2013	219.0	
AOC_5	SHM-10-07	3/12/2013	219.2	
AOC_5	SHM-10-07	4/22/2013	219.6	
AOC_5	SHM-10-07	4/25/2013	219.7	
AOC_5	SHM-10-07	5/15/2013	219.8	
AOC_5	SHM-10-07	5/23/2013	219.4	
AOC_5	SHM-10-07	6/11/2013	219.9	
AOC_5	SHM-10-07	10/21/2013	218.6	
AOC_5	SHM-10-07	4/22/2014	219.1	
AOC_5	SHM-10-07	10/6/2014	218.8	
AOC_5	SHM-10-07	6/3/2015	220.0	
AOC_5	SHM-10-07	6/17/2015	220.0	
AOC_5	SHM-10-07	8/18/2015	219.6	
AOC_5	SHM-10-07	10/7/2015	219.0	
AOC_5	SHM-10-07	10/20/2015	218.8	
AOC_5	SHM-10-07	12/16/2015	218.6	
AOC_5	SHM-10-07	4/6/2016	219.4	
AOC_5	SHM-10-07	6/9/2016	219.4	
AOC_5	SHM-10-07	8/16/2016	218.7	
AOC_5	SHM-10-07	11/16/2016	218.5	
AOC_5	SHM-10-07	5/11/2018		207.0
AOC_5	SHM-10-07	11/1/2018	220.3	
AOC_5	SHM-10-07	10/22/2019	219.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-10-08	11/5/2012	205.8	
AOC_5	SHM-10-08	5/15/2013	205.4	
AOC_5	SHM-10-08	6/11/2013	206.6	
AOC_5	SHM-10-08	10/21/2013	204.6	
AOC_5	SHM-10-08	4/22/2014	205.6	
AOC_5	SHM-10-08	10/6/2014	204.5	
AOC_5	SHM-10-08	6/8/2015	204.8	
AOC_5	SHM-10-08	11/1/2018	205.4	
AOC_5	SHM-10-08	10/22/2019	204.4	
AOC_5	SHM-10-10	11/5/2012	206.6	
AOC_5	SHM-10-10	5/15/2013	206.5	
AOC_5	SHM-10-10	5/29/2013	205.7	
AOC_5	SHM-10-10	6/11/2013	207.4	
AOC_5	SHM-10-10	10/21/2013	206.4	
AOC_5	SHM-10-10	11/20/2013	206.3	
AOC_5	SHM-10-10	4/22/2014	207.2	
AOC_5	SHM-10-10	10/6/2014	206.3	
AOC_5	SHM-10-10	6/3/2015	206.9	
AOC_5	SHM-10-10	6/17/2015	206.4	
AOC_5	SHM-10-10	10/20/2015	206.2	
AOC_5	SHM-10-10	12/16/2015	206.4	
AOC_5	SHM-10-10	6/9/2016	206.5	
AOC_5	SHM-10-10	11/1/2018	206.9	
AOC_5	SHM-10-10	10/22/2019	206.1	
AOC_5	SHM-10-11	9/14/2010	223.3	
AOC_5	SHM-10-11	11/5/2012	222.6	
AOC_5	SHM-10-11	11/6/2012	222.7	
AOC_5	SHM-10-11	2/14/2013	222.5	
AOC_5	SHM-10-11	3/12/2013	222.8	
AOC_5	SHM-10-11	4/22/2013	223.5	
AOC_5	SHM-10-11	4/25/2013	223.5	
AOC_5	SHM-10-11	5/15/2013	223.4	
AOC_5	SHM-10-11	5/23/2013	223.3	
AOC_5	SHM-10-11	6/11/2013	223.5	
AOC_5	SHM-10-11	10/21/2013	222.8	
AOC_5	SHM-10-11	11/19/2013	222.2	
AOC_5	SHM-10-11	4/22/2014	222.8	
AOC_5	SHM-10-11	10/6/2014	222.3	
AOC_5	SHM-10-11	6/3/2015	224.4	
AOC_5	SHM-10-11	6/17/2015	223.9	
AOC_5	SHM-10-11	10/20/2015	222.4	
AOC_5	SHM-10-11	12/16/2015	222.0	
AOC_5	SHM-10-11	6/9/2016	222.9	
AOC_5	SHM-10-11	8/16/2016	222.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-10-11	11/15/2016	221.6	
AOC_5	SHM-10-11	11/1/2018	224.6	
AOC_5	SHM-10-11	12/5/2018	225.9	
AOC_5	SHM-10-11	4/11/2019	225.6	
AOC_5	SHM-10-11	10/22/2019	223.5	
AOC_5	SHM-10-11	4/29/2020	225.1	
AOC_5	SHM-10-12	9/14/2010	220.9	
AOC_5	SHM-10-12	6/26/2012	221.6	
AOC_5	SHM-10-12	11/5/2012	220.4	
AOC_5	SHM-10-12	11/6/2012	220.5	
AOC_5	SHM-10-12	2/14/2013	220.5	
AOC_5	SHM-10-12	3/12/2013	220.7	
AOC_5	SHM-10-12	4/22/2013	221.5	
AOC_5	SHM-10-12	4/25/2013	221.5	
AOC_5	SHM-10-12	5/15/2013	222.1	
AOC_5	SHM-10-12	5/23/2013	221.5	
AOC_5	SHM-10-12	6/11/2013	221.6	
AOC_5	SHM-10-12	10/21/2013	220.6	
AOC_5	SHM-10-12	11/19/2013	220.1	
AOC_5	SHM-10-12	4/22/2014	220.6	
AOC_5	SHM-10-12	10/6/2014	220.2	
AOC_5	SHM-10-12	6/3/2015	221.8	
AOC_5	SHM-10-12	6/17/2015	221.7	
AOC_5	SHM-10-12	10/20/2015	220.3	
AOC_5	SHM-10-12	12/16/2015	219.9	
AOC_5	SHM-10-12	6/9/2016	221.1	
AOC_5	SHM-10-12	8/16/2016	220.2	
AOC_5	SHM-10-12	11/15/2016	219.6	
AOC_5	SHM-10-12	11/1/2018	222.0	
AOC_5	SHM-10-12	10/22/2019	221.4	
AOC_5	SHM-10-12	4/29/2020	223.2	
AOC_5	SHM-10-13	9/14/2010	218.2	
AOC_5	SHM-10-13	11/5/2012	218.3	
AOC_5	SHM-10-13	11/6/2012	218.4	
AOC_5	SHM-10-13	2/14/2013	218.0	
AOC_5	SHM-10-13	3/12/2013	218.6	
AOC_5	SHM-10-13	4/22/2013	219.1	
AOC_5	SHM-10-13	5/15/2013	219.0	
AOC_5	SHM-10-13	5/23/2013	219.0	
AOC_5	SHM-10-13	6/11/2013	219.3	
AOC_5	SHM-10-13	10/21/2013	217.9	
AOC_5	SHM-10-13	4/22/2014	218.7	
AOC_5	SHM-10-13	10/6/2014	217.9	
AOC_5	SHM-10-13	6/3/2015	219.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-10-13	6/17/2015	219.2	
AOC_5	SHM-10-13	10/20/2015	217.9	
AOC_5	SHM-10-13	12/16/2015	217.7	
AOC_5	SHM-10-13	6/9/2016	218.7	
AOC_5	SHM-10-13	8/16/2016	217.8	
AOC_5	SHM-10-13	11/16/2016	217.7	
AOC_5	SHM-10-13	11/1/2018	219.6	
AOC_5	SHM-10-13	10/22/2019	218.8	
AOC_5	SHM-10-14	9/14/2010	216.6	
AOC_5	SHM-10-14	6/26/2012	217.8	
AOC_5	SHM-10-14	11/5/2012	217.1	
AOC_5	SHM-10-14	11/6/2012	217.3	
AOC_5	SHM-10-14	2/14/2013	217.3	
AOC_5	SHM-10-14	3/12/2013	217.5	
AOC_5	SHM-10-14	4/22/2013	218.0	
AOC_5	SHM-10-14	4/25/2013	218.0	
AOC_5	SHM-10-14	5/15/2013	217.7	
AOC_5	SHM-10-14	5/23/2013	217.6	
AOC_5	SHM-10-14	6/11/2013	218.2	
AOC_5	SHM-10-14	10/21/2013	216.4	
AOC_5	SHM-10-14	4/22/2014	217.9	
AOC_5	SHM-10-14	10/6/2014	216.4	
AOC_5	SHM-10-14	6/3/2015	218.0	
AOC_5	SHM-10-14	6/17/2015	217.8	
AOC_5	SHM-10-14	10/20/2015	216.4	
AOC_5	SHM-10-14	12/16/2015	216.5	
AOC_5	SHM-10-14	6/9/2016	217.4	
AOC_5	SHM-10-14	8/16/2016	216.3	
AOC_5	SHM-10-14	11/16/2016	216.5	
AOC_5	SHM-10-14	11/1/2018	218.4	
AOC_5	SHM-10-14	10/22/2019	217.1	
AOC_5	SHM-10-15	9/14/2010	218.8	
AOC_5	SHM-10-15	11/5/2012	218.6	
AOC_5	SHM-10-15	11/6/2012	218.7	
AOC_5	SHM-10-15	4/25/2013	219.9	
AOC_5	SHM-10-15	5/15/2013	219.8	
AOC_5	SHM-10-15	5/24/2013	219.7	
AOC_5	SHM-10-15	6/11/2013	218.9	
AOC_5	SHM-10-15	10/21/2013	218.5	
AOC_5	SHM-10-15	11/20/2013	217.9	
AOC_5	SHM-10-15	4/22/2014	219.3	
AOC_5	SHM-10-15	10/6/2014	218.3	
AOC_5	SHM-10-15	6/3/2015	220.1	
AOC_5	SHM-10-15	6/17/2015	219.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-10-15	10/20/2015	218.3	
AOC_5	SHM-10-15	12/16/2015	218.1	
AOC_5	SHM-10-15	6/9/2016	219.4	
AOC_5	SHM-10-15	8/16/2016	218.3	
AOC_5	SHM-10-15	11/16/2016	218.0	
AOC_5	SHM-10-15	11/1/2018	220.2	
AOC_5	SHM-10-15	10/22/2019	219.3	
AOC_5	SHM-10-16	9/14/2010	210.5	
AOC_5	SHM-10-16	6/26/2012	211.6	
AOC_5	SHM-10-16	11/5/2012	211.9	
AOC_5	SHM-10-16	11/6/2012	212.0	
AOC_5	SHM-10-16	3/13/2013	212.4	
AOC_5	SHM-10-16	4/25/2013	211.7	
AOC_5	SHM-10-16	5/15/2013	211.2	
AOC_5	SHM-10-16	5/28/2013	212.2	
AOC_5	SHM-10-16	5/30/2013	212.0	
AOC_5	SHM-10-16	6/11/2013	211.5	
AOC_5	SHM-10-16	10/21/2013	210.6	
AOC_5	SHM-10-16	11/20/2013	210.0	
AOC_5	SHM-10-16	4/22/2014	212.8	
AOC_5	SHM-10-16	10/6/2014	210.4	
AOC_5	SHM-10-16	6/3/2015	211.7	
AOC_5	SHM-10-16	6/17/2015	211.3	
AOC_5	SHM-10-16	10/20/2015	210.2	
AOC_5	SHM-10-16	12/16/2015	210.7	
AOC_5	SHM-10-16	6/9/2016	211.1	
AOC_5	SHM-10-16	6/23/2016	210.7	
AOC_5	SHM-10-16	8/16/2016	210.0	
AOC_5	SHM-10-16	10/20/2016	209.9	
AOC_5	SHM-10-16	11/16/2016	211.2	
AOC_5	SHM-10-16	5/22/2017		201.0
AOC_5	SHM-10-16	11/1/2018	212.0	
AOC_5	SHM-10-16	10/22/2019	210.6	
AOC_5	SHM-11-02	11/5/2012	217.9	
AOC_5	SHM-11-02	11/6/2012	218.0	
AOC_5	SHM-11-02	5/15/2013	218.0	
AOC_5	SHM-11-02	5/30/2013	218.3	
AOC_5	SHM-11-02	6/11/2013	218.6	
AOC_5	SHM-11-02	10/21/2013	215.9	
AOC_5	SHM-11-02	11/20/2013	216.9	
AOC_5	SHM-11-02	4/22/2014	217.9	
AOC_5	SHM-11-02	4/24/2014	217.9	
AOC_5	SHM-11-02	10/6/2014	217.6	
AOC_5	SHM-11-02	6/2/2015	218.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-11-02	6/5/2015	217.5	
AOC_5	SHM-11-02	6/17/2015	218.0	
AOC_5	SHM-11-02	8/18/2015	217.8	
AOC_5	SHM-11-02	10/7/2015	217.5	
AOC_5	SHM-11-02	10/20/2015	217.8	
AOC_5	SHM-11-02	12/16/2015	217.4	
AOC_5	SHM-11-02	6/9/2016	217.8	
AOC_5	SHM-11-02	6/23/2016	217.8	
AOC_5	SHM-11-02	8/16/2016	217.2	
AOC_5	SHM-11-02	11/16/2016	217.8	
AOC_5	SHM-11-02	5/22/2017	218.4	
AOC_5	SHM-11-02	5/11/2018	218.6	
AOC_5	SHM-11-02	11/1/2018	218.4	
AOC_5	SHM-11-02	4/11/2019	218.8	
AOC_5	SHM-11-02	10/22/2019	218.4	
AOC_5	SHM-11-02	5/18/2020	219.2	
AOC_5	SHM-11-02	5/19/2020	220.0	
AOC_5	SHM-11-06	11/5/2012	216.4	
AOC_5	SHM-11-06	11/6/2012	216.3	
AOC_5	SHM-11-06	2/14/2013	215.9	
AOC_5	SHM-11-06	3/12/2013	216.3	
AOC_5	SHM-11-06	4/22/2013	216.3	
AOC_5	SHM-11-06	4/25/2013	216.3	
AOC_5	SHM-11-06	5/15/2013	216.1	
AOC_5	SHM-11-06	5/28/2013	215.8	
AOC_5	SHM-11-06	5/30/2013	216.6	
AOC_5	SHM-11-06	6/11/2013	216.8	
AOC_5	SHM-11-06	10/21/2013	213.9	
AOC_5	SHM-11-06	11/20/2013	214.7	
AOC_5	SHM-11-06	4/22/2014	216.6	
AOC_5	SHM-11-06	10/6/2014	215.5	
AOC_5	SHM-11-06	6/3/2015	216.3	
AOC_5	SHM-11-06	6/17/2015	216.1	
AOC_5	SHM-11-06	8/18/2015	215.7	
AOC_5	SHM-11-06	10/7/2015	215.3	
AOC_5	SHM-11-06	10/20/2015	215.6	
AOC_5	SHM-11-06	12/16/2015	215.5	
AOC_5	SHM-11-06	4/6/2016	216.4	
AOC_5	SHM-11-06	6/9/2016	215.9	
AOC_5	SHM-11-06	8/16/2016	215.1	
AOC_5	SHM-11-06	5/22/2017	218.4	
AOC_5	SHM-11-06	5/11/2018	217.0	
AOC_5	SHM-11-06	11/1/2018	216.7	
AOC_5	SHM-11-06	4/11/2019	216.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-11-06	10/22/2019	216.1	
AOC_5	SHM-11-06	5/18/2020	217.2	
AOC_5	SHM-11-06	5/20/2020	217.2	
AOC_5	SHM-11-07	11/5/2012	217.9	
AOC_5	SHM-11-07	2/14/2013	217.7	
AOC_5	SHM-11-07	3/12/2013	217.9	
AOC_5	SHM-11-07	3/13/2013	218.0	
AOC_5	SHM-11-07	4/22/2013	218.2	
AOC_5	SHM-11-07	5/15/2013	218.2	
AOC_5	SHM-11-07	5/30/2013	218.4	
AOC_5	SHM-11-07	6/11/2013	218.6	
AOC_5	SHM-11-07	10/21/2013	216.6	
AOC_5	SHM-11-07	4/22/2014	217.9	
AOC_5	SHM-11-07	10/6/2014	217.6	
AOC_5	SHM-11-07	6/3/2015	218.5	
AOC_5	SHM-11-07	6/17/2015	218.4	
AOC_5	SHM-11-07	8/18/2015	218.1	
AOC_5	SHM-11-07	10/7/2015	217.6	
AOC_5	SHM-11-07	10/20/2015	217.8	
AOC_5	SHM-11-07	12/16/2015	217.4	
AOC_5	SHM-11-07	6/9/2016	218.1	
AOC_5	SHM-11-07	8/16/2016	217.4	
AOC_5	SHM-11-07	11/1/2018	218.8	
AOC_5	SHM-11-07	10/22/2019	218.4	
AOC_5	SHM-13-01	10/21/2013	204.9	
AOC_5	SHM-13-01	11/21/2013	204.8	
AOC_5	SHM-13-01	4/22/2014	206.0	
AOC_5	SHM-13-01	10/6/2014	204.7	
AOC_5	SHM-13-01	6/3/2015	205.2	
AOC_5	SHM-13-01	10/20/2015	204.6	
AOC_5	SHM-13-01	12/16/2015	204.9	
AOC_5	SHM-13-01	11/16/2016	205.4	
AOC_5	SHM-13-01	11/1/2018	205.7	
AOC_5	SHM-13-01	10/22/2019	204.6	
AOC_5	SHM-13-02	5/15/2013	206.2	
AOC_5	SHM-13-02	5/29/2013	206.4	
AOC_5	SHM-13-02	6/11/2013	207.2	
AOC_5	SHM-13-02	10/21/2013	205.8	
AOC_5	SHM-13-02	11/21/2013	205.7	
AOC_5	SHM-13-02	4/22/2014	206.8	
AOC_5	SHM-13-02	10/6/2014	205.8	
AOC_5	SHM-13-02	6/17/2015	205.9	
AOC_5	SHM-13-02	10/20/2015	205.7	
AOC_5	SHM-13-02	12/16/2015	205.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-13-02	6/9/2016	205.9	
AOC_5	SHM-13-02	11/1/2018	206.5	
AOC_5	SHM-13-02	10/22/2019	205.7	
AOC_5	SHM-13-03	5/15/2013	207.0	
AOC_5	SHM-13-03	5/29/2013	206.2	
AOC_5	SHM-13-03	6/11/2013	207.8	
AOC_5	SHM-13-03	10/21/2013	207.0	
AOC_5	SHM-13-03	11/20/2013	206.9	
AOC_5	SHM-13-03	4/22/2014	207.7	
AOC_5	SHM-13-03	4/23/2014	207.7	
AOC_5	SHM-13-03	10/6/2014	206.9	
AOC_5	SHM-13-03	6/2/2015	206.9	
AOC_5	SHM-13-03	6/8/2015	206.7	
AOC_5	SHM-13-03	6/17/2015	206.5	
AOC_5	SHM-13-03	10/20/2015	206.3	
AOC_5	SHM-13-03	6/9/2016	206.8	
AOC_5	SHM-13-03	6/23/2016	206.6	
AOC_5	SHM-13-03	5/22/2017	207.0	
AOC_5	SHM-13-03	5/11/2018		201.8
AOC_5	SHM-13-03	11/1/2018	207.2	
AOC_5	SHM-13-03	4/11/2019	207.2	
AOC_5	SHM-13-03	10/22/2019	206.4	
AOC_5	SHM-13-03	5/18/2020	206.9	
AOC_5	SHM-13-03	5/21/2020	206.9	
AOC_5	SHM-13-04	5/15/2013	207.9	
AOC_5	SHM-13-04	5/28/2013	208.1	
AOC_5	SHM-13-04	6/11/2013	208.5	
AOC_5	SHM-13-04	10/21/2013	207.6	
AOC_5	SHM-13-04	4/22/2014	209.2	
AOC_5	SHM-13-04	4/24/2014	209.1	
AOC_5	SHM-13-04	10/6/2014	207.5	
AOC_5	SHM-13-04	6/2/2015	208.0	
AOC_5	SHM-13-04	6/9/2015	208.1	
AOC_5	SHM-13-04	6/17/2015	207.9	
AOC_5	SHM-13-04	10/20/2015	207.4	
AOC_5	SHM-13-04	12/16/2015	207.7	
AOC_5	SHM-13-04	6/9/2016	207.9	
AOC_5	SHM-13-04	6/24/2016	207.7	
AOC_5	SHM-13-04	8/16/2016	207.2	
AOC_5	SHM-13-04	11/16/2016		
AOC_5	SHM-13-04	5/22/2017	208.6	
AOC_5	SHM-13-04	5/11/2018	208.5	
AOC_5	SHM-13-04	11/1/2018	208.2	
AOC_5	SHM-13-04	4/11/2019	208.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-13-04	10/22/2019	207.3	
AOC_5	SHM-13-04	5/18/2020	208.5	
AOC_5	SHM-13-04	5/20/2020	208.4	
AOC_5	SHM-13-05	5/15/2013	208.4	
AOC_5	SHM-13-05	5/28/2013	208.6	
AOC_5	SHM-13-05	6/11/2013	209.2	
AOC_5	SHM-13-05	10/21/2013	208.1	
AOC_5	SHM-13-05	11/21/2013	208.0	
AOC_5	SHM-13-05	4/22/2014	209.6	
AOC_5	SHM-13-05	10/6/2014	207.2	
AOC_5	SHM-13-05	6/2/2015	208.7	
AOC_5	SHM-13-05	6/17/2015	208.5	
AOC_5	SHM-13-05	10/20/2015	208.1	
AOC_5	SHM-13-05	12/16/2015	208.4	
AOC_5	SHM-13-05	6/9/2016	208.5	
AOC_5	SHM-13-05	8/16/2016	207.9	
AOC_5	SHM-13-05	11/1/2018	208.9	
AOC_5	SHM-13-05	10/22/2019	208.0	
AOC_5	SHM-13-06	6/11/2013	207.5	
AOC_5	SHM-13-06	6/13/2013	208.0	
AOC_5	SHM-13-06	10/21/2013	206.4	
AOC_5	SHM-13-06	11/21/2013	206.3	
AOC_5	SHM-13-06	4/22/2014	207.6	
AOC_5	SHM-13-06	4/24/2014	207.5	
AOC_5	SHM-13-06	10/6/2014	206.3	
AOC_5	SHM-13-06	6/2/2015	206.9	
AOC_5	SHM-13-06	6/8/2015	206.8	
AOC_5	SHM-13-06	6/17/2015	206.5	
AOC_5	SHM-13-06	10/20/2015		
AOC_5	SHM-13-06	12/16/2015	206.5	
AOC_5	SHM-13-06	12/22/2015	206.5	
AOC_5	SHM-13-06	6/9/2016	206.6	
AOC_5	SHM-13-06	6/24/2016	206.4	
AOC_5	SHM-13-06	11/16/2016		
AOC_5	SHM-13-06	5/22/2017		
AOC_5	SHM-13-06	5/11/2018	207.0	
AOC_5	SHM-13-06	11/1/2018	207.0	
AOC_5	SHM-13-06	4/11/2019	206.9	
AOC_5	SHM-13-06	10/22/2019	206.2	
AOC_5	SHM-13-06	5/18/2020	206.8	
AOC_5	SHM-13-06	5/19/2020	206.8	
AOC_5	SHM-13-07	11/21/2013	206.6	
AOC_5	SHM-13-07	4/22/2014	207.9	
AOC_5	SHM-13-07	4/24/2014	207.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-13-07	10/6/2014	206.7	
AOC_5	SHM-13-07	6/2/2015	207.3	
AOC_5	SHM-13-07	6/8/2015	207.1	
AOC_5	SHM-13-07	6/17/2015	206.9	
AOC_5	SHM-13-07	10/20/2015	206.6	
AOC_5	SHM-13-07	12/16/2015	206.8	
AOC_5	SHM-13-07	6/9/2016	206.9	
AOC_5	SHM-13-07	6/24/2016	206.8	
AOC_5	SHM-13-07	5/22/2017	207.5	
AOC_5	SHM-13-07	5/11/2018	207.3	
AOC_5	SHM-13-07	11/1/2018		
AOC_5	SHM-13-07	4/11/2019	207.2	
AOC_5	SHM-13-07	10/22/2019	206.4	
AOC_5	SHM-13-07	5/18/2020	207.1	
AOC_5	SHM-13-07	5/22/2020	207.0	
AOC_5	SHM-13-08	6/11/2013	208.2	
AOC_5	SHM-13-08	6/13/2013	208.6	
AOC_5	SHM-13-08	10/21/2013	207.9	
AOC_5	SHM-13-08	11/21/2013	207.3	
AOC_5	SHM-13-08	4/22/2014	208.6	
AOC_5	SHM-13-08	4/24/2014	208.6	
AOC_5	SHM-13-08	10/6/2014	208.2	
AOC_5	SHM-13-08	6/2/2015	207.8	
AOC_5	SHM-13-08	6/8/2015	206.8	
AOC_5	SHM-13-08	6/17/2015	207.6	
AOC_5	SHM-13-08	10/20/2015	207.3	
AOC_5	SHM-13-08	12/16/2015	207.5	
AOC_5	SHM-13-08	6/9/2016	207.7	
AOC_5	SHM-13-08	6/24/2016	207.6	
AOC_5	SHM-13-08	5/22/2017	208.1	
AOC_5	SHM-13-08	5/11/2018	208.0	
AOC_5	SHM-13-08	11/1/2018	207.9	
AOC_5	SHM-13-08	4/11/2019	207.0	
AOC_5	SHM-13-08	10/22/2019	207.0	
AOC_5	SHM-13-08	5/18/2020	207.8	
AOC_5	SHM-13-08	5/22/2020	207.7	
AOC_5	SHM-13-14D	2/19/2014	207.0	
AOC_5	SHM-13-14D	4/23/2014	207.6	
AOC_5	SHM-13-14D	10/6/2014	206.9	
AOC_5	SHM-13-14D	6/9/2016	207.1	
AOC_5	SHM-13-14D	11/1/2018	207.3	
AOC_5	SHM-13-14D	10/22/2019	206.5	
AOC_5	SHM-13-14S	2/19/2014		202.9
AOC_5	SHM-13-14S	4/23/2014	207.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-13-14S	10/6/2014	206.8	
AOC_5	SHM-13-14S	6/9/2016	207.0	
AOC_5	SHM-13-14S	11/1/2018	207.2	
AOC_5	SHM-13-14S	10/22/2019	206.4	
AOC_5	SHM-13-15	2/19/2014	206.9	
AOC_5	SHM-13-15	4/23/2014	207.5	
AOC_5	SHM-13-15	10/6/2014	206.8	
AOC_5	SHM-13-15	6/9/2016	207.0	
AOC_5	SHM-13-15	11/1/2018		
AOC_5	SHM-13-15	10/22/2019	206.3	
AOC_5	SHM-93-01A	3/30/1993	220.3	
AOC_5	SHM-93-01A	6/22/1993	219.6	
AOC_5	SHM-93-01A	9/30/1993	218.8	
AOC_5	SHM-93-01A	11/8/1993	220.2	
AOC_5	SHM-93-01A	3/30/1994	220.5	
AOC_5	SHM-93-01A	6/28/1994	220.1	
AOC_5	SHM-93-01A	10/4/1994	220.4	
AOC_5	SHM-93-01A	1/31/1995	221.0	
AOC_5	SHM-93-01A	5/9/1995	219.7	
AOC_5	SHM-93-01A	12/7/1995	220.8	
AOC_5	SHM-93-01A	3/26/1996	220.9	
AOC_5	SHM-93-01A	7/23/1996	220.4	
AOC_5	SHM-93-01A	6/2/1997	220.3	
AOC_5	SHM-93-01A	6/19/1998	222.8	
AOC_5	SHM-93-01A	6/26/1998	222.2	
AOC_5	SHM-93-01A	7/1/1998	221.7	
AOC_5	SHM-93-01A	7/17/1998	220.9	
AOC_5	SHM-93-01A	7/31/1998	220.4	
AOC_5	SHM-93-01A	8/28/1998	219.8	
AOC_5	SHM-93-01A	10/14/1998	219.6	
AOC_5	SHM-93-01A	12/10/1998	219.3	
AOC_5	SHM-93-01A	2/23/1999	219.0	
AOC_5	SHM-93-01A	6/6/1999	219.2	
AOC_5	SHM-93-01A	9/8/1999	218.5	
AOC_5	SHM-93-01A	11/16/2001	218.9	
AOC_5	SHM-93-01A	4/26/2007	221.8	
AOC_5	SHM-93-01A	4/28/2008		234.7
AOC_5	SHM-93-01A	10/26/2009	219.5	
AOC_5	SHM-93-01A	4/27/2010	221.1	
AOC_5	SHM-93-01A	9/14/2010	219.0	
AOC_5	SHM-93-01A	7/25/2011	219.8	
AOC_5	SHM-93-01A	10/7/2015	219.2	
AOC_5	SHM-93-01A	4/29/2020	221.8	
AOC_5	SHM-93-10C	3/30/1993	217.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-10C	6/22/1993	217.2	
AOC_5	SHM-93-10C	9/30/1993	217.2	
AOC_5	SHM-93-10C	11/8/1993	217.3	
AOC_5	SHM-93-10C	3/30/1994	218.2	
AOC_5	SHM-93-10C	6/28/1994	217.3	
AOC_5	SHM-93-10C	10/4/1994	217.5	
AOC_5	SHM-93-10C	1/31/1995	217.9	
AOC_5	SHM-93-10C	5/9/1995	217.2	
AOC_5	SHM-93-10C	12/7/1995	217.7	
AOC_5	SHM-93-10C	3/26/1996	218.0	
AOC_5	SHM-93-10C	7/23/1996	217.7	
AOC_5	SHM-93-10C	1/15/1997	218.0	
AOC_5	SHM-93-10C	6/2/1997	217.8	
AOC_5	SHM-93-10C	4/23/1998	217.9	
AOC_5	SHM-93-10C	6/19/1998	218.9	
AOC_5	SHM-93-10C	6/26/1998	218.7	
AOC_5	SHM-93-10C	7/1/1998	218.5	
AOC_5	SHM-93-10C	7/17/1998	217.9	
AOC_5	SHM-93-10C	7/31/1998	217.7	
AOC_5	SHM-93-10C	8/28/1998	217.4	
AOC_5	SHM-93-10C	10/14/1998	217.4	
AOC_5	SHM-93-10C	12/10/1998	217.3	
AOC_5	SHM-93-10C	2/23/1999	217.4	
AOC_5	SHM-93-10C	6/6/1999	217.0	
AOC_5	SHM-93-10C	9/8/1999	215.7	
AOC_5	SHM-93-10C	8/4/2005	218.0	
AOC_5	SHM-93-10C	8/24/2005	217.8	
AOC_5	SHM-93-10C	4/10/2006	218.0	
AOC_5	SHM-93-10C	6/5/2006	219.3	
AOC_5	SHM-93-10C	9/18/2006	217.9	
AOC_5	SHM-93-10C	12/15/2006	218.8	
AOC_5	SHM-93-10C	4/8/2007	218.5	
AOC_5	SHM-93-10C	4/9/2007	218.5	
AOC_5	SHM-93-10C	10/15/2007	218.3	
AOC_5	SHM-93-10C	2/20/2008	219.6	
AOC_5	SHM-93-10C	2/25/2008	219.3	
AOC_5	SHM-93-10C	3/4/2008	219.1	
AOC_5	SHM-93-10C	4/16/2008	218.9	
AOC_5	SHM-93-10C	9/30/2008	217.8	
AOC_5	SHM-93-10C	10/3/2008	219.0	
AOC_5	SHM-93-10C	4/28/2009	218.8	
AOC_5	SHM-93-10C	10/20/2009	218.0	
AOC_5	SHM-93-10C	11/3/2009	218.2	
AOC_5	SHM-93-10C	4/20/2010	219.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-10C	10/7/2010	218.0	
AOC_5	SHM-93-10C	4/4/2011	218.8	
AOC_5	SHM-93-10C	11/8/2011	219.1	
AOC_5	SHM-93-10C	4/10/2012	218.1	
AOC_5	SHM-93-10C	11/5/2012	218.8	
AOC_5	SHM-93-10C	11/6/2012	218.8	
AOC_5	SHM-93-10C	5/15/2013	218.2	
AOC_5	SHM-93-10C	6/11/2013	219.2	
AOC_5	SHM-93-10C	10/21/2013	216.2	
AOC_5	SHM-93-10C	4/22/2014	218.7	
AOC_5	SHM-93-10C	10/6/2014	217.9	
AOC_5	SHM-93-10C	10/20/2015	218.2	
AOC_5	SHM-93-10D	3/30/1994	218.7	
AOC_5	SHM-93-10D	6/28/1994	217.2	
AOC_5	SHM-93-10D	10/4/1994	217.5	
AOC_5	SHM-93-10D	5/9/1995	217.0	
AOC_5	SHM-93-10D	12/7/1995	217.6	
AOC_5	SHM-93-10D	3/26/1996	217.7	
AOC_5	SHM-93-10D	1/15/1997	217.8	
AOC_5	SHM-93-10D	6/2/1997	217.6	
AOC_5	SHM-93-10D	4/23/1998	217.6	
AOC_5	SHM-93-10D	6/19/1998	218.3	
AOC_5	SHM-93-10D	6/26/1998	218.4	
AOC_5	SHM-93-10D	7/1/1998	218.2	
AOC_5	SHM-93-10D	7/17/1998	217.7	
AOC_5	SHM-93-10D	7/31/1998	217.5	
AOC_5	SHM-93-10D	8/28/1998	217.2	
AOC_5	SHM-93-10D	10/14/1998	217.1	
AOC_5	SHM-93-10D	12/10/1998	217.0	
AOC_5	SHM-93-10D	2/23/1999	217.2	
AOC_5	SHM-93-10D	6/6/1999	216.8	
AOC_5	SHM-93-10D	9/8/1999	216.4	
AOC_5	SHM-93-10D	8/4/2005	217.6	
AOC_5	SHM-93-10D	8/24/2005	217.4	
AOC_5	SHM-93-10D	8/26/2005	217.4	
AOC_5	SHM-93-10D	4/10/2006	217.7	
AOC_5	SHM-93-10D	6/5/2006	218.8	
AOC_5	SHM-93-10D	9/18/2006	217.5	
AOC_5	SHM-93-10D	12/15/2006	218.4	
AOC_5	SHM-93-10D	4/8/2007	217.8	
AOC_5	SHM-93-10D	4/9/2007	217.8	
AOC_5	SHM-93-10D	10/15/2007	217.9	
AOC_5	SHM-93-10D	2/20/2008	219.1	
AOC_5	SHM-93-10D	2/25/2008	219.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-10D	3/4/2008	218.7	
AOC_5	SHM-93-10D	4/16/2008	218.1	
AOC_5	SHM-93-10D	9/30/2008	219.2	
AOC_5	SHM-93-10D	10/3/2008	218.4	
AOC_5	SHM-93-10D	4/28/2009	218.2	
AOC_5	SHM-93-10D	11/3/2009	217.7	
AOC_5	SHM-93-10D	4/20/2010	219.0	
AOC_5	SHM-93-10D	10/7/2010	217.4	
AOC_5	SHM-93-10D	4/4/2011	218.4	
AOC_5	SHM-93-10D	11/8/2011	218.3	
AOC_5	SHM-93-10D	4/10/2012	217.4	
AOC_5	SHM-93-10D	11/5/2012	218.1	
AOC_5	SHM-93-10D	11/6/2012	218.1	
AOC_5	SHM-93-10D	5/15/2013	217.5	
AOC_5	SHM-93-10D	6/11/2013	218.2	
AOC_5	SHM-93-10D	10/21/2013	215.2	
AOC_5	SHM-93-10D	4/22/2014	217.9	
AOC_5	SHM-93-10D	10/6/2014	217.3	
AOC_5	SHM-93-10D	11/1/2018	217.8	
AOC_5	SHM-93-10D	10/22/2019	218.0	
AOC_5	SHM-93-18B	3/30/1993	218.4	
AOC_5	SHM-93-18B	6/22/1993	217.7	
AOC_5	SHM-93-18B	9/30/1993	217.8	
AOC_5	SHM-93-18B	11/8/1993	217.9	
AOC_5	SHM-93-18B	3/30/1994	219.1	
AOC_5	SHM-93-18B	6/28/1994	217.9	
AOC_5	SHM-93-18B	10/4/1994	218.3	
AOC_5	SHM-93-18B	1/31/1995	219.7	
AOC_5	SHM-93-18B	5/9/1995	217.8	
AOC_5	SHM-93-18B	12/7/1995	218.4	
AOC_5	SHM-93-18B	3/26/1996	218.8	
AOC_5	SHM-93-18B	7/23/1996	218.5	
AOC_5	SHM-93-18B	1/15/1997	218.9	
AOC_5	SHM-93-18B	6/2/1997	218.8	
AOC_5	SHM-93-18B	4/23/1998	218.7	
AOC_5	SHM-93-18B	6/19/1998	220.1	
AOC_5	SHM-93-18B	6/26/1998	219.7	
AOC_5	SHM-93-18B	7/1/1998	219.5	
AOC_5	SHM-93-18B	7/17/1998	218.8	
AOC_5	SHM-93-18B	7/31/1998	218.4	
AOC_5	SHM-93-18B	8/28/1998	218.0	
AOC_5	SHM-93-18B	10/14/1998	218.1	
AOC_5	SHM-93-18B	12/10/1998	217.8	
AOC_5	SHM-93-18B	2/23/1999	218.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-18B	6/6/1999	217.5	
AOC_5	SHM-93-18B	9/8/1999	216.9	
AOC_5	SHM-93-18B	11/16/2001	217.5	
AOC_5	SHM-93-18B	8/4/2005	218.4	
AOC_5	SHM-93-18B	8/24/2005	218.0	
AOC_5	SHM-93-18B	8/26/2005	218.0	
AOC_5	SHM-93-18B	4/10/2006	218.2	
AOC_5	SHM-93-18B	6/5/2006	219.9	
AOC_5	SHM-93-18B	9/18/2006	218.1	
AOC_5	SHM-93-18B	10/19/2006	218.2	
AOC_5	SHM-93-18B	12/15/2006	219.3	
AOC_5	SHM-93-18B	4/8/2007	218.8	
AOC_5	SHM-93-18B	4/9/2007	218.8	
AOC_5	SHM-93-18B	10/15/2007	218.5	
AOC_5	SHM-93-18B	2/20/2008	220.1	
AOC_5	SHM-93-18B	2/25/2008	219.7	
AOC_5	SHM-93-18B	3/4/2008	219.4	
AOC_5	SHM-93-18B	4/16/2008	219.2	
AOC_5	SHM-93-18B	9/30/2008	219.3	
AOC_5	SHM-93-18B	4/28/2009	219.0	
AOC_5	SHM-93-18B	11/3/2009	218.4	
AOC_5	SHM-93-18B	4/20/2010	220.0	
AOC_5	SHM-93-18B	10/7/2010	218.2	
AOC_5	SHM-93-18B	4/4/2011	219.2	
AOC_5	SHM-93-18B	11/8/2011	219.4	
AOC_5	SHM-93-18B	4/10/2012	218.1	
AOC_5	SHM-93-18B	11/5/2012	219.0	
AOC_5	SHM-93-18B	11/6/2012	219.0	
AOC_5	SHM-93-18B	5/15/2013	218.2	
AOC_5	SHM-93-18B	6/11/2013	219.4	
AOC_5	SHM-93-18B	10/21/2013	216.1	
AOC_5	SHM-93-18B	4/22/2014	218.9	
AOC_5	SHM-93-18B	10/6/2014	218.0	
AOC_5	SHM-93-18B	6/17/2015	218.2	
AOC_5	SHM-93-18B	8/18/2015	218.0	
AOC_5	SHM-93-18B	10/7/2015	217.8	
AOC_5	SHM-93-18B	10/20/2015	218.3	
AOC_5	SHM-93-18B	12/16/2015	217.8	
AOC_5	SHM-93-18B	6/9/2016	218.1	
AOC_5	SHM-93-18B	6/24/2016	217.9	
AOC_5	SHM-93-18B	8/16/2016	217.6	
AOC_5	SHM-93-18B	11/15/2016	218.2	
AOC_5	SHM-93-18B	5/22/2017	218.9	
AOC_5	SHM-93-18B	11/1/2018	219.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-18B	10/22/2019	221.7	
AOC_5	SHM-93-18B	4/29/2020	219.4	
AOC_5	SHM-93-22B	6/26/1998	214.5	
AOC_5	SHM-93-22B	7/1/1998	214.4	
AOC_5	SHM-93-22B	7/17/1998	213.5	
AOC_5	SHM-93-22B	7/31/1998	212.8	
AOC_5	SHM-93-22B	8/28/1998	212.0	
AOC_5	SHM-93-22B	10/14/1998	212.3	
AOC_5	SHM-93-22B	12/10/1998	212.2	
AOC_5	SHM-93-22B	2/23/1999	212.9	
AOC_5	SHM-93-22B	6/6/1999	211.9	
AOC_5	SHM-93-22B	9/8/1999	211.1	
AOC_5	SHM-93-22B	11/16/2001	211.9	
AOC_5	SHM-93-22B	8/4/2005	212.7	
AOC_5	SHM-93-22B	8/24/2005	212.2	
AOC_5	SHM-93-22B	8/26/2005	212.0	
AOC_5	SHM-93-22B	4/10/2006	212.7	
AOC_5	SHM-93-22B	6/5/2006	214.4	
AOC_5	SHM-93-22B	7/15/2006	212.5	
AOC_5	SHM-93-22B	9/18/2006	212.4	
AOC_5	SHM-93-22B	12/15/2006	213.5	
AOC_5	SHM-93-22B	4/8/2007	213.5	
AOC_5	SHM-93-22B	4/9/2007	213.5	
AOC_5	SHM-93-22B	10/15/2007	211.3	
AOC_5	SHM-93-22B	2/20/2008	213.3	
AOC_5	SHM-93-22B	2/25/2008	213.2	
AOC_5	SHM-93-22B	3/4/2008	212.5	
AOC_5	SHM-93-22B	4/16/2008	213.6	
AOC_5	SHM-93-22B	7/15/2008	211.6	
AOC_5	SHM-93-22B	9/30/2008	212.8	
AOC_5	SHM-93-22B	10/1/2008	212.9	
AOC_5	SHM-93-22B	1/20/2009	212.9	
AOC_5	SHM-93-22B	4/28/2009	213.2	
AOC_5	SHM-93-22B	10/16/2009	211.1	
AOC_5	SHM-93-22B	11/3/2009	211.8	
AOC_5	SHM-93-22B	4/20/2010	214.1	
AOC_5	SHM-93-22B	9/14/2010	210.8	
AOC_5	SHM-93-22B	10/7/2010	210.9	
AOC_5	SHM-93-22B	4/4/2011	213.4	
AOC_5	SHM-93-22B	11/8/2011	213.4	
AOC_5	SHM-93-22B	4/10/2012	211.9	
AOC_5	SHM-93-22B	6/26/2012	211.9	
AOC_5	SHM-93-22B	9/11/2012	210.8	
AOC_5	SHM-93-22B	11/5/2012	212.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-22B	11/6/2012	212.2	
AOC_5	SHM-93-22B	3/13/2013	212.8	
AOC_5	SHM-93-22B	4/23/2013	212.1	
AOC_5	SHM-93-22B	4/25/2013	212.0	
AOC_5	SHM-93-22B	5/15/2013	210.5	
AOC_5	SHM-93-22B	5/28/2013	212.6	
AOC_5	SHM-93-22B	5/30/2013	212.4	
AOC_5	SHM-93-22B	6/11/2013	212.9	
AOC_5	SHM-93-22B	10/21/2013	210.9	
AOC_5	SHM-93-22B	10/23/2013	210.7	
AOC_5	SHM-93-22B	4/22/2014	210.1	
AOC_5	SHM-93-22B	4/24/2014	213.0	
AOC_5	SHM-93-22B	10/6/2014	210.7	
AOC_5	SHM-93-22B	6/2/2015	211.0	
AOC_5	SHM-93-22B	6/8/2015	211.5	
AOC_5	SHM-93-22B	6/17/2015	211.7	
AOC_5	SHM-93-22B	10/20/2015	210.4	
AOC_5	SHM-93-22B	12/16/2015	211.0	
AOC_5	SHM-93-22B	6/9/2016	211.6	
AOC_5	SHM-93-22B	6/23/2016	211.0	
AOC_5	SHM-93-22B	6/24/2016	211.0	
AOC_5	SHM-93-22B	8/16/2016	210.3	
AOC_5	SHM-93-22B	10/20/2016	210.2	
AOC_5	SHM-93-22B	11/16/2016	211.4	
AOC_5	SHM-93-22B	5/22/2017	211.7	
AOC_5	SHM-93-22B	5/11/2018	212.8	
AOC_5	SHM-93-22B	11/1/2018	212.3	
AOC_5	SHM-93-22B	4/11/2019	212.3	
AOC_5	SHM-93-22B	10/22/2019	210.9	
AOC_5	SHM-93-22B	5/18/2020	212.7	
AOC_5	SHM-93-22B	5/21/2020	212.5	
AOC_5	SHM-93-22C	3/30/1993	213.6	
AOC_5	SHM-93-22C	6/22/1993	212.3	
AOC_5	SHM-93-22C	9/30/1993	212.2	
AOC_5	SHM-93-22C	11/8/1993	212.9	
AOC_5	SHM-93-22C	3/30/1994	214.5	
AOC_5	SHM-93-22C	6/28/1994	212.6	
AOC_5	SHM-93-22C	10/4/1994	212.9	
AOC_5	SHM-93-22C	1/31/1995	213.7	
AOC_5	SHM-93-22C	5/9/1995	212.5	
AOC_5	SHM-93-22C	12/7/1995	213.4	
AOC_5	SHM-93-22C	3/26/1996	214.3	
AOC_5	SHM-93-22C	7/23/1996	213.0	
AOC_5	SHM-93-22C	1/15/1997	213.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-22C	6/2/1997	213.4	
AOC_5	SHM-93-22C	4/23/1998	213.8	
AOC_5	SHM-93-22C	6/19/1998	215.0	
AOC_5	SHM-93-22C	6/26/1998	214.6	
AOC_5	SHM-93-22C	7/1/1998	214.5	
AOC_5	SHM-93-22C	7/17/1998	213.6	
AOC_5	SHM-93-22C	7/31/1998	212.9	
AOC_5	SHM-93-22C	8/28/1998	212.1	
AOC_5	SHM-93-22C	10/14/1998	212.3	
AOC_5	SHM-93-22C	12/10/1998	212.2	
AOC_5	SHM-93-22C	2/23/1999	212.9	
AOC_5	SHM-93-22C	6/6/1999	211.9	
AOC_5	SHM-93-22C	9/8/1999	211.1	
AOC_5	SHM-93-22C	11/16/2001	211.9	
AOC_5	SHM-93-22C	8/4/2005	212.8	
AOC_5	SHM-93-22C	8/24/2005	212.2	
AOC_5	SHM-93-22C	8/26/2005	212.1	
AOC_5	SHM-93-22C	4/10/2006	212.8	
AOC_5	SHM-93-22C	6/5/2006	214.5	
AOC_5	SHM-93-22C	9/18/2006	212.4	
AOC_5	SHM-93-22C	12/15/2006	213.5	
AOC_5	SHM-93-22C	4/8/2007	213.7	
AOC_5	SHM-93-22C	4/9/2007	213.7	
AOC_5	SHM-93-22C	10/15/2007	211.3	
AOC_5	SHM-93-22C	2/20/2008	214.6	
AOC_5	SHM-93-22C	2/25/2008	214.5	
AOC_5	SHM-93-22C	3/4/2008	213.8	
AOC_5	SHM-93-22C	4/16/2008	213.8	
AOC_5	SHM-93-22C	7/15/2008	211.7	
AOC_5	SHM-93-22C	9/30/2008	212.9	
AOC_5	SHM-93-22C	10/2/2008	213.1	
AOC_5	SHM-93-22C	1/20/2009	210.5	
AOC_5	SHM-93-22C	4/28/2009	213.4	
AOC_5	SHM-93-22C	7/16/2009	211.5	
AOC_5	SHM-93-22C	10/21/2009	210.9	
AOC_5	SHM-93-22C	11/3/2009	211.9	
AOC_5	SHM-93-22C	4/20/2010	214.2	
AOC_5	SHM-93-22C	10/7/2010	210.9	
AOC_5	SHM-93-22C	4/4/2011	213.6	
AOC_5	SHM-93-22C	11/8/2011	213.5	
AOC_5	SHM-93-22C	4/10/2012	210.8	
AOC_5	SHM-93-22C	6/26/2012	211.8	
AOC_5	SHM-93-22C	9/11/2012	210.9	
AOC_5	SHM-93-22C	11/5/2012	212.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-22C	11/6/2012	212.3	
AOC_5	SHM-93-22C	3/13/2013	213.6	
AOC_5	SHM-93-22C	4/23/2013	212.2	
AOC_5	SHM-93-22C	5/15/2013	211.6	
AOC_5	SHM-93-22C	5/28/2013	212.7	
AOC_5	SHM-93-22C	5/30/2013	212.1	
AOC_5	SHM-93-22C	6/11/2013	212.9	
AOC_5	SHM-93-22C	10/21/2013	210.7	
AOC_5	SHM-93-22C	4/22/2014	213.3	
AOC_5	SHM-93-22C	4/24/2014	213.1	
AOC_5	SHM-93-22C	10/6/2014	210.7	
AOC_5	SHM-93-22C	6/17/2015	211.5	
AOC_5	SHM-93-22C	10/20/2015	210.5	
AOC_5	SHM-93-22C	12/16/2015	211.0	
AOC_5	SHM-93-22C	6/9/2016	211.3	
AOC_5	SHM-93-22C	8/16/2016	210.3	
AOC_5	SHM-93-22C	11/16/2016	211.4	
AOC_5	SHM-93-22C	11/1/2018	212.4	
AOC_5	SHM-93-22C	10/22/2019	210.8	
AOC_5	SHM-93-24A	3/30/1993	222.5	
AOC_5	SHM-93-24A	6/22/1993	221.4	
AOC_5	SHM-93-24A	9/30/1993	220.9	
AOC_5	SHM-93-24A	11/8/1993	221.0	
AOC_5	SHM-93-24A	3/30/1994	222.8	
AOC_5	SHM-93-24A	6/28/1994	221.8	
AOC_5	SHM-93-24A	10/4/1994	221.8	
AOC_5	SHM-93-24A	1/31/1995	222.2	
AOC_5	SHM-93-24A	5/9/1995	221.5	
AOC_5	SHM-93-24A	12/7/1995	221.5	
AOC_5	SHM-93-24A	3/26/1996	222.5	
AOC_5	SHM-93-24A	7/23/1996	222.8	
AOC_5	SHM-93-24A	1/15/1997	223.1	
AOC_5	SHM-93-24A	6/2/1997	223.0	
AOC_5	SHM-93-24A	4/23/1998	222.9	
AOC_5	SHM-93-24A	6/19/1998	224.2	
AOC_5	SHM-93-24A	6/26/1998	224.0	
AOC_5	SHM-93-24A	7/1/1998	223.8	
AOC_5	SHM-93-24A	7/17/1998	223.4	
AOC_5	SHM-93-24A	7/31/1998	223.0	
AOC_5	SHM-93-24A	8/28/1998	222.3	
AOC_5	SHM-93-24A	10/14/1998	222.0	
AOC_5	SHM-93-24A	12/10/1998	221.4	
AOC_5	SHM-93-24A	2/23/1999	221.7	
AOC_5	SHM-93-24A	6/6/1999	220.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-93-24A	9/8/1999	220.0	
AOC_5	SHM-93-24A	11/6/2012	222.4	
AOC_5	SHM-93-24A	4/25/2013	222.0	
AOC_5	SHM-93-24A	5/15/2013	221.8	
AOC_5	SHM-93-24A	6/11/2013	223.4	
AOC_5	SHM-93-24A	10/21/2013	221.0	
AOC_5	SHM-93-24A	4/22/2014	222.4	
AOC_5	SHM-93-24A	6/17/2015	222.1	
AOC_5	SHM-93-24A	10/7/2015	221.3	
AOC_5	SHM-93-24A	12/16/2015	221.1	
AOC_5	SHM-93-24A	6/9/2016	221.4	
AOC_5	SHM-93-24A	6/24/2016	221.2	
AOC_5	SHM-93-24A	8/16/2016	221.1	
AOC_5	SHM-93-24A	11/15/2016	221.1	
AOC_5	SHM-93-24A	5/22/2017	222.7	
AOC_5	SHM-93-24A	11/1/2018	223.3	
AOC_5	SHM-93-24A	10/22/2019	222.3	
AOC_5	SHM-93-24A	4/29/2020	223.6	
AOC_5	SHM-95-27X	4/29/2020	224.3	
AOC_5	SHM-96-22B	8/24/2005	211.7	
AOC_5	SHM-96-22B	4/10/2006	212.2	
AOC_5	SHM-96-22B	6/5/2006	213.9	
AOC_5	SHM-96-22B	9/18/2006	211.9	
AOC_5	SHM-96-22B	12/15/2006	213.0	
AOC_5	SHM-96-22B	4/9/2007	213.1	
AOC_5	SHM-96-22B	10/15/2007	210.9	
AOC_5	SHM-96-22B	2/20/2008	213.7	
AOC_5	SHM-96-22B	2/25/2008	214.0	
AOC_5	SHM-96-22B	3/4/2008	213.1	
AOC_5	SHM-96-22B	4/16/2008	213.2	
AOC_5	SHM-96-22B	7/15/2008	211.1	
AOC_5	SHM-96-22B	9/30/2008	212.3	
AOC_5	SHM-96-22B	10/1/2008	212.5	
AOC_5	SHM-96-22B	1/20/2009	212.5	
AOC_5	SHM-96-5B	7/17/1998	213.7	
AOC_5	SHM-96-5B	7/31/1998	213.1	
AOC_5	SHM-96-5B	8/28/1998	212.3	
AOC_5	SHM-96-5B	10/14/1998	212.5	
AOC_5	SHM-96-5B	12/10/1998	212.5	
AOC_5	SHM-96-5B	2/23/1999	213.1	
AOC_5	SHM-96-5B	6/6/1999	212.2	
AOC_5	SHM-96-5B	9/8/1999	211.4	
AOC_5	SHM-96-5B	11/16/2001	212.2	
AOC_5	SHM-96-5B	8/4/2005	213.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-96-5B	8/24/2005	212.5	
AOC_5	SHM-96-5B	8/26/2005	212.3	
AOC_5	SHM-96-5B	4/10/2006	213.1	
AOC_5	SHM-96-5B	6/5/2006	214.7	
AOC_5	SHM-96-5B	9/18/2006	212.7	
AOC_5	SHM-96-5B	12/15/2006	213.8	
AOC_5	SHM-96-5B	4/8/2007	213.8	
AOC_5	SHM-96-5B	4/9/2007	213.8	
AOC_5	SHM-96-5B	10/15/2007	211.8	
AOC_5	SHM-96-5B	2/20/2008	214.5	
AOC_5	SHM-96-5B	2/25/2008	214.7	
AOC_5	SHM-96-5B	3/4/2008	213.9	
AOC_5	SHM-96-5B	4/16/2008	213.9	
AOC_5	SHM-96-5B	7/15/2008	212.0	
AOC_5	SHM-96-5B	9/30/2008	213.2	
AOC_5	SHM-96-5B	10/1/2008	213.3	
AOC_5	SHM-96-5B	1/21/2009	213.2	
AOC_5	SHM-96-5B	4/28/2009	213.5	
AOC_5	SHM-96-5B	7/15/2009	212.9	
AOC_5	SHM-96-5B	10/19/2009	211.5	
AOC_5	SHM-96-5B	11/3/2009	212.2	
AOC_5	SHM-96-5B	4/20/2010	214.5	
AOC_5	SHM-96-5B	9/14/2010	211.1	
AOC_5	SHM-96-5B	10/7/2010	211.3	
AOC_5	SHM-96-5B	4/4/2011	213.7	
AOC_5	SHM-96-5B	11/8/2011	213.7	
AOC_5	SHM-96-5B	4/10/2012	212.2	
AOC_5	SHM-96-5B	6/26/2012	212.4	
AOC_5	SHM-96-5B	9/11/2012	211.2	
AOC_5	SHM-96-5B	11/5/2012	212.7	
AOC_5	SHM-96-5B	11/6/2012	212.6	
AOC_5	SHM-96-5B	3/13/2013	213.1	
AOC_5	SHM-96-5B	4/23/2013	212.4	
AOC_5	SHM-96-5B	4/25/2013	212.4	
AOC_5	SHM-96-5B	5/15/2013	211.9	
AOC_5	SHM-96-5B	5/21/2013	212.0	
AOC_5	SHM-96-5B	5/30/2013	212.8	
AOC_5	SHM-96-5B	6/11/2013	212.4	
AOC_5	SHM-96-5B	10/21/2013	211.1	
AOC_5	SHM-96-5B	10/22/2013	210.6	
AOC_5	SHM-96-5B	4/22/2014	213.2	
AOC_5	SHM-96-5B	5/21/2014	212.7	
AOC_5	SHM-96-5B	9/30/2014	211.1	
AOC_5	SHM-96-5B	10/6/2014	211.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-96-5B	6/2/2015	212.5	
AOC_5	SHM-96-5B	6/5/2015	212.2	
AOC_5	SHM-96-5B	6/17/2015	212.1	
AOC_5	SHM-96-5B	10/20/2015	211.1	
AOC_5	SHM-96-5B	12/16/2015	211.4	
AOC_5	SHM-96-5B	6/9/2016	212.0	
AOC_5	SHM-96-5B	6/23/2016	211.4	
AOC_5	SHM-96-5B	8/16/2016	210.8	
AOC_5	SHM-96-5B	10/20/2016	210.7	
AOC_5	SHM-96-5B	11/15/2016	211.8	
AOC_5	SHM-96-5B	5/22/2017	213.2	
AOC_5	SHM-96-5B	5/11/2018	213.2	
AOC_5	SHM-96-5B	11/1/2018	212.8	
AOC_5	SHM-96-5B	4/11/2019	212.7	
AOC_5	SHM-96-5B	10/22/2019	211.4	
AOC_5	SHM-96-5B	5/18/2020	213.1	
AOC_5	SHM-96-5B	5/19/2020	213.1	
AOC_5	SHM-96-5C	6/26/1998	214.8	
AOC_5	SHM-96-5C	7/1/1998	214.6	
AOC_5	SHM-96-5C	7/17/1998	213.7	
AOC_5	SHM-96-5C	7/31/1998	213.1	
AOC_5	SHM-96-5C	8/28/1998	212.3	
AOC_5	SHM-96-5C	10/14/1998	212.5	
AOC_5	SHM-96-5C	2/23/1999	213.2	
AOC_5	SHM-96-5C	6/6/1999	212.2	
AOC_5	SHM-96-5C	9/8/1999	211.4	
AOC_5	SHM-96-5C	11/16/2001	212.2	
AOC_5	SHM-96-5C	8/4/2005	213.0	
AOC_5	SHM-96-5C	8/24/2005	212.4	
AOC_5	SHM-96-5C	8/26/2005	212.3	
AOC_5	SHM-96-5C	4/10/2006	213.1	
AOC_5	SHM-96-5C	6/5/2006	214.7	
AOC_5	SHM-96-5C	9/18/2006	212.7	
AOC_5	SHM-96-5C	12/15/2006	213.8	
AOC_5	SHM-96-5C	4/8/2007	213.8	
AOC_5	SHM-96-5C	4/9/2007	213.8	
AOC_5	SHM-96-5C	10/15/2007	211.8	
AOC_5	SHM-96-5C	2/20/2008	214.5	
AOC_5	SHM-96-5C	2/25/2008	214.7	
AOC_5	SHM-96-5C	3/4/2008	213.9	
AOC_5	SHM-96-5C	4/16/2008	214.0	
AOC_5	SHM-96-5C	7/15/2008	212.1	
AOC_5	SHM-96-5C	9/30/2008	213.3	
AOC_5	SHM-96-5C	10/1/2008	213.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-96-5C	1/21/2009	213.2	
AOC_5	SHM-96-5C	4/28/2009	213.5	
AOC_5	SHM-96-5C	7/15/2009	212.9	
AOC_5	SHM-96-5C	10/19/2009	211.6	
AOC_5	SHM-96-5C	11/3/2009	212.2	
AOC_5	SHM-96-5C	4/20/2010	214.5	
AOC_5	SHM-96-5C	10/7/2010	211.3	
AOC_5	SHM-96-5C	4/4/2011	213.7	
AOC_5	SHM-96-5C	11/8/2011	213.7	
AOC_5	SHM-96-5C	4/10/2012	210.1	
AOC_5	SHM-96-5C	6/26/2012	212.4	
AOC_5	SHM-96-5C	9/11/2012	211.2	
AOC_5	SHM-96-5C	11/5/2012	212.7	
AOC_5	SHM-96-5C	11/6/2012	212.7	
AOC_5	SHM-96-5C	3/13/2013	213.1	
AOC_5	SHM-96-5C	4/23/2013	212.4	
AOC_5	SHM-96-5C	5/15/2013	211.9	
AOC_5	SHM-96-5C	5/28/2013	213.0	
AOC_5	SHM-96-5C	5/30/2013	212.8	
AOC_5	SHM-96-5C	6/11/2013	213.4	
AOC_5	SHM-96-5C	10/21/2013	211.1	
AOC_5	SHM-96-5C	10/22/2013	211.0	
AOC_5	SHM-96-5C	4/22/2014	213.4	
AOC_5	SHM-96-5C	10/6/2014	211.2	
AOC_5	SHM-96-5C	6/3/2015	212.4	
AOC_5	SHM-96-5C	6/17/2015	212.1	
AOC_5	SHM-96-5C	10/20/2015	211.0	
AOC_5	SHM-96-5C	12/16/2015	211.4	
AOC_5	SHM-96-5C	6/9/2016	212.0	
AOC_5	SHM-96-5C	8/16/2016	210.8	
AOC_5	SHM-96-5C	11/15/2016	211.8	
AOC_5	SHM-96-5C	11/1/2018	212.8	
AOC_5	SHM-96-5C	10/22/2019	211.4	
AOC_5	SHM-99-31A	6/6/1999	209.8	
AOC_5	SHM-99-31A	9/8/1999	209.0	
AOC_5	SHM-99-31A	11/16/2001	210.3	
AOC_5	SHM-99-31A	8/4/2005	210.8	
AOC_5	SHM-99-31A	8/24/2005	209.9	
AOC_5	SHM-99-31A	8/26/2005	210.0	
AOC_5	SHM-99-31A	4/10/2006	211.8	
AOC_5	SHM-99-31A	6/5/2006	213.3	
AOC_5	SHM-99-31A	9/18/2006	210.6	
AOC_5	SHM-99-31A	12/15/2006	212.4	
AOC_5	SHM-99-31A	4/8/2007	212.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-99-31A	4/9/2007	212.5	
AOC_5	SHM-99-31A	10/15/2007	210.4	
AOC_5	SHM-99-31A	2/25/2008	212.6	
AOC_5	SHM-99-31A	3/4/2008	212.5	
AOC_5	SHM-99-31A	4/16/2008	212.4	
AOC_5	SHM-99-31A	9/30/2008	212.8	
AOC_5	SHM-99-31A	10/2/2008	212.7	
AOC_5	SHM-99-31A	4/28/2009	212.4	
AOC_5	SHM-99-31A	10/20/2009	210.9	
AOC_5	SHM-99-31A	11/3/2009	211.5	
AOC_5	SHM-99-31A	4/20/2010	212.6	
AOC_5	SHM-99-31A	10/7/2010	211.2	
AOC_5	SHM-99-31A	4/4/2011	212.4	
AOC_5	SHM-99-31A	11/8/2011	212.6	
AOC_5	SHM-99-31A	4/10/2012	210.5	
AOC_5	SHM-99-31A	11/5/2012	212.2	
AOC_5	SHM-99-31A	4/25/2013	211.2	
AOC_5	SHM-99-31A	5/30/2013	212.2	
AOC_5	SHM-99-31A	10/23/2013	209.8	
AOC_5	SHM-99-31A	10/6/2014	209.9	
AOC_5	SHM-99-31A	6/17/2015	210.4	
AOC_5	SHM-99-31A	12/16/2015	210.8	
AOC_5	SHM-99-31A	6/9/2016	210.3	
AOC_5	SHM-99-31A	8/16/2016	209.5	
AOC_5	SHM-99-31A	11/1/2018	212.6	
AOC_5	SHM-99-31A	10/22/2019	210.4	
AOC_5	SHM-99-31B	6/6/1999	209.8	
AOC_5	SHM-99-31B	9/8/1999	209.1	
AOC_5	SHM-99-31B	11/16/2001	210.0	
AOC_5	SHM-99-31B	8/4/2005	210.5	
AOC_5	SHM-99-31B	8/24/2005	210.1	
AOC_5	SHM-99-31B	8/26/2005	210.1	
AOC_5	SHM-99-31B	4/10/2006	210.8	
AOC_5	SHM-99-31B	6/5/2006	212.0	
AOC_5	SHM-99-31B	9/18/2006	210.5	
AOC_5	SHM-99-31B	12/15/2006	211.4	
AOC_5	SHM-99-31B	4/8/2007	211.4	
AOC_5	SHM-99-31B	4/9/2007	211.4	
AOC_5	SHM-99-31B	10/15/2007	210.0	
AOC_5	SHM-99-31B	2/25/2008	212.0	
AOC_5	SHM-99-31B	3/4/2008	211.6	
AOC_5	SHM-99-31B	4/16/2008	212.6	
AOC_5	SHM-99-31B	9/30/2008	211.0	
AOC_5	SHM-99-31B	10/2/2008	211.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-99-31B	4/28/2009	211.3	
AOC_5	SHM-99-31B	10/20/2009	209.9	
AOC_5	SHM-99-31B	11/3/2009	210.3	
AOC_5	SHM-99-31B	4/20/2010	212.0	
AOC_5	SHM-99-31B	10/7/2010	209.7	
AOC_5	SHM-99-31B	4/4/2011	211.3	
AOC_5	SHM-99-31B	11/8/2011	211.3	
AOC_5	SHM-99-31B	4/10/2012	210.1	
AOC_5	SHM-99-31B	11/5/2012	210.5	
AOC_5	SHM-99-31B	5/30/2013	210.6	
AOC_5	SHM-99-31B	10/23/2013	209.3	
AOC_5	SHM-99-31B	10/6/2014	209.5	
AOC_5	SHM-99-31B	6/17/2015	210.0	
AOC_5	SHM-99-31B	12/16/2015	209.8	
AOC_5	SHM-99-31B	6/9/2016	210.0	
AOC_5	SHM-99-31B	8/16/2016	209.2	
AOC_5	SHM-99-31B	11/1/2018	210.6	
AOC_5	SHM-99-31B	10/22/2019	209.5	
AOC_5	SHM-99-31C	6/6/1999	209.7	
AOC_5	SHM-99-31C	9/8/1999	209.0	
AOC_5	SHM-99-31C	11/16/2001	210.0	
AOC_5	SHM-99-31C	8/4/2005	210.4	
AOC_5	SHM-99-31C	8/24/2005	210.0	
AOC_5	SHM-99-31C	8/26/2005	210.0	
AOC_5	SHM-99-31C	4/10/2006	210.7	
AOC_5	SHM-99-31C	6/5/2006	212.0	
AOC_5	SHM-99-31C	9/18/2006	210.4	
AOC_5	SHM-99-31C	12/15/2006	211.4	
AOC_5	SHM-99-31C	4/8/2007	211.4	
AOC_5	SHM-99-31C	4/9/2007	211.4	
AOC_5	SHM-99-31C	10/15/2007	209.9	
AOC_5	SHM-99-31C	2/25/2008	212.0	
AOC_5	SHM-99-31C	3/4/2008	211.6	
AOC_5	SHM-99-31C	4/16/2008	211.5	
AOC_5	SHM-99-31C	9/30/2008	210.9	
AOC_5	SHM-99-31C	10/2/2008	211.0	
AOC_5	SHM-99-31C	4/28/2009	211.2	
AOC_5	SHM-99-31C	10/20/2009	209.8	
AOC_5	SHM-99-31C	11/3/2009	210.2	
AOC_5	SHM-99-31C	4/20/2010	211.9	
AOC_5	SHM-99-31C	10/7/2010	209.6	
AOC_5	SHM-99-31C	4/4/2011	211.3	
AOC_5	SHM-99-31C	11/8/2011	211.2	
AOC_5	SHM-99-31C	4/10/2012	210.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-99-31C	11/5/2012	210.5	
AOC_5	SHM-99-31C	4/25/2013	210.3	
AOC_5	SHM-99-31C	5/30/2013	210.5	
AOC_5	SHM-99-31C	10/23/2013	209.1	
AOC_5	SHM-99-31C	10/6/2014	209.5	
AOC_5	SHM-99-31C	6/17/2015	210.0	
AOC_5	SHM-99-31C	12/16/2015	209.8	
AOC_5	SHM-99-31C	6/9/2016	209.9	
AOC_5	SHM-99-31C	8/16/2016	209.2	
AOC_5	SHM-99-31C	10/20/2016	209.1	
AOC_5	SHM-99-31C	11/1/2018	210.6	
AOC_5	SHM-99-31C	10/22/2019	209.5	
AOC_5	SHM-99-32X	6/6/1999	211.0	
AOC_5	SHM-99-32X	9/8/1999	210.3	
AOC_5	SHM-99-32X	11/16/2001	211.2	
AOC_5	SHM-99-32X	8/4/2005	211.6	
AOC_5	SHM-99-32X	8/24/2005	211.1	
AOC_5	SHM-99-32X	8/26/2005	211.1	
AOC_5	SHM-99-32X	4/10/2006	211.7	
AOC_5	SHM-99-32X	6/5/2006	213.1	
AOC_5	SHM-99-32X	9/18/2006	211.5	
AOC_5	SHM-99-32X	12/15/2006	212.4	
AOC_5	SHM-99-32X	4/8/2007	212.5	
AOC_5	SHM-99-32X	4/9/2007	212.5	
AOC_5	SHM-99-32X	10/15/2007	211.0	
AOC_5	SHM-99-32X	9/30/2008	212.0	
AOC_5	SHM-99-32X	10/2/2008	212.2	
AOC_5	SHM-99-32X	4/28/2009	212.3	
AOC_5	SHM-99-32X	10/20/2009	210.9	
AOC_5	SHM-99-32X	11/3/2009	211.3	
AOC_5	SHM-99-32X	4/20/2010	213.0	
AOC_5	SHM-99-32X	10/7/2010	210.7	
AOC_5	SHM-99-32X	4/4/2011	212.3	
AOC_5	SHM-99-32X	11/8/2011	212.3	
AOC_5	SHM-99-32X	4/10/2012	211.0	
AOC_5	SHM-99-32X	11/5/2012	211.6	
AOC_5	SHM-99-32X	4/25/2013	211.3	
AOC_5	SHM-99-32X	5/15/2013	211.0	
AOC_5	SHM-99-32X	5/30/2013	211.6	
AOC_5	SHM-99-32X	6/11/2013	212.2	
AOC_5	SHM-99-32X	10/21/2013	210.1	
AOC_5	SHM-99-32X	10/23/2013	210.0	
AOC_5	SHM-99-32X	4/22/2014	212.3	
AOC_5	SHM-99-32X	10/6/2014	210.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHM-99-32X	6/17/2015	211.1	
AOC_5	SHM-99-32X	10/20/2015	210.5	
AOC_5	SHM-99-32X	12/16/2015	210.9	
AOC_5	SHM-99-32X	6/9/2016	211.0	
AOC_5	SHM-99-32X	8/16/2016	210.2	
AOC_5	SHM-99-32X	10/20/2016	210.2	
AOC_5	SHM-99-32X	11/16/2016	211.3	
AOC_5	SHM-99-32X	11/1/2018	212.0	
AOC_5	SHM-99-32X	10/22/2019	210.5	
AOC_5	SHP-01-36X	11/16/2001	216.1	
AOC_5	SHP-01-36X	8/4/2005	216.0	
AOC_5	SHP-01-36X	8/24/2005	216.8	
AOC_5	SHP-01-36X	8/26/2005	215.9	
AOC_5	SHP-01-36X	6/5/2006	216.7	
AOC_5	SHP-01-36X	12/15/2006	215.7	
AOC_5	SHP-01-36X	4/8/2007	215.8	
AOC_5	SHP-01-36X	4/9/2007	215.8	
AOC_5	SHP-01-36X	4/26/2007	216.5	
AOC_5	SHP-01-36X	10/15/2007	217.8	
AOC_5	SHP-01-36X	11/7/2007	216.7	
AOC_5	SHP-01-36X	2/12/2008	216.7	
AOC_5	SHP-01-36X	2/20/2008	217.1	
AOC_5	SHP-01-36X	2/25/2008	217.2	
AOC_5	SHP-01-36X	3/4/2008	216.7	
AOC_5	SHP-01-36X	4/16/2008	216.4	
AOC_5	SHP-01-36X	4/28/2008	216.2	
AOC_5	SHP-01-36X	6/10/2008	216.0	
AOC_5	SHP-01-36X	8/19/2008	216.4	
AOC_5	SHP-01-36X	9/15/2008	216.4	
AOC_5	SHP-01-36X	9/30/2008	216.4	
AOC_5	SHP-01-36X	10/6/2008	216.2	
AOC_5	SHP-01-36X	4/28/2009	216.4	
AOC_5	SHP-01-36X	7/5/2009	216.1	
AOC_5	SHP-01-36X	9/14/2009	216.0	
AOC_5	SHP-01-36X	10/21/2009	216.1	
AOC_5	SHP-01-36X	10/26/2009	216.2	
AOC_5	SHP-01-36X	11/3/2009	216.2	
AOC_5	SHP-01-36X	4/20/2010	216.4	
AOC_5	SHP-01-36X	4/27/2010	216.2	
AOC_5	SHP-01-36X	9/14/2010	215.7	
AOC_5	SHP-01-36X	10/7/2010	216.4	
AOC_5	SHP-01-36X	4/4/2011	217.4	
AOC_5	SHP-01-36X	7/25/2011	215.9	
AOC_5	SHP-01-36X	11/8/2011	216.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-01-36X	4/10/2012	215.9	
AOC_5	SHP-01-36X	6/26/2012	216.2	
AOC_5	SHP-01-36X	11/5/2012	216.7	
AOC_5	SHP-01-36X	11/6/2012	216.7	
AOC_5	SHP-01-36X	4/25/2013	216.2	
AOC_5	SHP-01-36X	5/15/2013	216.4	
AOC_5	SHP-01-36X	6/11/2013	217.5	
AOC_5	SHP-01-36X	10/21/2013	212.8	
AOC_5	SHP-01-36X	11/19/2013	215.8	
AOC_5	SHP-01-36X	4/22/2014	216.6	
AOC_5	SHP-01-36X	10/6/2014	217.1	
AOC_5	SHP-01-36X	6/3/2015	216.9	
AOC_5	SHP-01-36X	6/17/2015	216.3	
AOC_5	SHP-01-36X	8/18/2015	216.2	
AOC_5	SHP-01-36X	10/7/2015	216.3	
AOC_5	SHP-01-36X	10/20/2015	217.5	
AOC_5	SHP-01-36X	12/16/2015	216.3	
AOC_5	SHP-01-36X	6/9/2016	216.5	
AOC_5	SHP-01-36X	8/16/2016	216.1	
AOC_5	SHP-01-36X	10/20/2016	216.1	
AOC_5	SHP-01-36X	11/15/2016	217.0	
AOC_5	SHP-01-36X	5/22/2017	216.4	
AOC_5	SHP-01-36X	5/11/2018	216.6	
AOC_5	SHP-01-36X	11/1/2018	216.3	
AOC_5	SHP-01-36X	4/11/2019	216.2	
AOC_5	SHP-01-36X	10/22/2019	217.3	
AOC_5	SHP-01-36X	5/18/2020	218.8	
AOC_5	SHP-01-36X	5/20/2020	216.4	
AOC_5	SHP-01-37X	11/16/2001	216.2	
AOC_5	SHP-01-37X	8/4/2005	216.0	
AOC_5	SHP-01-37X	8/24/2005	215.9	
AOC_5	SHP-01-37X	8/26/2005	216.3	
AOC_5	SHP-01-37X	4/10/2006	216.1	
AOC_5	SHP-01-37X	6/5/2006	216.7	
AOC_5	SHP-01-37X	9/18/2006	216.1	
AOC_5	SHP-01-37X	12/15/2006	216.3	
AOC_5	SHP-01-37X	4/8/2007	216.0	
AOC_5	SHP-01-37X	4/9/2007	216.0	
AOC_5	SHP-01-37X	4/26/2007	216.5	
AOC_5	SHP-01-37X	9/10/2007	216.0	
AOC_5	SHP-01-37X	10/15/2007		214.2
AOC_5	SHP-01-37X	11/7/2007	216.8	
AOC_5	SHP-01-37X	2/12/2008	216.8	
AOC_5	SHP-01-37X	2/20/2008	217.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-01-37X	2/25/2008	216.8	
AOC_5	SHP-01-37X	3/4/2008	216.8	
AOC_5	SHP-01-37X	4/16/2008	216.5	
AOC_5	SHP-01-37X	4/28/2008	216.3	
AOC_5	SHP-01-37X	6/10/2008	216.1	
AOC_5	SHP-01-37X	8/19/2008	216.5	
AOC_5	SHP-01-37X	9/15/2008	216.5	
AOC_5	SHP-01-37X	9/30/2008	216.5	
AOC_5	SHP-01-37X	10/6/2008	216.3	
AOC_5	SHP-01-37X	4/28/2009	216.4	
AOC_5	SHP-01-37X	7/5/2009	216.2	
AOC_5	SHP-01-37X	9/14/2009	216.1	
AOC_5	SHP-01-37X	10/21/2009	216.3	
AOC_5	SHP-01-37X	10/26/2009	216.3	
AOC_5	SHP-01-37X	11/3/2009	216.3	
AOC_5	SHP-01-37X	4/20/2010	216.4	
AOC_5	SHP-01-37X	4/27/2010	216.3	
AOC_5	SHP-01-37X	9/14/2010	215.9	
AOC_5	SHP-01-37X	10/7/2010	216.6	
AOC_5	SHP-01-37X	4/4/2011	216.5	
AOC_5	SHP-01-37X	7/25/2011	216.0	
AOC_5	SHP-01-37X	11/8/2011	216.5	
AOC_5	SHP-01-37X	4/10/2012	216.1	
AOC_5	SHP-01-37X	6/26/2012	216.3	
AOC_5	SHP-01-37X	11/5/2012	216.8	
AOC_5	SHP-01-37X	11/6/2012	216.9	
AOC_5	SHP-01-37X	4/25/2013	216.3	
AOC_5	SHP-01-37X	5/15/2013	216.6	
AOC_5	SHP-01-37X	6/11/2013	217.6	
AOC_5	SHP-01-37X	10/21/2013		212.8
AOC_5	SHP-01-37X	11/19/2013	216.0	
AOC_5	SHP-01-37X	4/22/2014	216.7	
AOC_5	SHP-01-37X	10/6/2014	217.2	
AOC_5	SHP-01-37X	6/3/2015	217.0	
AOC_5	SHP-01-37X	6/17/2015	216.4	
AOC_5	SHP-01-37X	8/18/2015	216.3	
AOC_5	SHP-01-37X	10/7/2015	216.4	
AOC_5	SHP-01-37X	10/20/2015	217.4	
AOC_5	SHP-01-37X	12/16/2015	216.4	
AOC_5	SHP-01-37X	4/6/2016	216.4	
AOC_5	SHP-01-37X	6/9/2016	216.6	
AOC_5	SHP-01-37X	8/16/2016	216.2	
AOC_5	SHP-01-37X	10/20/2016	216.3	
AOC_5	SHP-01-37X	11/15/2016	217.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-01-37X	5/22/2017	216.4	
AOC_5	SHP-01-37X	5/11/2018	216.7	
AOC_5	SHP-01-37X	11/1/2018	216.4	
AOC_5	SHP-01-37X	4/11/2019	216.3	
AOC_5	SHP-01-37X	10/22/2019	216.9	
AOC_5	SHP-01-37X	5/18/2020	219.5	
AOC_5	SHP-01-37X	5/20/2020	216.4	
AOC_5	SHP-01-38A	11/16/2001	216.5	
AOC_5	SHP-01-38A	8/4/2005	216.6	
AOC_5	SHP-01-38A	8/24/2005	216.5	
AOC_5	SHP-01-38A	8/26/2005	216.5	
AOC_5	SHP-01-38A	4/10/2006	216.8	
AOC_5	SHP-01-38A	6/5/2006	217.4	
AOC_5	SHP-01-38A	9/18/2006	216.7	
AOC_5	SHP-01-38A	12/15/2006	216.9	
AOC_5	SHP-01-38A	4/8/2007	216.5	
AOC_5	SHP-01-38A	4/9/2007	216.5	
AOC_5	SHP-01-38A	4/26/2007	217.1	
AOC_5	SHP-01-38A	9/10/2007	216.5	
AOC_5	SHP-01-38A	10/15/2007	217.4	
AOC_5	SHP-01-38A	2/12/2008	217.3	
AOC_5	SHP-01-38A	2/20/2008	217.5	
AOC_5	SHP-01-38A	2/25/2008	217.2	
AOC_5	SHP-01-38A	3/4/2008	217.4	
AOC_5	SHP-01-38A	4/16/2008	217.0	
AOC_5	SHP-01-38A	8/19/2008	217.0	
AOC_5	SHP-01-38A	9/30/2008	217.1	
AOC_5	SHP-01-38A	10/6/2008	216.9	
AOC_5	SHP-01-38A	4/28/2009	217.0	
AOC_5	SHP-01-38A	7/5/2009	216.8	
AOC_5	SHP-01-38A	10/21/2009	216.7	
AOC_5	SHP-01-38A	10/26/2009	216.9	
AOC_5	SHP-01-38A	11/3/2009	216.8	
AOC_5	SHP-01-38A	4/20/2010	217.1	
AOC_5	SHP-01-38A	9/14/2010	216.9	
AOC_5	SHP-01-38A	10/7/2010	216.8	
AOC_5	SHP-01-38A	4/4/2011	216.9	
AOC_5	SHP-01-38A	11/8/2011	217.0	
AOC_5	SHP-01-38A	4/10/2012	216.6	
AOC_5	SHP-01-38A	11/5/2012	217.0	
AOC_5	SHP-01-38A	4/25/2013	216.6	
AOC_5	SHP-01-38A	5/15/2013	216.8	
AOC_5	SHP-01-38A	5/23/2013	217.1	
AOC_5	SHP-01-38A	5/30/2013	217.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-01-38A	6/11/2013	217.8	
AOC_5	SHP-01-38A	10/21/2013	213.6	
AOC_5	SHP-01-38A	11/19/2013	216.2	
AOC_5	SHP-01-38A	4/22/2014	216.9	
AOC_5	SHP-01-38A	10/6/2014	217.2	
AOC_5	SHP-01-38A	6/3/2015	217.2	
AOC_5	SHP-01-38A	6/17/2015	216.6	
AOC_5	SHP-01-38A	8/18/2015	216.5	
AOC_5	SHP-01-38A	10/7/2015	216.6	
AOC_5	SHP-01-38A	10/20/2015	217.4	
AOC_5	SHP-01-38A	12/16/2015	216.6	
AOC_5	SHP-01-38A	4/6/2016	216.7	
AOC_5	SHP-01-38A	6/9/2016	216.7	
AOC_5	SHP-01-38A	8/16/2016	216.3	
AOC_5	SHP-01-38A	10/20/2016	216.4	
AOC_5	SHP-01-38A	11/16/2016	217.3	
AOC_5	SHP-01-38A	5/22/2017	216.9	
AOC_5	SHP-01-38A	5/11/2018	217.0	
AOC_5	SHP-01-38A	11/1/2018	216.8	
AOC_5	SHP-01-38A	4/11/2019	216.8	
AOC_5	SHP-01-38A	10/22/2019	217.5	
AOC_5	SHP-01-38A	5/18/2020	217.3	
AOC_5	SHP-01-38A	5/21/2020	216.8	
AOC_5	SHP-01-38B	11/16/2001	216.5	
AOC_5	SHP-01-38B	8/4/2005	216.7	
AOC_5	SHP-01-38B	8/24/2005	216.5	
AOC_5	SHP-01-38B	8/26/2005	216.7	
AOC_5	SHP-01-38B	4/10/2006	216.9	
AOC_5	SHP-01-38B	6/5/2006	217.5	
AOC_5	SHP-01-38B	9/18/2006	216.8	
AOC_5	SHP-01-38B	12/15/2006	217.0	
AOC_5	SHP-01-38B	4/8/2007	216.6	
AOC_5	SHP-01-38B	4/9/2007	216.6	
AOC_5	SHP-01-38B	4/26/2007	217.4	
AOC_5	SHP-01-38B	9/10/2007	216.6	
AOC_5	SHP-01-38B	10/15/2007	217.4	
AOC_5	SHP-01-38B	2/20/2008	217.7	
AOC_5	SHP-01-38B	2/25/2008	217.3	
AOC_5	SHP-01-38B	3/4/2008	217.4	
AOC_5	SHP-01-38B	4/16/2008	217.3	
AOC_5	SHP-01-38B	8/19/2008	217.1	
AOC_5	SHP-01-38B	9/30/2008	217.2	
AOC_5	SHP-01-38B	4/28/2009	217.2	
AOC_5	SHP-01-38B	7/5/2009	217.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-01-38B	10/26/2009	216.9	
AOC_5	SHP-01-38B	11/3/2009	216.9	
AOC_5	SHP-01-38B	4/20/2010	217.3	
AOC_5	SHP-01-38B	10/7/2010	216.9	
AOC_5	SHP-01-38B	4/4/2011	217.2	
AOC_5	SHP-01-38B	11/8/2011	217.2	
AOC_5	SHP-01-38B	4/10/2012	216.7	
AOC_5	SHP-01-38B	11/5/2012	217.0	
AOC_5	SHP-01-38B	5/15/2013	216.8	
AOC_5	SHP-01-38B	5/23/2013	217.1	
AOC_5	SHP-01-38B	6/11/2013	217.8	
AOC_5	SHP-01-38B	10/21/2013	213.6	
AOC_5	SHP-01-38B	4/22/2014	216.9	
AOC_5	SHP-01-38B	10/6/2014	217.2	
AOC_5	SHP-01-38B	6/3/2015	217.2	
AOC_5	SHP-01-38B	6/17/2015	216.6	
AOC_5	SHP-01-38B	8/18/2015	216.5	
AOC_5	SHP-01-38B	10/20/2015	217.4	
AOC_5	SHP-01-38B	12/16/2015	216.6	
AOC_5	SHP-01-38B	6/9/2016	216.8	
AOC_5	SHP-01-38B	8/16/2016	216.3	
AOC_5	SHP-01-38B	5/11/2018	217.1	
AOC_5	SHP-01-38B	11/1/2018	216.8	
AOC_5	SHP-01-38B	4/11/2019	216.8	
AOC_5	SHP-01-38B	10/22/2019	217.5	
AOC_5	SHP-05-43	8/24/2005	215.3	
AOC_5	SHP-05-43	4/10/2006	215.9	
AOC_5	SHP-05-43	6/5/2006	216.5	
AOC_5	SHP-05-43	9/18/2006	215.4	
AOC_5	SHP-05-43	10/19/2006	215.5	
AOC_5	SHP-05-43	12/15/2006	216.1	
AOC_5	SHP-05-43	4/8/2007		208.4
AOC_5	SHP-05-43	4/9/2007		208.4
AOC_5	SHP-05-43	4/26/2007	216.9	
AOC_5	SHP-05-43	10/15/2007	215.7	
AOC_5	SHP-05-43	11/7/2007	215.6	
AOC_5	SHP-05-43	2/12/2008	216.5	
AOC_5	SHP-05-43	2/20/2008	216.7	
AOC_5	SHP-05-43	2/25/2008	216.8	
AOC_5	SHP-05-43	3/4/2008	216.6	
AOC_5	SHP-05-43	4/16/2008	216.6	
AOC_5	SHP-05-43	4/28/2008	216.3	
AOC_5	SHP-05-43	6/10/2008	215.8	
AOC_5	SHP-05-43	8/19/2008	216.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-43	9/15/2008	216.0	
AOC_5	SHP-05-43	9/30/2008	215.8	
AOC_5	SHP-05-43	4/28/2009	216.3	
AOC_5	SHP-05-43	7/5/2009	216.0	
AOC_5	SHP-05-43	9/14/2009	215.3	
AOC_5	SHP-05-43	10/26/2009	215.3	
AOC_5	SHP-05-43	11/3/2009	215.5	
AOC_5	SHP-05-43	4/20/2010	217.2	
AOC_5	SHP-05-43	4/27/2010	217.0	
AOC_5	SHP-05-43	9/14/2010	214.6	
AOC_5	SHP-05-43	10/7/2010	215.0	
AOC_5	SHP-05-43	4/4/2011	216.3	
AOC_5	SHP-05-43	7/25/2011	215.2	
AOC_5	SHP-05-43	11/8/2011	216.5	
AOC_5	SHP-05-43	4/10/2012	215.4	
AOC_5	SHP-05-43	6/26/2012	215.5	
AOC_5	SHP-05-43	11/5/2012	216.0	
AOC_5	SHP-05-43	11/6/2012	216.0	
AOC_5	SHP-05-43	2/14/2013	215.4	
AOC_5	SHP-05-43	3/12/2013	215.8	
AOC_5	SHP-05-43	4/22/2013	215.7	
AOC_5	SHP-05-43	4/25/2013	215.7	
AOC_5	SHP-05-43	5/15/2013	215.6	
AOC_5	SHP-05-43	6/11/2013	216.3	
AOC_5	SHP-05-43	10/21/2013	213.1	
AOC_5	SHP-05-43	4/22/2014	216.2	
AOC_5	SHP-05-43	10/6/2014	215.3	
AOC_5	SHP-05-43	6/2/2015	215.9	
AOC_5	SHP-05-43	6/17/2015	215.6	
AOC_5	SHP-05-43	8/18/2015	215.3	
AOC_5	SHP-05-43	10/7/2015	215.0	
AOC_5	SHP-05-43	10/20/2015	215.4	
AOC_5	SHP-05-43	12/16/2015	215.1	
AOC_5	SHP-05-43	4/6/2016	215.9	
AOC_5	SHP-05-43	6/9/2016	215.5	
AOC_5	SHP-05-43	8/16/2016	214.8	
AOC_5	SHP-05-43	5/11/2018	216.3	
AOC_5	SHP-05-43	11/1/2018	216.0	
AOC_5	SHP-05-43	4/11/2019	216.0	
AOC_5	SHP-05-43	10/22/2019	215.7	
AOC_5	SHP-05-44	8/24/2005	215.7	
AOC_5	SHP-05-44	4/10/2006	216.1	
AOC_5	SHP-05-44	6/5/2006	216.3	
AOC_5	SHP-05-44	9/18/2006	215.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-44	10/19/2006	216.0	
AOC_5	SHP-05-44	12/15/2006	216.3	
AOC_5	SHP-05-44	4/8/2007		205.6
AOC_5	SHP-05-44	4/9/2007		205.6
AOC_5	SHP-05-44	4/26/2007	216.9	
AOC_5	SHP-05-44	9/10/2007	215.6	
AOC_5	SHP-05-44	10/15/2007	217.1	
AOC_5	SHP-05-44	11/7/2007	216.3	
AOC_5	SHP-05-44	2/12/2008	216.7	
AOC_5	SHP-05-44	2/20/2008	217.1	
AOC_5	SHP-05-44	2/25/2008	216.9	
AOC_5	SHP-05-44	3/4/2008	216.8	
AOC_5	SHP-05-44	4/16/2008	216.7	
AOC_5	SHP-05-44	4/28/2008	216.4	
AOC_5	SHP-05-44	6/10/2008	216.1	
AOC_5	SHP-05-44	8/19/2008	216.4	
AOC_5	SHP-05-44	9/15/2008	216.3	
AOC_5	SHP-05-44	9/30/2008	216.2	
AOC_5	SHP-05-44	4/28/2009	216.1	
AOC_5	SHP-05-44	7/5/2009	216.2	
AOC_5	SHP-05-44	9/14/2009	215.8	
AOC_5	SHP-05-44	10/26/2009	215.9	
AOC_5	SHP-05-44	11/3/2009	216.0	
AOC_5	SHP-05-44	4/20/2010	217.0	
AOC_5	SHP-05-44	4/27/2010	216.8	
AOC_5	SHP-05-44	9/14/2010	215.3	
AOC_5	SHP-05-44	10/7/2010	215.7	
AOC_5	SHP-05-44	4/4/2011	216.5	
AOC_5	SHP-05-44	7/25/2011	215.7	
AOC_5	SHP-05-44	11/8/2011	216.6	
AOC_5	SHP-05-44	4/10/2012	215.9	
AOC_5	SHP-05-44	6/26/2012	215.9	
AOC_5	SHP-05-44	11/5/2012	216.5	
AOC_5	SHP-05-44	11/6/2012	216.4	
AOC_5	SHP-05-44	2/14/2013	216.0	
AOC_5	SHP-05-44	3/12/2013	216.3	
AOC_5	SHP-05-44	4/22/2013	216.1	
AOC_5	SHP-05-44	4/25/2013	216.2	
AOC_5	SHP-05-44	5/15/2013	216.1	
AOC_5	SHP-05-44	5/30/2013	216.7	
AOC_5	SHP-05-44	6/11/2013	216.9	
AOC_5	SHP-05-44	10/21/2013	213.2	
AOC_5	SHP-05-44	4/22/2014	216.5	
AOC_5	SHP-05-44	10/6/2014	216.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-44	6/2/2015	216.5	
AOC_5	SHP-05-44	6/17/2015	216.1	
AOC_5	SHP-05-44	8/18/2015	215.9	
AOC_5	SHP-05-44	10/7/2015	215.7	
AOC_5	SHP-05-44	10/20/2015		206.1
AOC_5	SHP-05-44	12/16/2015	215.8	
AOC_5	SHP-05-44	4/6/2016	216.3	
AOC_5	SHP-05-44	6/9/2016	216.1	
AOC_5	SHP-05-44	8/16/2016	215.5	
AOC_5	SHP-05-44	10/20/2016	215.5	
AOC_5	SHP-05-44	11/15/2016	216.3	
AOC_5	SHP-05-44	5/11/2018	216.6	
AOC_5	SHP-05-44	11/1/2018	216.8	
AOC_5	SHP-05-44	4/11/2019	216.4	
AOC_5	SHP-05-44	10/22/2019	215.7	
AOC_5	SHP-05-45A	8/4/2005	213.4	
AOC_5	SHP-05-45A	8/24/2005	212.8	
AOC_5	SHP-05-45A	8/26/2005	212.3	
AOC_5	SHP-05-45A	4/10/2006	213.3	
AOC_5	SHP-05-45A	6/5/2006	214.9	
AOC_5	SHP-05-45A	9/18/2006	213.0	
AOC_5	SHP-05-45A	10/19/2006	212.5	
AOC_5	SHP-05-45A	12/15/2006	213.9	
AOC_5	SHP-05-45A	4/8/2007	213.6	
AOC_5	SHP-05-45A	4/9/2007	213.6	
AOC_5	SHP-05-45A	4/26/2007	215.4	
AOC_5	SHP-05-45A	10/15/2007	211.3	
AOC_5	SHP-05-45A	2/20/2008	214.4	
AOC_5	SHP-05-45A	2/25/2008	215.1	
AOC_5	SHP-05-45A	3/4/2008	213.8	
AOC_5	SHP-05-45A	4/16/2008	213.9	
AOC_5	SHP-05-45A	4/28/2008		222.0
AOC_5	SHP-05-45A	6/10/2008	212.6	
AOC_5	SHP-05-45A	8/19/2008	213.3	
AOC_5	SHP-05-45A	9/15/2008	213.7	
AOC_5	SHP-05-45A	9/30/2008	213.1	
AOC_5	SHP-05-45A	4/28/2009	213.5	
AOC_5	SHP-05-45A	9/14/2009	211.6	
AOC_5	SHP-05-45A	10/26/2009	212.4	
AOC_5	SHP-05-45A	11/3/2009	211.9	
AOC_5	SHP-05-45A	4/20/2010	214.4	
AOC_5	SHP-05-45A	9/14/2010	211.0	
AOC_5	SHP-05-45A	10/7/2010	210.8	
AOC_5	SHP-05-45A	4/4/2011	213.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-45A	7/25/2011	211.6	
AOC_5	SHP-05-45A	11/8/2011	213.7	
AOC_5	SHP-05-45A	4/10/2012	210.2	
AOC_5	SHP-05-45A	6/26/2012	211.9	
AOC_5	SHP-05-45A	9/11/2012	210.6	
AOC_5	SHP-05-45A	11/5/2012	212.4	
AOC_5	SHP-05-45A	11/6/2012	212.4	
AOC_5	SHP-05-45A	3/13/2013	212.8	
AOC_5	SHP-05-45A	4/23/2013	212.2	
AOC_5	SHP-05-45A	4/25/2013	211.5	
AOC_5	SHP-05-45A	5/15/2013	211.7	
AOC_5	SHP-05-45A	5/30/2013	212.5	
AOC_5	SHP-05-45A	6/11/2013	212.9	
AOC_5	SHP-05-45A	10/21/2013	211.4	
AOC_5	SHP-05-45A	4/22/2014	213.2	
AOC_5	SHP-05-45A	10/6/2014	210.6	
AOC_5	SHP-05-45A	6/3/2015	212.5	
AOC_5	SHP-05-45A	6/17/2015	212.2	
AOC_5	SHP-05-45A	10/20/2015	210.3	
AOC_5	SHP-05-45A	12/16/2015	210.8	
AOC_5	SHP-05-45A	6/9/2016	212.1	
AOC_5	SHP-05-45A	8/16/2016	210.2	
AOC_5	SHP-05-45A	10/20/2016	210.0	
AOC_5	SHP-05-45A	11/1/2018	212.4	
AOC_5	SHP-05-45A	10/22/2019	210.8	
AOC_5	SHP-05-45B	8/4/2005	213.5	
AOC_5	SHP-05-45B	8/24/2005	212.8	
AOC_5	SHP-05-45B	8/26/2005	212.0	
AOC_5	SHP-05-45B	4/10/2006	213.3	
AOC_5	SHP-05-45B	6/5/2006	214.9	
AOC_5	SHP-05-45B	9/18/2006	213.0	
AOC_5	SHP-05-45B	10/19/2006	212.5	
AOC_5	SHP-05-45B	12/15/2006	214.0	
AOC_5	SHP-05-45B	4/8/2007	213.6	
AOC_5	SHP-05-45B	4/9/2007	213.6	
AOC_5	SHP-05-45B	4/26/2007	215.3	
AOC_5	SHP-05-45B	10/15/2007	211.2	
AOC_5	SHP-05-45B	2/20/2008	214.3	
AOC_5	SHP-05-45B	2/25/2008	215.1	
AOC_5	SHP-05-45B	3/4/2008	213.8	
AOC_5	SHP-05-45B	4/16/2008	214.0	
AOC_5	SHP-05-45B	4/28/2008		184.7
AOC_5	SHP-05-45B	6/10/2008	212.6	
AOC_5	SHP-05-45B	8/19/2008	213.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-45B	9/30/2008	213.9	
AOC_5	SHP-05-45B	4/28/2009	213.5	
AOC_5	SHP-05-45B	9/14/2009	211.5	
AOC_5	SHP-05-45B	10/26/2009	212.5	
AOC_5	SHP-05-45B	11/3/2009	211.8	
AOC_5	SHP-05-45B	4/20/2010	214.3	
AOC_5	SHP-05-45B	4/27/2010	213.8	
AOC_5	SHP-05-45B	9/14/2010	211.1	
AOC_5	SHP-05-45B	10/7/2010	210.8	
AOC_5	SHP-05-45B	4/4/2011	213.5	
AOC_5	SHP-05-45B	7/25/2011	211.6	
AOC_5	SHP-05-45B	11/8/2011	213.7	
AOC_5	SHP-05-45B	4/10/2012	212.2	
AOC_5	SHP-05-45B	6/26/2012	212.0	
AOC_5	SHP-05-45B	9/11/2012	210.6	
AOC_5	SHP-05-45B	11/5/2012	212.3	
AOC_5	SHP-05-45B	11/6/2012	212.2	
AOC_5	SHP-05-45B	3/13/2013	212.6	
AOC_5	SHP-05-45B	4/23/2013	212.1	
AOC_5	SHP-05-45B	4/25/2013	213.4	
AOC_5	SHP-05-45B	5/15/2013	211.6	
AOC_5	SHP-05-45B	5/30/2013	212.4	
AOC_5	SHP-05-45B	6/11/2013	212.9	
AOC_5	SHP-05-45B	10/21/2013	211.5	
AOC_5	SHP-05-45B	4/22/2014	213.2	
AOC_5	SHP-05-45B	10/6/2014	210.8	
AOC_5	SHP-05-45B	6/3/2015	212.6	
AOC_5	SHP-05-45B	6/17/2015	212.3	
AOC_5	SHP-05-45B	10/20/2015	210.4	
AOC_5	SHP-05-45B	12/16/2015	210.9	
AOC_5	SHP-05-45B	6/9/2016	212.1	
AOC_5	SHP-05-45B	8/16/2016	210.3	
AOC_5	SHP-05-45B	10/20/2016	210.1	
AOC_5	SHP-05-45B	11/1/2018	212.2	
AOC_5	SHP-05-45B	10/22/2019	210.7	
AOC_5	SHP-05-46A	8/4/2005	213.5	
AOC_5	SHP-05-46A	8/24/2005	212.9	
AOC_5	SHP-05-46A	8/26/2005	212.4	
AOC_5	SHP-05-46A	4/10/2006	213.4	
AOC_5	SHP-05-46A	6/5/2006	215.1	
AOC_5	SHP-05-46A	9/18/2006	213.1	
AOC_5	SHP-05-46A	10/19/2006	212.7	
AOC_5	SHP-05-46A	12/15/2006	214.2	
AOC_5	SHP-05-46A	4/8/2007	213.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-46A	4/9/2007	213.8	
AOC_5	SHP-05-46A	4/26/2007	215.5	
AOC_5	SHP-05-46A	10/15/2007	212.3	
AOC_5	SHP-05-46A	2/20/2008	215.2	
AOC_5	SHP-05-46A	2/25/2008	215.8	
AOC_5	SHP-05-46A	3/4/2008	214.7	
AOC_5	SHP-05-46A	4/16/2008	214.9	
AOC_5	SHP-05-46A	4/28/2008	213.5	
AOC_5	SHP-05-46A	6/10/2008	213.6	
AOC_5	SHP-05-46A	8/19/2008	213.5	
AOC_5	SHP-05-46A	9/15/2008	214.5	
AOC_5	SHP-05-46A	9/30/2008	213.9	
AOC_5	SHP-05-46A	4/28/2009	214.4	
AOC_5	SHP-05-46A	7/5/2009	213.7	
AOC_5	SHP-05-46A	9/14/2009	212.6	
AOC_5	SHP-05-46A	10/26/2009	213.2	
AOC_5	SHP-05-46A	11/3/2009	212.9	
AOC_5	SHP-05-46A	4/20/2010	215.4	
AOC_5	SHP-05-46A	9/14/2010	211.9	
AOC_5	SHP-05-46A	10/7/2010	211.8	
AOC_5	SHP-05-46A	4/4/2011	214.5	
AOC_5	SHP-05-46A	7/25/2011	212.6	
AOC_5	SHP-05-46A	11/8/2011	214.6	
AOC_5	SHP-05-46A	4/10/2012	213.1	
AOC_5	SHP-05-46A	6/26/2012	212.8	
AOC_5	SHP-05-46A	9/11/2012	211.1	
AOC_5	SHP-05-46A	11/5/2012	213.4	
AOC_5	SHP-05-46A	11/6/2012	212.6	
AOC_5	SHP-05-46A	2/14/2013	213.7	
AOC_5	SHP-05-46A	3/12/2013	213.5	
AOC_5	SHP-05-46A	3/13/2013	213.0	
AOC_5	SHP-05-46A	4/22/2013	213.2	
AOC_5	SHP-05-46A	4/23/2013	212.6	
AOC_5	SHP-05-46A	4/25/2013	213.2	
AOC_5	SHP-05-46A	5/15/2013	212.6	
AOC_5	SHP-05-46A	5/30/2013	212.8	
AOC_5	SHP-05-46A	6/11/2013	213.9	
AOC_5	SHP-05-46A	10/21/2013	212.2	
AOC_5	SHP-05-46A	4/22/2014	214.1	
AOC_5	SHP-05-46A	10/6/2014	210.8	
AOC_5	SHP-05-46A	6/3/2015	212.8	
AOC_5	SHP-05-46A	6/17/2015	213.0	
AOC_5	SHP-05-46A	10/20/2015	211.4	
AOC_5	SHP-05-46A	12/16/2015	211.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-46A	6/9/2016	212.3	
AOC_5	SHP-05-46A	8/16/2016	210.6	
AOC_5	SHP-05-46A	10/20/2016	210.4	
AOC_5	SHP-05-46A	11/1/2018	213.3	
AOC_5	SHP-05-46A	10/22/2019	211.2	
AOC_5	SHP-05-46B	8/4/2005	213.6	
AOC_5	SHP-05-46B	8/24/2005	213.0	
AOC_5	SHP-05-46B	8/26/2005	212.6	
AOC_5	SHP-05-46B	4/10/2006	213.5	
AOC_5	SHP-05-46B	6/5/2006	215.2	
AOC_5	SHP-05-46B	9/18/2006	213.2	
AOC_5	SHP-05-46B	12/15/2006	214.1	
AOC_5	SHP-05-46B	4/8/2007	213.8	
AOC_5	SHP-05-46B	4/9/2007	213.8	
AOC_5	SHP-05-46B	10/15/2007	211.0	
AOC_5	SHP-05-46B	2/20/2008	214.0	
AOC_5	SHP-05-46B	2/25/2008	214.6	
AOC_5	SHP-05-46B	3/4/2008	213.5	
AOC_5	SHP-05-46B	4/16/2008	213.6	
AOC_5	SHP-05-46B	4/28/2008	213.6	
AOC_5	SHP-05-46B	6/10/2008	212.4	
AOC_5	SHP-05-46B	9/15/2008	213.2	
AOC_5	SHP-05-46B	9/30/2008	212.7	
AOC_5	SHP-05-46B	4/28/2009	213.1	
AOC_5	SHP-05-46B	7/5/2009	212.5	
AOC_5	SHP-05-46B	9/14/2009	211.3	
AOC_5	SHP-05-46B	10/26/2009	212.0	
AOC_5	SHP-05-46B	11/3/2009	211.7	
AOC_5	SHP-05-46B	4/20/2010	214.1	
AOC_5	SHP-05-46B	4/27/2010	213.6	
AOC_5	SHP-05-46B	9/14/2010	210.6	
AOC_5	SHP-05-46B	10/7/2010	210.6	
AOC_5	SHP-05-46B	4/4/2011	213.3	
AOC_5	SHP-05-46B	7/25/2011	211.3	
AOC_5	SHP-05-46B	11/8/2011	213.4	
AOC_5	SHP-05-46B	4/10/2012	211.9	
AOC_5	SHP-05-46B	6/26/2012	211.5	
AOC_5	SHP-05-46B	9/11/2012	211.1	
AOC_5	SHP-05-46B	11/5/2012	212.1	
AOC_5	SHP-05-46B	11/6/2012	212.7	
AOC_5	SHP-05-46B	3/13/2013	213.1	
AOC_5	SHP-05-46B	4/23/2013	212.6	
AOC_5	SHP-05-46B	5/15/2013	211.4	
AOC_5	SHP-05-46B	5/30/2013	212.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-46B	6/11/2013	212.7	
AOC_5	SHP-05-46B	10/21/2013	210.9	
AOC_5	SHP-05-46B	4/22/2014	212.9	
AOC_5	SHP-05-46B	10/6/2014	210.5	
AOC_5	SHP-05-46B	6/17/2015	210.8	
AOC_5	SHP-05-46B	10/20/2015	210.1	
AOC_5	SHP-05-46B	12/16/2015	211.3	
AOC_5	SHP-05-46B	6/9/2016	212.4	
AOC_5	SHP-05-46B	8/16/2016	210.7	
AOC_5	SHP-05-46B	10/20/2016	210.5	
AOC_5	SHP-05-46B	5/11/2018	213.4	
AOC_5	SHP-05-46B	11/1/2018	212.9	
AOC_5	SHP-05-46B	4/11/2019	212.8	
AOC_5	SHP-05-46B	10/22/2019	211.3	
AOC_5	SHP-05-47A	8/4/2005	212.8	
AOC_5	SHP-05-47A	8/24/2005	211.4	
AOC_5	SHP-05-47A	4/10/2006	212.0	
AOC_5	SHP-05-47A	9/18/2006	211.7	
AOC_5	SHP-05-47A	12/15/2006	212.7	
AOC_5	SHP-05-47A	4/8/2007	211.8	
AOC_5	SHP-05-47A	4/9/2007	211.8	
AOC_5	SHP-05-47A	10/15/2007	211.9	
AOC_5	SHP-05-47A	2/25/2008	213.1	
AOC_5	SHP-05-47A	3/4/2008	213.1	
AOC_5	SHP-05-47A	4/16/2008	213.1	
AOC_5	SHP-05-47A	9/30/2008	213.0	
AOC_5	SHP-05-47A	4/28/2009	213.0	
AOC_5	SHP-05-47A	11/3/2009	212.7	
AOC_5	SHP-05-47A	4/20/2010	212.8	
AOC_5	SHP-05-47A	10/7/2010	214.5	
AOC_5	SHP-05-47A	4/4/2011	215.0	
AOC_5	SHP-05-47A	11/8/2011	212.9	
AOC_5	SHP-05-47A	4/10/2012	212.1	
AOC_5	SHP-05-47A	11/5/2012	212.6	
AOC_5	SHP-05-47A	11/6/2012	212.8	
AOC_5	SHP-05-47A	5/15/2013	212.0	
AOC_5	SHP-05-47A	5/30/2013	211.9	
AOC_5	SHP-05-47A	4/22/2014	212.7	
AOC_5	SHP-05-47A	6/3/2015	213.0	
AOC_5	SHP-05-47A	10/7/2015	211.4	
AOC_5	SHP-05-47A	10/20/2015	212.3	
AOC_5	SHP-05-47A	12/16/2015	212.9	
AOC_5	SHP-05-47A	11/15/2016	212.9	
AOC_5	SHP-05-47A	5/11/2018	212.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-47A	11/1/2018	212.6	
AOC_5	SHP-05-47A	4/11/2019	213.2	
AOC_5	SHP-05-47A	10/22/2019	211.8	
AOC_5	SHP-05-47B	8/4/2005	214.2	
AOC_5	SHP-05-47B	8/24/2005	211.5	
AOC_5	SHP-05-47B	8/26/2005	211.6	
AOC_5	SHP-05-47B	4/10/2006	212.2	
AOC_5	SHP-05-47B	9/18/2006	211.8	
AOC_5	SHP-05-47B	12/15/2006	212.7	
AOC_5	SHP-05-47B	4/8/2007	212.8	
AOC_5	SHP-05-47B	4/9/2007	212.8	
AOC_5	SHP-05-47B	10/15/2007	212.3	
AOC_5	SHP-05-47B	2/25/2008	213.7	
AOC_5	SHP-05-47B	3/4/2008	213.3	
AOC_5	SHP-05-47B	4/16/2008	213.2	
AOC_5	SHP-05-47B	9/30/2008	213.4	
AOC_5	SHP-05-47B	4/28/2009	213.0	
AOC_5	SHP-05-47B	11/3/2009	212.9	
AOC_5	SHP-05-47B	4/20/2010	212.9	
AOC_5	SHP-05-47B	10/7/2010	210.7	
AOC_5	SHP-05-47B	4/4/2011	210.4	
AOC_5	SHP-05-47B	11/8/2011	213.4	
AOC_5	SHP-05-47B	4/10/2012	212.3	
AOC_5	SHP-05-47B	11/5/2012	212.8	
AOC_5	SHP-05-47B	11/6/2012	212.9	
AOC_5	SHP-05-47B	5/15/2013	212.6	
AOC_5	SHP-05-47B	5/30/2013	212.7	
AOC_5	SHP-05-47B	10/21/2013	211.5	
AOC_5	SHP-05-47B	4/22/2014	213.5	
AOC_5	SHP-05-47B	6/3/2015	211.0	
AOC_5	SHP-05-47B	6/17/2015	211.9	
AOC_5	SHP-05-47B	10/7/2015	211.4	
AOC_5	SHP-05-47B	10/20/2015	212.4	
AOC_5	SHP-05-47B	12/16/2015	212.9	
AOC_5	SHP-05-47B	6/9/2016	212.7	
AOC_5	SHP-05-47B	8/16/2016	211.4	
AOC_5	SHP-05-47B	11/15/2016	213.0	
AOC_5	SHP-05-47B	5/11/2018	213.2	
AOC_5	SHP-05-47B	11/1/2018	212.6	
AOC_5	SHP-05-47B	4/11/2019	213.2	
AOC_5	SHP-05-47B	10/22/2019	213.0	
AOC_5	SHP-05-48A	8/4/2005	211.8	
AOC_5	SHP-05-48A	4/10/2006	213.8	
AOC_5	SHP-05-48A	6/5/2006	214.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-48A	9/18/2006	213.1	
AOC_5	SHP-05-48A	4/8/2007	213.9	
AOC_5	SHP-05-48A	4/9/2007	213.9	
AOC_5	SHP-05-48A	2/25/2008	215.1	
AOC_5	SHP-05-48A	3/4/2008	214.7	
AOC_5	SHP-05-48A	4/16/2008	213.8	
AOC_5	SHP-05-48A	9/30/2008	213.8	
AOC_5	SHP-05-48A	4/28/2009	213.9	
AOC_5	SHP-05-48A	11/3/2009	213.7	
AOC_5	SHP-05-48A	4/20/2010	212.5	
AOC_5	SHP-05-48A	10/7/2010	212.3	
AOC_5	SHP-05-48A	4/4/2011	213.9	
AOC_5	SHP-05-48A	11/8/2011	212.6	
AOC_5	SHP-05-48A	11/5/2012	211.4	
AOC_5	SHP-05-48A	5/30/2013	212.4	
AOC_5	SHP-05-48A	4/22/2014	212.6	
AOC_5	SHP-05-48A	6/3/2015	212.5	
AOC_5	SHP-05-48A	10/20/2015		
AOC_5	SHP-05-48A	11/1/2018	212.7	
AOC_5	SHP-05-48A	10/22/2019	213.5	
AOC_5	SHP-05-48B	8/4/2005	211.3	
AOC_5	SHP-05-48B	4/10/2006	211.0	
AOC_5	SHP-05-48B	6/5/2006	211.9	
AOC_5	SHP-05-48B	9/18/2006	210.4	
AOC_5	SHP-05-48B	12/15/2006	211.1	
AOC_5	SHP-05-48B	4/8/2007	211.0	
AOC_5	SHP-05-48B	4/9/2007	211.0	
AOC_5	SHP-05-48B	2/25/2008	212.2	
AOC_5	SHP-05-48B	3/4/2008	212.1	
AOC_5	SHP-05-48B	4/16/2008	211.1	
AOC_5	SHP-05-48B	9/30/2008	211.4	
AOC_5	SHP-05-48B	4/28/2009	210.9	
AOC_5	SHP-05-48B	11/3/2009	211.0	
AOC_5	SHP-05-48B	4/20/2010	212.4	
AOC_5	SHP-05-48B	10/7/2010	210.5	
AOC_5	SHP-05-48B	4/4/2011	211.1	
AOC_5	SHP-05-48B	11/8/2011	212.8	
AOC_5	SHP-05-48B	4/10/2012	211.2	
AOC_5	SHP-05-48B	11/5/2012	212.4	
AOC_5	SHP-05-48B	5/15/2013	211.9	
AOC_5	SHP-05-48B	5/30/2013	212.4	
AOC_5	SHP-05-48B	4/22/2014	212.5	
AOC_5	SHP-05-48B	6/3/2015	212.4	
AOC_5	SHP-05-48B	6/17/2015	210.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-48B	10/20/2015		
AOC_5	SHP-05-48B	5/11/2018	212.7	
AOC_5	SHP-05-48B	11/1/2018	212.7	
AOC_5	SHP-05-48B	4/11/2019	212.8	
AOC_5	SHP-05-48B	10/22/2019	213.1	
AOC_5	SHP-05-49A	8/24/2005	210.7	
AOC_5	SHP-05-49A	4/10/2006	212.3	
AOC_5	SHP-05-49A	6/5/2006	211.7	
AOC_5	SHP-05-49A	9/18/2006	210.9	
AOC_5	SHP-05-49A	12/15/2006	211.4	
AOC_5	SHP-05-49A	10/15/2007	212.2	
AOC_5	SHP-05-49A	2/25/2008	212.9	
AOC_5	SHP-05-49A	3/4/2008	212.8	
AOC_5	SHP-05-49A	4/16/2008	211.2	
AOC_5	SHP-05-49A	9/30/2008	212.5	
AOC_5	SHP-05-49A	4/28/2009	212.7	
AOC_5	SHP-05-49A	11/3/2009	212.6	
AOC_5	SHP-05-49A	4/20/2010	211.1	
AOC_5	SHP-05-49A	10/7/2010	212.5	
AOC_5	SHP-05-49A	4/4/2011	212.6	
AOC_5	SHP-05-49A	11/8/2011	211.3	
AOC_5	SHP-05-49A	11/5/2012	211.0	
AOC_5	SHP-05-49A	4/25/2013	210.9	
AOC_5	SHP-05-49A	4/22/2014	211.0	
AOC_5	SHP-05-49A	6/3/2015	212.9	
AOC_5	SHP-05-49A	10/20/2015		
AOC_5	SHP-05-49A	12/16/2015	210.8	
AOC_5	SHP-05-49A	5/11/2018	211.2	
AOC_5	SHP-05-49A	11/1/2018	211.3	
AOC_5	SHP-05-49A	4/11/2019	211.2	
AOC_5	SHP-05-49A	10/22/2019	211.0	
AOC_5	SHP-05-49B	8/4/2005	210.8	
AOC_5	SHP-05-49B	8/24/2005	210.9	
AOC_5	SHP-05-49B	8/26/2005	210.5	
AOC_5	SHP-05-49B	6/5/2006	212.0	
AOC_5	SHP-05-49B	9/18/2006	210.5	
AOC_5	SHP-05-49B	12/15/2006	210.9	
AOC_5	SHP-05-49B	2/20/2008	210.5	
AOC_5	SHP-05-49B	2/25/2008	209.7	
AOC_5	SHP-05-49B	3/4/2008	209.7	
AOC_5	SHP-05-49B	4/16/2008	210.2	
AOC_5	SHP-05-49B	9/30/2008	209.9	
AOC_5	SHP-05-49B	4/28/2009	209.6	
AOC_5	SHP-05-49B	11/3/2009	209.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-05-49B	4/20/2010	210.9	
AOC_5	SHP-05-49B	10/7/2010	209.5	
AOC_5	SHP-05-49B	4/4/2011	209.5	
AOC_5	SHP-05-49B	11/8/2011	211.1	
AOC_5	SHP-05-49B	4/10/2012	210.6	
AOC_5	SHP-05-49B	11/5/2012	211.2	
AOC_5	SHP-05-49B	5/15/2013	210.7	
AOC_5	SHP-05-49B	10/21/2013	210.8	
AOC_5	SHP-05-49B	4/22/2014	211.3	
AOC_5	SHP-05-49B	10/6/2014	210.7	
AOC_5	SHP-05-49B	6/3/2015	210.7	
AOC_5	SHP-05-49B	6/17/2015	210.5	
AOC_5	SHP-05-49B	10/20/2015	210.4	
AOC_5	SHP-05-49B	12/16/2015	210.6	
AOC_5	SHP-05-49B	8/16/2016	210.2	
AOC_5	SHP-05-49B	5/11/2018	211.4	
AOC_5	SHP-05-49B	11/1/2018	211.5	
AOC_5	SHP-05-49B	4/11/2019	211.2	
AOC_5	SHP-05-49B	10/22/2019	211.0	
AOC_5	SHP-07-01BD	2/20/2008		
AOC_5	SHP-07-01BS	2/20/2008		
AOC_5	SHP-07-01CD	2/20/2008		
AOC_5	SHP-07-01CS	2/20/2008		
AOC_5	SHP-07-01DD	2/20/2008		
AOC_5	SHP-07-01DS	2/20/2008		
AOC_5	SHP-07-03A	2/20/2008	210.6	
AOC_5	SHP-07-03A	6/11/2013	206.7	
AOC_5	SHP-07-03A	10/21/2013	204.6	
AOC_5	SHP-07-03A	10/6/2014	204.5	
AOC_5	SHP-07-03B	2/20/2008	211.6	
AOC_5	SHP-07-03C	2/20/2008		
AOC_5	SHP-07-03D	2/20/2008		
AOC_5	SHP-07-03E	2/20/2008		
AOC_5	SHP-07-03E	5/15/2013		
AOC_5	SHP-07-05X	4/25/2013		
AOC_5	SHP-07-05X	5/15/2013		
AOC_5	SHP-07-05X	5/30/2013		
AOC_5	SHP-07-05X	6/11/2013		
AOC_5	SHP-13-03	4/23/2014		-2.6
AOC_5	SHP-2016-06A	5/22/2017	215.6	
AOC_5	SHP-2016-06A	5/11/2018	214.8	
AOC_5	SHP-2016-06A	11/1/2018	212.2	
AOC_5	SHP-2016-06A	4/11/2019	214.1	
AOC_5	SHP-2016-06A	10/22/2019	211.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-2016-06A	5/18/2020	222.2	
AOC_5	SHP-2016-06A	5/21/2020	213.3	
AOC_5	SHP-2016-06B	5/22/2017	222.1	
AOC_5	SHP-2016-06B	5/11/2018	221.7	
AOC_5	SHP-2016-06B	11/1/2018	220.6	
AOC_5	SHP-2016-06B	4/11/2019	221.6	
AOC_5	SHP-2016-06B	10/22/2019	217.8	
AOC_5	SHP-2016-06B	5/18/2020	215.6	
AOC_5	SHP-2016-06B	5/21/2020	220.9	
AOC_5	SHP-2016-06C	5/11/2018	222.0	
AOC_5	SHP-2016-06C	11/1/2018	220.8	
AOC_5	SHP-2016-06C	4/11/2019	222.4	
AOC_5	SHP-2016-06C	10/22/2019	218.2	
AOC_5	SHP-2016-06C	5/18/2020	222.2	
AOC_5	SHP-2016-06C	5/21/2020	221.6	
AOC_5	SHP-2016-07A	5/22/2017	251.0	
AOC_5	SHP-2016-07A	5/11/2018	251.4	
AOC_5	SHP-2016-07A	11/1/2018	248.7	
AOC_5	SHP-2016-07A	4/11/2019	249.7	
AOC_5	SHP-2016-07A	10/22/2019		
AOC_5	SHP-2016-07A	5/18/2020	250.4	
AOC_5	SHP-2016-07A	5/20/2020	250.1	
AOC_5	SHP-2016-07B	5/22/2017	242.9	
AOC_5	SHP-2016-07B	5/11/2018	244.4	
AOC_5	SHP-2016-07B	11/1/2018	241.9	
AOC_5	SHP-2016-07B	4/11/2019	243.3	
AOC_5	SHP-2016-07B	10/22/2019	229.5	
AOC_5	SHP-2016-07B	5/15/2020	243.9	
AOC_5	SHP-2016-07B	5/18/2020	243.6	
AOC_5	SHP-2016-1A	8/16/2016		210.0
AOC_5	SHP-2016-1A	10/20/2016		209.9
AOC_5	SHP-2016-1A	5/22/2017	213.0	
AOC_5	SHP-2016-1A	5/11/2018	213.1	
AOC_5	SHP-2016-1A	11/1/2018	212.5	
AOC_5	SHP-2016-1A	4/11/2019	212.6	
AOC_5	SHP-2016-1A	10/22/2019	210.4	
AOC_5	SHP-2016-1A	5/15/2020	213.2	
AOC_5	SHP-2016-1A	5/18/2020	213.0	
AOC_5	SHP-2016-1B	8/16/2016	209.2	
AOC_5	SHP-2016-1B	10/20/2016	208.8	
AOC_5	SHP-2016-1B	5/22/2017	210.8	
AOC_5	SHP-2016-1B	5/11/2018	211.4	
AOC_5	SHP-2016-1B	11/1/2018	210.6	
AOC_5	SHP-2016-1B	4/11/2019	211.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-2016-1B	10/22/2019	209.5	
AOC_5	SHP-2016-1B	5/15/2020	211.5	
AOC_5	SHP-2016-1B	5/18/2020	211.1	
AOC_5	SHP-2016-2A	8/16/2016	210.1	
AOC_5	SHP-2016-2A	10/20/2016	210.0	
AOC_5	SHP-2016-2A	5/22/2017	212.5	
AOC_5	SHP-2016-2A	5/11/2018	212.7	
AOC_5	SHP-2016-2A	11/1/2018	212.8	
AOC_5	SHP-2016-2A	4/11/2019	212.2	
AOC_5	SHP-2016-2A	10/22/2019	210.5	
AOC_5	SHP-2016-2A	5/18/2020	212.7	
AOC_5	SHP-2016-2A	5/20/2020	211.6	
AOC_5	SHP-2016-2B	10/20/2016	210.0	
AOC_5	SHP-2016-2B	5/22/2017	212.6	
AOC_5	SHP-2016-2B	5/11/2018	212.6	
AOC_5	SHP-2016-2B	11/1/2018	212.7	
AOC_5	SHP-2016-2B	4/11/2019	212.2	
AOC_5	SHP-2016-2B	10/22/2019	209.7	
AOC_5	SHP-2016-2B	5/18/2020	212.6	
AOC_5	SHP-2016-2B	5/20/2020	212.5	
AOC_5	SHP-2016-3A	8/16/2016	209.7	
AOC_5	SHP-2016-3A	10/20/2016	210.1	
AOC_5	SHP-2016-3A	5/22/2017	212.6	
AOC_5	SHP-2016-3A	5/11/2018	212.8	
AOC_5	SHP-2016-3A	11/1/2018	212.1	
AOC_5	SHP-2016-3A	4/11/2019	212.3	
AOC_5	SHP-2016-3A	10/22/2019	210.7	
AOC_5	SHP-2016-3A	5/18/2020	212.4	
AOC_5	SHP-2016-3A	5/20/2020	212.6	
AOC_5	SHP-2016-3B	8/16/2016	210.1	
AOC_5	SHP-2016-3B	10/20/2016	210.1	
AOC_5	SHP-2016-3B	5/22/2017	212.7	
AOC_5	SHP-2016-3B	5/11/2018	212.7	
AOC_5	SHP-2016-3B	11/1/2018	212.2	
AOC_5	SHP-2016-3B	4/11/2019	212.3	
AOC_5	SHP-2016-3B	10/22/2019	210.8	
AOC_5	SHP-2016-3B	5/18/2020	212.6	
AOC_5	SHP-2016-3B	5/20/2020	212.5	
AOC_5	SHP-2016-4A	8/16/2016	210.0	
AOC_5	SHP-2016-4A	10/20/2016	210.0	
AOC_5	SHP-2016-4A	5/22/2017	212.6	
AOC_5	SHP-2016-4A	5/11/2018	212.7	
AOC_5	SHP-2016-4A	11/1/2018	212.2	
AOC_5	SHP-2016-4A	4/11/2019	212.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-2016-4A	10/22/2019		205.1
AOC_5	SHP-2016-4A	5/18/2020	212.6	
AOC_5	SHP-2016-4A	5/21/2020	212.5	
AOC_5	SHP-2016-4B	8/16/2016	210.0	
AOC_5	SHP-2016-4B	10/20/2016	210.0	
AOC_5	SHP-2016-4B	5/22/2017	212.5	
AOC_5	SHP-2016-4B	5/11/2018	212.7	
AOC_5	SHP-2016-4B	11/1/2018	212.2	
AOC_5	SHP-2016-4B	4/11/2019	212.2	
AOC_5	SHP-2016-4B	10/22/2019	210.7	
AOC_5	SHP-2016-4B	5/18/2020	212.6	
AOC_5	SHP-2016-4B	5/21/2020	212.4	
AOC_5	SHP-2016-5A	8/16/2016	210.1	
AOC_5	SHP-2016-5A	10/20/2016	210.0	
AOC_5	SHP-2016-5A	5/22/2017	212.6	
AOC_5	SHP-2016-5A	5/11/2018	212.7	
AOC_5	SHP-2016-5A	11/1/2018	212.2	
AOC_5	SHP-2016-5A	4/11/2019	212.2	
AOC_5	SHP-2016-5A	10/22/2019	210.9	
AOC_5	SHP-2016-5A	5/18/2020	212.7	
AOC_5	SHP-2016-5A	5/21/2020	212.5	
AOC_5	SHP-2016-5B	8/16/2016	210.0	
AOC_5	SHP-2016-5B	10/20/2016	209.9	
AOC_5	SHP-2016-5B	5/22/2017	212.6	
AOC_5	SHP-2016-5B	5/11/2018	212.7	
AOC_5	SHP-2016-5B	11/1/2018	212.2	
AOC_5	SHP-2016-5B	4/11/2019	212.2	
AOC_5	SHP-2016-5B	10/22/2019	210.7	
AOC_5	SHP-2016-5B	5/18/2020	212.7	
AOC_5	SHP-2016-5B	5/21/2020	212.5	
AOC_5	SHP-2017-01	5/11/2018	212.1	
AOC_5	SHP-2017-01	11/1/2018	210.9	
AOC_5	SHP-2017-01	4/11/2019	211.1	
AOC_5	SHP-2017-01	10/22/2019	209.5	
AOC_5	SHP-2017-01	5/18/2020	212.0	
AOC_5	SHP-2017-02	5/11/2018	211.4	
AOC_5	SHP-2017-02	11/1/2018	211.2	
AOC_5	SHP-2017-02	4/11/2019	210.8	
AOC_5	SHP-2017-02	10/22/2019	209.3	
AOC_5	SHP-2017-02	5/18/2020	211.5	
AOC_5	SHP-99-01B	6/6/1999	263.2	
AOC_5	SHP-99-01B	4/26/2007	268.7	
AOC_5	SHP-99-01B	4/28/2008	268.1	
AOC_5	SHP-99-01B	6/10/2008	265.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-99-01B	8/19/2008	263.4	
AOC_5	SHP-99-01B	5/15/2013	267.3	
AOC_5	SHP-99-01B	6/11/2013	268.3	
AOC_5	SHP-99-01B	4/22/2014	269.2	
AOC_5	SHP-99-01B	6/17/2015	263.7	
AOC_5	SHP-99-01B	6/9/2016	266.2	
AOC_5	SHP-99-01B	6/24/2016	263.8	
AOC_5	SHP-99-01B	11/15/2016		
AOC_5	SHP-99-01B	5/22/2017	268.4	
AOC_5	SHP-99-01B	11/1/2018	267.7	
AOC_5	SHP-99-01B	10/22/2019	263.3	
AOC_5	SHP-99-01C	6/6/1999	261.2	
AOC_5	SHP-99-01C	9/8/1999	249.2	
AOC_5	SHP-99-01C	11/16/2001	248.9	
AOC_5	SHP-99-01C	4/26/2007	266.2	
AOC_5	SHP-99-01C	4/28/2008	264.5	
AOC_5	SHP-99-01C	6/10/2008	262.4	
AOC_5	SHP-99-01C	8/19/2008	260.4	
AOC_5	SHP-99-01C	11/6/2012	252.7	
AOC_5	SHP-99-01C	5/15/2013	263.2	
AOC_5	SHP-99-01C	6/11/2013	264.9	
AOC_5	SHP-99-01C	10/21/2013	249.8	
AOC_5	SHP-99-01C	4/22/2014	266.1	
AOC_5	SHP-99-01C	10/6/2014	250.0	
AOC_5	SHP-99-01C	6/2/2015	262.2	
AOC_5	SHP-99-01C	6/17/2015	261.0	
AOC_5	SHP-99-01C	10/20/2015	249.6	
AOC_5	SHP-99-01C	12/16/2015	248.8	
AOC_5	SHP-99-01C	6/9/2016	261.9	
AOC_5	SHP-99-01C	6/24/2016	260.2	
AOC_5	SHP-99-01C	11/15/2016	249.1	
AOC_5	SHP-99-01C	5/22/2017	265.0	
AOC_5	SHP-99-01C	11/1/2018	263.6	
AOC_5	SHP-99-01C	10/22/2019	249.6	
AOC_5	SHP-99-29X	6/6/1999	219.4	
AOC_5	SHP-99-29X	9/8/1999	217.7	
AOC_5	SHP-99-29X	11/16/2001	218.2	
AOC_5	SHP-99-29X	4/26/2007	221.5	
AOC_5	SHP-99-29X	10/15/2007	218.8	
AOC_5	SHP-99-29X	2/20/2008	220.2	
AOC_5	SHP-99-29X	2/25/2008	220.5	
AOC_5	SHP-99-29X	3/4/2008	220.7	
AOC_5	SHP-99-29X	4/16/2008	222.1	
AOC_5	SHP-99-29X	9/15/2008	220.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-99-29X	9/30/2008	220.0	
AOC_5	SHP-99-29X	10/6/2008	218.9	
AOC_5	SHP-99-29X	4/28/2009	222.1	
AOC_5	SHP-99-29X	9/14/2009	220.5	
AOC_5	SHP-99-29X	10/22/2009	219.6	
AOC_5	SHP-99-29X	10/26/2009	219.5	
AOC_5	SHP-99-29X	11/3/2009	219.5	
AOC_5	SHP-99-29X	4/20/2010	222.5	
AOC_5	SHP-99-29X	4/27/2010	222.6	
AOC_5	SHP-99-29X	9/14/2010	218.9	
AOC_5	SHP-99-29X	10/7/2010	217.6	
AOC_5	SHP-99-29X	4/4/2011	220.9	
AOC_5	SHP-99-29X	7/25/2011	220.3	
AOC_5	SHP-99-29X	11/8/2011	221.0	
AOC_5	SHP-99-29X	4/10/2012	221.0	
AOC_5	SHP-99-29X	6/26/2012	220.6	
AOC_5	SHP-99-29X	11/5/2012	218.8	
AOC_5	SHP-99-29X	11/6/2012	218.9	
AOC_5	SHP-99-29X	4/25/2013	220.8	
AOC_5	SHP-99-29X	5/15/2013	220.6	
AOC_5	SHP-99-29X	6/11/2013	220.6	
AOC_5	SHP-99-29X	10/21/2013	218.8	
AOC_5	SHP-99-29X	10/22/2013	218.6	
AOC_5	SHP-99-29X	4/22/2014	220.0	
AOC_5	SHP-99-29X	10/6/2014	218.5	
AOC_5	SHP-99-29X	6/3/2015	220.7	
AOC_5	SHP-99-29X	6/17/2015	220.5	
AOC_5	SHP-99-29X	10/7/2015	218.6	
AOC_5	SHP-99-29X	10/20/2015	218.4	
AOC_5	SHP-99-29X	12/16/2015	218.3	
AOC_5	SHP-99-29X	6/9/2016	220.1	
AOC_5	SHP-99-29X	8/16/2016	218.6	
AOC_5	SHP-99-29X	11/16/2016	218.1	
AOC_5	SHP-99-29X	5/11/2018	221.5	
AOC_5	SHP-99-29X	11/1/2018	220.6	
AOC_5	SHP-99-29X	4/11/2019	222.5	
AOC_5	SHP-99-29X	10/22/2019	219.4	
AOC_5	SHP-99-31A	4/10/2012	209.0	
AOC_5	SHP-99-31A	11/5/2012	210.7	
AOC_5	SHP-99-31A	5/15/2013	209.0	
AOC_5	SHP-99-31A	6/11/2013	208.9	
AOC_5	SHP-99-31A	10/21/2013	208.3	
AOC_5	SHP-99-31A	4/22/2014	209.5	
AOC_5	SHP-99-31A	10/6/2014	208.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-99-31A	6/3/2015	208.7	
AOC_5	SHP-99-31A	10/20/2015	208.0	
AOC_5	SHP-99-31A	10/21/2015	208.0	
AOC_5	SHP-99-31B	4/10/2012		-4.4
AOC_5	SHP-99-31B	11/5/2012		-3.9
AOC_5	SHP-99-31B	5/15/2013		-4.4
AOC_5	SHP-99-31B	6/11/2013		-3.3
AOC_5	SHP-99-31B	10/21/2013		-5.0
AOC_5	SHP-99-31B	4/22/2014		-3.0
AOC_5	SHP-99-31B	10/6/2014		-4.9
AOC_5	SHP-99-31B	6/3/2015		-4.0
AOC_5	SHP-99-31B	10/20/2015		-4.9
AOC_5	SHP-99-31C	4/10/2012		-4.6
AOC_5	SHP-99-31C	11/5/2012		-4.1
AOC_5	SHP-99-31C	5/15/2013		-4.7
AOC_5	SHP-99-31C	6/11/2013		-3.6
AOC_5	SHP-99-31C	10/21/2013		-5.3
AOC_5	SHP-99-31C	4/22/2014		-1.9
AOC_5	SHP-99-31C	10/6/2014		-5.1
AOC_5	SHP-99-31C	6/3/2015		-4.3
AOC_5	SHP-99-31C	10/20/2015		-5.2
AOC_5	SHP-99-31C	11/16/2016		-4.4
AOC_5	SHP-99-33A	2/23/1999	211.5	
AOC_5	SHP-99-33A	6/6/1999	209.7	
AOC_5	SHP-99-33A	9/8/1999	208.9	
AOC_5	SHP-99-33A	11/16/2001	209.9	
AOC_5	SHP-99-33A	8/4/2005	210.2	
AOC_5	SHP-99-33A	8/24/2005	209.9	
AOC_5	SHP-99-33A	8/26/2005	209.8	
AOC_5	SHP-99-33A	4/10/2006	210.9	
AOC_5	SHP-99-33A	6/5/2006	212.4	
AOC_5	SHP-99-33A	9/18/2006	210.4	
AOC_5	SHP-99-33A	12/15/2006	211.5	
AOC_5	SHP-99-33A	4/25/2013	210.6	
AOC_5	SHP-99-33A	5/30/2013	211.0	
AOC_5	SHP-99-33A	10/20/2015		
AOC_5	SHP-99-33B	2/23/1999	210.6	
AOC_5	SHP-99-33B	6/6/1999	209.4	
AOC_5	SHP-99-33B	9/8/1999	208.6	
AOC_5	SHP-99-33B	11/16/2001	209.6	
AOC_5	SHP-99-33B	8/4/2005	210.4	
AOC_5	SHP-99-33B	8/24/2005	210.2	
AOC_5	SHP-99-33B	8/26/2005	210.2	
AOC_5	SHP-99-33B	4/10/2006	210.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-99-33B	6/5/2006	212.0	
AOC_5	SHP-99-33B	9/18/2006	210.5	
AOC_5	SHP-99-33B	12/15/2006	211.3	
AOC_5	SHP-99-34A	2/23/1999	210.0	
AOC_5	SHP-99-34A	6/6/1999	208.8	
AOC_5	SHP-99-34A	9/8/1999	208.5	
AOC_5	SHP-99-34A	11/16/2001	209.1	
AOC_5	SHP-99-34A	8/4/2005	209.0	
AOC_5	SHP-99-34A	8/24/2005	208.9	
AOC_5	SHP-99-34A	8/26/2005	208.9	
AOC_5	SHP-99-34A	6/5/2006	211.0	
AOC_5	SHP-99-34A	12/15/2006	209.9	
AOC_5	SHP-99-34A	4/8/2007	209.8	
AOC_5	SHP-99-34A	4/9/2007	209.8	
AOC_5	SHP-99-34A	10/15/2007	209.2	
AOC_5	SHP-99-34A	2/20/2008	211.0	
AOC_5	SHP-99-34A	2/25/2008	210.2	
AOC_5	SHP-99-34A	3/4/2008	210.2	
AOC_5	SHP-99-34A	4/16/2008	210.1	
AOC_5	SHP-99-34A	9/30/2008	210.4	
AOC_5	SHP-99-34A	4/28/2009	210.2	
AOC_5	SHP-99-34A	11/3/2009	211.0	
AOC_5	SHP-99-34A	4/20/2010	210.0	
AOC_5	SHP-99-34A	10/7/2010	209.9	
AOC_5	SHP-99-34A	4/4/2011	210.0	
AOC_5	SHP-99-34A	11/8/2011	210.3	
AOC_5	SHP-99-34A	4/10/2012	209.2	
AOC_5	SHP-99-34B	2/23/1999	212.9	
AOC_5	SHP-99-34B	6/6/1999	211.6	
AOC_5	SHP-99-34B	9/8/1999	210.9	
AOC_5	SHP-99-34B	11/16/2001	211.4	
AOC_5	SHP-99-34B	8/4/2005	211.4	
AOC_5	SHP-99-34B	8/24/2005	211.6	
AOC_5	SHP-99-34B	8/26/2005	211.7	
AOC_5	SHP-99-34B	4/10/2006	211.7	
AOC_5	SHP-99-34B	6/5/2006	212.9	
AOC_5	SHP-99-34B	9/18/2006	212.0	
AOC_5	SHP-99-34B	12/15/2006	212.5	
AOC_5	SHP-99-34B	4/8/2007	212.5	
AOC_5	SHP-99-34B	4/9/2007	212.5	
AOC_5	SHP-99-34B	10/15/2007	211.1	
AOC_5	SHP-99-34B	2/20/2008	212.6	
AOC_5	SHP-99-34B	2/25/2008	213.3	
AOC_5	SHP-99-34B	3/4/2008	213.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-99-34B	4/16/2008	212.6	
AOC_5	SHP-99-34B	9/30/2008	212.3	
AOC_5	SHP-99-34B	4/28/2009	212.1	
AOC_5	SHP-99-34B	11/3/2009	213.0	
AOC_5	SHP-99-34B	4/20/2010	213.4	
AOC_5	SHP-99-34B	10/7/2010	211.0	
AOC_5	SHP-99-34B	4/4/2011	213.1	
AOC_5	SHP-99-34B	11/8/2011	212.7	
AOC_5	SHP-99-34B	4/10/2012	211.3	
AOC_5	SHP-99-34B	11/5/2012	211.7	
AOC_5	SHP-99-34B	4/25/2013	212.1	
AOC_5	SHP-99-34B	5/15/2013	211.6	
AOC_5	SHP-99-34B	5/30/2013	211.9	
AOC_5	SHP-99-34B	6/11/2013	212.3	
AOC_5	SHP-99-34B	10/21/2013	210.7	
AOC_5	SHP-99-34B	10/6/2014	211.1	
AOC_5	SHP-99-34B	6/3/2015	212.0	
AOC_5	SHP-99-34B	6/17/2015	211.8	
AOC_5	SHP-99-34B	10/20/2015	211.0	
AOC_5	SHP-99-34B	12/16/2015	211.5	
AOC_5	SHP-99-34B	6/9/2016	211.7	
AOC_5	SHP-99-34B	8/16/2016	210.8	
AOC_5	SHP-99-34B	10/20/2016	210.8	
AOC_5	SHP-99-34B	11/1/2018	212.3	
AOC_5	SHP-99-34B	10/22/2019	211.1	
AOC_5	SHP-99-35X	6/6/1999	217.8	
AOC_5	SHP-99-35X	9/8/1999	220.1	
AOC_5	SHP-99-35X	11/16/2001	220.6	
AOC_5	SHP-99-35X	8/4/2005	222.0	
AOC_5	SHP-99-35X	8/24/2005	221.8	
AOC_5	SHP-99-35X	8/26/2005	223.2	
AOC_5	SHP-99-35X	4/10/2006	222.5	
AOC_5	SHP-99-35X	6/5/2006	222.6	
AOC_5	SHP-99-35X	9/18/2006	221.9	
AOC_5	SHP-99-35X	12/15/2006	221.5	
AOC_5	SHP-99-35X	4/8/2007	221.5	
AOC_5	SHP-99-35X	4/9/2007	221.5	
AOC_5	SHP-99-35X	10/15/2007	221.0	
AOC_5	SHP-99-35X	2/20/2008	221.2	
AOC_5	SHP-99-35X	2/25/2008	221.3	
AOC_5	SHP-99-35X	3/4/2008	221.5	
AOC_5	SHP-99-35X	4/16/2008	222.6	
AOC_5	SHP-99-35X	6/10/2008	222.4	
AOC_5	SHP-99-35X	8/19/2008	221.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHP-99-35X	9/15/2008	221.5	
AOC_5	SHP-99-35X	9/30/2008	218.6	
AOC_5	SHP-99-35X	4/28/2009	222.4	
AOC_5	SHP-99-35X	9/14/2009	221.7	
AOC_5	SHP-99-35X	10/26/2009	221.3	
AOC_5	SHP-99-35X	11/3/2009	221.3	
AOC_5	SHP-99-35X	4/20/2010	223.0	
AOC_5	SHP-99-35X	4/27/2010	223.3	
AOC_5	SHP-99-35X	9/14/2010	221.1	
AOC_5	SHP-99-35X	10/7/2010	221.0	
AOC_5	SHP-99-35X	4/4/2011	221.4	
AOC_5	SHP-99-35X	7/25/2011	221.5	
AOC_5	SHP-99-35X	11/8/2011	221.8	
AOC_5	SHP-99-35X	4/10/2012	221.7	
AOC_5	SHP-99-35X	6/26/2012	221.4	
AOC_5	SHP-99-35X	11/5/2012	220.7	
AOC_5	SHP-99-35X	11/6/2012	220.8	
AOC_5	SHP-99-35X	4/25/2013	221.4	
AOC_5	SHP-99-35X	5/15/2013	221.4	
AOC_5	SHP-99-35X	6/11/2013	221.4	
AOC_5	SHP-99-35X	10/21/2013	221.3	
AOC_5	SHP-99-35X	4/22/2014	221.2	
AOC_5	SHP-99-35X	10/6/2014	223.3	
AOC_5	SHP-99-35X	6/3/2015	221.9	
AOC_5	SHP-99-35X	6/17/2015	221.9	
AOC_5	SHP-99-35X	10/20/2015	222.7	
AOC_5	SHP-99-35X	12/16/2015	219.6	
AOC_5	SHP-99-35X	6/9/2016	221.6	
AOC_5	SHP-99-35X	8/16/2016	221.2	
AOC_5	SHP-99-35X	11/15/2016	220.5	
AOC_5	SHP-99-35X	5/11/2018	222.5	
AOC_5	SHP-99-35X	11/1/2018		232.3
AOC_5	SHP-99-35X	4/11/2019	223.7	
AOC_5	SHP-99-35X	10/22/2019	221.9	
AOC_5	SHP-99-35X	4/29/2020	223.4	
AOC_5	SHSG-13-01G	7/20/2013	198.1	
AOC_5	SHSG-13-01G	4/23/2014	198.6	
AOC_5	SHSG-13-01G	10/6/2014		
AOC_5	SHSG-13-01G	10/7/2014	198.7	
AOC_5	SHSG-13-01G	10/20/2015		
AOC_5	SHSG-13-01G	10/22/2019	200.5	
AOC_5	SHSG-13-02G	7/20/2013	202.9	
AOC_5	SHSG-13-02G	4/23/2014	202.5	
AOC_5	SHSG-13-02G	10/6/2014		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_5	SHSG-13-02G	10/7/2014	202.1	
AOC_5	SHSG-13-02G	10/20/2015		
AOC_5	SHSG-14-01G	4/23/2014	208.8	
AOC_5	SHSG-14-01G	10/22/2019	212.3	
AOC_50	50PZ-19-01	8/14/2019	209.9	
AOC_50	50PZ-19-01	10/7/2019	209.0	
AOC_50	50PZ-19-01	4/27/2020	210.2	
AOC_50	50PZ-19-02	8/14/2019	207.0	
AOC_50	50PZ-19-02	10/7/2019	205.9	
AOC_50	50PZ-19-02	4/27/2020	207.7	
AOC_50	50PZ-19-03	10/7/2019	213.3	
AOC_50	50PZ-19-03	4/27/2020	214.8	
AOC_50	50PZ-19-04	10/7/2019	208.2	
AOC_50	50PZ-19-04	4/27/2020	209.3	
AOC_50	50PZ-19-05	10/7/2019	212.1	
AOC_50	50PZ-19-05	4/27/2020	212.9	
AOC_50	50PZ-19-06	10/7/2019	204.5	
AOC_50	50PZ-19-06	4/27/2020	207.6	
AOC_50	50PZ-19-07	10/7/2019	201.0	
AOC_50	50PZ-19-07	4/27/2020	202.6	
AOC_50	G6M-01-01X	10/12/2015	201.0	
AOC_50	G6M-02-01X	6/15/2015	208.0	
AOC_50	G6M-02-01X	10/12/2015	206.4	
AOC_50	G6M-02-01X	2/3/2016	206.4	
AOC_50	G6M-02-01X	5/18/2016	207.4	
AOC_50	G6M-02-01X	11/7/2016		
AOC_50	G6M-02-01X	5/15/2017		
AOC_50	G6M-02-01X	10/2/2017	207.3	
AOC_50	G6M-02-01X	4/2/2018	208.3	
AOC_50	G6M-02-01X	10/15/2018	209.3	
AOC_50	G6M-02-01X	4/2/2019	210.3	
AOC_50	G6M-02-01X	8/14/2019	209.1	
AOC_50	G6M-02-01X	10/7/2019	208.1	
AOC_50	G6M-02-01X	4/27/2020	209.3	
AOC_50	G6M-02-01X	5/11/2020	209.7	
AOC_50	G6M-02-02X	10/12/2015	207.4	
AOC_50	G6M-02-03X	8/21/2015	203.2	
AOC_50	G6M-02-03X	10/12/2015	202.7	
AOC_50	G6M-02-03X	5/18/2016	204.0	
AOC_50	G6M-02-03X	11/7/2016	202.6	
AOC_50	G6M-02-03X	5/15/2017	205.6	
AOC_50	G6M-02-03X	10/2/2017		174.4
AOC_50	G6M-02-03X	8/14/2019	204.9	
AOC_50	G6M-02-03X	10/7/2019	203.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-02-03X	4/27/2020	206.4	
AOC_50	G6M-02-03X	5/11/2020	206.5	
AOC_50	G6M-02-04X	6/15/2015	204.8	
AOC_50	G6M-02-04X	8/21/2015	203.2	
AOC_50	G6M-02-04X	9/14/2015	202.8	
AOC_50	G6M-02-04X	10/12/2015	202.6	
AOC_50	G6M-02-04X	5/18/2016	203.9	
AOC_50	G6M-02-04X	11/7/2016	202.5	
AOC_50	G6M-02-04X	5/15/2017	205.6	
AOC_50	G6M-02-04X	10/2/2017	203.3	
AOC_50	G6M-02-04X	4/2/2018	205.3	
AOC_50	G6M-02-04X	10/15/2018	206.2	
AOC_50	G6M-02-04X	4/2/2019	206.4	
AOC_50	G6M-02-04X	8/14/2019	204.8	
AOC_50	G6M-02-04X	10/7/2019	202.9	
AOC_50	G6M-02-04X	4/27/2020	206.3	
AOC_50	G6M-02-04X	5/11/2020	206.5	
AOC_50	G6M-02-06X	8/21/2015	205.8	
AOC_50	G6M-02-06X	5/18/2016	201.5	
AOC_50	G6M-02-06X	11/7/2016	201.2	
AOC_50	G6M-02-06X	5/15/2017	204.4	
AOC_50	G6M-02-06X	10/2/2017	200.4	
AOC_50	G6M-02-06X	4/2/2018	203.6	
AOC_50	G6M-02-06X	10/15/2018	204.7	
AOC_50	G6M-02-06X	4/2/2019	204.4	
AOC_50	G6M-02-06X	10/7/2019	201.3	
AOC_50	G6M-02-06X	4/27/2020	204.4	
AOC_50	G6M-02-06X	5/11/2020	203.9	
AOC_50	G6M-02-07X	6/15/2015		148.7
AOC_50	G6M-02-07X	8/21/2015		
AOC_50	G6M-02-07X	5/18/2016	201.3	
AOC_50	G6M-02-07X	11/7/2016	201.0	
AOC_50	G6M-02-07X	5/15/2017	204.0	
AOC_50	G6M-02-07X	10/2/2017	200.5	
AOC_50	G6M-02-07X	4/2/2018	203.5	
AOC_50	G6M-02-07X	10/15/2018	204.5	
AOC_50	G6M-02-07X	4/2/2019	204.1	
AOC_50	G6M-02-07X	10/7/2019	201.1	
AOC_50	G6M-02-07X	4/27/2020	204.2	
AOC_50	G6M-02-07X	5/11/2020	203.7	
AOC_50	G6M-02-08X	8/21/2015	210.2	
AOC_50	G6M-02-08X	9/9/2015	209.8	
AOC_50	G6M-02-08X	10/12/2015	209.3	
AOC_50	G6M-02-08X	2/3/2016	210.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-02-08X	5/18/2016	210.1	
AOC_50	G6M-02-08X	11/7/2016	208.5	
AOC_50	G6M-02-08X	5/15/2017	209.8	
AOC_50	G6M-02-08X	10/2/2017	209.3	
AOC_50	G6M-02-08X	4/2/2018	210.1	
AOC_50	G6M-02-08X	10/15/2018	212.3	
AOC_50	G6M-02-08X	4/2/2019	211.7	
AOC_50	G6M-02-08X	8/14/2019	211.9	
AOC_50	G6M-02-08X	10/7/2019	209.6	
AOC_50	G6M-02-08X	4/27/2020	210.9	
AOC_50	G6M-02-08X	5/11/2020	212.7	
AOC_50	G6M-02-09X	8/21/2015	204.0	
AOC_50	G6M-02-09X	10/12/2015	203.5	
AOC_50	G6M-02-10X	10/12/2015	202.4	
AOC_50	G6M-02-11X	6/15/2015	202.8	
AOC_50	G6M-02-11X	8/21/2015	202.1	
AOC_50	G6M-02-11X	9/10/2015	201.6	
AOC_50	G6M-02-11X	10/12/2015	201.5	
AOC_50	G6M-02-11X	2/3/2016	202.2	
AOC_50	G6M-02-11X	5/18/2016	202.8	
AOC_50	G6M-02-11X	11/7/2016	201.9	
AOC_50	G6M-02-11X	5/15/2017	204.7	
AOC_50	G6M-02-11X	10/2/2017	202.0	
AOC_50	G6M-02-11X	4/2/2018	204.5	
AOC_50	G6M-02-11X	10/15/2018	205.5	
AOC_50	G6M-02-11X	4/2/2019	205.3	
AOC_50	G6M-02-11X	8/14/2019	203.5	
AOC_50	G6M-02-11X	10/7/2019	202.3	
AOC_50	G6M-02-11X	4/27/2020	205.5	
AOC_50	G6M-02-11X	5/11/2020	205.4	
AOC_50	G6M-02-12X	6/15/2015	202.7	
AOC_50	G6M-02-12X	10/12/2015	200.5	
AOC_50	G6M-02-12X	5/18/2016	202.7	
AOC_50	G6M-02-12X	11/7/2016	201.8	
AOC_50	G6M-02-12X	5/15/2017	204.7	
AOC_50	G6M-02-12X	10/2/2017	201.8	
AOC_50	G6M-02-12X	10/7/2019	203.2	
AOC_50	G6M-02-12X	4/27/2020	205.4	
AOC_50	G6M-02-12X	5/11/2020	205.3	
AOC_50	G6M-02-13X	6/15/2015	203.6	
AOC_50	G6M-02-13X	8/21/2015	202.9	
AOC_50	G6M-02-13X	9/11/2015	201.4	
AOC_50	G6M-02-13X	10/12/2015	202.3	
AOC_50	G6M-02-13X	5/18/2016	203.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-02-13X	11/7/2016	197.0	
AOC_50	G6M-02-13X	5/15/2017	205.3	
AOC_50	G6M-02-13X	10/2/2017	202.9	
AOC_50	G6M-02-13X	4/2/2018	205.1	
AOC_50	G6M-02-13X	10/15/2018	206.0	
AOC_50	G6M-02-13X	4/2/2019		155.5
AOC_50	G6M-02-13X	10/7/2019	202.8	
AOC_50	G6M-02-13X	4/27/2020	205.9	
AOC_50	G6M-02-13X	5/11/2020	206.1	
AOC_50	G6M-02-31BR	10/12/2015	208.3	
AOC_50	G6M-03-01X	6/15/2015	211.1	
AOC_50	G6M-03-01X	8/21/2015	210.2	
AOC_50	G6M-03-01X	9/10/2015	210.2	
AOC_50	G6M-03-01X	10/12/2015	209.3	
AOC_50	G6M-03-01X	2/3/2016	209.2	
AOC_50	G6M-03-01X	5/18/2016	210.1	
AOC_50	G6M-03-01X	11/7/2016	208.7	
AOC_50	G6M-03-01X	5/15/2017	211.7	
AOC_50	G6M-03-01X	10/2/2017	210.5	
AOC_50	G6M-03-01X	4/27/2020	212.7	
AOC_50	G6M-03-02X	6/15/2015	210.2	
AOC_50	G6M-03-02X	10/12/2015	209.7	
AOC_50	G6M-03-02X	5/18/2016	210.5	
AOC_50	G6M-03-02X	11/7/2016	208.8	
AOC_50	G6M-03-02X	5/15/2017	211.2	
AOC_50	G6M-03-02X	10/2/2017	210.9	
AOC_50	G6M-03-04X	10/12/2015	210.5	
AOC_50	G6M-03-07X	6/15/2015	205.7	
AOC_50	G6M-03-07X	9/14/2015	204.5	
AOC_50	G6M-03-07X	10/12/2015	204.2	
AOC_50	G6M-03-07X	2/3/2016	204.4	
AOC_50	G6M-03-07X	5/18/2016	205.3	
AOC_50	G6M-03-07X	11/7/2016	203.8	
AOC_50	G6M-03-07X	5/15/2017	206.7	
AOC_50	G6M-03-07X	10/2/2017	205.0	
AOC_50	G6M-03-07X	4/2/2018	206.4	
AOC_50	G6M-03-07X	10/15/2018	207.4	
AOC_50	G6M-03-07X	4/2/2019	207.9	
AOC_50	G6M-03-07X	8/14/2019	206.7	
AOC_50	G6M-03-07X	10/7/2019	205.2	
AOC_50	G6M-03-07X	4/27/2020	207.2	
AOC_50	G6M-03-07X	5/11/2020	207.7	
AOC_50	G6M-03-07X	5/13/2020	207.7	
AOC_50	G6M-03-08X	6/15/2015	202.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-03-08X	10/12/2015	201.3	
AOC_50	G6M-03-08X	2/3/2016	202.4	
AOC_50	G6M-03-08X	5/18/2016	202.6	
AOC_50	G6M-03-08X	11/7/2016	201.7	
AOC_50	G6M-03-08X	5/15/2017	204.5	
AOC_50	G6M-03-08X	10/2/2017	201.7	
AOC_50	G6M-03-08X	10/7/2019	202.0	
AOC_50	G6M-03-08X	4/27/2020	205.2	
AOC_50	G6M-03-08X	5/13/2020	204.8	
AOC_50	G6M-03-09X	6/15/2015	202.5	
AOC_50	G6M-03-09X	10/12/2015	201.3	
AOC_50	G6M-03-09X	2/3/2016	201.9	
AOC_50	G6M-03-09X	5/18/2016	202.5	
AOC_50	G6M-03-09X	11/7/2016	201.6	
AOC_50	G6M-03-09X	5/15/2017	204.4	
AOC_50	G6M-03-09X	10/2/2017	201.6	
AOC_50	G6M-03-09X	10/7/2019	202.0	
AOC_50	G6M-03-09X	4/27/2020	205.2	
AOC_50	G6M-03-09X	5/11/2020	205.1	
AOC_50	G6M-03-10X	6/15/2015	202.6	
AOC_50	G6M-03-10X	8/21/2015	201.9	
AOC_50	G6M-03-10X	9/10/2015		234.4
AOC_50	G6M-03-10X	10/12/2015	201.4	
AOC_50	G6M-03-10X	2/3/2016	201.8	
AOC_50	G6M-03-10X	5/18/2016	202.6	
AOC_50	G6M-03-10X	11/7/2016	201.7	
AOC_50	G6M-03-10X	5/15/2017	204.6	
AOC_50	G6M-03-10X	10/2/2017	201.7	
AOC_50	G6M-03-10X	4/2/2018	204.3	
AOC_50	G6M-03-10X	10/15/2018	205.3	
AOC_50	G6M-03-10X	4/2/2019	205.1	
AOC_50	G6M-03-10X	8/14/2019	203.3	
AOC_50	G6M-03-10X	10/7/2019	202.1	
AOC_50	G6M-03-10X	4/27/2020	205.3	
AOC_50	G6M-03-10X	5/11/2020	205.2	
AOC_50	G6M-03-11X	10/12/2015	201.9	
AOC_50	G6M-04-01X	6/15/2015	208.6	
AOC_50	G6M-04-01X	8/21/2015	207.9	
AOC_50	G6M-04-01X	10/12/2015	207.1	
AOC_50	G6M-04-01X	2/3/2016	206.9	
AOC_50	G6M-04-01X	5/18/2016	208.1	
AOC_50	G6M-04-01X	11/7/2016		
AOC_50	G6M-04-01X	5/15/2017		
AOC_50	G6M-04-01X	10/2/2017	208.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-04-01X	4/2/2018	209.1	
AOC_50	G6M-04-01X	10/15/2018	209.9	
AOC_50	G6M-04-01X	4/2/2019	211.0	
AOC_50	G6M-04-01X	8/14/2019	209.8	
AOC_50	G6M-04-01X	10/7/2019	208.7	
AOC_50	G6M-04-01X	4/27/2020	209.9	
AOC_50	G6M-04-01X	5/11/2020	210.2	
AOC_50	G6M-04-02X	6/15/2015	206.4	
AOC_50	G6M-04-02X	8/21/2015	207.5	
AOC_50	G6M-04-02X	9/11/2015	205.1	
AOC_50	G6M-04-02X	10/12/2015	204.8	
AOC_50	G6M-04-02X	2/3/2016	204.7	
AOC_50	G6M-04-02X	5/18/2016	206.0	
AOC_50	G6M-04-02X	11/7/2016	204.2	
AOC_50	G6M-04-02X	5/15/2017	206.9	
AOC_50	G6M-04-02X	10/2/2017	205.9	
AOC_50	G6M-04-02X	4/2/2018	207.0	
AOC_50	G6M-04-02X	10/15/2018	207.9	
AOC_50	G6M-04-02X	4/2/2019	208.7	
AOC_50	G6M-04-02X	8/14/2019	207.4	
AOC_50	G6M-04-02X	10/7/2019	205.8	
AOC_50	G6M-04-02X	4/27/2020	207.7	
AOC_50	G6M-04-02X	5/11/2020	205.2	
AOC_50	G6M-04-02X	5/12/2020	208.2	
AOC_50	G6M-04-03X	6/15/2015	208.3	
AOC_50	G6M-04-03X	8/21/2015	207.3	
AOC_50	G6M-04-03X	10/12/2015	205.7	
AOC_50	G6M-04-03X	2/3/2016	205.3	
AOC_50	G6M-04-03X	5/18/2016	206.8	
AOC_50	G6M-04-03X	5/15/2017	207.8	
AOC_50	G6M-04-03X	10/2/2017	206.8	
AOC_50	G6M-04-03X	4/2/2018	207.9	
AOC_50	G6M-04-03X	10/15/2018	208.7	
AOC_50	G6M-04-03X	4/2/2019	209.7	
AOC_50	G6M-04-03X	8/14/2019	208.3	
AOC_50	G6M-04-03X	10/7/2019	207.3	
AOC_50	G6M-04-03X	4/27/2020	208.8	
AOC_50	G6M-04-03X	5/11/2020	209.0	
AOC_50	G6M-04-03X	5/12/2020	208.9	
AOC_50	G6M-04-04X	6/15/2015	204.4	
AOC_50	G6M-04-04X	8/21/2015	203.6	
AOC_50	G6M-04-04X	9/14/2015	203.1	
AOC_50	G6M-04-04X	10/12/2015	202.9	
AOC_50	G6M-04-04X	2/3/2016	203.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-04-04X	5/18/2016	204.2	
AOC_50	G6M-04-04X	5/15/2017	205.6	
AOC_50	G6M-04-04X	10/2/2017	203.9	
AOC_50	G6M-04-04X	4/2/2018	205.5	
AOC_50	G6M-04-04X	10/15/2018	206.3	
AOC_50	G6M-04-04X	4/2/2019	206.8	
AOC_50	G6M-04-04X	8/14/2019	205.3	
AOC_50	G6M-04-04X	10/7/2019	203.8	
AOC_50	G6M-04-04X	4/27/2020	206.4	
AOC_50	G6M-04-04X	5/11/2020	206.5	
AOC_50	G6M-04-05X	6/15/2015	202.3	
AOC_50	G6M-04-05X	9/10/2015	201.4	
AOC_50	G6M-04-05X	10/12/2015	201.3	
AOC_50	G6M-04-05X	2/3/2016	201.7	
AOC_50	G6M-04-05X	5/18/2016	202.6	
AOC_50	G6M-04-05X	5/15/2017	204.6	
AOC_50	G6M-04-05X	10/2/2017	201.7	
AOC_50	G6M-04-05X	4/2/2018	204.3	
AOC_50	G6M-04-05X	10/15/2018	205.3	
AOC_50	G6M-04-05X	4/2/2019	205.1	
AOC_50	G6M-04-05X	8/14/2019	203.2	
AOC_50	G6M-04-05X	10/7/2019	202.0	
AOC_50	G6M-04-05X	4/27/2020	205.2	
AOC_50	G6M-04-05X	5/13/2020	204.0	
AOC_50	G6M-04-06X	6/15/2015	201.7	
AOC_50	G6M-04-06X	10/12/2015	200.8	
AOC_50	G6M-04-06X	5/18/2016	201.8	
AOC_50	G6M-04-06X	11/7/2016	201.2	
AOC_50	G6M-04-06X	5/15/2017	204.0	
AOC_50	G6M-04-06X	10/2/2017	200.7	
AOC_50	G6M-04-06X	10/7/2019	201.3	
AOC_50	G6M-04-06X	4/27/2020	204.4	
AOC_50	G6M-04-06X	5/11/2020	204.1	
AOC_50	G6M-04-07X	6/15/2015	201.8	
AOC_50	G6M-04-07X	10/12/2015	199.9	
AOC_50	G6M-04-07X	5/18/2016	201.9	
AOC_50	G6M-04-07X	11/7/2016	201.3	
AOC_50	G6M-04-07X	5/15/2017	203.7	
AOC_50	G6M-04-07X	10/2/2017	200.7	
AOC_50	G6M-04-07X	4/2/2018	203.3	
AOC_50	G6M-04-07X	10/15/2018	204.6	
AOC_50	G6M-04-07X	4/2/2019	204.3	
AOC_50	G6M-04-07X	10/7/2019	201.4	
AOC_50	G6M-04-07X	4/27/2020	204.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-04-07X	5/11/2020	204.3	
AOC_50	G6M-04-07X	5/12/2020	212.3	
AOC_50	G6M-04-08X	10/7/2019	201.3	
AOC_50	G6M-04-08X	4/27/2020	204.6	
AOC_50	G6M-04-08X	5/13/2020	203.8	
AOC_50	G6M-04-09X	6/15/2015	210.8	
AOC_50	G6M-04-09X	10/12/2015	209.0	
AOC_50	G6M-04-09X	2/3/2016	208.8	
AOC_50	G6M-04-09X	5/18/2016	209.9	
AOC_50	G6M-04-09X	11/7/2016	207.7	
AOC_50	G6M-04-09X	5/15/2017	211.1	
AOC_50	G6M-04-09X	10/2/2017	211.8	
AOC_50	G6M-04-09X	4/2/2018	211.3	
AOC_50	G6M-04-09X	10/15/2018	211.8	
AOC_50	G6M-04-09X	4/2/2019	213.0	
AOC_50	G6M-04-09X	10/7/2019	210.7	
AOC_50	G6M-04-09X	4/27/2020	212.2	
AOC_50	G6M-04-09X	5/11/2020	212.4	
AOC_50	G6M-04-10A	6/15/2015	211.2	
AOC_50	G6M-04-10A	8/21/2015	210.4	
AOC_50	G6M-04-10A	10/12/2015	209.6	
AOC_50	G6M-04-10A	5/18/2016	210.4	
AOC_50	G6M-04-10A	11/7/2016	208.7	
AOC_50	G6M-04-10A	5/15/2017	211.6	
AOC_50	G6M-04-10A	10/2/2017	210.7	
AOC_50	G6M-04-10A	4/2/2018	211.9	
AOC_50	G6M-04-10A	4/2/2019	212.5	
AOC_50	G6M-04-10A	8/14/2019	211.2	
AOC_50	G6M-04-10A	10/7/2019	210.9	
AOC_50	G6M-04-10A	4/27/2020	212.7	
AOC_50	G6M-04-10A	5/11/2020	213.0	
AOC_50	G6M-04-10A	5/12/2020	212.9	
AOC_50	G6M-04-10X	6/15/2015	210.3	
AOC_50	G6M-04-10X	8/21/2015	210.0	
AOC_50	G6M-04-10X	9/9/2015	209.5	
AOC_50	G6M-04-10X	10/12/2015	209.1	
AOC_50	G6M-04-10X	2/3/2016	209.6	
AOC_50	G6M-04-10X	5/18/2016	209.7	
AOC_50	G6M-04-10X	11/7/2016	208.2	
AOC_50	G6M-04-10X	5/15/2017	211.2	
AOC_50	G6M-04-10X	10/2/2017	210.3	
AOC_50	G6M-04-10X	4/2/2018	211.4	
AOC_50	G6M-04-10X	10/15/2018	212.1	
AOC_50	G6M-04-10X	4/2/2019	213.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-04-10X	8/14/2019	211.7	
AOC_50	G6M-04-10X	10/7/2019	210.6	
AOC_50	G6M-04-10X	4/27/2020	212.1	
AOC_50	G6M-04-10X	5/11/2020	212.4	
AOC_50	G6M-04-11X	6/15/2015	210.0	
AOC_50	G6M-04-11X	10/12/2015	208.3	
AOC_50	G6M-04-11X	5/18/2016	209.0	
AOC_50	G6M-04-11X	11/7/2016	207.3	
AOC_50	G6M-04-11X	5/15/2017	210.2	
AOC_50	G6M-04-11X	10/2/2017	209.3	
AOC_50	G6M-04-11X	4/2/2018	210.4	
AOC_50	G6M-04-11X	10/15/2018	211.1	
AOC_50	G6M-04-11X	4/2/2019	212.2	
AOC_50	G6M-04-11X	8/14/2019	210.9	
AOC_50	G6M-04-11X	10/7/2019	209.9	
AOC_50	G6M-04-11X	4/27/2020	211.0	
AOC_50	G6M-04-11X	5/11/2020	211.6	
AOC_50	G6M-04-12X	8/21/2015	211.0	
AOC_50	G6M-04-13X	6/15/2015	211.3	
AOC_50	G6M-04-13X	8/21/2015	210.4	
AOC_50	G6M-04-13X	10/12/2015	209.6	
AOC_50	G6M-04-13X	5/18/2016	210.6	
AOC_50	G6M-04-13X	11/7/2016	208.5	
AOC_50	G6M-04-13X	5/15/2017	211.8	
AOC_50	G6M-04-13X	10/2/2017	210.7	
AOC_50	G6M-04-13X	4/2/2018	211.9	
AOC_50	G6M-04-13X	10/15/2018	212.6	
AOC_50	G6M-04-13X	4/2/2019	213.5	
AOC_50	G6M-04-13X	10/7/2019	211.1	
AOC_50	G6M-04-13X	4/27/2020	212.7	
AOC_50	G6M-04-13X	5/11/2020	213.0	
AOC_50	G6M-04-14X	5/18/2016	201.7	
AOC_50	G6M-04-14X	11/7/2016	201.3	
AOC_50	G6M-04-14X	5/15/2017	204.2	
AOC_50	G6M-04-14X	10/2/2017		190.2
AOC_50	G6M-04-14X	4/2/2018	203.8	
AOC_50	G6M-04-14X	10/15/2018	204.8	
AOC_50	G6M-04-14X	4/2/2019	204.4	
AOC_50	G6M-04-14X	10/7/2019	201.3	
AOC_50	G6M-04-14X	4/27/2020	201.6	
AOC_50	G6M-04-14X	5/13/2020	203.8	
AOC_50	G6M-04-15X	6/15/2015	210.8	
AOC_50	G6M-04-15X	10/12/2015	209.1	
AOC_50	G6M-04-15X	5/18/2016	210.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-04-15X	11/7/2016	208.2	
AOC_50	G6M-04-15X	5/15/2017	211.1	
AOC_50	G6M-04-15X	10/2/2017	210.2	
AOC_50	G6M-04-15X	4/2/2018	211.3	
AOC_50	G6M-04-15X	10/15/2018	211.9	
AOC_50	G6M-04-15X	4/2/2019	212.9	
AOC_50	G6M-04-15X	8/14/2019	211.7	
AOC_50	G6M-04-15X	10/7/2019	210.6	
AOC_50	G6M-04-15X	4/27/2020	212.1	
AOC_50	G6M-04-15X	5/11/2020	212.4	
AOC_50	G6M-04-22X	6/15/2015	209.7	
AOC_50	G6M-04-22X	10/12/2015	208.1	
AOC_50	G6M-04-22X	5/18/2016	208.9	
AOC_50	G6M-04-22X	11/7/2016	207.1	
AOC_50	G6M-04-22X	5/15/2017	209.9	
AOC_50	G6M-04-22X	10/2/2017	209.3	
AOC_50	G6M-04-22X	4/2/2018	210.0	
AOC_50	G6M-04-22X	10/15/2018	210.7	
AOC_50	G6M-04-22X	4/2/2019	211.9	
AOC_50	G6M-04-22X	8/14/2019	210.8	
AOC_50	G6M-04-22X	10/7/2019	209.8	
AOC_50	G6M-04-22X	4/27/2020	210.8	
AOC_50	G6M-04-22X	5/11/2020	211.3	
AOC_50	G6M-04-31X	6/15/2015		184.5
AOC_50	G6M-04-31X	10/12/2015	208.2	
AOC_50	G6M-04-31X	5/18/2016	208.7	
AOC_50	G6M-04-31X	11/7/2016	207.3	
AOC_50	G6M-04-31X	5/15/2017	210.0	
AOC_50	G6M-04-31X	10/2/2017	204.6	
AOC_50	G6M-04-31X	4/2/2018	210.3	
AOC_50	G6M-04-31X	10/15/2018	211.1	
AOC_50	G6M-04-31X	4/2/2019	212.2	
AOC_50	G6M-04-31X	8/14/2019	211.0	
AOC_50	G6M-04-31X	10/7/2019	209.9	
AOC_50	G6M-04-31X	4/27/2020	211.3	
AOC_50	G6M-04-31X	5/11/2020	211.5	
AOC_50	G6M-06-01X	4/27/2020	206.0	
AOC_50	G6M-07-01X	4/2/2019	210.5	
AOC_50	G6M-07-01X	5/11/2020	209.8	
AOC_50	G6M-07-01X	5/13/2020	209.9	
AOC_50	G6M-07-02X	6/15/2015	211.4	
AOC_50	G6M-07-02X	10/12/2015	209.7	
AOC_50	G6M-07-02X	5/18/2016	210.4	
AOC_50	G6M-07-02X	11/7/2016	208.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-07-02X	5/15/2017	211.3	
AOC_50	G6M-07-02X	10/2/2017	210.5	
AOC_50	G6M-07-02X	4/2/2018	211.2	
AOC_50	G6M-07-02X	10/15/2018	213.0	
AOC_50	G6M-07-02X	4/2/2019	212.9	
AOC_50	G6M-07-02X	8/14/2019	212.3	
AOC_50	G6M-07-02X	10/7/2019	210.6	
AOC_50	G6M-07-02X	4/27/2020	212.0	
AOC_50	G6M-07-02X	5/11/2020	213.1	
AOC_50	G6M-07-02X	5/12/2020	213.0	
AOC_50	G6M-13-01X	6/15/2015	202.6	
AOC_50	G6M-13-01X	10/12/2015	201.4	
AOC_50	G6M-13-01X	2/3/2016	201.9	
AOC_50	G6M-13-01X	5/18/2016	202.7	
AOC_50	G6M-13-01X	11/7/2016	201.8	
AOC_50	G6M-13-01X	5/15/2017	204.6	
AOC_50	G6M-13-01X	10/2/2017	201.9	
AOC_50	G6M-13-01X	4/2/2018	204.4	
AOC_50	G6M-13-01X	10/15/2018	205.4	
AOC_50	G6M-13-01X	4/2/2019	205.1	
AOC_50	G6M-13-01X	8/14/2019	203.4	
AOC_50	G6M-13-01X	10/7/2019	210.3	
AOC_50	G6M-13-01X	4/27/2020	205.7	
AOC_50	G6M-13-01X	5/11/2020	205.3	
AOC_50	G6M-13-02X	6/15/2015	203.6	
AOC_50	G6M-13-02X	10/12/2015	202.3	
AOC_50	G6M-13-02X	5/18/2016	203.6	
AOC_50	G6M-13-02X	11/7/2016	202.3	
AOC_50	G6M-13-02X	5/15/2017	205.2	
AOC_50	G6M-13-02X	10/2/2017	202.9	
AOC_50	G6M-13-02X	4/2/2018	205.1	
AOC_50	G6M-13-02X	10/15/2018	205.9	
AOC_50	G6M-13-02X	4/2/2019	206.2	
AOC_50	G6M-13-02X	8/14/2019	204.5	
AOC_50	G6M-13-02X	10/7/2019	203.0	
AOC_50	G6M-13-02X	4/27/2020	206.0	
AOC_50	G6M-13-02X	5/11/2020	205.8	
AOC_50	G6M-13-02X	5/12/2020	205.9	
AOC_50	G6M-13-03X	6/15/2015	206.2	
AOC_50	G6M-13-03X	10/12/2015	204.6	
AOC_50	G6M-13-03X	5/18/2016	205.8	
AOC_50	G6M-13-03X	11/7/2016	204.0	
AOC_50	G6M-13-03X	5/15/2017	207.0	
AOC_50	G6M-13-03X	10/2/2017	205.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-13-03X	4/2/2018	207.0	
AOC_50	G6M-13-03X	10/15/2018	207.7	
AOC_50	G6M-13-03X	4/2/2019	211.5	
AOC_50	G6M-13-03X	8/14/2019	207.1	
AOC_50	G6M-13-03X	10/7/2019	205.5	
AOC_50	G6M-13-03X	4/27/2020	207.8	
AOC_50	G6M-13-03X	5/11/2020	208.0	
AOC_50	G6M-13-04X	6/15/2015	203.0	
AOC_50	G6M-13-04X	10/12/2015	201.6	
AOC_50	G6M-13-04X	2/3/2016	202.2	
AOC_50	G6M-13-04X	5/18/2016	202.9	
AOC_50	G6M-13-04X	11/7/2016	201.9	
AOC_50	G6M-13-04X	5/15/2017	204.7	
AOC_50	G6M-13-04X	10/2/2017	202.1	
AOC_50	G6M-13-04X	4/2/2018	204.6	
AOC_50	G6M-13-04X	10/15/2018	205.6	
AOC_50	G6M-13-04X	4/2/2019	205.4	
AOC_50	G6M-13-04X	8/14/2019	202.7	
AOC_50	G6M-13-04X	10/7/2019	202.4	
AOC_50	G6M-13-04X	4/27/2020	205.6	
AOC_50	G6M-13-04X	5/11/2020	205.4	
AOC_50	G6M-13-05X	6/15/2015	210.7	
AOC_50	G6M-13-05X	10/12/2015	209.0	
AOC_50	G6M-13-05X	2/3/2016	209.0	
AOC_50	G6M-13-05X	5/18/2016	209.9	
AOC_50	G6M-13-05X	11/7/2016	208.2	
AOC_50	G6M-13-05X	5/15/2017	211.1	
AOC_50	G6M-13-05X	10/2/2017	210.0	
AOC_50	G6M-13-05X	4/2/2018	211.2	
AOC_50	G6M-13-05X	10/15/2018	211.9	
AOC_50	G6M-13-05X	4/2/2019	212.8	
AOC_50	G6M-13-05X	8/14/2019	211.6	
AOC_50	G6M-13-05X	10/7/2019	210.5	
AOC_50	G6M-13-05X	4/27/2020	211.5	
AOC_50	G6M-13-05X	5/11/2020	212.3	
AOC_50	G6M-13-05X	5/12/2020	212.2	
AOC_50	G6M-13-06X	6/15/2015	210.5	
AOC_50	G6M-13-06X	8/21/2015	209.7	
AOC_50	G6M-13-06X	9/9/2015	209.2	
AOC_50	G6M-13-06X	10/12/2015	208.6	
AOC_50	G6M-13-06X	2/3/2016	208.5	
AOC_50	G6M-13-06X	5/18/2016	209.8	
AOC_50	G6M-13-06X	11/7/2016	207.8	
AOC_50	G6M-13-06X	5/15/2017	210.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-13-06X	10/2/2017	210.0	
AOC_50	G6M-13-06X	4/2/2018	211.0	
AOC_50	G6M-13-06X	10/15/2018	211.7	
AOC_50	G6M-13-06X	4/2/2019	212.7	
AOC_50	G6M-13-06X	10/7/2019	210.4	
AOC_50	G6M-13-06X	4/27/2020	211.6	
AOC_50	G6M-13-06X	5/11/2020	212.1	
AOC_50	G6M-18-01	4/2/2019	205.5	
AOC_50	G6M-18-01	8/14/2019	203.8	
AOC_50	G6M-18-01	10/7/2019	202.3	
AOC_50	G6M-18-01	4/27/2020	205.6	
AOC_50	G6M-18-01	5/11/2020	205.7	
AOC_50	G6M-18-02	4/2/2019	204.4	
AOC_50	G6M-18-02	8/14/2019	202.5	
AOC_50	G6M-18-02	10/7/2019	201.1	
AOC_50	G6M-18-02	4/27/2020	204.7	
AOC_50	G6M-18-02	5/11/2020	204.5	
AOC_50	G6M-92-10X	10/12/2015	210.8	
AOC_50	G6M-93-13X	9/9/2015	211.1	
AOC_50	G6M-93-13X	10/12/2015	210.5	
AOC_50	G6M-93-13X	2/3/2016	210.3	
AOC_50	G6M-93-13X	5/18/2016	211.6	
AOC_50	G6M-93-13X	11/7/2016	209.5	
AOC_50	G6M-93-13X	5/15/2017	212.7	
AOC_50	G6M-93-13X	10/2/2017	211.8	
AOC_50	G6M-94-15A	10/12/2015	211.9	
AOC_50	G6M-95-19X	6/15/2015	211.6	
AOC_50	G6M-95-19X	10/12/2015	209.7	
AOC_50	G6M-95-19X	5/18/2016	210.6	
AOC_50	G6M-95-19X	11/7/2016	208.6	
AOC_50	G6M-95-19X	5/15/2017	211.9	
AOC_50	G6M-95-19X	10/2/2017	210.9	
AOC_50	G6M-95-19X	4/2/2018	212.1	
AOC_50	G6M-95-19X	10/15/2018	212.7	
AOC_50	G6M-95-19X	4/2/2019	213.7	
AOC_50	G6M-95-19X	8/14/2019	212.2	
AOC_50	G6M-95-19X	10/7/2019	211.2	
AOC_50	G6M-95-19X	4/27/2020	212.8	
AOC_50	G6M-95-19X	5/11/2020	213.1	
AOC_50	G6M-95-20X	6/15/2015	212.2	
AOC_50	G6M-95-20X	10/12/2015	209.9	
AOC_50	G6M-95-20X	5/18/2016	210.8	
AOC_50	G6M-95-20X	11/7/2016	209.0	
AOC_50	G6M-95-20X	5/15/2017	212.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-95-20X	10/2/2017	211.0	
AOC_50	G6M-95-20X	4/2/2018	213.4	
AOC_50	G6M-95-20X	10/15/2018	213.1	
AOC_50	G6M-95-20X	4/2/2019	213.9	
AOC_50	G6M-95-20X	8/14/2019	212.4	
AOC_50	G6M-95-20X	10/7/2019	211.3	
AOC_50	G6M-95-20X	4/27/2020	213.1	
AOC_50	G6M-95-20X	5/11/2020	213.4	
AOC_50	G6M-96-22A	6/15/2015	212.8	
AOC_50	G6M-96-22A	10/12/2015	211.0	
AOC_50	G6M-96-22A	5/18/2016	211.8	
AOC_50	G6M-96-22A	11/7/2016	210.7	
AOC_50	G6M-96-22A	5/15/2017	213.8	
AOC_50	G6M-96-22A	10/2/2017	211.7	
AOC_50	G6M-96-22A	8/14/2019	212.9	
AOC_50	G6M-96-22A	10/7/2019	211.8	
AOC_50	G6M-96-22A	4/27/2020	214.4	
AOC_50	G6M-96-22A	5/11/2020	214.2	
AOC_50	G6M-96-22B	6/15/2015	212.2	
AOC_50	G6M-96-22B	10/12/2015	210.2	
AOC_50	G6M-96-22B	5/18/2016	211.4	
AOC_50	G6M-96-22B	11/7/2016	210.0	
AOC_50	G6M-96-22B	5/15/2017	213.1	
AOC_50	G6M-96-22B	10/2/2017	211.2	
AOC_50	G6M-96-22B	8/14/2019	212.5	
AOC_50	G6M-96-22B	10/7/2019	211.5	
AOC_50	G6M-96-22B	4/27/2020	213.7	
AOC_50	G6M-96-22B	5/11/2020	213.7	
AOC_50	G6M-96-25A	10/12/2015	211.2	
AOC_50	G6M-96-25A	8/14/2019	213.3	
AOC_50	G6M-96-25B	10/12/2015	208.5	
AOC_50	G6M-96-25B	8/14/2019	210.8	
AOC_50	G6M-96-26A	10/12/2015	210.8	
AOC_50	G6M-96-26B	10/12/2015	209.8	
AOC_50	G6M-97-05B	10/12/2015	201.2	
AOC_50	G6M-97-05B	2/3/2016	201.4	
AOC_50	G6M-97-05B	5/18/2016	202.2	
AOC_50	G6M-97-05B	11/7/2016	201.5	
AOC_50	G6M-97-05B	5/15/2017	204.2	
AOC_50	G6M-97-05B	10/2/2017	201.5	
AOC_50	G6M-97-05B	4/2/2018	205.1	
AOC_50	G6M-97-05B	10/15/2018	205.1	
AOC_50	G6M-97-05B	4/2/2019	204.8	
AOC_50	G6M-97-05B	8/14/2019	203.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	G6M-97-05B	10/7/2019	201.8	
AOC_50	G6M-97-05B	4/27/2020	204.9	
AOC_50	G6M-97-05B	5/11/2020	204.9	
AOC_50	G6M-97-09B	10/12/2015	208.7	
AOC_50	G6M-97-27X	10/12/2015	210.4	
AOC_50	G6M-97-28X	10/12/2015	202.5	
AOC_50	G6M-97-28X	5/18/2016	203.9	
AOC_50	G6M-97-28X	11/7/2016	202.4	
AOC_50	G6M-97-28X	5/15/2017	205.4	
AOC_50	G6M-97-28X	10/2/2017	203.3	
AOC_50	G6M-97-28X	4/2/2018	205.2	
AOC_50	G6M-97-28X	10/15/2018	206.1	
AOC_50	G6M-97-28X	4/2/2019	206.3	
AOC_50	G6M-97-28X	8/14/2019	204.7	
AOC_50	G6M-97-28X	10/7/2019	203.2	
AOC_50	G6M-97-28X	4/27/2020	206.2	
AOC_50	G6M-97-28X	5/11/2020	206.4	
AOC_50	G6M-97-29X	10/12/2015	202.2	
AOC_50	G6M-98-32X	10/12/2015	202.4	
AOC_50	G6P-97-05X	4/2/2019	211.9	
AOC_50	G6P-97-05X	8/14/2019	210.7	
AOC_50	G6P-97-05X	10/7/2019	209.4	
AOC_50	G6P-97-05X	4/27/2020	211.5	
AOC_50	G6P-97-05X	5/11/2020	211.8	
AOC_50	MW-3	6/15/2015	203.0	
AOC_50	MW-3	10/12/2015	201.6	
AOC_50	MW-3	2/3/2016	202.0	
AOC_50	MW-3	5/18/2016	202.8	
AOC_50	MW-3	11/7/2016	202.0	
AOC_50	MW-3	5/15/2017	204.7	
AOC_50	MW-3	10/2/2017	201.6	
AOC_50	MW-3	10/7/2019	202.5	
AOC_50	MW-3	4/27/2020	205.6	
AOC_50	MW-3	5/13/2020	205.4	
AOC_50	MW-4	10/12/2015	202.5	
AOC_50	MW-5	10/12/2015	202.5	
AOC_50	MW-6	10/12/2015	201.9	
AOC_50	MW-7	6/15/2015	203.1	
AOC_50	MW-7	10/12/2015	201.9	
AOC_50	MW-7	5/18/2016	207.2	
AOC_50	MW-7	6/24/2016		253.1
AOC_50	MW-7	11/7/2016	202.0	
AOC_50	MW-7	11/15/2016		
AOC_50	MW-7	5/15/2017	205.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	MW-7	5/22/2017		258.9
AOC_50	MW-7	10/2/2017	202.3	
AOC_50	MW-7	4/2/2018	204.6	
AOC_50	MW-7	10/15/2018	205.7	
AOC_50	MW-7	11/1/2018		
AOC_50	MW-7	4/2/2019	205.6	
AOC_50	MW-7	10/7/2019	201.8	
AOC_50	MW-7	4/27/2020	205.6	
AOC_50	MW-7	5/11/2020	205.7	
AOC_50	MW-7 (IT)	10/7/2019		
AOC_50	MW-7 (IT)	4/27/2020	208.6	
AOC_50	XSA-12-95X	6/15/2015	199.3	
AOC_50	XSA-12-95X	10/12/2015	200.8	
AOC_50	XSA-12-95X	5/18/2016	201.4	
AOC_50	XSA-12-95X	5/15/2017		233.0
AOC_50	XSA-12-95X	10/2/2017	195.3	
AOC_50	XSA-12-95X	4/2/2018	200.8	
AOC_50	XSA-12-95X	10/15/2018	203.6	
AOC_50	XSA-12-95X	4/2/2019	202.4	
AOC_50	XSA-12-95X	10/7/2019	199.2	
AOC_50	XSA-12-95X	4/27/2020	204.3	
AOC_50	XSA-12-95X	5/11/2020	209.5	
AOC_50	XSA-12-96X	6/15/2015	203.4	
AOC_50	XSA-12-96X	5/18/2016	201.4	
AOC_50	XSA-12-96X	5/15/2017		226.0
AOC_50	XSA-12-96X	10/2/2017	200.4	
AOC_50	XSA-12-96X	4/2/2018	203.9	
AOC_50	XSA-12-96X	10/15/2018	204.4	
AOC_50	XSA-12-96X	4/2/2019	204.0	
AOC_50	XSA-12-96X	10/7/2019	201.0	
AOC_50	XSA-12-96X	4/27/2020	204.2	
AOC_50	XSA-12-96X	5/11/2020	204.9	
AOC_50	XSA-12-96X	5/12/2020	218.5	
AOC_50	XSA-12-97X	6/15/2015	197.3	
AOC_50	XSA-12-97X	10/12/2015	200.3	
AOC_50	XSA-12-97X	5/18/2016	201.4	
AOC_50	XSA-12-97X	11/7/2016	197.1	
AOC_50	XSA-12-97X	5/15/2017		233.5
AOC_50	XSA-12-97X	10/2/2017	196.5	
AOC_50	XSA-12-97X	4/2/2018	200.2	
AOC_50	XSA-12-97X	10/15/2018	205.2	
AOC_50	XSA-12-97X	4/2/2019	202.9	
AOC_50	XSA-12-97X	10/7/2019	199.6	
AOC_50	XSA-12-97X	4/27/2020	204.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_50	XSA-12-97X	5/11/2020	216.5	
AOC_50	XSA-12-98X	6/15/2015		143.7
AOC_50	XSA-12-98X	4/2/2018	203.4	
AOC_50	XSA-12-98X	10/15/2018	206.6	
AOC_50	XSA-12-98X	4/2/2019	204.1	
AOC_50	XSA-12-98X	10/7/2019	200.7	
AOC_50	XSA-12-98X	4/27/2020	206.7	
AOC_50	XSA-12-98X	5/11/2020	205.4	
AOC_57	5702MW-19-01A	3/12/2020	223.8	
AOC_57	5702MW-19-01B	3/12/2020	223.8	
AOC_57	5702MW-20-01A	3/12/2020	219.4	
AOC_57	5702MW-20-01B	3/12/2020	220.5	
AOC_57	5702MW-20-02A	3/12/2020	222.6	
AOC_57	5702MW-20-03A	3/12/2020	220.7	
AOC_57	5702MW-20-04A	3/12/2020	221.2	
AOC_57	5702MW-20-05A	3/12/2020	219.9	
AOC_57	5702MW-20-05B	3/12/2020	221.2	
AOC_57	5702MW-20-06A	3/12/2020	221.3	
AOC_57	5702MW-20-07A	3/12/2020	219.2	
AOC_57	5703MW-20-01A	3/12/2020	220.9	
AOC_57	5703MW-20-01B	3/12/2020	220.5	
AOC_57	5703MW-20-02A	3/12/2020	222.3	
AOC_57	5703MW-20-03A	3/12/2020	220.7	
AOC_57	5703MW-20-04A	3/12/2020	221.1	
AOC_57	5703PZ-19-01	3/12/2020	219.9	
AOC_57	57M-03-01X	5/18/2005	221.6	
AOC_57	57M-03-01X	11/7/2005	222.0	
AOC_57	57M-03-01X	6/5/2006	222.5	
AOC_57	57M-03-01X	6/9/2006	224.7	
AOC_57	57M-03-01X	10/17/2006	223.4	
AOC_57	57M-03-01X	10/19/2006	221.3	
AOC_57	57M-03-01X	5/23/2007	222.0	
AOC_57	57M-03-01X	10/15/2007	220.8	
AOC_57	57M-03-01X	6/25/2008	221.6	
AOC_57	57M-03-01X	5/8/2009	222.2	
AOC_57	57M-03-01X	5/20/2010	222.3	
AOC_57	57M-03-01X	6/30/2011	221.7	
AOC_57	57M-03-01X	5/15/2012	221.8	
AOC_57	57M-03-01X	6/13/2013	222.0	
AOC_57	57M-03-01X	6/18/2014	221.1	
AOC_57	57M-03-01X	6/21/2015	221.1	
AOC_57	57M-03-01X	5/19/2016	220.9	
AOC_57	57M-03-01X	6/19/2017	221.7	
AOC_57	57M-03-01X	5/8/2018	221.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-03-01X	9/28/2018	222.1	
AOC_57	57M-03-01X	4/5/2019	222.0	
AOC_57	57M-03-01X	3/12/2020	221.4	
AOC_57	57M-03-01X	5/13/2020	221.9	
AOC_57	57M-03-02X	12/1/2003	220.1	
AOC_57	57M-03-02X	5/25/2004	219.8	
AOC_57	57M-03-02X	10/7/2004	219.6	
AOC_57	57M-03-02X	5/18/2005	219.9	
AOC_57	57M-03-02X	11/7/2005	220.3	
AOC_57	57M-03-02X	6/5/2006	220.6	
AOC_57	57M-03-02X	6/9/2006	222.9	
AOC_57	57M-03-02X	10/17/2006	222.0	
AOC_57	57M-03-02X	10/19/2006	219.7	
AOC_57	57M-03-02X	5/23/2007	220.0	
AOC_57	57M-03-02X	10/15/2007	219.5	
AOC_57	57M-03-02X	6/25/2008	220.1	
AOC_57	57M-03-02X	5/8/2009	221.0	
AOC_57	57M-03-02X	5/20/2010	220.6	
AOC_57	57M-03-02X	6/30/2011	219.9	
AOC_57	57M-03-02X	5/15/2012	220.4	
AOC_57	57M-03-02X	6/13/2013	220.9	
AOC_57	57M-03-02X	6/18/2014	219.5	
AOC_57	57M-03-02X	6/21/2015	219.6	
AOC_57	57M-03-02X	5/19/2016	219.6	
AOC_57	57M-03-02X	6/19/2017	220.1	
AOC_57	57M-03-02X	5/8/2018	220.2	
AOC_57	57M-03-02X	10/1/2018	220.4	
AOC_57	57M-03-02X	4/5/2019	220.3	
AOC_57	57M-03-02X	3/12/2020	219.8	
AOC_57	57M-03-02X	5/13/2020	220.0	
AOC_57	57M-03-03X	5/18/2005	219.1	
AOC_57	57M-03-03X	11/7/2005	219.3	
AOC_57	57M-03-03X	6/5/2006	219.5	
AOC_57	57M-03-03X	6/9/2006	223.1	
AOC_57	57M-03-03X	10/17/2006	222.5	
AOC_57	57M-03-03X	10/19/2006	218.9	
AOC_57	57M-03-03X	5/23/2007	219.0	
AOC_57	57M-03-03X	10/15/2007	219.0	
AOC_57	57M-03-03X	6/25/2008	219.3	
AOC_57	57M-03-03X	5/8/2009	219.3	
AOC_57	57M-03-03X	5/20/2010	219.4	
AOC_57	57M-03-03X	6/30/2011	219.1	
AOC_57	57M-03-03X	5/15/2012	219.5	
AOC_57	57M-03-03X	6/13/2013	219.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-03-03X	6/18/2014	218.6	
AOC_57	57M-03-03X	6/21/2015	218.9	
AOC_57	57M-03-03X	5/19/2016	219.0	
AOC_57	57M-03-03X	6/19/2017		210.3
AOC_57	57M-03-03X	5/8/2018	219.3	
AOC_57	57M-03-03X	10/1/2018	219.2	
AOC_57	57M-03-03X	4/5/2019	219.1	
AOC_57	57M-03-03X	3/12/2020	219.1	
AOC_57	57M-03-03X	5/13/2020	219.3	
AOC_57	57M-03-04X	12/1/2003	219.4	
AOC_57	57M-03-04X	5/25/2004	219.1	
AOC_57	57M-03-04X	10/7/2004	219.0	
AOC_57	57M-03-04X	5/18/2005	219.1	
AOC_57	57M-03-04X	11/7/2005	219.4	
AOC_57	57M-03-04X	6/5/2006	216.5	
AOC_57	57M-03-04X	6/9/2006	219.1	
AOC_57	57M-03-04X	10/17/2006	221.6	
AOC_57	57M-03-04X	10/19/2006	219.0	
AOC_57	57M-03-04X	5/23/2007	219.0	
AOC_57	57M-03-04X	10/15/2007	219.0	
AOC_57	57M-03-04X	6/25/2008	219.2	
AOC_57	57M-03-04X	5/8/2009	219.7	
AOC_57	57M-03-04X	5/20/2010	219.4	
AOC_57	57M-03-04X	6/30/2011	219.1	
AOC_57	57M-03-04X	5/15/2012	219.6	
AOC_57	57M-03-04X	6/13/2013	219.6	
AOC_57	57M-03-04X	6/18/2014	218.9	
AOC_57	57M-03-04X	6/21/2015	218.9	
AOC_57	57M-03-04X	5/19/2016	219.0	
AOC_57	57M-03-04X	6/19/2017	219.2	
AOC_57	57M-03-04X	5/8/2018	219.4	
AOC_57	57M-03-04X	10/1/2018	219.4	
AOC_57	57M-03-04X	4/5/2019	219.4	
AOC_57	57M-03-04X	3/12/2020	219.1	
AOC_57	57M-03-04X	5/13/2020	219.3	
AOC_57	57M-03-05X	12/1/2003	219.4	
AOC_57	57M-03-05X	5/25/2004	219.3	
AOC_57	57M-03-05X	10/7/2004	219.1	
AOC_57	57M-03-05X	5/18/2005	219.3	
AOC_57	57M-03-05X	11/7/2005	219.5	
AOC_57	57M-03-05X	6/5/2006	219.5	
AOC_57	57M-03-05X	6/9/2006	221.9	
AOC_57	57M-03-05X	10/17/2006	221.7	
AOC_57	57M-03-05X	10/19/2006	219.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-03-05X	5/23/2007	219.3	
AOC_57	57M-03-05X	10/15/2007	219.1	
AOC_57	57M-03-05X	6/25/2008	219.4	
AOC_57	57M-03-05X	5/8/2009	219.5	
AOC_57	57M-03-05X	5/20/2010	219.5	
AOC_57	57M-03-05X	6/30/2011	219.2	
AOC_57	57M-03-05X	5/15/2012	219.5	
AOC_57	57M-03-05X	6/13/2013	219.5	
AOC_57	57M-03-05X	6/18/2014	219.1	
AOC_57	57M-03-05X	6/21/2015	219.1	
AOC_57	57M-03-05X	5/19/2016	219.2	
AOC_57	57M-03-05X	6/19/2017	219.2	
AOC_57	57M-03-05X	5/8/2018	219.5	
AOC_57	57M-03-05X	10/1/2018	219.5	
AOC_57	57M-03-05X	4/5/2019	219.4	
AOC_57	57M-03-05X	3/12/2020	219.3	
AOC_57	57M-03-05X	5/13/2020	219.4	
AOC_57	57M-03-06X	5/18/2005	219.3	
AOC_57	57M-03-06X	11/7/2005	219.4	
AOC_57	57M-03-06X	6/5/2006	219.6	
AOC_57	57M-03-06X	6/9/2006	222.2	
AOC_57	57M-03-06X	10/17/2006	221.8	
AOC_57	57M-03-06X	10/19/2006	219.1	
AOC_57	57M-03-06X	5/23/2007	219.3	
AOC_57	57M-03-06X	10/15/2007	219.1	
AOC_57	57M-03-06X	6/25/2008	219.4	
AOC_57	57M-03-06X	5/8/2009	219.7	
AOC_57	57M-03-06X	5/20/2010	219.5	
AOC_57	57M-03-06X	6/30/2011	219.2	
AOC_57	57M-03-06X	5/15/2012	219.6	
AOC_57	57M-03-06X	6/13/2013	219.6	
AOC_57	57M-03-06X	6/18/2014		210.3
AOC_57	57M-03-06X	6/21/2015	219.1	
AOC_57	57M-03-06X	5/19/2016	219.1	
AOC_57	57M-03-06X	6/19/2017	219.2	
AOC_57	57M-03-06X	5/8/2018	219.5	
AOC_57	57M-03-06X	9/28/2018	219.5	
AOC_57	57M-03-06X	4/5/2019	219.5	
AOC_57	57M-03-06X	3/12/2020	219.1	
AOC_57	57M-03-06X	5/13/2020	219.5	
AOC_57	57M-95-03X	5/18/2005	222.6	
AOC_57	57M-95-03X	11/7/2005	223.2	
AOC_57	57M-95-03X	6/5/2006	224.0	
AOC_57	57M-95-03X	6/9/2006	226.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-95-03X	10/17/2006	223.9	
AOC_57	57M-95-03X	10/19/2006	221.8	
AOC_57	57M-95-03X	5/23/2007	223.2	
AOC_57	57M-95-03X	10/15/2007	220.9	
AOC_57	57M-95-03X	6/25/2008	221.9	
AOC_57	57M-95-03X	6/28/2008	224.1	
AOC_57	57M-95-03X	5/8/2009	222.6	
AOC_57	57M-95-03X	5/20/2010	222.7	
AOC_57	57M-95-03X	6/30/2011	221.7	
AOC_57	57M-95-03X	5/15/2012	221.9	
AOC_57	57M-95-03X	6/13/2013	222.3	
AOC_57	57M-95-03X	6/18/2014	221.2	
AOC_57	57M-95-03X	6/21/2015	221.3	
AOC_57	57M-95-03X	5/19/2016	221.3	
AOC_57	57M-95-03X	6/19/2017	222.0	
AOC_57	57M-95-03X	5/8/2018	222.4	
AOC_57	57M-95-03X	9/29/2018	222.2	
AOC_57	57M-95-03X	4/5/2019	222.9	
AOC_57	57M-95-03X	3/12/2020	222.1	
AOC_57	57M-95-03X	5/13/2020	222.5	
AOC_57	57M-95-05X	5/18/2005	220.7	
AOC_57	57M-95-05X	11/7/2005	221.0	
AOC_57	57M-95-05X	6/5/2006	221.4	
AOC_57	57M-95-05X	6/9/2006	223.5	
AOC_57	57M-95-05X	10/17/2006	222.6	
AOC_57	57M-95-05X	10/19/2006	220.5	
AOC_57	57M-95-05X	5/23/2007	220.8	
AOC_57	57M-95-05X	10/15/2007	220.3	
AOC_57	57M-95-05X	6/25/2008	220.9	
AOC_57	57M-95-05X	5/8/2009	221.7	
AOC_57	57M-95-05X	5/20/2010	221.5	
AOC_57	57M-95-05X	6/30/2011	221.0	
AOC_57	57M-95-05X	5/15/2012	221.2	
AOC_57	57M-95-05X	6/13/2013	222.0	
AOC_57	57M-95-05X	6/18/2014	220.4	
AOC_57	57M-95-05X	6/21/2015	220.5	
AOC_57	57M-95-05X	5/19/2016	220.3	
AOC_57	57M-95-05X	6/19/2017		225.8
AOC_57	57M-95-05X	5/8/2018	221.1	
AOC_57	57M-95-05X	9/28/2018	221.7	
AOC_57	57M-95-05X	4/5/2019	221.1	
AOC_57	57M-95-05X	3/12/2020	220.4	
AOC_57	57M-95-05X	5/13/2020	221.0	
AOC_57	57M-95-06X	5/18/2005	221.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-95-06X	11/7/2005	222.4	
AOC_57	57M-95-06X	6/5/2006	223.2	
AOC_57	57M-95-06X	6/9/2006	225.4	
AOC_57	57M-95-06X	10/17/2006	223.8	
AOC_57	57M-95-06X	10/19/2006	221.7	
AOC_57	57M-95-06X	5/23/2007	222.5	
AOC_57	57M-95-06X	10/15/2007	221.0	
AOC_57	57M-95-06X	6/25/2008	221.8	
AOC_57	57M-95-06X	5/8/2009	222.3	
AOC_57	57M-95-06X	5/20/2010	222.5	
AOC_57	57M-95-06X	6/30/2011	221.8	
AOC_57	57M-95-06X	5/15/2012	221.9	
AOC_57	57M-95-06X	6/13/2013	221.9	
AOC_57	57M-95-06X	6/18/2014	221.3	
AOC_57	57M-95-06X	6/21/2015	220.7	
AOC_57	57M-95-06X	5/19/2016	221.0	
AOC_57	57M-95-06X	6/19/2017	222.7	
AOC_57	57M-95-06X	5/8/2018	223.0	
AOC_57	57M-95-06X	9/25/2018	222.0	
AOC_57	57M-95-06X	4/5/2019	222.3	
AOC_57	57M-95-06X	3/12/2020	221.6	
AOC_57	57M-95-06X	5/13/2020	222.1	
AOC_57	57M-95-07X	5/18/2005	219.8	
AOC_57	57M-95-07X	11/7/2005	220.0	
AOC_57	57M-95-07X	6/5/2006	220.2	
AOC_57	57M-95-07X	6/9/2006	222.4	
AOC_57	57M-95-07X	10/17/2006	221.8	
AOC_57	57M-95-07X	10/19/2006	219.6	
AOC_57	57M-95-07X	5/23/2007	219.8	
AOC_57	57M-95-07X	10/15/2007	219.5	
AOC_57	57M-95-07X	6/25/2008	219.9	
AOC_57	57M-95-07X	5/8/2009	220.5	
AOC_57	57M-95-07X	5/20/2010	220.2	
AOC_57	57M-95-07X	6/30/2011	219.8	
AOC_57	57M-95-07X	5/15/2012	220.2	
AOC_57	57M-95-07X	6/13/2013	220.5	
AOC_57	57M-95-07X	6/18/2014	219.5	
AOC_57	57M-95-07X	6/21/2015	219.6	
AOC_57	57M-95-07X	5/19/2016	219.6	
AOC_57	57M-95-07X	6/19/2017	219.8	
AOC_57	57M-95-07X	5/8/2018	220.1	
AOC_57	57M-95-07X	10/1/2018	220.2	
AOC_57	57M-95-07X	4/5/2019	220.1	
AOC_57	57M-95-07X	3/12/2020	219.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-95-07X	5/13/2020	220.0	
AOC_57	57M-96-09X	5/18/2005	225.8	
AOC_57	57M-96-09X	11/7/2005	226.7	
AOC_57	57M-96-09X	6/9/2006	226.7	
AOC_57	57M-96-09X	10/17/2006	224.9	
AOC_57	57M-96-09X	5/23/2007	226.0	
AOC_57	57M-96-09X	10/15/2007	224.1	
AOC_57	57M-96-10X	5/18/2005	222.2	
AOC_57	57M-96-10X	11/7/2005	222.6	
AOC_57	57M-96-10X	6/5/2006	223.0	
AOC_57	57M-96-10X	6/9/2006	223.8	
AOC_57	57M-96-10X	10/17/2006	222.4	
AOC_57	57M-96-10X	10/19/2006	221.6	
AOC_57	57M-96-10X	5/23/2007	222.5	
AOC_57	57M-96-10X	10/15/2007	221.2	
AOC_57	57M-96-10X	6/25/2008	221.6	
AOC_57	57M-96-10X	6/28/2008	222.4	
AOC_57	57M-96-10X	5/8/2009	222.7	
AOC_57	57M-96-10X	5/20/2010	222.2	
AOC_57	57M-96-10X	6/30/2011	221.5	
AOC_57	57M-96-10X	5/15/2012	221.9	
AOC_57	57M-96-10X	6/13/2013		
AOC_57	57M-96-10X	6/18/2014	221.3	
AOC_57	57M-96-10X	6/21/2015	221.3	
AOC_57	57M-96-10X	5/19/2016		
AOC_57	57M-96-10X	6/19/2017		
AOC_57	57M-96-10X	5/8/2018	222.2	
AOC_57	57M-96-10X	4/5/2019	222.5	
AOC_57	57M-96-10X	5/13/2020	222.2	
AOC_57	57M-96-11X	5/18/2005	219.6	
AOC_57	57M-96-11X	11/7/2005	219.8	
AOC_57	57M-96-11X	6/5/2006	219.8	
AOC_57	57M-96-11X	6/9/2006	222.0	
AOC_57	57M-96-11X	10/17/2006	221.4	
AOC_57	57M-96-11X	10/19/2006	219.3	
AOC_57	57M-96-11X	5/23/2007	219.7	
AOC_57	57M-96-11X	10/15/2007	219.2	
AOC_57	57M-96-11X	6/25/2008	218.5	
AOC_57	57M-96-11X	6/28/2008	220.7	
AOC_57	57M-96-11X	5/8/2009	219.8	
AOC_57	57M-96-11X	5/20/2010	219.6	
AOC_57	57M-96-11X	6/30/2011	219.2	
AOC_57	57M-96-11X	5/15/2012	219.2	
AOC_57	57M-96-11X	6/13/2013	219.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-96-11X	6/18/2014	218.7	
AOC_57	57M-96-11X	6/21/2015	219.1	
AOC_57	57M-96-11X	5/19/2016	219.2	
AOC_57	57M-96-11X	6/19/2017	219.3	
AOC_57	57M-96-11X	5/8/2018	219.4	
AOC_57	57M-96-11X	9/24/2018	219.3	
AOC_57	57M-96-11X	4/5/2019	219.5	
AOC_57	57M-96-11X	3/12/2020	219.5	
AOC_57	57M-96-11X	5/13/2020	219.2	
AOC_57	57M-96-12X	5/18/2005	221.3	
AOC_57	57M-96-12X	11/7/2005	221.6	
AOC_57	57M-96-12X	6/5/2006	221.9	
AOC_57	57M-96-12X	6/9/2006	223.9	
AOC_57	57M-96-12X	10/17/2006	223.0	
AOC_57	57M-96-12X	10/19/2006	221.0	
AOC_57	57M-96-12X	5/23/2007	221.5	
AOC_57	57M-96-12X	10/15/2007	220.4	
AOC_57	57M-96-12X	6/25/2008	221.1	
AOC_57	57M-96-12X	6/28/2008	223.1	
AOC_57	57M-96-12X	5/8/2009	221.5	
AOC_57	57M-96-12X	5/20/2010	221.5	
AOC_57	57M-96-12X	6/30/2011	220.7	
AOC_57	57M-96-12X	5/15/2012	221.0	
AOC_57	57M-96-12X	6/13/2013	221.2	
AOC_57	57M-96-12X	6/18/2014	220.3	
AOC_57	57M-96-12X	6/21/2015	220.4	
AOC_57	57M-96-12X	5/19/2016	220.5	
AOC_57	57M-96-12X	6/19/2017	220.9	
AOC_57	57M-96-12X	5/8/2018	221.3	
AOC_57	57M-96-12X	9/25/2018	221.1	
AOC_57	57M-96-12X	4/5/2019	221.5	
AOC_57	57M-96-12X	3/12/2020	221.0	
AOC_57	57M-96-12X	5/13/2020	221.3	
AOC_57	57M-96-13X	5/18/2005	220.1	
AOC_57	57M-96-13X	11/7/2005	221.4	
AOC_57	57M-96-13X	6/5/2006	221.6	
AOC_57	57M-96-13X	6/9/2006	223.7	
AOC_57	57M-96-13X	10/17/2006	223.0	
AOC_57	57M-96-13X	10/19/2006	220.9	
AOC_57	57M-96-13X	5/23/2007	221.4	
AOC_57	57M-96-13X	10/15/2007	220.4	
AOC_57	57M-96-13X	6/25/2008	220.9	
AOC_57	57M-96-13X	5/8/2009	221.4	
AOC_57	57M-96-13X	5/20/2010	221.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57M-96-13X	6/30/2011	220.6	
AOC_57	57M-96-13X	5/15/2012	221.0	
AOC_57	57M-96-13X	6/13/2013	221.1	
AOC_57	57M-96-13X	6/18/2014	220.2	
AOC_57	57M-96-13X	6/21/2015	220.3	
AOC_57	57M-96-13X	5/19/2016	220.6	
AOC_57	57M-96-13X	6/19/2017	220.8	
AOC_57	57M-96-13X	5/8/2018	221.2	
AOC_57	57M-96-13X	9/25/2018	221.1	
AOC_57	57M-96-13X	4/5/2019	221.4	
AOC_57	57M-96-13X	3/12/2020	221.0	
AOC_57	57M-96-13X	5/13/2020	221.2	
AOC_57	57P-98-03X	5/18/2005	218.0	
AOC_57	57P-98-03X	11/7/2005	218.1	
AOC_57	57P-98-03X	6/9/2006		
AOC_57	57P-98-03X	10/17/2006		
AOC_57	57P-98-03X	10/19/2006	218.0	
AOC_57	57P-98-03X	5/23/2007	218.1	
AOC_57	57P-98-03X	10/15/2007	218.0	
AOC_57	57P-98-03X	6/25/2008	218.1	
AOC_57	57P-98-03X	6/28/2008	220.3	
AOC_57	57P-98-03X	5/8/2009	218.3	
AOC_57	57P-98-03X	5/20/2010	218.2	
AOC_57	57P-98-03X	6/30/2011	217.7	
AOC_57	57P-98-03X	5/15/2012	218.0	
AOC_57	57P-98-03X	6/13/2013	218.3	
AOC_57	57P-98-03X	6/18/2014	217.7	
AOC_57	57P-98-03X	6/19/2017		
AOC_57	57P-98-03X	5/8/2018	218.1	
AOC_57	57P-98-03X	9/24/2018	218.0	
AOC_57	57P-98-03X	4/5/2019	218.1	
AOC_57	57P-98-03X	3/12/2020	218.1	
AOC_57	57P-98-03X	5/13/2020	218.1	
AOC_57	57P-98-04X	6/25/2008	218.3	
AOC_57	57P-98-04X	6/28/2008	220.3	
AOC_57	57P-98-04X	5/8/2009	218.4	
AOC_57	57P-98-04X	5/20/2010	218.3	
AOC_57	57P-98-04X	6/30/2011	218.2	
AOC_57	57P-98-04X	5/15/2012	218.3	
AOC_57	57P-98-04X	6/13/2013	218.4	
AOC_57	57P-98-04X	6/18/2014		
AOC_57	57P-98-04X	6/19/2017	218.1	
AOC_57	57P-98-04X	5/8/2018	218.2	
AOC_57	57P-98-04X	9/24/2018	218.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57P-98-04X	4/5/2019	218.2	
AOC_57	57P-98-04X	3/12/2020	218.2	
AOC_57	57P-98-04X	5/13/2020	217.7	
AOC_57	57WP-05-01	6/9/2006		
AOC_57	57WP-05-01	10/17/2006		
AOC_57	57WP-05-01	5/23/2007		
AOC_57	57WP-05-01	10/15/2007		
AOC_57	57WP-05-01	6/25/2008		
AOC_57	57WP-05-01	5/8/2009		
AOC_57	57WP-05-01	5/20/2010		
AOC_57	57WP-05-01	6/13/2013		-1.1
AOC_57	57WP-05-01	6/18/2014		-1.9
AOC_57	57WP-05-01	5/19/2016		-2.1
AOC_57	57WP-05-01	6/19/2017		
AOC_57	57WP-05-01	5/13/2020		-1.7
AOC_57	57WP-06-02	6/5/2006	219.3	
AOC_57	57WP-06-02	6/14/2006		
AOC_57	57WP-06-02	10/17/2006		
AOC_57	57WP-06-02	10/19/2006	218.9	
AOC_57	57WP-06-02	5/23/2007	219.1	
AOC_57	57WP-06-02	10/15/2007	219.0	
AOC_57	57WP-06-02	6/25/2008	219.3	
AOC_57	57WP-06-02	6/28/2008	221.9	
AOC_57	57WP-06-02	5/8/2009	219.8	
AOC_57	57WP-06-02	5/20/2010		
AOC_57	57WP-06-02	6/30/2011	219.2	
AOC_57	57WP-06-02	5/15/2012	219.7	
AOC_57	57WP-06-02	6/13/2013	219.7	
AOC_57	57WP-06-02	6/18/2014	219.0	
AOC_57	57WP-06-02	5/19/2016	219.1	
AOC_57	57WP-06-02	6/19/2017	219.4	
AOC_57	57WP-06-02	5/8/2018	218.5	
AOC_57	57WP-06-02	10/1/2018	219.5	
AOC_57	57WP-06-02	4/5/2019	219.4	
AOC_57	57WP-06-02	3/12/2020	219.2	
AOC_57	57WP-06-02	5/13/2020	219.5	
AOC_57	57WP-06-03	6/5/2006	220.3	
AOC_57	57WP-06-03	6/14/2006		
AOC_57	57WP-06-03	10/17/2006		
AOC_57	57WP-06-03	10/19/2006	219.7	
AOC_57	57WP-06-03	5/23/2007	220.2	
AOC_57	57WP-06-03	10/15/2007	219.6	
AOC_57	57WP-06-03	6/25/2008	220.0	
AOC_57	57WP-06-03	6/28/2008	222.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_57	57WP-06-03	5/8/2009	220.4	
AOC_57	57WP-06-03	5/20/2010		
AOC_57	57WP-06-03	6/30/2011	219.8	
AOC_57	57WP-06-03	5/15/2012	219.7	
AOC_57	57WP-06-03	6/13/2013	220.0	
AOC_57	57WP-06-03	6/18/2014	219.4	
AOC_57	57WP-06-03	6/19/2017	219.9	
AOC_57	57WP-06-03	5/8/2018	219.9	
AOC_57	57WP-06-03	9/28/2018	220.0	
AOC_57	57WP-06-03	4/5/2019	219.7	
AOC_57	57WP-06-03	3/12/2020	219.8	
AOC_57	57WP-06-03	5/13/2020	219.9	
AOC_69W	69W-94-12	5/18/2005	221.8	
AOC_69W	69W-94-12	5/23/2005	222.6	
AOC_69W	69W-94-12	10/3/2005	222.0	
AOC_69W	69W-94-12	10/14/2005	222.8	
AOC_69W	69W-94-12	6/5/2006	222.4	
AOC_69W	69W-94-12	6/13/2006	223.2	
AOC_69W	69W-94-12	10/15/2007	219.7	
AOC_69W	69W-94-12	10/17/2007	220.5	
AOC_69W	69W-94-12	10/28/2008	221.3	
AOC_69W	69W-94-12	10/22/2009	221.2	
AOC_69W	69W-94-12	10/26/2009	220.4	
AOC_69W	69W-94-12	10/7/2010	219.9	
AOC_69W	69W-94-12	10/15/2010	220.7	
AOC_69W	69W-94-12	10/13/2011	221.6	
AOC_69W	69W-94-12	10/22/2012	219.3	
AOC_69W	69W-94-12	11/6/2013	219.4	
AOC_69W	69W-94-12	10/20/2014	219.1	
AOC_69W	69W-94-12	10/7/2015	219.3	
AOC_69W	69W-94-12	10/25/2016	218.6	
AOC_69W	69W-94-12	10/30/2017	221.7	
AOC_69W	69W-94-12	10/8/2018	221.8	
AOC_69W	69W-94-12	10/2/2019	222.7	
AOC_69W	69W-94-13	5/18/2005	221.7	
AOC_69W	69W-94-13	5/23/2005	222.5	
AOC_69W	69W-94-13	10/3/2005	221.7	
AOC_69W	69W-94-13	10/14/2005	222.5	
AOC_69W	69W-94-13	6/5/2006	222.2	
AOC_69W	69W-94-13	6/13/2006	223.0	
AOC_69W	69W-94-13	10/15/2007	219.4	
AOC_69W	69W-94-13	10/17/2007	220.2	
AOC_69W	69W-94-13	10/28/2008	221.1	
AOC_69W	69W-94-13	10/22/2009	220.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	69W-94-13	10/26/2009	220.0	
AOC_69W	69W-94-13	10/7/2010	219.9	
AOC_69W	69W-94-13	10/15/2010	220.7	
AOC_69W	69W-94-13	10/13/2011	221.5	
AOC_69W	69W-94-13	10/22/2012	219.1	
AOC_69W	69W-94-13	11/6/2013	219.2	
AOC_69W	69W-94-13	10/20/2014	219.0	
AOC_69W	69W-94-13	10/7/2015	219.2	
AOC_69W	69W-94-13	10/25/2016	218.3	
AOC_69W	69W-94-13	10/30/2017	221.6	
AOC_69W	69W-94-13	10/8/2018	221.8	
AOC_69W	69W-94-13	10/2/2019	219.7	
AOC_69W	69W-94-14	5/18/2005	220.8	
AOC_69W	69W-94-14	5/23/2005	221.6	
AOC_69W	69W-94-14	10/3/2005	220.8	
AOC_69W	69W-94-14	10/14/2005	221.6	
AOC_69W	69W-94-14	6/5/2006	221.2	
AOC_69W	69W-94-14	6/13/2006	222.0	
AOC_69W	69W-94-14	10/15/2007	218.7	
AOC_69W	69W-94-14	10/17/2007	219.5	
AOC_69W	69W-94-14	10/28/2008	220.2	
AOC_69W	69W-94-14	10/22/2009	220.4	
AOC_69W	69W-94-14	10/26/2009	219.6	
AOC_69W	69W-94-14	10/7/2010	219.3	
AOC_69W	69W-94-14	10/15/2010	220.1	
AOC_69W	69W-94-14	10/13/2011	220.6	
AOC_69W	69W-94-14	10/22/2012	218.5	
AOC_69W	69W-94-14	11/6/2013	218.5	
AOC_69W	69W-94-14	10/20/2014	218.3	
AOC_69W	69W-94-14	10/7/2015	218.5	
AOC_69W	69W-94-14	10/25/2016	217.8	
AOC_69W	69W-94-14	10/30/2017	221.2	
AOC_69W	69W-94-14	10/9/2018	221.0	
AOC_69W	69W-94-14	10/2/2019	218.8	
AOC_69W	69WP-08-01	10/28/2008		-2.3
AOC_69W	69WP-08-01	10/22/2009		
AOC_69W	69WP-08-01	10/26/2009		-2.9
AOC_69W	69WP-08-01	10/7/2010		-2.7
AOC_69W	69WP-08-01	10/15/2010		
AOC_69W	69WP-08-01	10/13/2011		-2.2
AOC_69W	69WP-08-01	10/22/2012		-3.9
AOC_69W	69WP-08-01	11/6/2013		-3.9
AOC_69W	69WP-08-01	10/20/2014		-4.0
AOC_69W	69WP-08-01	10/7/2015		-3.8

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	69WP-08-01	10/25/2016		-4.6
AOC_69W	69WP-08-01	10/30/2017		-2.4
AOC_69W	69WP-08-01	10/9/2018		-2.0
AOC_69W	69WP-08-01	6/28/2019		-2.1
AOC_69W	69WP-08-01	10/2/2019		-3.6
AOC_69W	69WP-13-01	11/6/2013	217.5	
AOC_69W	69WP-13-01	10/20/2014	217.3	
AOC_69W	69WP-13-01	10/7/2015	217.4	
AOC_69W	69WP-13-01	10/25/2016	216.6	
AOC_69W	69WP-13-01	10/30/2017	218.8	
AOC_69W	69WP-13-01	10/9/2018	219.0	
AOC_69W	69WP-13-01	10/2/2019	217.4	
AOC_69W	ZWM-01-25X	5/18/2005	220.0	
AOC_69W	ZWM-01-25X	5/23/2005	220.8	
AOC_69W	ZWM-01-25X	10/3/2005	220.3	
AOC_69W	ZWM-01-25X	10/14/2005	221.1	
AOC_69W	ZWM-01-25X	6/5/2006	220.5	
AOC_69W	ZWM-01-25X	6/13/2006	221.3	
AOC_69W	ZWM-01-25X	10/15/2007	218.2	
AOC_69W	ZWM-01-25X	10/17/2007	219.0	
AOC_69W	ZWM-01-25X	10/28/2008	219.6	
AOC_69W	ZWM-01-25X	10/22/2009	219.8	
AOC_69W	ZWM-01-25X	10/26/2009	219.0	
AOC_69W	ZWM-01-25X	10/7/2010	218.9	
AOC_69W	ZWM-01-25X	10/15/2010	219.7	
AOC_69W	ZWM-01-25X	10/13/2011	219.9	
AOC_69W	ZWM-01-25X	10/22/2012	218.0	
AOC_69W	ZWM-01-25X	11/6/2013	218.1	
AOC_69W	ZWM-01-25X	10/20/2014	217.8	
AOC_69W	ZWM-01-25X	10/7/2015	218.0	
AOC_69W	ZWM-01-25X	10/25/2016	217.3	
AOC_69W	ZWM-01-25X	10/30/2017	220.7	
AOC_69W	ZWM-01-25X	10/9/2018	220.2	
AOC_69W	ZWM-01-25X	10/2/2019	218.3	
AOC_69W	ZWM-01-26X	5/18/2005	220.6	
AOC_69W	ZWM-01-26X	5/23/2005	221.4	
AOC_69W	ZWM-01-26X	10/3/2005	221.3	
AOC_69W	ZWM-01-26X	10/14/2005	222.1	
AOC_69W	ZWM-01-26X	6/5/2006	221.4	
AOC_69W	ZWM-01-26X	6/13/2006	222.2	
AOC_69W	ZWM-01-26X	10/15/2007	218.8	
AOC_69W	ZWM-01-26X	10/17/2007	219.6	
AOC_69W	ZWM-01-26X	10/28/2008	220.2	
AOC_69W	ZWM-01-26X	10/22/2009	220.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	ZWM-01-26X	10/26/2009	219.7	
AOC_69W	ZWM-01-26X	10/7/2010	219.0	
AOC_69W	ZWM-01-26X	10/15/2010	219.8	
AOC_69W	ZWM-01-26X	10/13/2011	220.4	
AOC_69W	ZWM-01-26X	10/22/2012	218.6	
AOC_69W	ZWM-01-26X	11/6/2013	218.7	
AOC_69W	ZWM-01-26X	10/20/2014	218.5	
AOC_69W	ZWM-01-26X	10/7/2015	218.7	
AOC_69W	ZWM-01-26X	10/25/2016	218.0	
AOC_69W	ZWM-01-26X	10/30/2017	221.2	
AOC_69W	ZWM-01-26X	10/8/2018	220.6	
AOC_69W	ZWM-01-26X	5/16/2019	220.9	
AOC_69W	ZWM-01-26X	6/28/2019	222.4	
AOC_69W	ZWM-01-26X	10/2/2019	218.9	
AOC_69W	ZWM-95-15X	5/18/2005	220.5	
AOC_69W	ZWM-95-15X	5/23/2005	221.3	
AOC_69W	ZWM-95-15X	10/3/2005	220.6	
AOC_69W	ZWM-95-15X	10/14/2005	221.4	
AOC_69W	ZWM-95-15X	6/5/2006	220.9	
AOC_69W	ZWM-95-15X	6/13/2006	221.7	
AOC_69W	ZWM-95-15X	10/15/2007	218.5	
AOC_69W	ZWM-95-15X	10/17/2007	219.3	
AOC_69W	ZWM-95-15X	10/28/2008	220.0	
AOC_69W	ZWM-95-15X	10/22/2009	220.2	
AOC_69W	ZWM-95-15X	10/26/2009	219.4	
AOC_69W	ZWM-95-15X	10/7/2010	219.3	
AOC_69W	ZWM-95-15X	10/15/2010	220.1	
AOC_69W	ZWM-95-15X	10/13/2011	220.4	
AOC_69W	ZWM-95-15X	10/22/2012	218.3	
AOC_69W	ZWM-95-15X	11/6/2013	218.4	
AOC_69W	ZWM-95-15X	10/20/2014	218.1	
AOC_69W	ZWM-95-15X	10/7/2015	218.3	
AOC_69W	ZWM-95-15X	10/25/2016	217.6	
AOC_69W	ZWM-95-15X	10/30/2017	221.0	
AOC_69W	ZWM-95-15X	10/9/2018	220.9	
AOC_69W	ZWM-95-15X	10/2/2019	218.7	
AOC_69W	ZWM-95-16X	5/18/2005	223.3	
AOC_69W	ZWM-95-16X	5/23/2005	224.1	
AOC_69W	ZWM-95-16X	10/3/2005	223.2	
AOC_69W	ZWM-95-16X	10/14/2005	224.0	
AOC_69W	ZWM-95-16X	6/5/2006	224.1	
AOC_69W	ZWM-95-16X	6/13/2006	224.9	
AOC_69W	ZWM-95-16X	10/15/2007	220.7	
AOC_69W	ZWM-95-16X	10/17/2007	221.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	ZWM-95-16X	10/28/2008	222.5	
AOC_69W	ZWM-95-16X	10/22/2009	222.6	
AOC_69W	ZWM-95-16X	10/26/2009	221.8	
AOC_69W	ZWM-95-16X	10/7/2010	220.7	
AOC_69W	ZWM-95-16X	10/15/2010	221.5	
AOC_69W	ZWM-95-16X	10/13/2011	223.1	
AOC_69W	ZWM-95-16X	11/6/2013		
AOC_69W	ZWM-95-16X	10/20/2014		
AOC_69W	ZWM-95-16X	10/7/2015	220.5	
AOC_69W	ZWM-95-16X	10/25/2016	219.5	
AOC_69W	ZWM-95-16X	10/30/2017	221.4	
AOC_69W	ZWM-95-16X	10/8/2018	223.3	
AOC_69W	ZWM-95-16X	10/2/2019	221.0	
AOC_69W	ZWM-95-17X	12/7/1995	222.9	
AOC_69W	ZWM-95-17X	3/26/1996	225.0	
AOC_69W	ZWM-95-17X	7/23/1996	224.3	
AOC_69W	ZWM-95-17X	1/15/1997	225.2	
AOC_69W	ZWM-95-17X	6/2/1997	224.9	
AOC_69W	ZWM-95-17X	10/14/1998	222.7	
AOC_69W	ZWM-95-17X	12/10/1998	221.5	
AOC_69W	ZWM-95-17X	2/23/1999	222.6	
AOC_69W	ZWM-95-17X	6/6/1999	222.2	
AOC_69W	ZWM-95-17X	9/8/1999	230.2	
AOC_69W	ZWM-95-17X	5/18/2005	224.7	
AOC_69W	ZWM-95-17X	5/23/2005	225.5	
AOC_69W	ZWM-95-17X	10/3/2005	224.4	
AOC_69W	ZWM-95-17X	10/14/2005	225.2	
AOC_69W	ZWM-95-17X	6/5/2006	225.6	
AOC_69W	ZWM-95-17X	6/13/2006	226.4	
AOC_69W	ZWM-95-17X	10/15/2007	221.7	
AOC_69W	ZWM-95-17X	10/17/2007	222.5	
AOC_69W	ZWM-95-17X	10/28/2008	223.8	
AOC_69W	ZWM-95-17X	10/22/2009	223.6	
AOC_69W	ZWM-95-17X	10/26/2009	222.8	
AOC_69W	ZWM-95-17X	10/7/2010	221.7	
AOC_69W	ZWM-95-17X	10/15/2010	222.5	
AOC_69W	ZWM-95-17X	10/13/2011	224.4	
AOC_69W	ZWM-95-17X	10/22/2012	221.3	
AOC_69W	ZWM-95-17X	11/6/2013	221.5	
AOC_69W	ZWM-95-17X	10/20/2014	221.2	
AOC_69W	ZWM-95-17X	10/7/2015	221.4	
AOC_69W	ZWM-95-17X	10/25/2016	230.2	
AOC_69W	ZWM-95-17X	10/30/2017	222.3	
AOC_69W	ZWM-95-17X	10/8/2018	224.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	ZWM-95-17X	5/16/2019	224.9	
AOC_69W	ZWM-95-17X	6/28/2019	224.4	
AOC_69W	ZWM-95-17X	10/2/2019	221.9	
AOC_69W	ZWM-95-18X	5/18/2005	219.4	
AOC_69W	ZWM-95-18X	5/23/2005	220.2	
AOC_69W	ZWM-95-18X	10/3/2005	219.4	
AOC_69W	ZWM-95-18X	10/14/2005	220.2	
AOC_69W	ZWM-95-18X	6/5/2006	219.6	
AOC_69W	ZWM-95-18X	6/13/2006	220.4	
AOC_69W	ZWM-95-18X	10/15/2007	217.6	
AOC_69W	ZWM-95-18X	10/17/2007	218.4	
AOC_69W	ZWM-95-18X	10/28/2008	218.9	
AOC_69W	ZWM-95-18X	10/22/2009	219.1	
AOC_69W	ZWM-95-18X	10/26/2009	218.3	
AOC_69W	ZWM-95-18X	10/7/2010	218.6	
AOC_69W	ZWM-95-18X	10/15/2010	219.4	
AOC_69W	ZWM-95-18X	10/13/2011	219.2	
AOC_69W	ZWM-95-18X	10/22/2012	217.3	
AOC_69W	ZWM-95-18X	11/6/2013	217.4	
AOC_69W	ZWM-95-18X	10/20/2014	217.2	
AOC_69W	ZWM-95-18X	10/7/2015	217.4	
AOC_69W	ZWM-95-18X	10/25/2016	216.6	
AOC_69W	ZWM-95-18X	10/30/2017	219.5	
AOC_69W	ZWM-95-18X	10/9/2018	219.5	
AOC_69W	ZWM-95-18X	10/2/2019	217.6	
AOC_69W	ZWM-99-22X	6/19/2003	222.4	
AOC_69W	ZWM-99-22X	9/23/2003	224.2	
AOC_69W	ZWM-99-22X	5/25/2004	222.2	
AOC_69W	ZWM-99-22X	10/7/2004	220.7	
AOC_69W	ZWM-99-22X	5/18/2005	222.5	
AOC_69W	ZWM-99-22X	6/13/2005	222.5	
AOC_69W	ZWM-99-22X	10/3/2005	222.4	
AOC_69W	ZWM-99-22X	10/14/2005	223.2	
AOC_69W	ZWM-99-22X	6/5/2006	223.0	
AOC_69W	ZWM-99-22X	6/13/2006	223.8	
AOC_69W	ZWM-99-22X	10/15/2007	219.9	
AOC_69W	ZWM-99-22X	10/17/2007	220.7	
AOC_69W	ZWM-99-22X	9/30/2008	221.7	
AOC_69W	ZWM-99-22X	10/28/2008	221.7	
AOC_69W	ZWM-99-22X	10/22/2009	221.7	
AOC_69W	ZWM-99-22X	10/26/2009	220.9	
AOC_69W	ZWM-99-22X	10/7/2010	220.3	
AOC_69W	ZWM-99-22X	10/15/2010	221.1	
AOC_69W	ZWM-99-22X	10/13/2011	222.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	ZWM-99-22X	10/22/2012	219.7	
AOC_69W	ZWM-99-22X	11/6/2013	219.8	
AOC_69W	ZWM-99-22X	10/20/2014	219.5	
AOC_69W	ZWM-99-22X	10/7/2015	219.7	
AOC_69W	ZWM-99-22X	10/25/2016	218.6	
AOC_69W	ZWM-99-22X	10/30/2017	221.7	
AOC_69W	ZWM-99-22X	10/8/2018	222.5	
AOC_69W	ZWM-99-22X	10/2/2019	220.1	
AOC_69W	ZWM-99-23X	5/18/2005	220.8	
AOC_69W	ZWM-99-23X	5/23/2005	221.6	
AOC_69W	ZWM-99-23X	10/3/2005	221.0	
AOC_69W	ZWM-99-23X	10/14/2005	221.8	
AOC_69W	ZWM-99-23X	6/5/2006	220.2	
AOC_69W	ZWM-99-23X	6/13/2006	221.0	
AOC_69W	ZWM-99-23X	10/15/2007	218.7	
AOC_69W	ZWM-99-23X	10/17/2007	219.5	
AOC_69W	ZWM-99-23X	10/28/2008	220.2	
AOC_69W	ZWM-99-23X	10/22/2009	220.3	
AOC_69W	ZWM-99-23X	10/26/2009	219.5	
AOC_69W	ZWM-99-23X	10/7/2010	219.3	
AOC_69W	ZWM-99-23X	10/15/2010	220.1	
AOC_69W	ZWM-99-23X	10/13/2011	220.5	
AOC_69W	ZWM-99-23X	10/22/2012	218.4	
AOC_69W	ZWM-99-23X	11/6/2013	218.6	
AOC_69W	ZWM-99-23X	10/20/2014	218.3	
AOC_69W	ZWM-99-23X	10/7/2015	215.1	
AOC_69W	ZWM-99-23X	10/25/2016	217.7	
AOC_69W	ZWM-99-23X	10/30/2017	220.9	
AOC_69W	ZWM-99-23X	10/9/2018	220.9	
AOC_69W	ZWM-99-23X	10/2/2019	218.9	
AOC_69W	ZWM-99-24X	5/18/2005	221.3	
AOC_69W	ZWM-99-24X	5/23/2005	222.1	
AOC_69W	ZWM-99-24X	10/3/2005	221.3	
AOC_69W	ZWM-99-24X	10/14/2005	221.1	
AOC_69W	ZWM-99-24X	6/5/2006	224.7	
AOC_69W	ZWM-99-24X	6/13/2006	225.5	
AOC_69W	ZWM-99-24X	10/15/2007	219.1	
AOC_69W	ZWM-99-24X	10/17/2007	219.9	
AOC_69W	ZWM-99-24X	10/28/2008	220.8	
AOC_69W	ZWM-99-24X	10/22/2009	220.9	
AOC_69W	ZWM-99-24X	10/26/2009	220.1	
AOC_69W	ZWM-99-24X	10/7/2010	219.7	
AOC_69W	ZWM-99-24X	10/15/2010	220.5	
AOC_69W	ZWM-99-24X	10/13/2011	221.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	ZWM-99-24X	10/22/2012	218.9	
AOC_69W	ZWM-99-24X	11/6/2013	218.9	
AOC_69W	ZWM-99-24X	10/20/2014	218.7	
AOC_69W	ZWM-99-24X	10/7/2015	218.9	
AOC_69W	ZWM-99-24X	10/25/2016	218.1	
AOC_69W	ZWM-99-24X	10/30/2017	221.9	
AOC_69W	ZWM-99-24X	10/8/2018	221.5	
AOC_69W	ZWM-99-24X	10/2/2019	219.2	
AOC_69W	ZWP-95-01X	12/7/1995	220.6	
AOC_69W	ZWP-95-01X	3/26/1996	221.4	
AOC_69W	ZWP-95-01X	7/23/1996	221.6	
AOC_69W	ZWP-95-01X	1/15/1997	221.4	
AOC_69W	ZWP-95-01X	6/2/1997	221.3	
AOC_69W	ZWP-95-01X	10/14/1998	220.0	
AOC_69W	ZWP-95-01X	12/10/1998	218.9	
AOC_69W	ZWP-95-01X	2/23/1999	220.2	
AOC_69W	ZWP-95-01X	6/6/1999	219.6	
AOC_69W	ZWP-95-01X	9/8/1999	217.7	
AOC_69W	ZWP-95-01X	5/18/2005	221.3	
AOC_69W	ZWP-95-01X	5/23/2005	222.1	
AOC_69W	ZWP-95-01X	10/3/2005	221.3	
AOC_69W	ZWP-95-01X	10/14/2005	222.1	
AOC_69W	ZWP-95-01X	6/5/2006	221.7	
AOC_69W	ZWP-95-01X	6/13/2006	222.5	
AOC_69W	ZWP-95-01X	10/15/2007	219.1	
AOC_69W	ZWP-95-01X	10/17/2007	219.9	
AOC_69W	ZWP-95-01X	10/28/2008	220.8	
AOC_69W	ZWP-95-01X	10/22/2009	220.8	
AOC_69W	ZWP-95-01X	10/26/2009	220.0	
AOC_69W	ZWP-95-01X	10/7/2010	219.7	
AOC_69W	ZWP-95-01X	10/15/2010	220.5	
AOC_69W	ZWP-95-01X	10/13/2011	221.1	
AOC_69W	ZWP-95-01X	10/22/2012	219.0	
AOC_69W	ZWP-95-01X	11/6/2013	218.9	
AOC_69W	ZWP-95-01X	10/20/2014	218.7	
AOC_69W	ZWP-95-01X	10/7/2015	218.9	
AOC_69W	ZWP-95-01X	10/25/2016	218.1	
AOC_69W	ZWP-95-01X	10/30/2017	221.8	
AOC_69W	ZWP-95-01X	10/8/2018	221.6	
AOC_69W	ZWP-95-01X	5/16/2019	221.8	
AOC_69W	ZWP-95-01X	6/28/2019	223.3	
AOC_69W	ZWP-95-01X	10/2/2019	219.2	
AOC_69W	ZWP-95-02X	12/7/1995	218.8	
AOC_69W	ZWP-95-02X	3/26/1996	219.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_69W	ZWP-95-02X	7/23/1996	219.3	
AOC_69W	ZWP-95-02X	1/15/1997	219.6	
AOC_69W	ZWP-95-02X	6/2/1997	219.5	
AOC_69W	ZWP-95-02X	10/14/1998	218.5	
AOC_69W	ZWP-95-02X	12/10/1998	217.6	
AOC_69W	ZWP-95-02X	2/23/1999	218.6	
AOC_69W	ZWP-95-02X	6/6/1999	218.1	
AOC_69W	ZWP-95-02X	9/8/1999	216.4	
AOC_69W	ZWP-95-02X	5/18/2005	219.4	
AOC_69W	ZWP-95-02X	5/23/2005	220.2	
AOC_69W	ZWP-95-02X	10/3/2005	219.5	
AOC_69W	ZWP-95-02X	10/14/2005	220.3	
AOC_69W	ZWP-95-02X	6/5/2006	219.7	
AOC_69W	ZWP-95-02X	6/13/2006	220.5	
AOC_69W	ZWP-95-02X	10/15/2007	217.7	
AOC_69W	ZWP-95-02X	10/17/2007	218.5	
AOC_69W	ZWP-95-02X	10/28/2008	219.2	
AOC_69W	ZWP-95-02X	10/22/2009	219.3	
AOC_69W	ZWP-95-02X	10/26/2009	218.5	
AOC_69W	ZWP-95-02X	10/7/2010	218.4	
AOC_69W	ZWP-95-02X	10/15/2010	219.2	
AOC_69W	ZWP-95-02X	10/13/2011	219.3	
AOC_69W	ZWP-95-02X	10/22/2012	217.5	
AOC_69W	ZWP-95-02X	11/6/2013	217.6	
AOC_69W	ZWP-95-02X	10/20/2014	217.3	
AOC_69W	ZWP-95-02X	10/7/2015	217.4	
AOC_69W	ZWP-95-02X	10/25/2016	216.7	
AOC_69W	ZWP-95-02X	10/30/2017	219.8	
AOC_69W	ZWP-95-02X	10/8/2018	219.7	
AOC_69W	ZWP-95-02X	10/2/2019	217.6	
AOC_74	74MW-19-04A	3/12/2020	220.7	
AOC_74	74PZ-19-01	3/19/2019	223.7	
AOC_74	74PZ-19-01	3/12/2020	222.9	
AOC_74	74PZ-19-02	3/19/2019	226.5	
AOC_74	74PZ-19-02	3/12/2020	225.2	
AOC_74	74PZ-19-03	3/19/2019	226.2	
AOC_74	74PZ-19-03	3/12/2020	224.9	
AOC_74	74PZ-19-04	3/19/2019	220.8	
AOC_74	74PZ-19-04	3/12/2020	220.3	
AOC_74	74PZ-19-05	3/19/2019	224.8	
AOC_74	74PZ-19-05	3/12/2020	223.5	
AOC_74	74PZ-19-06	3/19/2019	223.2	
AOC_74	74PZ-19-06	3/12/2020	222.3	
AOC_74	74PZ-19-07	3/19/2019	221.1	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_74	74PZ-19-07	3/12/2020	220.7	
AOC_74	74PZ-19-08	3/19/2019	220.3	
AOC_74	74PZ-19-08	3/12/2020	220.1	
AOC_74	74PZ-19-09	3/19/2019	220.3	
AOC_74	74PZ-19-09	3/12/2020	219.4	
AOC_74	74PZ-19-10	3/12/2020	219.0	
AOC_74	74PZ-20-01	3/12/2020	220.2	
AOC_74	74PZ-20-02	3/12/2020	224.2	
AOC_74	74PZ-20-03	3/12/2020	221.5	
AOC_74	74PZ-20-04	3/12/2020	224.2	
AOC_74	74PZ-20-05	3/12/2020	223.0	
AOC_75	75MW-19-01BR	2/20/2020	243.5	
AOC_75	75MW-19-01BR	3/12/2020	234.9	
AOC_75	75MW-19-01BR	8/31/2020	241.5	
AOC_75	75MW-19-02A	3/12/2020	230.4	
AOC_75	75MW-19-02B	3/12/2020	230.3	
AOC_75	75MW-19-02BR	3/12/2020	229.4	
AOC_75	75MW-19-02C	3/12/2020	229.4	
AOC_75	75MW-19-04A	3/12/2020	225.1	
AOC_75	75MW-19-04B	3/12/2020	225.0	
AOC_75	75PZ-19-01	3/12/2020	224.9	
AOC_75	75PZ-19-02	1/2/2020	231.9	
AOC_75	75PZ-19-02	3/12/2020	231.9	
AOC_75	75PZ-19-03	1/2/2020	228.5	
AOC_75	75PZ-19-03	3/12/2020	231.6	
AOC_75	75PZ-19-04	1/2/2020	233.9	
AOC_75	75PZ-19-04	3/12/2020	234.2	
AOC_75	75PZ-20-01	3/12/2020	225.3	
AOC_75	75PZ-20-02	3/12/2020	229.4	
AOC_75	75PZ-20-03	3/12/2020	229.9	
AOC_75	75PZ-20-04	3/12/2020	231.0	
AOC_75	75PZ-20-05	3/12/2020	232.7	
AOC_75	75PZ-20-05	8/31/2020	231.5	
AOC_75	75PZ-20-06	3/12/2020	231.2	
AOC_75	75PZ-20-07	3/12/2020	224.5	
AOC_75	MW75-UNKNOWN	3/12/2020	227.0	
AOC_76	76PZ-19-01	5/16/2019	243.9	
AOC_76	76PZ-19-01	6/28/2019	242.4	
AOC_76	76PZ-19-01	1/2/2020	243.8	
AOC_76	76PZ-19-01	2/20/2020	243.3	
AOC_76	76PZ-19-01	3/13/2020	243.4	
AOC_76	76PZ-19-01	8/31/2020	239.4	
AOC_76	76PZ-19-02	5/16/2019	230.8	
AOC_76	76PZ-19-02	6/28/2019	230.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_76	76PZ-19-03	5/16/2019	244.5	
AOC_76	76PZ-19-03	6/28/2019	243.3	
AOC_76	76PZ-19-03	1/2/2020	244.8	
AOC_76	76PZ-19-03	2/20/2020	244.5	
AOC_76	76PZ-19-03	3/13/2020	244.4	
AOC_76	76PZ-19-03	8/31/2020	240.7	
AOC_76	76PZ-19-04	5/16/2019	243.4	
AOC_76	76PZ-19-04	6/28/2019	242.9	
AOC_76	76PZ-19-04	1/2/2020	243.3	
AOC_76	76PZ-19-04	2/20/2020	243.5	
AOC_76	76PZ-19-04	3/13/2020	243.1	
AOC_76	76PZ-19-05	5/16/2019	242.8	
AOC_76	76PZ-19-05	6/28/2019	243.6	
AOC_76	76PZ-19-05	1/2/2020	242.6	
AOC_76	76PZ-19-05	2/20/2020	242.4	
AOC_76	76PZ-19-05	3/13/2020	242.3	
AOC_76	76PZ-19-06	5/16/2019	232.7	
AOC_76	76PZ-19-06	6/28/2019	233.1	
AOC_76	76PZ-19-07	5/16/2019	241.0	
AOC_76	76PZ-19-07	6/28/2019	239.9	
AOC_76	76PZ-19-08	5/16/2019	219.4	
AOC_76	76PZ-19-08	6/28/2019	218.9	
AOC_76	76PZ-19-09	5/16/2019	213.4	
AOC_76	76PZ-19-09	6/28/2019	212.6	
AOC_76	76PZ-19-10	5/16/2019	241.3	
AOC_76	76PZ-19-10	6/28/2019	240.6	
AOC_76	76PZ-19-11	5/16/2019	242.5	
AOC_76	76PZ-19-11	6/28/2019	241.7	
AOC_76	76PZ-19-12	5/16/2019	212.2	
AOC_76	76PZ-19-12	6/28/2019	211.5	
AOC_76	76PZ-19-13	5/16/2019	242.2	
AOC_76	76PZ-19-13	6/28/2019	241.4	
AOC_76	76PZ-19-14	5/16/2019	214.5	
AOC_76	76PZ-19-14	6/28/2019	213.7	
AOC_76	76PZ-19-15	5/16/2019	243.2	
AOC_76	76PZ-19-15	6/28/2019	242.4	
AOC_76	76PZ-19-15	1/2/2020	243.4	
AOC_76	76PZ-19-15	2/20/2020	243.4	
AOC_76	76PZ-19-15	3/13/2020	243.3	
AOC_76	76PZ-19-16	5/16/2019	232.8	
AOC_76	76PZ-19-16	6/28/2019	232.3	
AOC_76	76PZ-19-17	6/28/2019	211.7	
AOC_76	76PZ-19-18	6/28/2019	243.5	
AOC_76	76PZ-19-18	1/2/2020	243.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
AOC_76	76PZ-19-18	2/20/2020	243.7	
AOC_76	76PZ-19-18	3/12/2020	243.5	
AOC_76	76PZ-19-18	3/13/2020	243.6	
AOC_76	76PZ-19-18	8/31/2020	242.5	
AOC_76	76PZ-19-19	6/28/2019	237.2	
Cs_44_and	G3M-92-01X	6/22/1993		-23.3
Cs_44_and	G3M-92-01X	9/30/1993		-24.0
Cs_44_and	G3M-92-01X	11/8/1993		-24.3
Cs_44_and	G3M-92-03X	3/30/1993		-27.1
Cs_44_and	G3M-92-03X	6/22/1993		-24.6
Cs_44_and	G3M-92-03X	9/30/1993		-25.7
Cs_44_and	G3M-92-03X	11/8/1993		-25.8
Cs_44_and	G3M-92-04X	9/30/1993		-27.4
Cs_44_and	G3M-92-04X	11/8/1993		-27.5
Cs_44_and	G3M-92-05X	9/15/1992		-9.8
Cs_44_and	G3M-92-05X	12/22/1992		-30.4
Cs_44_and	G3M-92-05X	3/30/1993		-29.9
Cs_44_and	G3M-92-05X	6/22/1993		-29.4
Cs_44_and	G3M-92-05X	9/30/1993		-30.4
Cs_44_and	G3M-92-05X	11/8/1993		-30.6
Cs_44_and	G3M-92-05X	3/30/1994		-29.7
Cs_44_and	G3M-92-05X	6/28/1994		-28.9
Cs_44_and	G3M-92-05X	10/4/1994		-29.3
Cs_44_and	G3M-92-05X	1/31/1995		-29.2
Cs_44_and	G3M-92-05X	5/9/1995		-29.4
Cs_44_and	G3M-92-05X	12/7/1995		-29.9
Cs_44_and	G3M-92-05X	3/26/1996		-28.9
Cs_44_and	G3M-92-05X	7/23/1996		-28.0
Cs_44_and	G3M-92-05X	1/15/1997		-27.4
Cs_44_and	G3M-92-05X	12/10/1998		-29.5
Cs_44_and	G3M-92-05X	2/23/1999		-29.8
Cs_44_and	G3M-92-05X	6/6/1999		-30.1
Cs_44_and	G3M-92-05X	9/8/1999		-31.2
Cs_44_and	G3M-92-06X	3/30/1993		-27.3
Cs_44_and	G3M-92-06X	6/22/1993		-24.7
Cs_44_and	G3M-92-06X	9/30/1993		-25.8
Cs_44_and	G3M-92-06X	11/8/1993		-25.9
_and_Resid	2019001-03G	3/30/1993		-8.0
_and_Resid	2019001-03G	6/22/1993		-9.0
Consolidate	LFM-03-07	5/22/2006	301.0	
Consolidate	LFM-03-07	10/18/2006	293.0	
Consolidate	LFM-03-07	5/21/2007	301.2	
Consolidate	LFM-03-07	10/15/2007		
Consolidate	LFM-03-07	6/25/2008	294.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
Consolidate	LFM-03-07	10/23/2008	295.7	
Consolidate	LFM-03-07	5/5/2009	298.9	
Consolidate	LFM-03-07	10/21/2009	292.9	
Consolidate	LFM-03-07	5/21/2010		
Consolidate	LFM-03-07	10/13/2010	293.5	
Consolidate	LFM-03-07	6/12/2013	297.1	
Consolidate	LFM-03-07	10/25/2013		
Consolidate	LFM-03-07	6/19/2014	296.8	
Consolidate	LFM-03-07	10/23/2014	293.7	
Consolidate	LFM-03-07	6/10/2015	296.9	
Consolidate	LFM-03-07	10/6/2015		
Consolidate	LFM-03-07	5/17/2016		
Consolidate	LFM-03-07	10/12/2016		
Consolidate	LFM-03-07	6/21/2017		
Consolidate	LFM-03-07	10/26/2017		
Consolidate	LFM-03-07	4/5/2018	298.7	
Consolidate	LFM-03-07	10/11/2018	297.3	
Consolidate	LFM-03-07	4/9/2019	296.8	
Consolidate	LFM-03-07	10/4/2019	292.0	
Consolidate	LFM-03-07	5/14/2020	298.3	
Consolidate	LFM-03-07	8/31/2020	292.1	
Consolidate	LFM-99-01B	5/22/2006	327.0	
Consolidate	LFM-99-01B	10/18/2006	324.8	
Consolidate	LFM-99-01B	5/21/2007	327.2	
Consolidate	LFM-99-01B	10/15/2007	324.1	
Consolidate	LFM-99-01B	6/25/2008	325.7	
Consolidate	LFM-99-01B	10/24/2008	325.6	
Consolidate	LFM-99-01B	5/5/2009	326.6	
Consolidate	LFM-99-01B	10/21/2009	324.9	
Consolidate	LFM-99-01B	5/21/2010	326.1	
Consolidate	LFM-99-01B	10/13/2010	324.3	
Consolidate	LFM-99-01B	6/12/2013	325.7	
Consolidate	LFM-99-01B	10/25/2013	326.6	
Consolidate	LFM-99-01B	6/19/2014	325.2	
Consolidate	LFM-99-01B	10/23/2014	323.5	
Consolidate	LFM-99-01B	6/10/2015	325.2	
Consolidate	LFM-99-01B	10/6/2015	323.4	
Consolidate	LFM-99-01B	5/17/2016	325.5	
Consolidate	LFM-99-01B	10/12/2016	322.7	
Consolidate	LFM-99-01B	6/21/2017	325.6	
Consolidate	LFM-99-01B	10/26/2017	323.3	
Consolidate	LFM-99-01B	4/5/2018	325.9	
Consolidate	LFM-99-01B	10/11/2018	324.9	
Consolidate	LFM-99-01B	4/9/2019	325.6	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
Consolidate	LFM-99-01B	10/4/2019	323.4	
Consolidate	LFM-99-01B	5/13/2020	325.9	
Consolidate	LFM-99-01B	8/31/2020	323.3	
Consolidate	LFM-99-02B	5/22/2006	340.9	
Consolidate	LFM-99-02B	10/18/2006	335.0	
Consolidate	LFM-99-02B	5/21/2007	339.7	
Consolidate	LFM-99-02B	10/15/2007	334.3	
Consolidate	LFM-99-02B	6/25/2008	335.4	
Consolidate	LFM-99-02B	10/23/2008	335.6	
Consolidate	LFM-99-02B	5/5/2009	337.0	
Consolidate	LFM-99-02B	10/21/2009	334.7	
Consolidate	LFM-99-02B	5/21/2010	336.3	
Consolidate	LFM-99-02B	10/13/2010	335.2	
Consolidate	LFM-99-02B	6/12/2013	337.9	
Consolidate	LFM-99-02B	10/25/2013	332.5	
Consolidate	LFM-99-02B	6/19/2014	335.1	
Consolidate	LFM-99-02B	10/23/2014	334.3	
Consolidate	LFM-99-02B	6/11/2015	335.3	
Consolidate	LFM-99-02B	10/6/2015	333.3	
Consolidate	LFM-99-02B	5/17/2016	335.4	
Consolidate	LFM-99-02B	10/12/2016	332.2	
Consolidate	LFM-99-02B	6/21/2017	336.4	
Consolidate	LFM-99-02B	10/26/2017	333.6	
Consolidate	LFM-99-02B	4/5/2018	337.9	
Consolidate	LFM-99-02B	10/11/2018	336.1	
Consolidate	LFM-99-02B	4/9/2019	336.1	
Consolidate	LFM-99-02B	10/4/2019	332.6	
Consolidate	LFM-99-02B	3/13/2020	336.6	
Consolidate	LFM-99-02B	5/13/2020	338.0	
Consolidate	LFM-99-02B	5/15/2020	337.8	
Consolidate	LFM-99-02B	8/31/2020	331.9	
Consolidate	LFM-99-03B	5/22/2006	304.7	
Consolidate	LFM-99-03B	10/18/2006	299.0	
Consolidate	LFM-99-03B	5/21/2007	308.0	
Consolidate	LFM-99-03B	10/15/2007	299.0	
Consolidate	LFM-99-03B	6/25/2008	300.7	
Consolidate	LFM-99-03B	10/24/2008	300.3	
Consolidate	LFM-99-03B	5/5/2009	303.3	
Consolidate	LFM-99-03B	10/21/2009	299.2	
Consolidate	LFM-99-03B	5/21/2010	302.1	
Consolidate	LFM-99-03B	10/13/2010	299.5	
Consolidate	LFM-99-03B	6/12/2013	306.4	
Consolidate	LFM-99-03B	10/25/2013	298.2	
Consolidate	LFM-99-03B	6/19/2014	300.9	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
Consolidate	LFM-99-03B	10/23/2014	298.3	
Consolidate	LFM-99-03B	10/6/2015	298.6	
Consolidate	LFM-99-03B	5/17/2016	300.9	
Consolidate	LFM-99-03B	10/12/2016	298.2	
Consolidate	LFM-99-03B	6/21/2017	302.3	
Consolidate	LFM-99-03B	10/26/2017	298.1	
Consolidate	LFM-99-03B	4/5/2018	303.6	
Consolidate	LFM-99-03B	10/11/2018	302.1	
Consolidate	LFM-99-03B	4/9/2019	302.3	
Consolidate	LFM-99-03B	10/4/2019	298.2	
Consolidate	LFM-99-03B	5/13/2020	302.9	
Consolidate	LFM-99-03B	8/31/2020	298.1	
Consolidate	LFM-99-05A	5/22/2006	298.0	
Consolidate	LFM-99-05A	10/18/2006	291.9	
Consolidate	LFM-99-05A	5/21/2007	298.4	
Consolidate	LFM-99-05A	10/15/2007	291.1	
Consolidate	LFM-99-05A	6/25/2008	293.5	
Consolidate	LFM-99-05A	10/23/2008	294.0	
Consolidate	LFM-99-05A	5/5/2009	295.7	
Consolidate	LFM-99-05A	10/21/2009	292.2	
Consolidate	LFM-99-05A	5/21/2010		
Consolidate	LFM-99-05A	10/13/2010	293.2	
Consolidate	LFM-99-05A	6/12/2013	297.2	
Consolidate	LFM-99-05A	10/25/2013	290.7	
Consolidate	LFM-99-05A	6/19/2014	293.7	
Consolidate	LFM-99-05A	10/23/2014	291.4	
Consolidate	LFM-99-05A	6/11/2015	294.3	
Consolidate	LFM-99-05A	10/6/2015	290.6	
Consolidate	LFM-99-05A	5/17/2016	293.6	
Consolidate	LFM-99-05A	10/12/2016	290.0	
Consolidate	LFM-99-05A	6/21/2017	295.5	
Consolidate	LFM-99-05A	10/26/2017	291.3	
Consolidate	LFM-99-05A	4/5/2018	299.1	
Consolidate	LFM-99-05A	10/11/2018	294.9	
Consolidate	LFM-99-05A	4/9/2019	294.7	
Consolidate	LFM-99-05A	10/4/2019	290.7	
Consolidate	LFM-99-05A	3/13/2020	294.6	
Consolidate	LFM-99-05A	5/13/2020	295.9	
Consolidate	LFM-99-05A	5/14/2020	295.9	
Consolidate	LFM-99-05A	8/31/2020	290.7	
Consolidate	LFM-99-05B	5/22/2006	300.5	
Consolidate	LFM-99-05B	10/18/2006	294.2	
Consolidate	LFM-99-05B	5/21/2007	301.2	
Consolidate	LFM-99-05B	10/15/2007	293.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
Consolidate	LFM-99-05B	6/25/2008	295.8	
Consolidate	LFM-99-05B	10/23/2008	296.4	
Consolidate	LFM-99-05B	5/5/2009	298.4	
Consolidate	LFM-99-05B	10/21/2009	294.5	
Consolidate	LFM-99-05B	5/21/2010	297.3	
Consolidate	LFM-99-05B	10/13/2010	295.5	
Consolidate	LFM-99-05B	6/12/2013	297.2	
Consolidate	LFM-99-05B	10/25/2013	292.9	
Consolidate	LFM-99-05B	6/19/2014	296.4	
Consolidate	LFM-99-05B	10/23/2014	293.6	
Consolidate	LFM-99-05B	6/10/2015	296.7	
Consolidate	LFM-99-05B	10/6/2015	292.9	
Consolidate	LFM-99-05B	5/17/2016	296.3	
Consolidate	LFM-99-05B	10/12/2016	292.3	
Consolidate	LFM-99-05B	6/21/2017	298.3	
Consolidate	LFM-99-05B	10/26/2017	293.3	
Consolidate	LFM-99-05B	4/5/2018	296.1	
Consolidate	LFM-99-05B	10/11/2018	297.8	
Consolidate	LFM-99-05B	4/9/2019	300.7	
Consolidate	LFM-99-05B	10/4/2019	293.0	
Consolidate	LFM-99-05B	3/13/2020	297.5	
Consolidate	LFM-99-05B	5/13/2020	298.9	
Consolidate	LFM-99-05B	8/31/2020	293.0	
Consolidate	LFM-99-06A	5/22/2006	310.1	
Consolidate	LFM-99-06A	10/18/2006	302.7	
Consolidate	LFM-99-06A	5/21/2007	309.7	
Consolidate	LFM-99-06A	10/15/2007	298.7	
Consolidate	LFM-99-06A	6/25/2008	304.1	
Consolidate	LFM-99-06A	10/23/2008	305.2	
Consolidate	LFM-99-06A	5/5/2009	307.6	
Consolidate	LFM-99-06A	10/21/2009	300.8	
Consolidate	LFM-99-06A	5/21/2010	305.3	
Consolidate	LFM-99-06A	10/13/2010	299.9	
Consolidate	LFM-99-06A	6/12/2013	329.0	
Consolidate	LFM-99-06A	10/25/2013	319.5	
Consolidate	LFM-99-06A	6/19/2014	325.5	
Consolidate	LFM-99-06A	10/23/2014	319.6	
Consolidate	LFM-99-06A	6/10/2015	325.6	
Consolidate	LFM-99-06ARP	10/7/2015	320.2	
Consolidate	LFM-99-06ARP	5/17/2016	322.6	
Consolidate	LFM-99-06ARP	10/12/2016	318.8	
Consolidate	LFM-99-06ARP	6/21/2017	323.4	
Consolidate	LFM-99-06ARP	10/26/2017	320.1	
Consolidate	LFM-99-06ARP	4/5/2018	323.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
Consolidate	LFM-99-06ARP	10/11/2018	323.0	
Consolidate	LFM-99-06ARP	4/9/2019	322.6	
Consolidate	LFM-99-06ARP	10/4/2019	319.5	
Consolidate	LFM-99-06ARP	3/13/2020	323.0	
Consolidate	LFM-99-06ARP	5/13/2020	323.3	
Consolidate	LFM-99-06ARP	5/14/2020	323.2	
Consolidate	LFM-99-06ARP	8/31/2020	319.6	
ıer_Fort_De	1C	3/13/2020	244.3	
ıer_Fort_De	1C	8/31/2020	242.1	
ıer_Fort_De	1D-D	2/20/2020	245.2	
ıer_Fort_De	1D-D	3/13/2020	245.2	
ıer_Fort_De	1D-D	8/31/2020	242.8	
ıer_Fort_De	1D-S	2/20/2020	245.1	
ıer_Fort_De	1D-S	3/13/2020	245.2	
ıer_Fort_De	1D-S	8/31/2020	242.8	
ıer_Fort_De	1E-D	3/13/2020	242.2	
ıer_Fort_De	1E-D	8/31/2020	239.9	
ıer_Fort_De	1E-S	3/13/2020	242.7	
ıer_Fort_De	1E-S	8/31/2020	240.4	
ıer_Fort_De	1F-D	3/13/2020	253.2	
ıer_Fort_De	1F-D	8/31/2020	249.7	
ıer_Fort_De	1F-S	3/13/2020	256.6	
ıer_Fort_De	1F-S	8/31/2020	249.8	
ıer_Fort_De	B202-1	5/26/1992		-26.9
ıer_Fort_De	B202-1	9/15/1992		-28.6
ıer_Fort_De	B202-1	12/22/1992		-28.9
ıer_Fort_De	B202-1	3/30/1993		-27.5
ıer_Fort_De	B202-1	6/22/1993		-28.1
ıer_Fort_De	B202-1	9/30/1993		-29.0
ıer_Fort_De	B202-1	11/8/1993		-29.2
ıer_Fort_De	B202-1	3/30/1994		-27.1
ıer_Fort_De	B202-1	6/28/1994		-27.4
ıer_Fort_De	B202-1	10/4/1994		-27.8
ıer_Fort_De	B202-1	1/31/1995		-27.7
ıer_Fort_De	B202-1	5/9/1995		-28.0
ıer_Fort_De	B202-1	12/7/1995		-28.6
ıer_Fort_De	B202-1	3/26/1996		-27.0
ıer_Fort_De	B202-1	7/23/1996		-26.3
ıer_Fort_De	B202-1	1/15/1997		-25.8
ıer_Fort_De	B202-1	6/2/1997		-25.8
ıer_Fort_De	B202-1	4/23/1998		-25.9
ıer_Fort_De	B202-1	6/26/1998		-24.6
ıer_Fort_De	B202-1	7/1/1998		-24.6
ıer_Fort_De	B202-1	7/17/1998		-25.2

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
er_Fort_De	B202-1	7/31/1998		-25.7
er_Fort_De	B202-1	8/28/1998		-26.6
er_Fort_De	B202-1	10/14/1998		-27.0
er_Fort_De	B202-1	12/10/1998		-28.2
er_Fort_De	B202-1	2/23/1999		-27.9
er_Fort_De	B202-1	6/6/1999		-28.8
er_Fort_De	B202-1	9/8/1999		-30.7
er_Fort_De	B202-2	5/26/1992		-30.4
er_Fort_De	B202-2	9/15/1992		-32.3
er_Fort_De	B202-2	12/22/1992		-32.8
er_Fort_De	B202-2	3/30/1993		-32.2
er_Fort_De	B202-2	6/22/1993		-31.8
er_Fort_De	B202-2	9/30/1993		-32.9
er_Fort_De	B202-2	11/8/1993		-33.0
er_Fort_De	B202-2	3/30/1994		-31.1
er_Fort_De	B202-2	6/28/1994		-31.2
er_Fort_De	B202-2	10/4/1994		-31.5
er_Fort_De	B202-2	1/31/1995		-31.4
er_Fort_De	B202-2	12/7/1995		-32.2
er_Fort_De	B202-2	3/26/1996		-30.7
er_Fort_De	B202-2	7/23/1996		-30.0
er_Fort_De	B202-2	1/15/1997		-29.5
er_Fort_De	B202-2	4/23/1998		-29.8
er_Fort_De	B202-2	7/1/1998		-28.5
er_Fort_De	B202-2	7/17/1998		-28.9
er_Fort_De	B202-2	7/31/1998		-29.4
er_Fort_De	B202-2	8/28/1998		-30.2
er_Fort_De	B202-2	10/14/1998		-30.9
er_Fort_De	B202-2	12/10/1998		-32.0
er_Fort_De	B202-2	2/23/1999		-31.7
er_Fort_De	B202-2	6/6/1999		-32.5
er_Fort_De	B202-2	9/8/1999		-33.8
er_Fort_De	B202-3	5/26/1992		-29.4
er_Fort_De	B202-3	5/27/1992		-31.3
er_Fort_De	B202-3	9/15/1992		-31.5
er_Fort_De	B202-3	12/22/1992		-32.1
er_Fort_De	B202-3	3/30/1993		-31.5
er_Fort_De	B202-3	6/22/1993		-31.0
er_Fort_De	B202-3	9/30/1993		-32.3
er_Fort_De	B202-3	11/8/1993		-32.3
er_Fort_De	B202-3	3/30/1994		-30.5
er_Fort_De	B202-3	6/28/1994		-30.3
er_Fort_De	B202-3	10/4/1994		-30.7
er_Fort_De	B202-3	1/31/1995		-30.7

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
er_Fort_De	B202-3	5/9/1995		-31.0
er_Fort_De	B202-3	12/7/1995		-31.6
er_Fort_De	B202-3	3/26/1996		-30.0
er_Fort_De	B202-3	7/23/1996		-29.1
er_Fort_De	B202-3	1/15/1997		-28.7
er_Fort_De	B202-3	6/2/1997		-28.5
er_Fort_De	B202-3	4/23/1998		-29.0
er_Fort_De	B202-3	7/1/1998		-27.9
er_Fort_De	B202-3	7/17/1998		-28.0
er_Fort_De	B202-3	7/31/1998		-28.5
er_Fort_De	B202-3	8/28/1998		-29.3
er_Fort_De	B202-3	10/14/1998		-30.2
er_Fort_De	B202-3	12/10/1998		-31.2
er_Fort_De	B202-3	2/23/1999		-31.0
er_Fort_De	B202-3	6/6/1999		-31.8
er_Fort_De	B202-3	9/8/1999		-33.1
er_Fort_De	EA-04	5/26/1992		
er_Fort_De	EA-04	6/1/1992		
er_Fort_De	EA-05	5/26/1992		
er_Fort_De	EA-05	6/1/1992		
er_Fort_De	FD40	5/26/1992		
er_Fort_De	FD40	6/1/1992		
er_Fort_De	POL-1	5/26/1992		-19.1
er_Fort_De	POL-1	9/15/1992		-20.0
er_Fort_De	POL-1	12/22/1992		-19.0
er_Fort_De	POL-1	3/30/1993		-15.3
er_Fort_De	POL-1	6/22/1993		-19.4
er_Fort_De	POL-1	9/30/1993		-19.3
er_Fort_De	POL-1	11/8/1993		-19.2
er_Fort_De	POL-1	6/28/1994		-19.3
er_Fort_De	POL-1	10/4/1994		-19.3
er_Fort_De	POL-1	1/31/1995		-18.0
er_Fort_De	POL-1	5/9/1995		-19.2
er_Fort_De	POL-1	12/7/1995		-18.7
er_Fort_De	POL-1	3/26/1996		-17.7
er_Fort_De	POL-1	7/23/1996		-18.8
er_Fort_De	POL-1	1/15/1997		-17.9
er_Fort_De	POL-1	6/2/1997		-18.7
er_Fort_De	POL-1	4/23/1998		-18.3
er_Fort_De	POL-1	10/14/1998		-19.3
er_Fort_De	POL-1	12/10/1998		-20.1
er_Fort_De	POL-1	2/23/1999		-18.8
er_Fort_De	POL-2	5/26/1992		-27.7
er_Fort_De	POL-2	9/15/1992		-28.3

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
er_Fort_De	POL-2	12/22/1992		-28.0
er_Fort_De	POL-2	3/30/1993		-26.7
er_Fort_De	POL-2	6/22/1993		-25.4
er_Fort_De	POL-2	9/30/1993		-29.4
er_Fort_De	POL-2	11/8/1993		-27.9
er_Fort_De	POL-2	6/28/1994		-24.4
er_Fort_De	POL-2	10/4/1994		-27.4
er_Fort_De	POL-2	1/31/1995		-27.0
er_Fort_De	POL-2	5/9/1995		-27.4
er_Fort_De	POL-2	12/7/1995		-28.2
er_Fort_De	POL-2	1/15/1997		-23.7
er_Fort_De	POL-2	6/2/1997		-26.3
er_Fort_De	POL-2	4/23/1998		-24.7
er_Fort_De	POL-2	10/14/1998		-27.2
er_Fort_De	POL-2	12/10/1998		-28.7
er_Fort_De	POL-2	2/23/1999		-28.2
er_Fort_De	POL-3	5/26/1992		-25.4
er_Fort_De	POL-3	9/15/1992		-25.0
er_Fort_De	POL-3	12/22/1992		-26.7
er_Fort_De	POL-3	3/30/1993		-23.9
er_Fort_De	POL-3	6/22/1993		-25.7
er_Fort_De	POL-3	9/30/1993		-27.0
er_Fort_De	POL-3	11/8/1993		-26.7
er_Fort_De	POL-3	6/28/1994		-25.3
er_Fort_De	POL-3	10/4/1994		-25.9
er_Fort_De	POL-3	1/31/1995		-24.0
er_Fort_De	POL-3	5/9/1995		-25.9
er_Fort_De	POL-3	12/7/1995		-24.8
er_Fort_De	POL-3	1/15/1997		-22.8
er_Fort_De	POL-3	4/23/1998		-23.9
er_Fort_De	POL-3	10/14/1998		-25.9
er_Fort_De	POL-3	12/10/1998		-27.3
er_Fort_De	POL-3	2/23/1999		-25.2
er_Fort_De	SMW-2	4/23/1998		
er_Fort_De	SMW-2	6/19/1998		
er_Fort_De	SMW-2	2/23/1999		
er_Fort_De	SMW-2	9/8/1999		
er_Fort_De	SMW-2	1/19/2000		
er_Fort_De	SMW-2	5/24/2000		
er_Fort_De	SMW-2	11/14/2000		
er_Fort_De	SMW-2	5/10/2001		
er_Fort_De	SMW-2	11/16/2001		
er_Fort_De	SMW-2	7/10/2002		
er_Fort_De	SMW-2	6/19/2003		

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
ıer_Fort_De	SMW-2	12/1/2003		
ıer_Fort_De	SMW-2	5/25/2004		
ıer_Fort_De	SMW-2	8/30/2004		
ıer_Fort_De	SMW-2	12/8/2004		
ıer_Fort_De	SMW-2	5/18/2005		
ıer_Fort_De	SMW-2	11/7/2005		
ıer_Fort_De	SMW-2	12/8/2005		
ıer_Fort_De	SMW-2	2/16/2006		
ıer_Fort_De	SMW-2	6/5/2006		
ıer_Fort_De	SMW-2	9/18/2006		
ıer_Fort_De	SMW-2	12/15/2006		
ıer_Fort_De	SMW-2	5/7/2007		
ıer_Fort_De	SMW-2	6/25/2007		
ıer_Fort_De	SMW-2	11/17/2008		
ıer_Fort_De	SMW-2	4/28/2009		
ıer_Fort_De	SMW-2	7/5/2009		
ıer_Fort_De	SMW-2	10/26/2009		
ıer_Fort_De	SMW-2	1/22/2010		
ıer_Fort_De	SMW-2	4/6/2010		
ıer_Fort_De	SMW-2	7/7/2010		
ıer_Fort_De	SMW-2	1/14/2011		
ıer_Fort_De	SMW-2	4/4/2011		
ıer_Fort_De	SMW-2	7/25/2011		
ıer_Fort_De	SMW-2	10/13/2011		
ıer_Fort_De	SMW-2	4/10/2012		
ıer_Fort_De	SMW-2	4/22/2013		
ıer_Fort_De	WBP-93-01	10/4/1994		
ıer_Fort_De	WBP-93-01	1/31/1995		
ıer_Fort_De	WBP-93-01	5/9/1995		
ıer_Fort_De	WBP-93-01	12/7/1995		
ıer_Fort_De	WBP-93-01	6/5/2006		
ıer_Fort_De	WBP-93-01	12/15/2006		
ıve_Pond_A	92-1	5/26/1992	216.2	
ıve_Pond_A	92-1	6/1/1992		209.8
ıve_Pond_A	92-1	10/2/2018	214.4	
ıve_Pond_A	92-1	3/12/2020	214.8	
ıve_Pond_A	92-2	5/26/1992		-7.4
ıve_Pond_A	92-2	6/1/1992		-11.7
ıve_Pond_A	92-3	5/26/1992	216.2	
ıve_Pond_A	92-3	6/1/1992		209.9
ıve_Pond_A	92-3	10/2/2018	214.1	
ıve_Pond_A	92-3	3/12/2020	214.5	
ıve_Pond_A	92-4	5/26/1992	246.4	
ıve_Pond_A	92-4	6/1/1992	241.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
ve_Pond_A	92-4	10/2/2018	214.5	
ve_Pond_A	92-4	3/12/2020	214.8	
ve_Pond_A	92-5	5/26/1992	216.1	
ve_Pond_A	92-5	6/1/1992	215.9	
ve_Pond_A	CSMS-11-01	10/2/2018	216.1	
ve_Pond_A	CSMS-11-01	3/19/2019	216.1	
ve_Pond_A	CSMS-11-01	3/12/2020	216.3	
ve_Pond_A	CSMS-11-02	10/2/2018	215.1	
ve_Pond_A	CSMS-11-02	3/19/2019	214.9	
ve_Pond_A	CSMS-11-02	3/12/2020	215.4	
ve_Pond_A	GF-1	10/2/2018	214.1	
ve_Pond_A	GF-1	3/12/2020	214.5	
ve_Pond_A	GF-2	10/2/2018	214.2	
ve_Pond_A	GF-2	3/12/2020	214.7	
ve_Pond_A	GF-3A	10/2/2018	214.6	
ve_Pond_A	GF-3A	3/12/2020	215.6	
ve_Pond_A	GF-3B	10/2/2018	216.1	
ve_Pond_A	GF-3B	3/12/2020	216.1	
ve_Pond_A	GF-4	10/2/2018	212.5	
ve_Pond_A	GF-4	3/12/2020	213.5	
ve_Pond_A	GPMW-19-01A	3/12/2020	216.4	
ve_Pond_A	GPMW-19-01BR	3/12/2020	216.1	
ve_Pond_A	GPPZ-19-01	3/12/2020	216.0	
ve_Pond_A	MNG-1	5/26/1992		
ve_Pond_A	MNG-2	5/26/1992		-17.5
ve_Pond_A	MNG-2	3/30/1993		-16.8
ve_Pond_A	MNG-2	6/22/1993		-17.7
ve_Pond_A	MNG-2	9/30/1993		-17.7
ve_Pond_A	MNG-2	11/8/1993		-17.9
ve_Pond_A	MNG-2	12/20/2011		-19.2
ve_Pond_A	MNG-2R	10/2/2018	216.9	
ve_Pond_A	MNG-2R	3/19/2019	217.2	
ve_Pond_A	MNG-2R	3/12/2020	217.0	
ve_Pond_A	MNG-3R	10/2/2018	215.0	
ve_Pond_A	MNG-3R	3/19/2019	214.9	
ve_Pond_A	MNG-3R	3/12/2020	215.4	
ve_Pond_A	MNG-4	5/26/1992		
ve_Pond_A	MNG-5	5/26/1992		-15.9
ve_Pond_A	MNG-5	3/30/1993		-15.7
ve_Pond_A	MNG-5	6/22/1993		-15.9
ve_Pond_A	MNG-5	11/8/1993		-16.5
ve_Pond_A	MNG-5	12/20/2011		-15.2
ve_Pond_A	MNG-5R	10/2/2018	219.2	
ve_Pond_A	MNG-5R	3/19/2019	219.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
ve_Pond_A	MNG-5R	3/12/2020	219.1	
ve_Pond_A	MNG-6	5/26/1992		-34.0
ve_Pond_A	MNG-6	6/1/1992		-34.6
ve_Pond_A	MNG-6	3/30/1993		-33.1
ve_Pond_A	MNG-6	6/22/1993		-33.8
ve_Pond_A	MNG-6	9/30/1993		-33.8
ve_Pond_A	MNG-6	11/8/1993		-33.9
ve_Pond_A	MNG-6	12/20/2011		-35.0
ve_Pond_A	MNG-6R	10/2/2018	216.7	
ve_Pond_A	MNG-6R	3/19/2019	216.8	
ve_Pond_A	MNG-6R	3/12/2020	216.7	
ve_Pond_A	MNG-7	5/26/1992		
ve_Pond_A	MNG-7	6/1/1992		
ve_Pond_A	MNG-7	3/30/1993		
ve_Pond_A	MNG-7	9/30/1993		
ve_Pond_A	MNG-7	11/8/1993		
MacPherson	McPh-Sentinel	6/10/2008	204.7	
MacPherson	McPh-Sentinel	8/19/2008	203.7	
MacPherson	McPh-Sentinel	11/17/2008	204.1	
MacPherson	McPh-Sentinel	4/28/2009	203.8	
MacPherson	McPh-Sentinel	8/5/2009	204.3	
MacPherson	McPh-Sentinel	4/20/2010	205.8	
MacPherson	McPh-Sentinel	7/7/2010	203.0	
MacPherson	McPh-Sentinel	12/23/2010	203.9	
MacPherson	McPh-Sentinel	4/4/2011	205.7	
MacPherson	McPh-Sentinel	7/25/2011	203.4	
MacPherson	McPh-Sentinel	4/10/2012	203.8	
MacPherson	McPh-Sentinel	4/22/2013	204.2	
MacPherson	McPh-Sentinel	5/16/2019	205.4	
MacPherson	McPh-Sentinel	6/28/2019	204.3	
MacPherson	MPP-93-01	6/28/1994		
MacPherson	MPP-93-01	10/4/1994		
MacPherson	MPP-93-01	5/9/1995		
MacPherson	MPP-93-01	12/7/1995		
MacPherson	MPP-93-01	3/26/1996		
MacPherson	MPP-93-01	7/23/1996		
MacPherson	MPP-93-01	1/15/1997		
MacPherson	MPP-93-01	6/2/1997		
MacPherson	MPP-93-01	10/14/1998		
MacPherson	MPP-93-01	12/10/1998		
MacPherson	MPP-93-01	2/23/1999		
MacPherson	MPP-93-01	6/6/1999		
MacPherson	MPP-93-01	9/8/1999		
MacPherson	MPP-93-02	10/14/1998	202.5	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
MacPherson	MPP-93-02	12/10/1998	202.1	
MacPherson	MPP-93-02	2/23/1999	203.3	
MacPherson	MPP-93-02	6/6/1999	201.4	
MacPherson	MPP-93-02	9/8/1999	201.0	
MacPherson	MPP-93-02	5/16/2019	205.1	
MacPherson	MPP-93-02	6/28/2019	203.8	
MacPherson	MPP-93-03	6/28/1994	201.8	
MacPherson	MPP-93-03	10/4/1994	203.6	
MacPherson	MPP-93-03	1/31/1995	203.8	
MacPherson	MPP-93-03	5/9/1995	202.0	
MacPherson	MPP-93-03	12/7/1995	202.9	
MacPherson	MPP-93-03	3/26/1996	205.2	
MacPherson	MPP-93-03	7/23/1996	203.0	
MacPherson	MPP-93-03	1/15/1997	204.3	
MacPherson	MPP-93-03	6/2/1997	203.2	
MacPherson	MPP-93-03	5/16/2019	204.9	
MacPherson	MPP-93-03	6/28/2019	203.7	
MacPherson	MPPZ-19-01	5/16/2019	206.6	
MacPherson	MPPZ-19-01	6/28/2019	206.0	
MacPherson	MPPZ-19-02	6/28/2019	206.6	
MacPherson	MPPZ-19-03	5/16/2019	205.5	
MacPherson	MPPZ-19-03	6/28/2019	204.4	
lashua_Rive	NRSG-01	4/27/2020	202.7	
ton_Well_F	CPSG-01	1/3/2020		-3.7
ton_Well_F	CPSG-01	3/13/2020	244.3	
ton_Well_F	CPSG-01	9/1/2020	243.9	
ton_Well_F	CPSG-02	1/3/2020		-1.9
ton_Well_F	CPSG-02	3/13/2020	243.7	
ton_Well_F	CPSG-02	8/31/2020	242.0	
ton_Well_F	CSBSG-01	1/3/2020		-3.0
ton_Well_F	CSBSG-01	3/13/2020	235.4	
ton_Well_F	CSBSG-01	8/31/2020	233.5	
ton_Well_F	PTW-A	3/13/2020	243.4	
ton_Well_F	PTW-A	8/31/2020	241.0	
ton_Well_F	PTW-B	3/13/2020	242.5	
ton_Well_F	PTW-B	8/31/2020	236.1	
ton_Well_F	PWPZ-19-01	1/3/2020	243.0	
ton_Well_F	PWPZ-19-01	3/13/2020	243.8	
ton_Well_F	PWPZ-19-01	8/31/2020	241.1	
ton_Well_F	PWPZ-19-02	1/3/2020	237.2	
ton_Well_F	PWPZ-19-02	3/13/2020	237.2	
ton_Well_F	PWPZ-19-02	8/31/2020	236.1	
ton_Well_F	PWPZ-19-03	1/3/2020	243.6	
ton_Well_F	PWPZ-19-03	3/13/2020	242.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
ton_Well_F	PWPZ-19-03	8/31/2020	239.6	
ton_Well_F	PWPZ-19-04	1/3/2020	247.4	
ton_Well_F	PWPZ-19-04	3/13/2020	248.8	
ton_Well_F	PWPZ-19-04	8/31/2020	247.4	
ton_Well_F	PWPZ-19-05	1/3/2020	243.6	
ton_Well_F	PWPZ-19-05	3/13/2020	244.2	
ton_Well_F	PWPZ-19-05	8/31/2020	242.7	
ton_Well_F	PWPZ-19-06	1/3/2020	243.4	
ton_Well_F	PWPZ-19-06	8/31/2020	241.7	
ton_Well_F	PWPZ-19-07	1/3/2020	247.6	
ton_Well_F	PWPZ-19-07	3/13/2020	247.0	
ton_Well_F	PWPZ-19-07	8/31/2020	242.3	
ton_Well_F	PWPZ-19-08	1/3/2020	243.4	
ton_Well_F	PWPZ-19-08	3/13/2020	242.8	
ton_Well_F	PWPZ-19-08	8/31/2020	241.6	
ton_Well_F	PWPZ-19-09	1/3/2020	243.3	
ton_Well_F	PWPZ-19-09	3/13/2020	243.7	
ton_Well_F	PWPZ-19-09	8/31/2020	241.7	
ton_Well_F	PWPZ-19-10	1/3/2020	243.6	
ton_Well_F	PWPZ-19-10	3/13/2020	243.9	
ton_Well_F	PWPZ-19-10	8/31/2020	241.7	
ton_Well_F	PWPZ-20-01	3/13/2020	243.0	
ton_Well_F	PWPZ-20-01	8/31/2020	239.3	
ton_Well_F	PWPZ-20-02	8/31/2020		
ton_Well_F	PWPZ-20-03	8/31/2020		-18.0
ton_Well_F	PWPZ-20-04	8/31/2020		-29.5
ton_Well_F	PWPZ-20-05	8/31/2020		
ton_Well_F	PWPZ-20-06	8/31/2020		-10.8
ton_Well_F	PWPZ-20-07	9/1/2020		-7.4
ton_Well_F	PWPZ-20-08	8/31/2020		-80.4
ton_Well_F	PWPZ-20-09	8/31/2020		-75.0
ton_Well_F	PWPZ-20-10	8/31/2020		-12.3
ton_Well_F	PWPZ-20-11	8/31/2020		
ton_Well_F	PWPZ-20-12	8/31/2020		-12.3
ton_Well_F	PWPZ-20-13	8/31/2020		-10.5
Pond_and_	RPSG-01	1/3/2020		-2.2
Pond_and_	RPSG-01	2/20/2020	244.9	
Pond_and_	RPSG-01	3/13/2020	245.1	
Pond_and_	RPSG-01	8/31/2020	243.7	
ookin_Well_	MLSG-01	1/3/2020		-2.0
ookin_Well_	MLSG-01	3/13/2020	242.3	
ookin_Well_	MLSG-01	8/31/2020	240.9	
ookin_Well_	MW-9D	3/13/2020	233.7	
ookin_Well_	MW-A	3/13/2020	230.8	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
ookin_Well_	MW-B	3/13/2020	231.5	
ookin_Well_	MW-C	3/13/2020	231.5	
ookin_Well_	MW-D	3/13/2020	230.8	
ookin_Well_	MW-E	3/13/2020	230.8	
ookin_Well_	MW-F	3/13/2020	230.7	
ookin_Well_	MW-G	3/13/2020	233.8	
ookin_Well_	MW-H	3/13/2020	232.0	
ookin_Well_	MW-I	3/13/2020	230.5	
ookin_Well_	MW-J	3/13/2020	233.8	
ookin_Well_	MW-K	3/13/2020	233.8	
ookin_Well_	SWMW-20-01A	3/13/2020	357.4	
ookin_Well_	SWMW-20-01A	8/31/2020	351.6	
ookin_Well_	SWPZ-19-01	3/13/2020	230.0	
ookin_Well_	SWPZ-19-03	3/13/2020	241.2	
ookin_Well_	SWPZ-19-03	8/31/2020	236.4	
ookin_Well_	SWPZ-19-04	3/13/2020	232.2	
ookin_Well_	SWPZ-20-01	3/13/2020	329.2	
ookin_Well_	SWPZ-20-01	8/31/2020	327.3	
ookin_Well_	SWPZ-20-02	3/13/2020	242.4	
ookin_Well_	SWPZ-20-02	8/31/2020	240.6	
SP_Other	28M-92-01X	9/5/1992	238.1	
SP_Other	28M-92-01X	9/30/1993	237.6	
SP_Other	28M-92-01X	12/7/1995	241.4	
SP_Other	28M-92-01X	7/23/1996	240.3	
SP_Other	28M-92-01X	1/15/1997	241.4	
SP_Other	28M-92-01X	6/2/1997	241.4	
SP_Other	28M-92-01X	4/23/1998	247.6	
SP_Other	28M-92-02X	9/5/1992	236.9	
SP_Other	28M-92-02X	9/30/1993	236.8	
SP_Other	28M-92-02X	12/7/1995	237.3	
SP_Other	28M-92-02X	7/23/1996	239.1	
SP_Other	28M-92-02X	4/23/1998	245.5	
SP_Other	28M-92-03X	9/5/1992	227.6	
SP_Other	28M-92-03X	9/30/1993	233.2	
SP_Other	28M-92-04X	9/5/1992	235.7	
SP_Other	28M-92-04X	9/30/1993	230.1	
SP_Other	28M-92-04X	12/7/1995	236.2	
SP_Other	28M-92-04X	7/23/1996	237.6	
SP_Other	28M-92-04X	4/23/1998	244.3	
SP_Other	SPM-93-02X	7/23/1996	313.3	
SP_Other	SPM-93-02X	1/15/1997	316.3	
SP_Other	SPM-93-02X	4/23/1998	316.6	
SP_Other	SPM-93-02X	10/14/1998	311.6	
SP_Other	SPM-93-02X	12/6/1999	313.2	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
SP_Other	SPM-93-02X	10/26/2010	245.5	
SP_Other	SPM-93-02X	11/25/2014	247.4	
SP_Other	SPM-93-02X	11/26/2014	311.9	
SP_Other	SPM-93-02X	12/8/2015	245.4	
SP_Other	SPM-93-02X	12/10/2015	309.3	
SP_Other	SPM-93-02X	11/2/2016	243.7	
SP_Other	SPM-93-02X	11/27/2017	247.4	
SP_Other	SPM-93-02X	11/19/2018	250.5	
SP_Other	SPM-93-02X	11/26/2019	247.5	
SP_Other	SPM-93-03X	7/23/1996	247.0	
SP_Other	SPM-93-03X	1/15/1997	249.0	
SP_Other	SPM-93-03X	6/2/1997	248.4	
SP_Other	SPM-93-03X	4/23/1998	249.4	
SP_Other	SPM-93-03X	12/6/1999	247.4	
SP_Other	SPM-93-03X	10/21/2008		
SP_Other	SPM-93-03X	11/12/2009		
SP_Other	SPM-93-03X	10/26/2010		
SP_Other	SPM-93-05X	7/23/1996	232.4	
SP_Other	SPM-93-05X	1/15/1997	233.1	
SP_Other	SPM-93-05X	6/2/1997	233.4	
SP_Other	SPM-93-05X	4/23/1998	233.2	
SP_Other	SPM-93-05X	10/14/1998	232.1	
SP_Other	SPM-93-05X	12/6/1999	230.8	
SP_Other	SPM-93-05X	10/21/2008		
SP_Other	SPM-93-05X	10/26/2010	232.0	
SP_Other	SPM-93-05X	10/17/2011	232.6	
SP_Other	SPM-93-05X	11/13/2012		
SP_Other	SPM-93-05X	11/13/2013	231.2	
SP_Other	SPM-93-05X	11/25/2014	231.6	
SP_Other	SPM-93-05X	12/8/2015	231.1	
SP_Other	SPM-93-05X	11/2/2016	230.6	
SP_Other	SPM-93-05X	11/27/2017	231.7	
SP_Other	SPM-93-05X	2/22/2018	233.8	
SP_Other	SPM-93-05X	11/19/2018	233.7	
SP_Other	SPM-93-05X	11/25/2019	232.3	
SP_Other	SPM-93-07X	7/23/1996	240.1	
SP_Other	SPM-93-07X	10/14/1998	240.1	
SP_Other	SPM-93-07X	12/6/1999	235.3	
SP_Other	SPM-93-07X	10/22/2008		
SP_Other	SPM-93-07X	10/26/2010	240.7	
SP_Other	SPM-93-07X	10/18/2011	239.9	
SP_Other	SPM-93-07X	11/14/2013	237.5	
SP_Other	SPM-93-07X	11/25/2014	236.2	
SP_Other	SPM-93-07X	12/7/2015	235.7	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
SP_Other	SPM-93-07X	10/31/2016	234.0	
SP_Other	SPM-93-07X	2/22/2018	236.4	
SP_Other	SPM-93-07X	11/19/2018	239.1	
SP_Other	SPM-93-07X	11/25/2019	239.4	
SP_Other	SPM-93-08X	7/23/1996	241.0	
SP_Other	SPM-93-08X	10/27/1997	239.8	
SP_Other	SPM-93-08X	10/14/1998	241.1	
SP_Other	SPM-93-08X	10/21/1998	241.0	
SP_Other	SPM-93-08X	10/18/1999	236.9	
SP_Other	SPM-93-08X	12/6/1999	236.3	
SP_Other	SPM-93-08X	10/25/2000	238.5	
SP_Other	SPM-93-08X	10/15/2001	238.4	
SP_Other	SPM-93-08X	10/21/2002	235.0	
SP_Other	SPM-93-08X	10/28/2003	238.5	
SP_Other	SPM-93-08X	11/1/2004	237.7	
SP_Other	SPM-93-08X	11/14/2005	241.8	
SP_Other	SPM-93-08X	10/24/2006	241.9	
SP_Other	SPM-93-08X	10/23/2007	240.7	
SP_Other	SPM-93-08X	10/22/2008	241.4	
SP_Other	SPM-93-08X	11/12/2009	240.7	
SP_Other	SPM-93-08X	10/26/2010	240.9	
SP_Other	SPM-93-08X	10/18/2011	240.1	
SP_Other	SPM-93-08X	11/13/2012	238.2	
SP_Other	SPM-93-08X	11/14/2013	237.5	
SP_Other	SPM-93-08X	11/25/2014	236.4	
SP_Other	SPM-93-08X	12/7/2015	235.9	
SP_Other	SPM-93-08X	10/31/2016	234.4	
SP_Other	SPM-93-08X	11/13/2017	236.4	
SP_Other	SPM-93-08X	11/19/2018	239.5	
SP_Other	SPM-93-08X	11/25/2019	239.7	
SP_Other	SPM-93-09X	7/23/1996	235.6	
SP_Other	SPM-93-09X	1/15/1997	236.3	
SP_Other	SPM-93-09X	6/2/1997	237.0	
SP_Other	SPM-93-09X	4/23/1998	236.1	
SP_Other	SPM-93-09X	10/14/1998	235.5	
SP_Other	SPM-93-09X	12/6/1999	232.5	
SP_Other	SPM-93-09X	10/23/2008		
SP_Other	SPM-93-09X	11/25/2009		
SP_Other	SPM-93-09X	10/26/2010	235.1	
SP_Other	SPM-93-09X	10/18/2011	235.0	
SP_Other	SPM-93-09X	11/15/2012	234.0	
SP_Other	SPM-93-09X	11/13/2013		
SP_Other	SPM-93-09X	11/26/2014	232.8	
SP_Other	SPM-93-09X	12/7/2015	232.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
SP_Other	SPM-93-09X	10/31/2016	231.2	
SP_Other	SPM-93-09X	2/22/2018	233.0	
SP_Other	SPM-93-09X	11/19/2018	235.2	
SP_Other	SPM-93-09X	11/26/2019	234.6	
SP_Other	SPM-93-10X	7/23/1996	235.5	
SP_Other	SPM-93-10X	1/15/1997	235.7	
SP_Other	SPM-93-10X	6/2/1997	236.7	
SP_Other	SPM-93-10X	10/27/1997	234.3	
SP_Other	SPM-93-10X	4/23/1998	235.6	
SP_Other	SPM-93-10X	10/14/1998	235.2	
SP_Other	SPM-93-10X	10/21/1998	235.5	
SP_Other	SPM-93-10X	10/18/1999	233.1	
SP_Other	SPM-93-10X	12/6/1999	232.1	
SP_Other	SPM-93-10X	10/25/2000	234.0	
SP_Other	SPM-93-10X	10/15/2001	233.6	
SP_Other	SPM-93-10X	10/21/2002	231.4	
SP_Other	SPM-93-10X	10/28/2003	234.0	
SP_Other	SPM-93-10X	11/1/2004	233.2	
SP_Other	SPM-93-10X	11/14/2005	235.9	
SP_Other	SPM-93-10X	10/25/2006	236.0	
SP_Other	SPM-93-10X	10/24/2007	235.2	
SP_Other	SPM-93-10X	10/23/2008	235.5	
SP_Other	SPM-93-10X	11/25/2009	235.4	
SP_Other	SPM-93-10X	10/26/2010	235.2	
SP_Other	SPM-93-10X	10/18/2011	234.8	
SP_Other	SPM-93-10X	11/15/2012	233.6	
SP_Other	SPM-93-10X	11/13/2013	233.2	
SP_Other	SPM-93-10X	11/26/2014	232.5	
SP_Other	SPM-93-10X	12/7/2015	232.1	
SP_Other	SPM-93-10X	10/31/2016	231.0	
SP_Other	SPM-93-10X	11/13/2017	232.5	
SP_Other	SPM-93-10X	11/19/2018	234.8	
SP_Other	SPM-93-10X	11/26/2019	234.3	
SP_Other	SPM-93-11X	6/2/1997	236.0	
SP_Other	SPM-93-11X	10/14/1998	233.5	
SP_Other	SPM-93-11X	12/6/1999	231.3	
SP_Other	SPM-93-11X	10/21/2009		
SP_Other	SPM-93-11X	11/25/2009		
SP_Other	SPM-93-11X	10/26/2010		
SP_Other	SPM-93-11X	10/18/2011	234.1	
SP_Other	SPM-93-11X	11/15/2012	232.7	
SP_Other	SPM-93-11X	11/13/2013	247.2	
SP_Other	SPM-93-11X	11/26/2014	231.9	
SP_Other	SPM-93-11X	12/7/2015	231.3	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
SP_Other	SPM-93-11X	10/31/2016	230.1	
SP_Other	SPM-93-11X	11/27/2017	232.7	
SP_Other	SPM-93-11X	2/22/2018	233.0	
SP_Other	SPM-93-11X	11/19/2018	235.5	
SP_Other	SPM-93-11X	11/26/2019	233.2	
SP_Other	SPM-93-12X	6/2/1997	236.6	
SP_Other	SPM-93-12X	10/27/1997	232.6	
SP_Other	SPM-93-12X	10/14/1998	234.1	
SP_Other	SPM-93-12X	10/21/1998	234.3	
SP_Other	SPM-93-12X	10/18/1999	231.9	
SP_Other	SPM-93-12X	12/6/1999	232.1	
SP_Other	SPM-93-12X	10/25/2000	233.3	
SP_Other	SPM-93-12X	10/15/2001	232.6	
SP_Other	SPM-93-12X	10/21/2002	231.1	
SP_Other	SPM-93-12X	10/28/2003	233.5	
SP_Other	SPM-93-12X	11/1/2004	232.9	
SP_Other	SPM-93-12X	11/14/2005	235.9	
SP_Other	SPM-93-12X	10/25/2006	234.6	
SP_Other	SPM-93-12X	10/23/2007	233.5	
SP_Other	SPM-93-12X	10/21/2008	234.2	
SP_Other	SPM-93-12X	11/25/2009	234.4	
SP_Other	SPM-93-12X	10/25/2010	233.2	
SP_Other	SPM-93-12X	10/18/2011	234.2	
SP_Other	SPM-93-12X	11/15/2012	232.8	
SP_Other	SPM-93-12X	11/13/2013	232.2	
SP_Other	SPM-93-12X	11/26/2014	233.0	
SP_Other	SPM-93-12X	12/7/2015	230.9	
SP_Other	SPM-93-12X	10/31/2016	230.4	
SP_Other	SPM-93-12X	11/27/2017	232.6	
SP_Other	SPM-93-12X	11/19/2018	235.7	
SP_Other	SPM-93-12X	11/25/2019	233.1	
SP_Other	SPM-93-13X	10/14/1998	279.7	
SP_Other	SPM-93-13X	10/21/2008		
SP_Other	SPM-93-13X	11/12/2009		
SP_Other	SPM-93-13X	10/25/2010	278.6	
SP_Other	SPM-93-13X	10/18/2011	278.6	
SP_Other	SPM-93-13X	11/5/2012	278.1	
SP_Other	SPM-93-13X	11/13/2013	278.8	
SP_Other	SPM-93-13X	11/25/2014	276.9	
SP_Other	SPM-93-13X	12/8/2015	276.3	
SP_Other	SPM-93-13X	11/2/2016		
SP_Other	SPM-93-13X	11/19/2018	282.2	
SP_Other	SPM-93-13X	11/26/2019	278.0	
SP_Other	SPM-93-15X	7/23/1996	355.4	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
SP_Other	SPM-93-15X	1/15/1997	356.0	
SP_Other	SPM-93-15X	6/2/1997	356.0	
SP_Other	SPM-93-15X	4/23/1998	356.2	
SP_Other	SPM-93-15X	10/14/1998	355.2	
SP_Other	SPM-93-15X	12/6/1999	350.9	
SP_Other	SPM-93-15X	10/21/2008		
SP_Other	SPM-93-15X	10/26/2010	355.5	
SP_Other	SPM-93-15X	10/18/2011		
SP_Other	SPM-93-15X	11/13/2013	352.8	
SP_Other	SPM-93-15X	11/26/2014	355.4	
SP_Other	SPM-93-15X	11/14/2015	355.9	
SP_Other	SPM-93-15X	12/7/2015	352.8	
SP_Other	SPM-93-15X	11/2/2016	351.1	
SP_Other	SPM-93-15X	11/27/2017	355.4	
SP_Other	SPM-93-15X	11/19/2018	358.3	
SP_Other	SPM-93-15X	11/26/2019	356.3	
SP_Other	SPM-93-16X	7/23/1996	232.5	
SP_Other	SPM-93-16X	1/15/1997	232.9	
SP_Other	SPM-93-16X	6/2/1997	233.5	
SP_Other	SPM-93-16X	10/27/1997	232.1	
SP_Other	SPM-93-16X	4/23/1998	232.7	
SP_Other	SPM-93-16X	10/14/1998	232.3	
SP_Other	SPM-93-16X	10/21/1998	233.1	
SP_Other	SPM-93-16X	10/18/1999	230.8	
SP_Other	SPM-93-16X	12/6/1999	230.6	
SP_Other	SPM-93-16X	10/25/2000	232.1	
SP_Other	SPM-93-16X	10/15/2001	231.6	
SP_Other	SPM-93-16X	10/21/2002	229.4	
SP_Other	SPM-93-16X	10/28/2003	232.1	
SP_Other	SPM-93-16X	11/1/2004	231.4	
SP_Other	SPM-93-16X	11/14/2005	233.4	
SP_Other	SPM-93-16X	10/25/2006	233.5	
SP_Other	SPM-93-16X	10/24/2007	232.9	
SP_Other	SPM-93-16X	10/23/2008	233.2	
SP_Other	SPM-93-16X	11/25/2009	233.2	
SP_Other	SPM-93-16X	10/26/2010	232.9	
SP_Other	SPM-93-16X	10/18/2011	232.6	
SP_Other	SPM-93-16X	11/15/2012	231.7	
SP_Other	SPM-93-16X	11/13/2013	231.3	
SP_Other	SPM-93-16X	11/26/2014	230.9	
SP_Other	SPM-93-16X	12/7/2015	230.5	
SP_Other	SPM-93-16X	10/31/2016	229.7	
SP_Other	SPM-93-16X	11/13/2017	231.2	
SP_Other	SPM-93-16X	11/19/2018	233.0	

Table E.1

Measured Water Levels

Site	Well	Date	Measured Water Level (used for target average)	Measured Water Level (not used for target average)
SP_Other	SPM-93-16X	11/26/2019	232.5	
SP_Other	SPM-97-24X	10/27/1997	222.9	
SP_Other	SPM-97-24X	10/21/1998	224.2	
SP_Other	SPM-97-24X	10/18/1999	222.4	
SP_Other	SPM-97-24X	12/6/1999	222.5	
SP_Other	SPM-97-24X	10/25/2000	223.5	
SP_Other	SPM-97-24X	10/15/2001	223.1	
SP_Other	SPM-97-24X	10/21/2002	222.1	
SP_Other	SPM-97-24X	10/28/2003	223.9	
SP_Other	SPM-97-24X	11/1/2004	223.8	
SP_Other	SPM-97-24X	11/14/2005	226.6	
SP_Other	SPM-97-24X	10/24/2006	225.4	
SP_Other	SPM-97-24X	10/23/2007	224.6	
SP_Other	SPM-97-24X	10/21/2008	225.9	
SP_Other	SPM-97-24X	11/13/2009	225.3	
SP_Other	SPM-97-24X	10/25/2010	224.7	
SP_Other	SPM-97-24X	10/18/2011	225.7	
SP_Other	SPM-97-24X	11/15/2012	223.9	
SP_Other	SPM-97-24X	11/14/2013	223.4	
SP_Other	SPM-97-24X	11/25/2014	223.5	
SP_Other	SPM-97-24X	12/7/2015	222.0	
SP_Other	SPM-97-24X	10/31/2016	222.0	
SP_Other	SPM-97-24X	11/13/2017	223.6	
SP_Other	SPM-97-24X	11/19/2018	226.3	
SP_Other	SPM-97-24X	11/25/2019	240.1	

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
32M-01-13XBR	Main	AOC_32	629547.2	3025296.5	244.6	234.6	242.1	238.0	4.1
32M-01-14XBR	Main	AOC_32	629684.8	3025386.1	218.3	208.3	234.0	232.4	1.6
32M-01-14XOB	Main	AOC_32	629692.7	3025382.0	237.0	227.0	232.3	233.1	-0.8
32M-01-15XBR	Main	AOC_32	629568.1	3025254.0	223.5	213.5	237.9	237.5	0.4
32M-01-16XBR	Main	AOC_32	629604.1	3025102.0	236.7	226.7	234.4	237.0	-2.6
32M-01-17XBR	Main	AOC_32	629696.5	3025242.2	215.5	205.5	234.1	233.1	1.1
32M-01-18XBR	Main	AOC_32	629515.0	3025246.9	244.6	234.6	241.9	238.6	3.3
32M-92-01X	Main	AOC_32	629189.6	3025740.0	245.3	235.3	242.6	244.3	-1.7
32M-92-03X	Main	AOC_32	628772.0	3025213.2	235.0	225.0	232.8	232.9	-0.1
32PZ-19-01	Main	AOC_32	630756.5	3025650.8	228.4	218.4	227.2	224.9	2.3
32PZ-19-02	Main	AOC_32	630585.9	3024968.9	228.3	218.3	228.0	227.2	0.8
32Z-01-05XOB	Main	AOC_32	629137.5	3024524.9	235.5	225.5	232.1	232.5	-0.4
32Z-01-06XBR	Main	AOC_32	629526.4	3025592.1	243.1	233.1	243.7	238.7	5.0
32Z-01-07XOB	Main	AOC_32	629418.4	3025655.6	245.0	235.0	243.2	242.1	1.0
32Z-01-08XOB	Main	AOC_32	629071.0	3025511.6	246.6	236.6	241.8	243.4	-1.6
32Z-01-09XOB	Main	AOC_32	628871.7	3024575.9	234.3	224.3	231.6	231.8	-0.2
32Z-01-10XBR	Main	AOC_32	629597.3	3024914.4	245.3	235.3	241.0	236.6	4.4
32Z-01-11XBR	Main	AOC_32	629315.8	3025496.1	253.7	243.7	245.0	243.0	2.1
32Z-01-12XBR	Main	AOC_32	629002.2	3025272.7	230.5	220.5	237.8	237.1	0.7
32Z-99-02X	Main	AOC_32	629874.1	3024769.1	243.0	228.0	235.1	234.4	0.7
SHL-12	Main	AOC_32	630003.0	3025341.6	232.2	217.2	226.5	226.5	-0.1
SHL-17	Main	AOC_32	630287.5	3025390.8	225.9	215.9	226.5	225.9	0.7
SHL-24	Main	AOC_32	631303.0	3025638.5	126.8	116.8	223.1	222.8	0.4
SHL-25	Main	AOC_32	629698.6	3025251.9	232.8	222.8	232.4	233.5	-1.1
SHM-93-24A	Main	AOC_32	631308.1	3025647.4	222.2	212.2	222.1	223.1	-1.0
43M-01-16XBR	Main	AOC_43A	628980.9	3025055.1	209.5	199.5	232.4	232.5	-0.1
43M-01-16XOB	Main	AOC_43A	628981.2	3025060.4	233.1	223.1	232.4	232.6	-0.3
43M-01-17XBR	Main	AOC_43A	629073.3	3024934.9	211.0	201.0	232.1	232.2	-0.2
43M-01-17XOB	Main	AOC_43A	629073.3	3024941.0	235.0	225.0	232.0	232.4	-0.3
43M-01-20XBR	Main	AOC_43A	628852.1	3024830.0	189.5	179.5	230.9	231.3	-0.4
43M-01-20XOB	Main	AOC_43A	628852.0	3024833.8	233.8	223.8	231.6	231.3	0.3

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
43GPZ-19-01	Main	AOC_43G	626413.8	3020566.2	271.3	261.3	262.2	261.7	0.5
43GPZ-19-02	Main	AOC_43G	626472.6	3021108.8	271.1	261.1	262.7	260.9	1.8
43GPZ-19-03	Main	AOC_43G	626037.3	3021045.1	293.2	283.2	284.8	283.6	1.2
43GPZ-19-04	Main	AOC_43G	627045.5	3020688.1	252.2	242.2	248.7	248.1	0.6
43GPZ-19-05	Main	AOC_43G	627085.1	3020948.2	249.1	239.1	246.6	246.3	0.2
43GPZ-19-06	Main	AOC_43G	627231.6	3021120.8	245.1	235.1	245.0	245.1	-0.1
43GPZ-19-07	Main	AOC_43G	628085.6	3021393.0	243.7	233.7	244.9	243.5	1.4
43GPZ-19-08	Main	AOC_43G	626733.2	3021680.4	244.9	234.9	245.6	245.4	0.2
AAFES-2	Main	AOC_43G	626168.5	3020965.1	283.3	268.3	278.3	278.3	0.0
AAFES-5	Main	AOC_43G	626200.2	3020999.4	284.5	269.5	277.6	276.9	0.6
AAFES-6R	Main	AOC_43G	626119.8	3020911.0	281.8	271.8	278.4	279.6	-1.1
AAFES-7	Main	AOC_43G	626711.6	3020857.9	251.7	241.7	249.5	249.6	-0.2
XGM-20-01A	Main	AOC_43G	626682.6	3021077.4	247.4	237.4	248.8	248.5	0.3
XGM-20-02A	Main	AOC_43G	626578.5	3021013.9	252.4	242.4	251.4	253.3	-1.9
XGM-20-03A	Main	AOC_43G	626603.9	3020862.4	248.9	238.9	252.6	252.6	0.1
XGM-93-02X	Main	AOC_43G	626109.4	3020956.9	281.4	271.4	279.8	280.2	-0.5
XGM-94-04X	Main	AOC_43G	626072.6	3020880.0	280.1	270.1	280.5	280.8	-0.4
XGM-94-06X	Main	AOC_43G	626430.0	3020773.6	264.4	254.4	262.7	262.6	0.1
XGM-94-07X	Main	AOC_43G	626257.9	3020925.6	275.2	265.2	275.1	274.5	0.5
XGM-94-08X	Main	AOC_43G	626239.6	3020799.5	272.9	262.9	273.0	272.9	0.1
XGM-94-10X	Main	AOC_43G	626132.6	3020730.5	278.1	268.1	276.7	276.4	0.3
XGM-97-12X	Main	AOC_43G	626086.0	3020989.4	285.3	275.3	282.9	281.5	1.4
2446-03	Main	AOC_43J	623519.5	3018185.4	360.7	350.7	361.6	360.8	0.8
HA-3B	Main	AOC_43J	623729.3	3018253.3	327.2	319.2	356.9	357.8	-1.0
HA-3S	Main	AOC_43J	623734.9	3018255.1	359.0	346.0	354.5	355.6	-1.2
HA-4B	Main	AOC_43J	623729.5	3018170.4	329.8	321.8	359.3	357.8	1.5
HA-4S	Main	AOC_43J	623724.5	3018172.2	361.8	348.8	357.7	356.1	1.6
XJM-93-01X	Main	AOC_43J	623416.3	3018256.2	361.9	351.9	364.4	361.6	2.8
XJM-93-04X	Main	AOC_43J	623399.7	3018150.5	363.4	353.4	364.1	362.1	2.0
XJM-94-07X	Main	AOC_43J	623743.8	3018055.8	357.7	347.7	357.1	357.3	-0.1
XJM-94-08X	Main	AOC_43J	623635.6	3017979.7	358.3	348.3	358.6	359.0	-0.4

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
XJM-94-10X	Main	AOC_43J	623407.6	3017989.0	360.4	350.4	360.7	362.0	-1.3
XJM-97-11X	Main	AOC_43J	623378.0	3017992.7	343.0	333.0	361.6	362.4	-0.9
XJM-97-12X	Main	AOC_43J	623496.1	3018120.6	348.0	338.0	362.6	361.0	1.6
XJM-97-13X	Main	AOC_43J	623640.5	3017979.5	324.3	314.3	359.4	357.9	1.5
CAP-4	Main	AOC_5	629284.5	3027088.6	237.7	232.9	246.3	238.7	7.6
EPA-PZ-2012-1A	Main	AOC_5	630191.1	3028055.9	196.2	191.2	212.5	212.8	-0.3
EPA-PZ-2012-1B	Main	AOC_5	630192.9	3028057.1	146.3	141.3	212.5	212.7	-0.2
EPA-PZ-2012-2A	Main	AOC_5	630287.3	3028124.7	201.6	196.6	212.6	213.0	-0.3
EPA-PZ-2012-2B	Main	AOC_5	630290.4	3028124.7	146.6	141.6	212.5	213.0	-0.5
EPA-PZ-2012-3A	Main	AOC_5	630062.5	3028088.1	200.1	195.1	212.0	212.4	-0.5
EPA-PZ-2012-3B	Main	AOC_5	630064.6	3028086.1	150.6	145.6	211.9	212.4	-0.5
EPA-PZ-2012-4A	Main	AOC_5	629992.1	3028045.3	203.7	198.7	211.7	212.2	-0.5
EPA-PZ-2012-4B	Main	AOC_5	629989.9	3028043.8	144.0	139.0	211.5	212.0	-0.5
EPA-PZ-2012-5A	Main	AOC_5	630151.9	3028184.9	198.4	193.4	211.9	212.5	-0.6
EPA-PZ-2012-5B	Main	AOC_5	630155.3	3028186.1	147.7	142.7	212.0	212.4	-0.5
EPA-PZ-2012-6A	Main	AOC_5	629894.7	3028066.3	206.5	201.5	211.7	212.0	-0.3
EPA-PZ-2012-6B	Main	AOC_5	629894.4	3028069.2	156.6	151.6	211.4	211.8	-0.4
EPA-PZ-2012-7A	Main	AOC_5	629801.1	3028106.5	210.6	205.6	211.5	212.0	-0.5
EPA-PZ-2012-7B	Main	AOC_5	629800.9	3028109.2	175.5	170.5	211.6	212.0	-0.4
EW-01	Main	AOC_5	629942.8	3027960.2	167.0	142.0	209.9	207.9	2.0
EW-04	Main	AOC_5	629895.3	3027991.0	157.4	132.4	207.1	207.0	0.1
MW-1	Main	AOC_5	629284.7	3027071.2	242.3	240.3	243.0	239.2	3.8
N1-P1	Main	AOC_5	630723.4	3027867.8	162.8	157.8	215.5	215.4	0.1
N1-P2	Main	AOC_5	630723.4	3027867.8	187.8	182.8	215.8	215.4	0.3
N1-P3	Main	AOC_5	630723.4	3027867.8	215.8	210.8	216.1	215.6	0.6
N2-P1	Main	AOC_5	630658.7	3027311.1	185.6	180.6	216.5	216.3	0.2
N2-P2	Main	AOC_5	630658.7	3027311.1	216.6	211.6	216.5	216.3	0.2
N3-P1	Main	AOC_5	630778.0	3027130.2	186.8	183.8	216.4	216.5	-0.1
N3-P2	Main	AOC_5	630778.0	3027130.2	214.8	209.8	216.5	216.5	0.1
N4-P1	Main	AOC_5	631241.2	3026763.6	141.4	136.4	215.8	216.9	-1.1
N4-P2	Main	AOC_5	631241.2	3026763.6	179.4	174.4	215.5	216.8	-1.4

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
N4-P3	Main	AOC_5	631241.2	3026763.6	215.9	210.9	215.5	216.6	-1.0
N5-P1	Main	AOC_5	629805.8	3027173.2	145.0	143.0	219.2	218.2	1.1
N5-P2	Main	AOC_5	629805.8	3027173.2	217.5	212.5	219.2	218.2	1.1
N6-P1	Main	AOC_5	630017.1	3026338.6	170.6	168.6	221.9	221.9	0.0
N7-P1	Main	AOC_5	629990.9	3025618.3	187.2	185.2	225.2	225.3	-0.1
N7-P2	Main	AOC_5	629990.9	3025618.3	224.2	219.2	225.5	225.3	0.2
PZ-12-01	Main	AOC_5	630488.5	3027384.4	209.9	199.9	216.8	216.5	0.4
PZ-12-02	Main	AOC_5	630467.8	3027384.0	209.8	199.8	217.3	217.4	-0.1
PZ-12-03	Main	AOC_5	630474.5	3027193.5	208.9	198.9	216.8	216.6	0.2
PZ-12-04	Main	AOC_5	630452.9	3027193.8	211.1	201.1	217.9	217.8	0.1
PZ-12-05	Main	AOC_5	630479.4	3027087.3	210.1	200.1	217.1	216.7	0.4
PZ-12-06	Main	AOC_5	630454.8	3027081.9	213.4	203.4	218.1	218.1	0.0
PZ-12-07	Main	AOC_5	630568.5	3026971.8	220.8	210.8	217.1	217.2	-0.1
PZ-12-08	Main	AOC_5	630546.1	3026962.3	219.7	209.7	218.8	218.7	0.1
PZ-12-09	Main	AOC_5	630740.9	3026801.4	218.4	208.4	217.9	218.3	-0.4
PZ-12-10	Main	AOC_5	630724.0	3026778.5	219.0	209.0	219.6	219.5	0.1
RSK 15	Main	AOC_5	630585.3	3027062.0	217.4	212.4	217.2	216.8	0.4
RSK 19	Main	AOC_5	630560.4	3027219.5	215.7	210.7	217.1	216.5	0.6
RSK 37	Main	AOC_5	630730.2	3027114.5	217.5	212.5	214.6	216.5	-1.9
RSK 7	Main	AOC_5	630635.7	3027270.4	217.3	212.3	217.0	216.4	0.6
SHL-10	Main	AOC_5	630877.3	3026867.7	222.6	207.6	217.2	217.4	-0.2
SHL-11	Main	AOC_5	630495.9	3027316.4	222.0	207.0	216.8	216.5	0.3
SHL-13	Main	AOC_5	630540.4	3028105.4	214.0	199.0	213.8	214.2	-0.4
SHL-15	Main	AOC_5	629326.4	3025829.4	245.0	235.0	241.9	243.7	-1.8
SHL-17	Main	AOC_5	630287.5	3025390.8	225.9	215.9	226.5	225.9	0.7
SHL-18	Main	AOC_5	631186.4	3026475.2	219.7	209.7	218.4	219.3	-0.9
SHL-19	Main	AOC_5	630665.0	3026946.0	218.6	208.6	217.5	217.6	-0.1
SHL-20	Main	AOC_5	630463.3	3027329.6	195.7	185.7	217.1	217.5	-0.3
SHL-21	Main	AOC_5	630364.0	3027884.4	216.1	206.1	214.7	214.0	0.8
SHL-22	Main	AOC_5	630056.4	3028163.0	113.9	103.9	212.6	212.2	0.3
SHL-23	Main	AOC_5	629712.8	3027915.9	216.4	206.4	213.6	212.8	0.9

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
SHL-3	Main	AOC_5	630911.0	3026705.2	221.8	211.8	217.2	218.2	-1.0
SHL-4	Main	AOC_5	630576.2	3027057.2	223.1	213.1	216.9	216.8	0.1
SHL-5	Main	AOC_5	630192.2	3028125.1	213.8	203.8	213.8	212.7	1.1
SHL-6	Main	AOC_5	630951.2	3025248.8	198.5	188.5	225.8	225.8	0.0
SHL-7	Main	AOC_5	631332.8	3026277.9	223.8	213.8	218.5	219.8	-1.3
SHL-8D	Main	AOC_5	630407.1	3028126.6	150.8	148.8	213.3	213.5	-0.3
SHL-8S	Main	AOC_5	630407.1	3028126.6	166.8	164.8	213.3	213.5	-0.2
SHL-9	Main	AOC_5	630009.6	3028146.8	205.7	195.7	212.7	212.2	0.4
SHM-05-39A	Main	AOC_5	629761.4	3028544.3	184.8	182.8	210.2	210.0	0.3
SHM-05-39B	Main	AOC_5	629765.3	3028543.7	155.8	153.8	209.3	210.0	-0.7
SHM-05-40X	Main	AOC_5	629636.8	3028514.2	191.5	189.5	209.2	209.3	-0.1
SHM-05-41A	Main	AOC_5	629796.1	3028290.8	180.7	178.7	212.0	211.8	0.2
SHM-05-41B	Main	AOC_5	629796.3	3028299.2	160.5	158.5	211.9	211.8	0.1
SHM-05-41C	Main	AOC_5	629795.8	3028285.5	134.9	129.9	212.0	211.8	0.1
SHM-05-42A	Main	AOC_5	630017.6	3028376.1	173.7	171.7	212.0	211.9	0.1
SHM-05-42B	Main	AOC_5	630017.6	3028376.1	143.7	141.7	212.0	211.9	0.0
SHM-07-03	Main	AOC_5	629411.1	3028444.6	203.0	193.0	208.0	208.1	-0.1
SHM-07-05	Main	AOC_5	629632.1	3028513.3	168.3	159.3	208.9	209.3	-0.4
SHM-10-01	Main	AOC_5	628868.4	3028617.3	146.2	136.2	205.9	205.9	0.0
SHM-10-05A	Main	AOC_5	630441.8	3028943.4	185.4	175.4	209.8	211.5	-1.6
SHM-10-06	Main	AOC_5	630215.6	3027882.5	160.5	150.5	213.4	213.1	0.3
SHM-10-06A	Main	AOC_5	630300.7	3027895.7	169.0	159.0	213.6	213.6	0.1
SHM-10-07	Main	AOC_5	630301.4	3026889.8	205.0	195.0	219.3	219.3	0.0
SHM-10-10	Main	AOC_5	629105.3	3028873.6	159.4	149.4	206.5	206.4	0.1
SHM-10-11	Main	AOC_5	629990.6	3025971.5	211.2	201.2	223.3	223.5	-0.2
SHM-10-12	Main	AOC_5	629717.5	3026718.5	207.6	197.6	221.0	220.6	0.4
SHM-10-13	Main	AOC_5	629906.1	3027156.9	181.5	171.5	218.5	218.3	0.3
SHM-10-14	Main	AOC_5	629784.8	3027372.9	174.8	154.8	217.3	217.0	0.3
SHM-10-15	Main	AOC_5	629680.9	3027101.4	197.0	187.0	219.0	218.7	0.3
SHM-10-16	Main	AOC_5	629834.2	3028355.3	141.7	131.7	211.2	211.7	-0.5
SHM-11-02	Main	AOC_5	630457.8	3027075.7	186.7	172.7	218.0	218.0	0.0

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
SHM-11-06	Main	AOC_5	630411.3	3027590.1	208.3	198.3	216.1	215.9	0.2
SHM-11-07	Main	AOC_5	630414.6	3027132.5	197.2	192.2	218.0	217.9	0.1
SHM-13-01	Main	AOC_5	628556.7	3028294.8	166.8	156.8	205.1	205.4	-0.4
SHM-13-02	Main	AOC_5	628980.6	3028713.9	156.9	146.9	206.1	206.2	-0.1
SHM-13-03	Main	AOC_5	629173.4	3028990.9	167.9	157.9	206.9	206.5	0.4
SHM-13-04	Main	AOC_5	629479.6	3028606.2	207.3	197.3	208.1	207.9	0.2
SHM-13-05	Main	AOC_5	629829.5	3028776.7	150.4	140.4	208.4	208.8	-0.4
SHM-13-06	Main	AOC_5	629245.1	3028694.9	188.2	178.2	206.8	206.9	-0.1
SHM-13-07	Main	AOC_5	629331.4	3028760.8	199.1	189.1	207.0	207.1	-0.1
SHM-13-08	Main	AOC_5	629515.3	3028837.5	173.2	163.2	207.8	207.5	0.2
SHM-13-14D	Main	AOC_5	629391.9	3029016.6	162.5	152.5	207.1	207.0	0.1
SHM-13-14S	Main	AOC_5	629392.3	3029020.6	202.7	192.7	206.9	206.9	0.0
SHM-13-15	Main	AOC_5	629273.5	3029072.2	156.0	146.0	206.9	206.7	0.2
SHM-93-01A	Main	AOC_5	630677.0	3026712.0	225.2	215.2	220.2	220.1	0.2
SHM-93-10C	Main	AOC_5	630886.1	3026846.2	202.1	192.1	218.1	217.5	0.6
SHM-93-10D	Main	AOC_5	630894.7	3026828.8	196.8	186.8	217.8	217.5	0.3
SHM-93-18B	Main	AOC_5	631180.2	3026453.2	156.7	146.7	218.6	219.0	-0.4
SHM-93-22B	Main	AOC_5	630071.9	3028169.9	136.5	126.5	212.2	212.2	-0.1
SHM-93-22C	Main	AOC_5	630045.7	3028158.6	94.6	84.6	212.6	212.2	0.4
SHM-95-27X	Main	AOC_5	630752.7	3026164.5	204.8	194.8	224.3	223.0	1.3
SHM-96-22B	Main	AOC_5	630071.9	3028169.8	136.2	126.2	212.6	212.2	0.4
SHM-96-5B	Main	AOC_5	630158.1	3028112.9	137.4	127.4	212.5	212.5	0.0
SHM-96-5C	Main	AOC_5	630172.7	3028105.4	167.4	157.4	212.7	212.7	0.0
SHM-99-31A	Main	AOC_5	629895.0	3028559.1	208.8	198.8	211.4	210.7	0.7
SHM-99-31B	Main	AOC_5	629901.2	3028559.5	162.5	152.5	210.6	210.7	-0.1
SHM-99-31C	Main	AOC_5	629908.8	3028561.8	144.6	134.6	210.4	210.6	-0.2
SHM-99-32X	Main	AOC_5	630168.8	3028574.7	147.1	137.1	211.4	211.4	0.0
SHP-01-36X	Main	AOC_5	630737.9	3027688.8	217.0	212.0	216.4	215.8	0.6
SHP-01-37X	Main	AOC_5	630696.9	3027498.4	217.7	212.7	216.5	216.1	0.4
SHP-01-38A	Main	AOC_5	630545.5	3027171.5	217.3	212.3	216.8	216.5	0.3
SHP-01-38B	Main	AOC_5	630544.0	3027178.2	200.9	195.9	216.9	216.6	0.4

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
SHP-05-43	Main	AOC_5	630532.5	3027747.0	207.9	197.9	215.8	215.2	0.6
SHP-05-44	Main	AOC_5	630587.6	3027588.5	204.6	194.6	216.2	215.8	0.4
SHP-05-45A	Main	AOC_5	629995.5	3027962.0	206.3	201.3	212.5	212.3	0.2
SHP-05-45B	Main	AOC_5	629995.5	3027956.8	161.7	151.7	212.6	212.0	0.6
SHP-05-46A	Main	AOC_5	630041.5	3027941.1	206.3	201.3	213.2	212.5	0.6
SHP-05-46B	Main	AOC_5	630041.8	3027946.6	161.0	151.0	212.5	212.4	0.1
SHP-05-47A	Main	AOC_5	630523.3	3028226.4	212.4	211.4	212.6	212.5	0.1
SHP-05-47B	Main	AOC_5	630524.0	3028226.3	210.3	209.3	212.5	212.5	0.0
SHP-05-48A	Main	AOC_5	630046.4	3028569.6	212.1	211.1	213.3	211.0	2.3
SHP-05-48B	Main	AOC_5	630045.6	3028569.7	211.0	210.0	211.7	211.0	0.7
SHP-05-49A	Main	AOC_5	630250.6	3028663.7	211.3	210.3	211.7	210.0	1.7
SHP-05-49B	Main	AOC_5	630250.1	3028663.9	209.9	208.9	210.6	210.0	0.6
SHP-2016-06A	Main	AOC_5	629710.3	3027906.2	159.1	154.1	214.8	212.7	2.2
SHP-2016-06B	Main	AOC_5	629710.3	3027906.2	138.1	128.1	220.0	212.6	7.5
SHP-2016-06C	Main	AOC_5	629710.3	3027906.2	117.1	107.1	221.2	213.0	8.2
SHP-2016-07A	Main	AOC_5	629219.8	3026882.0	241.0	231.0	250.2	251.5	-1.3
SHP-2016-07B	Main	AOC_5	629219.8	3026882.0	193.0	183.0	241.4	243.8	-2.5
SHP-2016-1A	Main	AOC_5	629933.5	3027979.6	211.7	201.7	212.5	212.0	0.5
SHP-2016-1B	Main	AOC_5	629933.5	3027979.6	149.7	139.7	210.4	210.5	-0.1
SHP-2016-2A	Main	AOC_5	629925.8	3028200.3	203.7	198.7	211.7	212.1	-0.4
SHP-2016-2B	Main	AOC_5	629925.8	3028200.3	143.7	138.7	211.9	212.0	-0.2
SHP-2016-3A	Main	AOC_5	630007.3	3028174.3	201.1	196.1	211.7	212.2	-0.5
SHP-2016-3B	Main	AOC_5	630007.3	3028174.3	141.1	136.1	211.8	212.2	-0.4
SHP-2016-4A	Main	AOC_5	629902.2	3028146.7	202.6	197.6	211.8	212.1	-0.2
SHP-2016-4B	Main	AOC_5	629902.2	3028146.7	142.6	137.6	211.7	212.0	-0.3
SHP-2016-5A	Main	AOC_5	629963.6	3028113.5	199.9	194.9	211.8	212.2	-0.4
SHP-2016-5B	Main	AOC_5	629963.6	3028113.5	139.9	134.9	211.7	212.1	-0.4
SHP-99-01B	Main	AOC_5	629226.6	3026537.3	267.8	263.8	266.2	258.3	7.9
SHP-99-29X	Main	AOC_5	629539.1	3027143.4	222.5	212.5	219.9	220.1	-0.2
SHP-99-31A	Main	AOC_5	629895.0	3028559.1	208.6	198.6	208.8	210.7	-1.8
SHP-99-33A	Main	AOC_5	629818.1	3028551.6	210.6	205.6	210.5	210.2	0.3

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
SHP-99-33B	Main	AOC_5	629815.6	3028550.2	146.7	141.7	210.3	210.3	0.0
SHP-99-34A	Main	AOC_5	630294.4	3028552.4	207.1	202.1	209.8	210.5	-0.7
SHP-99-34B	Main	AOC_5	630294.4	3028552.4	148.2	143.2	211.9	211.9	0.0
SHP-99-35X	Main	AOC_5	629722.7	3026547.2	226.5	216.5	221.6	221.6	0.0
5702MW-19-01A	Main	AOC_57	632239.6	3023025.7	227.7	217.7	223.8	224.6	-0.7
5702MW-19-01B	Main	AOC_57	632237.0	3023020.9	207.9	197.9	223.8	224.4	-0.6
5702MW-20-01A	Main	AOC_57	632765.2	3022575.6	189.6	179.6	219.4	219.9	-0.5
5702MW-20-01B	Main	AOC_57	632761.6	3022574.4	149.7	139.7	220.5	220.5	0.0
5702MW-20-02A	Main	AOC_57	632508.3	3022840.0	211.7	201.7	222.6	223.1	-0.5
5702MW-20-03A	Main	AOC_57	632530.3	3022636.0	208.8	198.8	220.7	221.1	-0.4
5702MW-20-04A	Main	AOC_57	632758.4	3022723.5	162.7	152.7	221.2	221.8	-0.6
5702MW-20-05A	Main	AOC_57	632578.8	3022546.0	193.3	183.3	219.9	220.5	-0.6
5702MW-20-05B	Main	AOC_57	632575.5	3022550.8	153.3	143.3	221.2	220.9	0.3
5702MW-20-06A	Main	AOC_57	632671.4	3022688.5	164.1	154.1	221.3	221.5	-0.2
5702MW-20-07A	Main	AOC_57	632695.3	3022514.6	189.4	179.4	219.2	219.8	-0.6
5703MW-20-01A	Main	AOC_57	633310.1	3022963.7	223.2	213.2	220.9	220.8	0.1
5703MW-20-01B	Main	AOC_57	633315.6	3022962.9	175.1	165.1	220.5	221.0	-0.6
5703MW-20-02A	Main	AOC_57	633213.6	3022994.6	223.5	213.5	222.3	221.8	0.5
5703MW-20-03A	Main	AOC_57	633168.5	3022909.3	173.0	163.0	220.7	221.2	-0.4
5703MW-20-04A	Main	AOC_57	633265.6	3022990.4	169.2	159.2	221.1	221.5	-0.4
5703PZ-19-01	Main	AOC_57	633266.6	3022896.6	157.7	152.7	219.9	220.5	-0.6
57M-03-01X	Main	AOC_57	632664.4	3022695.1	224.4	214.4	221.9	221.3	0.6
57M-03-02X	Main	AOC_57	632652.7	3022574.6	221.0	211.0	220.3	220.0	0.3
57M-03-03X	Main	AOC_57	632697.3	3022501.2	217.0	207.0	219.5	219.1	0.4
57M-03-04X	Main	AOC_57	632732.8	3022512.8	217.5	207.5	219.2	219.1	0.1
57M-03-05X	Main	AOC_57	632765.3	3022567.8	217.6	207.6	219.5	219.4	0.1
57M-03-06X	Main	AOC_57	632784.1	3022592.3	218.3	208.3	219.6	219.5	0.1
57M-95-03X	Main	AOC_57	633253.4	3022997.2	223.8	213.8	222.5	221.5	1.1
57M-95-05X	Main	AOC_57	632528.2	3022618.5	223.0	213.0	221.2	220.9	0.2
57M-95-06X	Main	AOC_57	632762.5	3022717.5	220.8	210.8	222.2	221.3	0.9
57M-95-07X	Main	AOC_57	632547.8	3022491.6	218.5	208.5	220.1	219.9	0.2

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
57M-96-09X	Main	AOC_57	633132.3	3023093.8	226.6	216.6	225.7	223.2	2.6
57M-96-10X	Main	AOC_57	633338.5	3022925.4	223.3	213.3	222.2	220.1	2.1
57M-96-11X	Main	AOC_57	633267.8	3022891.5	218.0	208.0	219.6	219.7	-0.1
57M-96-12X	Main	AOC_57	633169.9	3022906.1	220.8	210.8	221.4	220.8	0.6
57M-96-13X	Main	AOC_57	633110.6	3022859.3	221.2	211.2	221.1	220.6	0.5
57P-98-03X	Main	AOC_57	633313.9	3022869.6	216.1	213.1	218.2	219.0	-0.8
57P-98-04X	Main	AOC_57	633254.2	3022867.9	216.2	213.2	218.4	219.2	-0.9
57WP-06-02	Main	AOC_57	632703.3	3022505.5	200.3	195.3	219.4	219.1	0.3
57WP-06-03	Main	AOC_57	633262.7	3022888.6	205.5	200.5	220.0	219.5	0.5
69W-94-12	Main	AOC_69W	627516.1	3025287.9	222.7	212.7	221.0	220.8	0.2
69W-94-13	Main	AOC_69W	627446.8	3025279.1	221.5	211.5	220.7	220.5	0.2
69W-94-14	Main	AOC_69W	627389.5	3025372.8	221.7	211.7	219.9	219.5	0.4
69WP-13-01	Main	AOC_69W	627169.6	3025781.1	218.0	218.0	217.7	216.5	1.2
ZWM-01-25X	Main	AOC_69W	627456.7	3025484.3	216.5	206.5	219.4	219.3	0.1
ZWM-01-26X	Main	AOC_69W	627550.4	3025430.9	217.9	207.9	220.1	220.2	0.0
ZWM-95-15X	Main	AOC_69W	627316.1	3025417.1	216.3	206.3	219.8	218.9	0.9
ZWM-95-16X	Main	AOC_69W	627553.1	3025146.4	222.5	212.5	222.3	221.9	0.4
ZWM-95-17X	Main	AOC_69W	627675.0	3024871.1	220.5	210.5	223.8	223.8	0.0
ZWM-95-18X	Main	AOC_69W	627306.7	3025554.4	214.7	204.7	218.7	218.1	0.5
ZWM-99-22X	Main	AOC_69W	627463.6	3025190.2	222.3	212.3	221.4	221.1	0.3
ZWM-99-23X	Main	AOC_69W	627474.0	3025406.2	218.7	208.7	219.7	219.8	-0.1
ZWM-99-24X	Main	AOC_69W	627307.2	3025302.5	217.3	207.3	220.6	219.4	1.2
ZWP-95-01X	Main	AOC_69W	627245.4	3025297.7	213.6	211.6	220.5	218.7	1.8
ZWP-95-02X	Main	AOC_69W	627252.2	3025503.8	210.4	208.4	218.7	217.9	0.8
74MW-19-04A	Main	AOC_74	634137.2	3023949.2	204.1	194.1	220.7	220.3	0.4
74PZ-19-01	Main	AOC_74	633692.5	3023395.6	225.5	215.5	223.3	222.6	0.7
74PZ-19-02	Main	AOC_74	633310.6	3023830.3	226.7	216.7	225.8	224.2	1.7
74PZ-19-03	Main	AOC_74	633069.4	3024181.0	220.6	210.6	225.5	224.0	1.6
74PZ-19-04	Main	AOC_74	634144.9	3023948.7	216.7	206.7	220.6	220.1	0.5
74PZ-19-05	Main	AOC_74	633822.5	3024351.2	223.2	213.2	224.1	222.8	1.4
74PZ-19-06	Main	AOC_74	633401.1	3024738.9	217.5	207.5	222.8	221.8	0.9

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
74PZ-19-07	Main	AOC_74	633824.1	3024827.5	218.6	208.6	220.9	220.2	0.7
74PZ-19-08	Main	AOC_74	634083.7	3024747.7	224.0	214.0	220.2	219.7	0.5
74PZ-19-09	Main	AOC_74	634521.9	3024557.0	219.5	209.5	219.9	219.2	0.7
74PZ-19-10	Main	AOC_74	634140.8	3023949.0	186.4	184.4	219.0	220.4	-1.4
74PZ-20-01	Main	AOC_74	634446.6	3024411.3	218.4	208.4	220.2	219.6	0.6
74PZ-20-02	Main	AOC_74	633699.0	3023988.0	217.6	207.6	224.2	223.7	0.5
74PZ-20-03	Main	AOC_74	634138.7	3024551.1	227.0	217.0	221.5	220.4	1.0
74PZ-20-04	Main	AOC_74	633457.2	3024309.0	225.5	215.5	224.2	223.6	0.6
74PZ-20-05	Main	AOC_74	634092.9	3024184.3	224.4	214.4	223.0	221.7	1.3
75MW-19-01BR	Main	AOC_75	628945.5	3021955.2	224.4	214.4	240.0	239.9	0.1
75MW-19-02A	Main	AOC_75	630775.3	3022532.7	210.3	200.3	230.4	229.7	0.7
75MW-19-02B	Main	AOC_75	630766.9	3022534.0	177.9	167.9	230.3	229.6	0.7
75MW-19-02BR	Main	AOC_75	630771.2	3022530.0	-60.1	-70.1	229.4	228.2	1.2
75MW-19-02C	Main	AOC_75	630773.9	3022561.9	38.0	28.0	229.4	228.9	0.5
75MW-19-04A	Main	AOC_75	631715.4	3022035.1	208.1	198.1	225.1	224.9	0.2
75MW-19-04B	Main	AOC_75	631713.0	3022030.7	178.0	168.0	225.0	224.8	0.2
75PZ-19-01	Main	AOC_75	631721.6	3022028.2	226.8	216.8	224.9	224.7	0.2
75PZ-19-02	Main	AOC_75	630327.0	3021645.3	233.0	223.0	231.9	230.8	1.0
75PZ-19-03	Main	AOC_75	630373.5	3022129.2	232.4	222.4	230.0	230.5	-0.5
75PZ-19-04	Main	AOC_75	629580.6	3022269.7	225.4	215.4	234.0	233.2	0.8
75PZ-20-01	Main	AOC_75	631915.7	3022301.2	224.9	214.9	225.3	224.3	1.0
75PZ-20-02	Main	AOC_75	631327.9	3022659.4	231.4	221.4	229.4	228.2	1.2
75PZ-20-03	Main	AOC_75	631092.2	3022208.9	229.5	219.5	229.9	229.0	0.9
75PZ-20-04	Main	AOC_75	630904.4	3021622.3	232.3	222.3	231.0	229.7	1.2
75PZ-20-05	Main	AOC_75	629855.6	3021245.4	233.5	223.5	232.1	231.7	0.4
75PZ-20-06	Main	AOC_75	630363.8	3022430.8	233.4	223.4	231.2	230.4	0.8
75PZ-20-07	Main	AOC_75	631557.9	3021697.1	224.3	214.3	224.5	224.7	-0.2
MW75-UNKNOWN	Main	AOC_75	631457.2	3021873.5	226.2	216.2	227.0	226.4	0.6
76PZ-19-01	Main	AOC_76	626641.5	3022569.0	243.5	233.5	242.7	242.2	0.5
76PZ-19-02	Main	AOC_76	627192.4	3024051.2	232.0	222.0	230.7	231.5	-0.8
76PZ-19-03	Main	AOC_76	627039.9	3022344.8	242.1	232.1	243.7	243.1	0.6

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
76PZ-19-04	Main	AOC_76	627714.4	3022221.7	244.6	234.6	243.3	242.9	0.4
76PZ-19-05	Main	AOC_76	626962.4	3022593.5	249.4	239.4	242.7	242.0	0.7
76PZ-19-06	Main	AOC_76	626789.2	3024036.0	234.9	224.9	232.9	232.4	0.5
76PZ-19-07	Main	AOC_76	626799.1	3023127.0	242.8	232.8	240.4	239.7	0.7
76PZ-19-08	Main	AOC_76	626609.8	3025581.7	210.3	200.3	219.2	219.3	-0.1
76PZ-19-09	Main	AOC_76	626848.9	3026474.5	210.8	200.8	213.0	212.8	0.2
76PZ-19-10	Main	AOC_76	627234.3	3022936.4	237.8	227.8	240.9	240.1	0.8
76PZ-19-11	Main	AOC_76	627286.1	3022638.8	240.8	230.8	242.1	241.1	1.0
76PZ-19-12	Main	AOC_76	627312.1	3026676.9	208.7	198.7	211.8	212.0	-0.2
76PZ-19-13	Main	AOC_76	627786.6	3022831.1	237.0	227.0	241.8	241.8	0.0
76PZ-19-14	Main	AOC_76	626358.0	3026359.8	213.1	203.1	214.1	213.4	0.7
76PZ-19-15	Main	AOC_76	627308.8	3022325.3	242.0	232.0	243.1	242.4	0.7
76PZ-19-16	Main	AOC_76	627493.3	3024063.7	229.8	219.8	232.6	232.2	0.3
76PZ-19-17	Main	AOC_76	625295.7	3026158.2	213.2	203.2	211.7	211.8	-0.1
76PZ-19-18	Main	AOC_76	627858.6	3021732.0	242.3	232.3	243.4	243.1	0.3
76PZ-19-19	Main	AOC_76	626100.4	3023685.9	240.0	230.0	237.2	237.8	-0.6
LFM-99-01B	Main	Devens_Consolidated_Landfill	624305.8	3018613.3	302.9	293.6	325.1	325.8	-0.7
LFM-99-02B	Main	Devens_Consolidated_Landfill	624305.6	3018229.3	338.5	329.2	335.6	338.9	-3.3
LFM-99-03B	Main	Devens_Consolidated_Landfill	624498.7	3019102.6	303.1	293.8	301.0	303.4	-2.5
LFM-99-05A	Main	Devens_Consolidated_Landfill	624886.5	3018948.0	296.8	287.5	293.8	296.8	-3.0
LFM-99-05B	Main	Devens_Consolidated_Landfill	624874.2	3018950.9	264.3	260.0	296.1	297.4	-1.3
LFM-99-06ARP	Main	Devens_Consolidated_Landfill	624993.4	3018340.6	325.1	315.8	321.8	313.3	8.5
1C	Main	Former_Fort_Devens	628164.0	3018704.9	199.6	194.6	243.2	243.3	-0.1
1D-D	Main	Former_Fort_Devens	627828.5	3020605.9	196.8	191.8	244.4	244.1	0.4
1D-S	Main	Former_Fort_Devens	627828.1	3020607.0	235.7	232.7	244.4	243.7	0.7
1E-D	Main	Former_Fort_Devens	629332.9	3018993.0	183.1	178.1	241.0	241.7	-0.7
1E-S	Main	Former_Fort_Devens	629334.2	3018993.7	241.2	238.2	241.5	241.5	0.0
1F-D	Main	Former_Fort_Devens	626720.6	3019761.0	233.8	228.8	251.5	252.5	-1.0
1F-S	Main	Former_Fort_Devens	626720.1	3019762.8	253.9	248.9	253.2	253.0	0.2
92-1	Main	Grove_Pond_Area	634242.2	3025938.4	172.5	166.5	215.1	215.0	0.1
92-3	Main	Grove_Pond_Area	634255.6	3025909.4	168.4	162.4	214.9	215.1	-0.1

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
92-5	Main	Grove_Pond_Area	633899.9	3026858.2	187.9	181.9	216.0	216.8	-0.8
CSMS-11-01	Main	Grove_Pond_Area	633877.8	3025631.5	220.7	210.7	216.1	215.6	0.6
CSMS-11-02	Main	Grove_Pond_Area	634304.2	3025614.1	218.9	208.9	215.1	215.6	-0.5
GF-1	Main	Grove_Pond_Area	634311.6	3026001.0	105.0	100.0	214.3	215.4	-1.1
GF-2	Main	Grove_Pond_Area	634185.3	3026015.9	107.6	100.6	214.5	215.3	-0.8
GF-3A	Main	Grove_Pond_Area	634258.3	3026080.1	121.5	116.5	215.1	215.4	-0.3
GF-3B	Main	Grove_Pond_Area	634258.5	3026074.2	210.6	205.6	216.1	216.2	-0.1
GF-4	Main	Grove_Pond_Area	634009.5	3026033.2	145.3	140.3	213.0	214.9	-2.0
GPMW-19-01A	Main	Grove_Pond_Area	633761.0	3025549.9	206.1	196.1	216.4	215.8	0.5
GPMW-19-01BR	Main	Grove_Pond_Area	633756.2	3025551.7	75.8	65.8	216.1	215.7	0.4
GPPZ-19-01	Main	Grove_Pond_Area	633757.6	3025557.0	145.7	140.7	216.0	215.5	0.4
MNG-2R	Main	Grove_Pond_Area	633011.0	3025606.6	219.5	209.5	217.0	217.8	-0.8
MNG-3R	Main	Grove_Pond_Area	634063.8	3025615.7	196.5	186.5	215.1	215.4	-0.3
MNG-5R	Main	Grove_Pond_Area	633156.5	3025390.3	223.5	213.5	219.3	218.7	0.5
MNG-6R	Main	Grove_Pond_Area	633467.4	3025321.2	219.7	209.7	216.7	217.2	-0.5
MPPZ-19-01	Main	MacPherson	626772.5	3027552.4	205.9	195.9	206.3	205.9	0.4
MPPZ-19-02	Main	MacPherson	627597.8	3027639.8	208.4	198.4	206.6	206.8	-0.2
PTW-A	Main	Patton_Well_Field	627734.7	3017995.9	194.9	189.9	242.2	241.0	1.3
PTW-B	Main	Patton_Well_Field	627732.3	3017995.8	187.6	182.6	239.3	241.0	-1.7
PWPZ-19-01	Main	Patton_Well_Field	628836.7	3019177.4	245.4	235.4	242.6	242.7	-0.1
PWPZ-19-02	Main	Patton_Well_Field	629733.7	3019425.1	237.1	227.1	236.8	237.0	-0.2
PWPZ-19-03	Main	Patton_Well_Field	630045.3	3018441.0	240.6	230.6	242.0	242.7	-0.7
PWPZ-19-04	Main	Patton_Well_Field	629277.9	3017203.4	248.4	238.4	247.9	247.4	0.5
PWPZ-19-05	Main	Patton_Well_Field	628514.8	3017150.1	242.7	232.7	243.5	244.2	-0.7
PWPZ-19-06	Main	Patton_Well_Field	628252.4	3018162.8	246.6	236.6	242.5	242.7	-0.2
PWPZ-19-07	Main	Patton_Well_Field	629411.3	3017814.9	244.7	234.8	245.6	245.8	-0.1
PWPZ-19-08	Main	Patton_Well_Field	628023.5	3018358.7	243.9	233.9	242.6	242.8	-0.2
PWPZ-19-09	Main	Patton_Well_Field	627777.7	3018422.6	244.5	234.5	242.9	243.1	-0.2
PWPZ-19-10	Main	Patton_Well_Field	627087.5	3018039.3	242.5	232.5	243.0	242.4	0.6
PWPZ-20-01	Main	Patton_Well_Field	627584.9	3017383.2	239.4	229.4	241.2	241.5	-0.4
MW-9D	Main	Shabokin_Well_Field	625898.9	3014610.8	172.4	162.4	233.7	231.8	1.9

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
MW-A	Main	Shabokin_Well_Field	625607.2	3014651.3	216.9	206.9	230.8	230.8	-0.1
MW-B	Main	Shabokin_Well_Field	625725.4	3014904.6	189.2	179.2	231.5	232.5	-1.0
MW-C	Main	Shabokin_Well_Field	625726.4	3014906.0	174.1	164.1	231.5	232.5	-1.0
MW-D	Main	Shabokin_Well_Field	625747.5	3014608.5	182.3	172.3	230.8	231.0	-0.2
MW-E	Main	Shabokin_Well_Field	625746.0	3014609.6	180.2	170.2	230.8	231.0	-0.2
MW-F	Main	Shabokin_Well_Field	625739.7	3014543.6	221.5	211.5	230.7	230.9	-0.2
MW-G	Main	Shabokin_Well_Field	625976.2	3014731.1	171.5	166.5	233.8	232.7	1.1
MW-H	Main	Shabokin_Well_Field	625817.6	3014401.7	217.7	207.7	232.0	231.1	0.9
MW-I	Main	Shabokin_Well_Field	625666.6	3014428.4	234.4	224.4	230.5	230.6	-0.1
MW-J	Main	Shabokin_Well_Field	626019.1	3014726.8	203.5	193.5	233.8	232.8	1.0
MW-K	Main	Shabokin_Well_Field	626018.3	3014725.3	203.5	193.5	233.8	232.8	1.0
SWMW-20-01A	Main	Shabokin_Well_Field	623813.1	3017855.1	358.0	348.0	354.5	354.6	-0.1
SWPZ-19-01	Main	Shabokin_Well_Field	625364.6	3014476.9	231.0	221.0	230.0	230.2	-0.2
SWPZ-19-03	Main	Shabokin_Well_Field	625580.7	3015861.3	242.4	232.4	238.8	238.8	0.0
SWPZ-19-04	Main	Shabokin_Well_Field	623974.7	3015553.2	233.9	223.9	232.2	231.8	0.4
SWPZ-20-01	Main	Shabokin_Well_Field	623460.8	3017049.2	323.6	313.6	328.3	331.1	-2.8
SWPZ-20-02	Main	Shabokin_Well_Field	625457.4	3016909.4	244.5	234.5	241.5	243.0	-1.5
MW-01A	North	AOC_20	626348.8	3030902.0	200.7	185.7	206.8	206.4	0.4
MW-02A	North	AOC_20	626214.8	3031750.7	205.7	190.7	206.7	206.9	-0.3
MW-04	North	AOC_20	625446.4	3032569.7	207.7	192.7	208.1	207.5	0.6
MW-06	North	AOC_20	624410.4	3033479.8	217.7	202.7	222.1	221.9	0.1
MW-07	North	AOC_20	624609.6	3031439.8	220.7	205.7	219.9	219.5	0.3
MW-WC1A	North	AOC_20	625913.9	3030133.6	203.2	191.7	207.2	206.8	0.4
MW-WC2	North	AOC_20	625338.2	3029975.5	205.0	190.5	209.5	208.2	1.3
PZ-1	North	AOC_20	625639.9	3031669.9	202.1	197.1	211.9	212.5	-0.7
PZ-5	North	AOC_20	625922.3	3030540.1	199.3	194.3	208.0	207.9	0.0
30PZ-19-01	North	AOC_30	626817.1	3035431.2	203.3	193.3	206.5	206.2	0.3
30PZ-19-02	North	AOC_30	626870.2	3034956.6	197.5	187.5	206.1	205.9	0.3
30PZ-19-03	North	AOC_30	626448.8	3035148.1	198.0	188.0	203.5	203.4	0.1
30PZ-19-04	North	AOC_30	626262.8	3034929.9	199.9	189.9	203.0	202.9	0.1
30PZ-19-05	North	AOC_30	627375.5	3035471.4	204.1	194.1	212.7	211.9	0.8

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
31PZ-19-01	North	AOC_31	626075.5	3034166.0	199.7	189.7	202.6	202.7	-0.1
31PZ-19-02D	North	AOC_31	625372.9	3033989.4	141.3	136.3	202.4	201.9	0.5
31PZ-19-02S	North	AOC_31	625374.2	3033989.9	198.3	193.3	202.1	201.7	0.4
SHM-10-02	North	AOC_5	628381.4	3028700.1	167.2	157.2	205.3	205.3	0.0
SHM-10-03	North	AOC_5	628436.3	3029000.3	171.3	161.3	205.7	205.6	0.1
SHM-10-04	North	AOC_5	628959.2	3029485.3	155.0	145.0	206.8	206.8	0.0
SHM-10-08	North	AOC_5	628351.7	3028526.5	165.9	155.9	205.2	205.2	0.0
50PZ-19-01	North	AOC_50	627821.1	3034978.4	206.8	196.8	209.7	209.1	0.6
50PZ-19-02	North	AOC_50	627345.5	3034648.6	208.2	198.2	206.9	206.6	0.3
50PZ-19-03	North	AOC_50	628849.2	3033897.4	215.6	205.6	214.1	212.5	1.5
50PZ-19-04	North	AOC_50	628182.7	3033509.9	212.0	202.0	208.8	208.4	0.3
50PZ-19-05	North	AOC_50	629266.5	3032501.4	217.2	207.2	212.5	212.6	-0.1
50PZ-19-06	North	AOC_50	628574.6	3031601.9	203.0	193.0	206.1	206.9	-0.9
50PZ-19-07	North	AOC_50	625891.4	3034626.9	203.0	193.0	201.8	202.0	-0.2
G6M-01-01X	North	AOC_50	626357.9	3033351.1	133.6	113.6	201.0	203.3	-2.2
G6M-02-01X	North	AOC_50	627859.2	3034746.2	183.1	168.1	208.3	208.5	-0.2
G6M-02-02X	North	AOC_50	627949.0	3034667.6	183.3	168.3	207.4	208.6	-1.3
G6M-02-03X	North	AOC_50	627143.5	3034149.4	173.7	158.7	204.3	204.9	-0.6
G6M-02-04X	North	AOC_50	627229.7	3034065.5	173.0	158.0	204.5	205.0	-0.5
G6M-02-06X	North	AOC_50	626093.3	3033118.1	149.7	139.7	203.2	202.3	0.9
G6M-02-07X	North	AOC_50	625702.4	3033654.5	177.7	167.7	202.8	202.2	0.6
G6M-02-08X	North	AOC_50	628301.7	3035050.8	162.7	152.7	210.4	210.9	-0.5
G6M-02-09X	North	AOC_50	627285.6	3033980.1	172.7	157.7	203.7	205.0	-1.3
G6M-02-10X	North	AOC_50	626714.0	3033677.5	139.3	129.3	202.4	203.9	-1.5
G6M-02-11X	North	AOC_50	626634.3	3033609.1	136.9	126.9	203.3	203.8	-0.5
G6M-02-12X	North	AOC_50	626546.4	3033555.9	133.9	123.9	203.1	203.7	-0.6
G6M-02-13X	North	AOC_50	627017.9	3033970.1	153.8	143.8	203.4	204.5	-1.1
G6M-02-31BR	North	AOC_50	628213.0	3034878.8	169.3	159.3	208.3	210.0	-1.7
G6M-03-01X	North	AOC_50	628308.9	3035060.1	172.9	152.9	210.4	211.0	-0.6
G6M-03-02X	North	AOC_50	628302.7	3035041.0	194.7	179.7	210.2	210.9	-0.7
G6M-03-04X	North	AOC_50	628431.6	3035001.4	209.5	194.5	210.5	211.3	-0.8

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
G6M-03-07X	North	AOC_50	627560.6	3034422.7	182.8	172.8	206.0	206.9	-0.9
G6M-03-08X	North	AOC_50	626483.2	3033490.5	134.4	119.4	202.9	203.7	-0.8
G6M-03-09X	North	AOC_50	626480.2	3033541.8	132.9	117.9	202.8	203.7	-0.9
G6M-03-10X	North	AOC_50	626447.6	3033630.8	144.5	129.5	203.3	203.8	-0.5
G6M-03-11X	North	AOC_50	626365.2	3033366.2	148.3	133.3	201.9	203.3	-1.4
G6M-04-01X	North	AOC_50	627999.9	3034762.4	179.7	169.7	208.9	209.0	-0.2
G6M-04-02X	North	AOC_50	627651.6	3034493.3	184.5	174.5	206.4	207.3	-0.9
G6M-04-03X	North	AOC_50	627791.6	3034595.3	179.8	169.8	207.8	208.0	-0.2
G6M-04-04X	North	AOC_50	627448.7	3034333.8	169.7	159.7	204.7	206.2	-1.4
G6M-04-05X	North	AOC_50	626482.5	3033496.6	158.6	148.6	203.2	203.7	-0.5
G6M-04-06X	North	AOC_50	626248.4	3033359.0	167.2	157.2	202.2	202.9	-0.7
G6M-04-07X	North	AOC_50	626248.4	3033349.2	141.8	131.8	203.4	202.9	0.4
G6M-04-08X	North	AOC_50	625617.4	3033449.9	123.2	113.2	203.2	202.2	1.0
G6M-04-09X	North	AOC_50	628303.8	3034944.5	187.4	177.4	210.8	210.5	0.3
G6M-04-10A	North	AOC_50	628385.4	3034996.1	192.4	182.4	211.3	211.1	0.2
G6M-04-10X	North	AOC_50	628380.0	3034998.9	170.5	160.5	210.7	211.0	-0.3
G6M-04-11X	North	AOC_50	628110.6	3034988.6	193.3	183.3	210.1	210.0	0.1
G6M-04-12X	North	AOC_50	628232.5	3035032.2	169.9	159.9	211.0	210.5	0.5
G6M-04-13X	North	AOC_50	628411.0	3034974.1	194.2	184.2	211.4	211.1	0.2
G6M-04-14X	North	AOC_50	625817.7	3033359.0	128.5	118.5	203.0	202.3	0.6
G6M-04-15X	North	AOC_50	628330.9	3034916.3	181.7	171.7	210.9	210.6	0.4
G6M-04-22X	North	AOC_50	628167.9	3034895.3	180.2	170.2	209.9	209.9	0.0
G6M-04-31X	North	AOC_50	628210.0	3034869.2	186.3	176.3	209.7	210.0	-0.3
G6M-06-01X	North	AOC_50	626954.6	3034144.1	158.5	138.5	206.0	204.6	1.4
G6M-07-01X	North	AOC_50	627885.2	3034805.0	184.2	173.2	210.1	208.7	1.3
G6M-07-02X	North	AOC_50	628407.4	3034987.4	200.4	195.4	211.4	211.1	0.3
G6M-13-01X	North	AOC_50	626402.1	3033736.9	140.2	130.2	204.0	203.8	0.3
G6M-13-02X	North	AOC_50	626820.1	3034076.7	149.0	139.0	204.4	204.4	0.0
G6M-13-03X	North	AOC_50	627535.4	3034543.7	184.8	174.8	206.7	207.0	-0.3
G6M-13-04X	North	AOC_50	626602.7	3033706.7	140.0	130.0	203.6	203.9	-0.3
G6M-13-05X	North	AOC_50	628219.4	3035037.3	178.9	168.9	210.8	210.4	0.4

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
G6M-13-06X	North	AOC_50	628269.8	3034982.1	175.4	165.4	210.3	210.5	-0.2
G6M-18-01	North	AOC_50	626508.0	3034124.3	148.6	138.6	204.6	204.1	0.5
G6M-18-02	North	AOC_50	626102.2	3033809.1	142.7	132.7	203.4	203.0	0.5
G6M-92-10X	North	AOC_50	628503.4	3035008.3	213.4	203.4	210.8	211.5	-0.8
G6M-93-13X	North	AOC_50	628274.3	3034988.4	213.9	203.9	211.1	210.6	0.5
G6M-94-15A	North	AOC_50	628328.6	3034924.4	217.7	207.7	211.9	210.7	1.2
G6M-95-19X	North	AOC_50	628384.3	3035057.7	174.4	164.4	211.6	211.2	0.4
G6M-95-20X	North	AOC_50	628485.8	3035005.9	204.5	199.5	212.0	211.5	0.5
G6M-96-22A	North	AOC_50	628391.1	3035142.8	176.3	166.3	212.5	211.8	0.7
G6M-96-22B	North	AOC_50	628384.4	3035149.2	150.9	145.9	211.9	211.8	0.2
G6M-96-25A	North	AOC_50	628065.4	3035061.0	214.3	204.6	212.3	210.2	2.1
G6M-96-25B	North	AOC_50	628065.4	3035061.0	175.9	165.9	209.7	210.1	-0.5
G6M-96-26A	North	AOC_50	628547.7	3034950.7	214.8	204.8	210.8	211.5	-0.8
G6M-96-26B	North	AOC_50	628554.4	3034947.6	154.9	144.9	209.8	211.4	-1.6
G6M-97-05B	North	AOC_50	626265.1	3033730.4	135.9	130.9	203.2	203.5	-0.3
G6M-97-09B	North	AOC_50	628271.9	3034545.3	185.8	175.8	208.7	209.7	-1.0
G6M-97-28X	North	AOC_50	627185.8	3034102.8	163.1	158.1	204.6	204.9	-0.3
G6M-97-29X	North	AOC_50	626733.8	3033672.1	85.0	75.0	202.2	203.9	-1.7
G6M-98-32X	North	AOC_50	626756.3	3033673.1	134.2	129.2	202.4	203.9	-1.5
G6P-97-05X	North	AOC_50	627296.4	3035151.1	201.6	191.6	211.1	208.5	2.6
MW-3	North	AOC_50	626756.6	3033717.3	137.4	126.4	203.1	204.0	-0.9
MW-6	North	AOC_50	626819.0	3033733.4	138.6	128.6	201.9	204.1	-2.2
MW-7	North	AOC_50	626806.1	3033767.8	138.7	128.7	204.2	204.1	0.1
MW-7 (IT)	North	AOC_50	627288.7	3035121.8	216.2	206.2	208.6	208.4	0.2
XSA-12-95X	North	AOC_50	626165.5	3033422.6	144.9	134.9	201.7	202.8	-1.1
XSA-12-96X	North	AOC_50	626043.1	3033529.4	146.6	136.6	204.6	202.7	2.0
XSA-12-97X	North	AOC_50	625909.0	3033633.5	139.4	129.4	201.9	202.5	-0.6
XSA-12-98X	North	AOC_50	625683.8	3033711.6	144.1	134.1	204.5	202.2	2.2
MPP-93-02	North	MacPherson	626050.3	3028511.6	187.7	182.7	202.8	203.3	-0.6
MPP-93-03	North	MacPherson	626054.7	3028924.5	187.1	182.1	203.5	203.2	0.3
MPPZ-19-03	North	MacPherson	626527.7	3028166.8	206.8	196.8	204.9	203.6	1.4

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
McPh-Sentinel	North	MacPherson	626470.0	3028078.7	118.9	113.9	204.3	203.6	0.7
25M-92-05X	South	AOC_25	614591.4	3005719.1	329.7	319.7	332.2	332.9	-0.7
25M-92-06X	South	AOC_25	615496.2	3005640.7	286.7	276.7	289.2	289.2	0.1
25M-92-07X	South	AOC_25	615490.0	3005962.2	290.0	280.0	294.4	293.5	0.9
25M-92-08X	South	AOC_25	615308.4	3005999.6	290.3	270.3	301.5	302.8	-1.2
26M-10-09X	South	AOC_25	614430.2	3008788.0	277.6	267.6	274.6	271.9	2.7
26M-14-10X	South	AOC_25	614911.3	3008660.4	276.5	266.5	275.2	271.6	3.6
26M-14-11X	South	AOC_25	615141.8	3008109.0	281.3	271.3	287.7	286.3	1.4
26M-92-01X	South	AOC_25	614915.2	3007313.5	313.6	303.6	309.3	308.5	0.8
26M-92-02X	South	AOC_25	614255.8	3008196.5	261.3	241.3	285.4	285.3	0.1
26M-92-03X	South	AOC_25	614252.7	3008189.9	284.6	274.6	285.3	285.3	0.0
26M-92-04X	South	AOC_25	614416.0	3008106.1	284.7	274.7	286.1	286.0	0.1
26M-92-05X	South	AOC_25	613741.7	3008158.4	285.5	275.5	287.1	287.1	-0.1
26M-92-06X	South	AOC_25	614046.3	3007845.9	289.2	279.2	290.0	291.5	-1.5
26M-92-07X	South	AOC_25	614696.7	3007822.5	288.0	278.0	288.6	288.9	-0.3
26WP-06-01R	South	AOC_25	614285.2	3008321.9	276.2	273.2	282.6	283.0	-0.5
26WP-08-02R	South	AOC_25	614059.2	3008937.9	272.9	269.9	279.8	278.1	1.7
26WP-09-01R	South	AOC_25	614325.0	3008610.7	277.9	274.9	281.1	281.4	-0.3
26WP-09-02R	South	AOC_25	614511.6	3008983.7	266.9	263.9	272.2	264.9	7.3
26WP-09-03R	South	AOC_25	613685.7	3008585.7	282.8	279.8	284.7	283.8	0.9
27M-93-07X	South	AOC_25	616843.1	3008814.5	222.1	212.1	238.3	239.2	-1.0
27M-93-09X	South	AOC_25	616861.9	3009179.3	215.9	205.9	236.4	236.5	-0.2
27M-93-10X	South	AOC_25	616872.1	3009166.4	234.5	224.5	235.6	236.6	-1.0
SPM-93-06X	South	AOC_25	615772.7	3009836.3	196.3	186.3	231.0	232.6	-1.6
SPM-97-23X	South	AOC_25	616719.8	3009865.2	205.2	195.2	229.5	230.6	-1.1
26M-97-08X	South	AOC_26	614221.5	3008209.6	272.4	262.4	285.4	285.1	0.3
26WP-06-01	South	AOC_26	614255.0	3008319.7	277.2	275.2	282.2	283.1	-0.9
26WP-08-02	South	AOC_26	614024.7	3008895.1	272.3	269.3	279.3	279.3	0.0
26WP-09-02	South	AOC_26	614504.9	3008971.9	249.5	246.5	261.1	265.0	-3.9
26WP-09-03	South	AOC_26	613717.7	3008555.6	284.2	281.2	283.7	283.9	-0.1
27M-92-01X	South	AOC_27	616851.2	3009431.5	235.2	225.2	233.5	234.0	-0.5

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
27M-93-05X	South	AOC_27	616850.7	3009444.6	175.0	165.0	232.7	233.2	-0.5
27M-93-06X	South	AOC_27	616841.1	3009437.9	198.5	188.5	233.1	233.7	-0.7
27M-93-08X	South	AOC_27	617066.6	3009359.1	199.4	189.4	232.8	233.6	-0.8
41M-92-01X	South	AOC_41	619695.0	3005472.6	219.8	209.8	223.6	223.2	0.3
41M-93-02B	South	AOC_41	619679.9	3005541.1	224.1	214.1	223.9	223.2	0.7
41M-93-04X	South	AOC_41	619669.0	3005242.1	221.8	217.8	223.5	223.5	0.0
41M-93-05X	South	AOC_41	619667.6	3005291.3	223.9	218.9	223.1	223.5	-0.3
41M-94-02C	South	AOC_41	619686.0	3005557.7	207.7	197.7	222.4	223.2	-0.8
41M-94-03B	South	AOC_41	619817.0	3005676.4	200.3	190.3	221.9	222.2	-0.3
41M-94-06X	South	AOC_41	619231.2	3005288.2	223.1	213.1	224.2	225.1	-0.9
41M-94-07X	South	AOC_41	619327.8	3005238.6	220.7	216.2	223.8	224.0	-0.2
41M-94-08A	South	AOC_41	619472.4	3005341.3	223.2	213.2	224.2	224.1	0.1
41M-94-08B	South	AOC_41	619465.9	3005341.1	206.1	196.1	223.7	224.3	-0.6
41M-94-09A	South	AOC_41	620029.3	3005820.6	221.4	211.4	220.7	221.2	-0.5
41M-94-09B	South	AOC_41	620035.9	3005820.8	204.6	194.6	220.5	221.1	-0.6
41M-94-10X	South	AOC_41	619345.9	3005403.3	225.4	215.4	229.7	227.6	2.1
41M-94-11X	South	AOC_41	619581.6	3005646.5	221.1	211.1	224.0	225.7	-1.7
41M-94-12X	South	AOC_41	620063.8	3005542.5	220.1	210.1	221.9	222.3	-0.3
41M-94-13X	South	AOC_41	619902.2	3005455.8	221.1	211.1	223.3	222.8	0.4
41M-94-14X	South	AOC_41	619430.1	3005218.7	218.9	213.9	223.5	223.7	-0.2
SPM-93-03X	South	SP_Other	615028.3	3010706.7	232.3	222.3	248.2	248.5	-0.2
SPM-93-05X	South	SP_Other	615762.5	3009845.7	223.8	213.8	232.2	232.4	-0.2
SPM-93-07X	South	SP_Other	618829.2	3007567.0	240.7	230.7	237.9	237.8	0.1
SPM-93-08X	South	SP_Other	618822.4	3007576.6	216.6	206.6	238.8	237.9	0.9
SPM-93-09X	South	SP_Other	617753.1	3005113.3	233.6	223.6	234.4	234.5	-0.1
SPM-93-10X	South	SP_Other	617740.3	3005100.0	207.7	197.7	234.2	234.5	-0.3
SPM-93-11X	South	SP_Other	615750.5	3002137.0	233.4	223.4	234.0	234.5	-0.5
SPM-93-12X	South	SP_Other	615756.7	3002150.3	202.9	192.9	233.3	234.1	-0.8
SPM-93-13X	South	SP_Other	615603.7	3007891.8	283.1	273.1	278.6	277.3	1.3
SPM-93-15X	South	SP_Other	613462.9	3002929.1	351.4	341.4	354.9	352.3	2.6
SPM-93-16X	South	SP_Other	617276.5	3004580.8	192.0	182.0	232.0	233.4	-1.3

Table E.2

Target Water Levels

Location	Post	Group	Easting	Northing	Top of Screen (feet/MSL)	Bottom of Screen (feet/MSL)	Target Water Level (feet/MSL)	Calculated Water Level (feet/MSL)	Residual[1] (feet)
SPM-97-24X	South	SP_Other	619281.0	3006553.9	201.2	191.2	224.7	225.8	-1.1

Note:

[1] Residual is calculated as Target Water Level - Calculated Water Level.

Table E.3

Three-Point Gradient Method – Magnitudes and Directions

Post	Definition Monitoring Wells	Estimated Direction (degrees)	Calculated Direction (degrees)	Direction Difference[1,3] (degrees)	Estimated Magnitude	Calculated Magnitude	Transformed[2] Estimated Magnitude	Transformed[2] Calculated Magnitude	Transformed Magnitude Residual[3]
South	25M-92-06X, 25M-92-05X, 25M-92-08X	101.9	105.6	-3.6	4.77E-02	4.90E-02	4.6	4.5	0.1
South	41M-94-11X, SPM-93-09X, SPM-93-08X	124.5	123.7	0.7	8.62E-03	7.17E-03	10.8	11.8	-1.0
South	27M-93-08X, 27M-93-09X, 27M-93-06X	23.7	22.0	1.7	1.44E-02	1.21E-02	8.3	9.1	-0.8
South	26M-10-09X, 26WP-09-01R, 26WP-08-02	35.4	37.1	-1.7	3.19E-02	4.68E-02	5.6	4.6	1.0
South	26WP-08-02, 26M-92-05X, 26WP-09-03	29.3	32.0	-2.7	9.96E-03	1.01E-02	10.0	10.0	0.1
South	26WP-08-02, 26WP-09-01R, 26M-92-05X	16.6	12.4	4.1	9.89E-03	1.00E-02	10.1	10.0	0.1
South	26M-92-07X, 26M-92-06X, 26M-92-04X	12.8	17.1	-4.3	1.17E-02	1.55E-02	9.2	8.0	1.2
South	26M-92-07X, 26M-92-04X, 26M-14-10X	21.5	24.1	-2.7	1.56E-02	2.03E-02	8.0	7.0	1.0
South	26M-14-10X, 26M-14-11X, 26M-92-07X	331.8	338.5	-6.8	2.10E-02	2.47E-02	6.9	6.4	0.5
South	26WP-09-01R, 26M-92-03X, 26M-92-05X	17.5	19.6	-2.1	9.78E-03	9.14E-03	10.1	10.5	-0.3
South	26M-92-04X, 26M-92-06X, 26M-92-03X	6.8	13.8	-7.0	1.30E-02	1.63E-02	8.8	7.8	0.9
South	26M-92-03X, 26M-92-06X, 26M-92-05X	12.7	8.8	3.9	1.25E-02	1.68E-02	8.9	7.7	1.2
South	26WP-09-02R, 26M-10-09X, 26WP-08-02	63.3	44.7	18.6	1.50E-02	3.57E-02	8.2	5.3	2.9
South	26WP-09-02R, 26M-14-10X, 26M-10-09X	8.4	15.8	-7.4	1.17E-02	3.33E-02	9.2	5.5	3.8
South	26M-14-11X, 26M-92-01X, 26M-92-07X	329.8	335.1	-5.3	3.77E-02	3.54E-02	5.1	5.3	-0.2
Former Main	PWPZ-19-07, PWPZ-19-04, PWPZ-19-05	309.3	309.0	0.3	7.81E-03	5.67E-03	11.3	13.3	-2.0
Former Main	LFM-99-05A, LFM-99-01B, LFM-99-03B	42.3	42.1	0.2	4.90E-02	4.55E-02	4.5	4.7	-0.2
Former Main	LFM-99-05A, LFM-03-07, LFM-99-01B	56.5	52.3	4.1	4.68E-02	4.36E-02	4.6	4.8	-0.2
Former Main	LFM-03-07, LFM-99-06ARP, LFM-99-01B	24.3	39.9	-15.6	9.62E-02	5.41E-02	3.2	4.3	-1.1
Former Main	LFM-99-02B, LFM-99-01B, LFM-99-06ARP	29.8	42.9	-13.1	3.16E-02	4.67E-02	5.6	4.6	1.0
Former Main	SWPZ-20-02, SWPZ-19-03, SWPZ-20-01	86.6	88.4	-1.8	4.37E-02	4.42E-02	4.8	4.8	0.0
Former Main	PWPZ-19-06, PWPZ-19-08, 1C	211.3	214.1	-2.8	1.62E-03	1.51E-03	24.9	25.7	-0.9
Former Main	PWPZ-19-07, PWPZ-19-06, PWPZ-19-01	297.5	299.8	-2.2	2.62E-03	2.58E-03	19.5	19.7	-0.1
Former Main	PWPZ-19-07, PWPZ-19-05, PWPZ-19-06	276.7	289.2	-12.5	2.61E-03	2.52E-03	19.6	19.9	-0.4
Former Main	PWPZ-19-06, 1C, PWPZ-19-01	123.4	120.2	3.2	1.81E-03	1.73E-03	23.5	24.0	-0.5
Former Main	1D-D, 1F-S, 43GPZ-19-04	64.5	58.7	5.8	6.43E-03	6.46E-03	12.5	12.4	0.0
Former Main	PWPZ-19-01, PWPZ-19-02, 1E-S	35.4	37.3	-1.9	8.06E-03	7.72E-03	11.1	11.4	-0.2
Former Main	1E-S, PWPZ-19-07, PWPZ-19-01	44.2	44.9	-0.7	5.18E-03	5.42E-03	13.9	13.6	0.3
Former Main	PWPZ-19-03, PWPZ-19-07, 1E-S	31.1	19.0	12.1	4.23E-03	3.89E-03	15.4	16.0	-0.7
Former Main	XGM-94-08X, 43GPZ-19-01, XGM-94-10X	108.3	110.5	-2.2	4.56E-02	4.58E-02	4.7	4.7	0.0
Former Main	XGM-94-06X, 43GPZ-19-01, XGM-94-08X	97.2	99.0	-1.7	5.38E-02	5.38E-02	4.3	4.3	0.0
Former Main	43GPZ-19-02, XGM-94-07X, AAFES-5	82.7	79.6	3.1	5.22E-02	5.56E-02	4.4	4.2	0.1
Former Main	XGM-94-07X, XGM-94-08X, AAFES-6R	127.0	115.7	11.4	3.31E-02	4.26E-02	5.5	4.8	0.7
Former Main	43GPZ-19-06, 43GPZ-19-05, XGM-20-01A	63.4	70.1	-6.7	7.45E-03	6.45E-03	11.6	12.5	-0.9
Former Main	43GPZ-19-05, 43GPZ-19-04, AAFES-7	38.9	53.1	-14.1	9.54E-03	9.36E-03	10.2	10.3	-0.1
Former Main	76PZ-19-01, 76PZ-19-05, 76PZ-19-03	353.2	2.4	-9.3	3.75E-03	4.31E-03	16.3	15.2	1.1
Former Main	76PZ-19-11, 76PZ-19-05, 76PZ-19-10	18.5	29.5	-11.0	4.48E-03	4.55E-03	14.9	14.8	0.1

Table E.3

Three-Point Gradient Method – Magnitudes and Directions

Post	Definition Monitoring Wells	Estimated Direction (degrees)	Calculated Direction (degrees)	Direction Difference[1,3] (degrees)	Estimated Magnitude	Calculated Magnitude	Transformed[2] Estimated Magnitude	Transformed[2] Calculated Magnitude	Transformed Magnitude Residual[3]
Former Main	76PZ-19-05, 76PZ-19-07, 76PZ-19-10	11.4	14.9	-3.4	4.72E-03	4.90E-03	14.6	14.3	0.3
Former Main	76PZ-19-01, 76PZ-19-07, 76PZ-19-05	353.4	2.3	-8.8	4.22E-03	4.41E-03	15.4	15.1	0.3
Former Main	76PZ-19-02, 76PZ-19-07, 76PZ-19-06	31.9	13.0	19.0	9.84E-03	8.32E-03	10.1	11.0	-0.9
Former Main	76PZ-19-10, 76PZ-19-07, 76PZ-19-02	17.8	18.4	-0.7	9.76E-03	8.22E-03	10.1	11.0	-0.9
Former Main	76PZ-19-16, 76PZ-19-13, 76PZ-19-02	312.0	338.7	-26.6	8.86E-03	7.65E-03	10.6	11.4	-0.8
Former Main	75PZ-19-02, 75PZ-20-05, 75PZ-19-04	130.9	109.2	21.7	2.22E-03	2.58E-03	21.2	19.7	1.6
Former Main	75PZ-19-03, 75PZ-19-02, 75PZ-19-04	59.8	84.4	-24.5	6.51E-03	3.45E-03	12.4	17.0	-4.6
Former Main	76PZ-19-03, 43GPZ-19-08, 76PZ-19-01	346.3	355.9	-9.7	3.24E-03	3.54E-03	17.6	16.8	0.8
Former Main	76PZ-19-18, 43GPZ-19-08, 76PZ-19-04	64.1	63.3	0.7	2.06E-03	2.20E-03	22.1	21.3	0.8
Former Main	76PZ-19-18, 43GPZ-19-06, 43GPZ-19-08	69.9	57.7	12.2	1.98E-03	2.32E-03	22.5	20.8	1.7
Former Main	43GPZ-19-06, XGM-20-01A, 43GPZ-19-08	53.4	51.2	2.3	8.14E-03	7.53E-03	11.1	11.5	-0.4
Former Main	76PZ-19-11, 76PZ-19-15, 76PZ-19-03	33.9	33.2	0.8	4.23E-03	5.15E-03	15.4	13.9	1.4
Former Main	76PZ-19-03, 76PZ-19-05, 76PZ-19-11	18.2	23.2	-5.1	4.53E-03	5.34E-03	14.9	13.7	1.2
Former Main	43GPZ-19-08, 76PZ-19-03, 76PZ-19-15	51.7	50.6	1.1	2.84E-03	3.45E-03	18.8	17.0	1.7
Former Main	57M-03-02X, 57M-95-07X, 57M-95-05X	149.5	148.8	0.7	8.79E-03	9.07E-03	10.7	10.5	0.2
Former Main	57M-03-05X, 57M-03-02X, 57M-95-06X	162.6	159.4	3.2	1.88E-02	1.38E-02	7.3	8.5	-1.2
Former Main	57M-03-01X, 57M-03-02X, 57M-95-05X	170.6	161.1	9.5	1.39E-02	1.13E-02	8.5	9.4	-0.9
Former Main	57M-95-06X, 57M-03-02X, 57M-03-01X	180.7	170.6	10.1	1.35E-02	1.07E-02	8.6	9.7	-1.1
Former Main	57M-03-02X, 57M-03-03X, 57M-95-07X	149.4	147.9	1.5	8.97E-03	1.04E-02	10.6	9.8	0.7
Former Main	57M-03-02X, 57M-03-05X, 57M-03-03X	136.6	150.8	-14.2	9.18E-03	1.04E-02	10.4	9.8	0.6
Former Main	57M-96-11X, 57M-96-12X, 57M-95-03X	151.0	150.0	0.9	2.96E-02	1.82E-02	5.8	7.4	-1.6
Former Main	57M-96-12X, 57M-96-11X, 57M-96-13X	147.8	147.3	0.6	2.76E-02	1.72E-02	6.0	7.6	-1.6
Former Main	57P-98-03X, 57M-96-11X, 57M-96-10X	182.3	168.5	13.8	7.01E-02	2.19E-02	3.8	6.8	-3.0
Former Main	57P-98-03X, 57P-98-04X, 57M-96-11X	175.1	166.6	8.5	5.45E-02	2.10E-02	4.3	6.9	-2.6
Former Main	57M-95-03X, 57M-96-12X, 57M-96-09X	156.3	158.4	-2.1	2.32E-02	1.26E-02	6.6	8.9	-2.3
Former Main	57M-96-12X, 57M-96-13X, 57M-96-09X	148.7	149.0	-0.3	2.41E-02	1.32E-02	6.4	8.7	-2.3
Former Main	74PZ-19-05, 74PZ-19-02, 74PZ-19-03	36.6	42.1	-5.4	2.36E-03	1.90E-03	20.6	22.9	-2.4
Former Main	74PZ-19-08, 74PZ-19-05, 74PZ-19-07	35.4	33.8	1.6	8.27E-03	6.46E-03	11.0	12.4	-1.4
Former Main	74PZ-19-09, 74PZ-19-05, 74PZ-19-08	28.6	33.5	-4.9	8.30E-03	6.46E-03	11.0	12.4	-1.5
Former Main	74PZ-19-09, 74PZ-19-04, 74PZ-19-05	114.5	109.3	5.2	7.76E-03	6.08E-03	11.4	12.8	-1.5
Former Main	74PZ-19-02, 74PZ-19-05, 74PZ-19-04	116.6	115.2	1.4	7.62E-03	5.74E-03	11.5	13.2	-1.7
Former Main	74PZ-19-05, 74PZ-19-06, 74PZ-19-07	23.7	26.7	-3.0	7.37E-03	6.01E-03	11.6	12.9	-1.2
Former Main	74PZ-19-05, 74PZ-19-03, 74PZ-19-06	10.7	14.1	-3.4	4.52E-03	3.45E-03	14.9	17.0	-2.2
Former Main	SHM-11-07, SHM-10-07, SHM-10-13	15.8	10.4	5.4	4.83E-03	5.30E-03	14.4	13.7	0.7
Former Main	MNG-6R, 74PZ-19-06, MNG-5R	47.9	42.4	5.5	1.37E-02	9.78E-03	8.5	10.1	-1.6
Former Main	74PZ-19-07, 74PZ-19-06, MNG-6R	12.6	16.0	-3.4	1.04E-02	8.03E-03	9.8	11.2	-1.3
Former Main	CSMS-11-02, 74PZ-19-07, MNG-6R	354.0	357.9	-4.0	7.92E-03	5.98E-03	11.2	12.9	-1.7

Table E.3

Three-Point Gradient Method – Magnitudes and Directions

Post	Definition Monitoring Wells	Estimated Direction (degrees)	Calculated Direction (degrees)	Direction Difference[1,3] (degrees)	Estimated Magnitude	Calculated Magnitude	Transformed[2] Estimated Magnitude	Transformed[2] Calculated Magnitude	Transformed Magnitude Residual[3]
Former Main	74PZ-19-08, 74PZ-19-07, CSMS-11-02	41.1	38.7	2.4	6.38E-03	5.03E-03	12.5	14.1	-1.6
Former Main	74PZ-19-09, 74PZ-19-08, CSMS-11-02	30.6	36.6	-6.0	5.94E-03	4.95E-03	13.0	14.2	-1.2
Former Main	69W-94-12, ZWM-99-22X, 69W-94-13	324.1	324.1	0.0	9.04E-03	7.76E-03	10.5	11.4	-0.8
Former Main	ZWM-95-16X, ZWM-99-22X, 69W-94-12	321.9	323.1	-1.2	9.83E-03	8.07E-03	10.1	11.1	-1.0
Former Main	ZWM-01-26X, ZWM-99-23X, ZWM-01-25X	290.4	309.3	-18.8	7.14E-03	8.57E-03	11.8	10.8	1.0
Former Main	ZWM-95-15X, 69W-94-14, ZWM-99-24X	15.8	312.8	63.0	7.81E-03	7.89E-03	11.3	11.3	0.1
Former Main	69W-94-14, 69W-94-13, ZWM-99-24X	7.6	313.8	53.8	8.73E-03	9.22E-03	10.7	10.4	0.3
Former Main	ZWM-01-25X, ZWM-95-15X, ZWM-95-18X	352.3	313.4	38.9	7.86E-03	7.24E-03	11.3	11.8	-0.5
Former Main	43M-01-20XOB, ZWM-95-17X, 32M-92-03X	236.2	229.7	6.5	8.13E-03	8.59E-03	11.1	10.8	0.3
Former Main	43M-01-16XOB, 32M-92-03X, 32Z-01-08XOB	212.1	214.0	-1.8	2.19E-02	2.53E-02	6.8	6.3	0.5
Former Main	32Z-01-05XOB, 32Z-01-09XOB, 43M-01-17XOB	267.4	269.4	-2.0	2.05E-03	2.86E-03	22.1	18.7	3.4
Former Main	43M-01-16XOB, 43M-01-17XOB, 43M-01-20XOB	191.1	211.6	-20.5	3.13E-03	5.11E-03	17.9	14.0	3.9
Former Main	32M-01-17XBR, 32Z-01-10XBR, 32M-01-18XBR	79.7	86.9	-7.2	4.41E-02	3.07E-02	4.8	5.7	-0.9
Former Main	SHM-10-12, SHP-99-35X, SHP-99-01B	86.2	84.0	2.1	9.00E-02	7.42E-02	3.3	3.7	-0.3
Former Main	SHM-10-11, SHP-99-01B, SHP-99-35X	63.5	63.0	0.6	9.95E-02	8.22E-02	3.2	3.5	-0.3
Former Main	SHM-10-11, N7-P1, SHL-15	78.7	80.3	-1.6	2.74E-02	2.98E-02	6.0	5.8	0.2
Former Main	N7-P1, SHL-12, 32M-01-14XOB	74.0	75.7	-1.7	2.02E-02	2.25E-02	7.0	6.7	0.4
Former Main	SHM-10-13, SHM-10-12, SHM-10-15	8.5	5.2	3.3	5.40E-03	5.25E-03	13.6	13.8	-0.2
Former Main	SHM-10-13, SHM-10-15, SHM-10-14	6.1	2.7	3.4	6.02E-03	6.03E-03	12.9	12.9	0.0
Former Main	SHM-10-15, SHP-99-29X, SHM-10-14	66.5	79.3	-12.8	8.32E-03	1.09E-02	11.0	9.6	1.4
Former Main	SHM-10-07, SHM-10-12, SHM-10-13	17.2	9.6	7.7	5.25E-03	5.14E-03	13.8	14.0	-0.1
Former Main	SHP-05-44, PZ-12-02, SHM-11-06	358.0	6.5	-8.5	5.48E-03	7.42E-03	13.5	11.6	1.9
Former Main	SHP-01-36X, SHP-01-37X, SHP-05-44	294.1	314.5	-20.4	2.26E-03	2.20E-03	21.0	21.3	-0.3
Former Main	N2-P1, SHP-01-38A, SHL-11	61.7	65.3	-3.6	1.85E-03	1.44E-03	23.3	26.3	-3.1
Former Main	PZ-12-03, SHP-01-38A, PZ-12-05	10.2	35.5	-25.3	3.05E-03	1.20E-03	18.1	28.8	-10.7
Former Main	SHL-11, PZ-12-01, N2-P1	114.4	50.4	63.9	1.73E-03	1.72E-03	24.1	24.1	0.0
Former Main	SHP-01-37X, N2-P1, PZ-12-01	96.5	52.1	44.4	1.81E-03	1.63E-03	23.5	24.8	-1.2
Former Main	N3-P1, SHL-19, SHL-4	6.9	353.4	13.5	5.41E-03	6.49E-03	13.6	12.4	1.2
Former Main	SHL-10, SHL-19, N3-P1	32.9	27.2	5.7	4.92E-03	5.12E-03	14.3	14.0	0.3
Former Main	SHP-05-44, SHP-01-37X, PZ-12-01	358.0	359.5	-1.6	3.29E-03	3.41E-03	17.4	17.1	0.3
Former Main	SHM-11-06, SHP-05-43, SHP-05-44	354.8	12.7	-17.9	2.39E-03	3.68E-03	20.4	16.5	4.0
Former Main	SHP-05-44, SHP-05-43, SHP-01-36X	302.3	318.6	-16.3	2.97E-03	3.38E-03	18.4	17.2	1.1
Former Main	SHP-01-36X, SHP-05-43, N1-P1	340.6	313.6	27.0	4.94E-03	3.21E-03	14.2	17.7	-3.4
Former Main	N1-P1, SHP-05-43, SHL-21	339.0	320.2	18.7	5.65E-03	6.00E-03	13.3	12.9	0.4
Former Main	SHP-05-43, SHM-11-06, SHL-21	327.5	337.6	-10.1	5.17E-03	6.69E-03	13.9	12.2	1.7
Former Main	PZ-12-08, PZ-12-10, SHM-93-01A	24.0	23.2	0.8	7.99E-03	7.43E-03	11.2	11.6	-0.4
Former Main	SHL-18, SHL-3, N4-P1	18.8	18.7	0.1	8.95E-03	8.18E-03	10.6	11.1	-0.5

Table E.3

Three-Point Gradient Method – Magnitudes and Directions

Post	Definition Monitoring Wells	Estimated Direction (degrees)	Calculated Direction (degrees)	Direction Difference[1,3] (degrees)	Estimated Magnitude	Calculated Magnitude	Transformed[2] Estimated Magnitude	Transformed[2] Calculated Magnitude	Transformed Magnitude Residual[3]
Former Main	PZ-12-09, SHL-10, SHL-3	80.2	34.0	46.2	4.80E-03	6.46E-03	14.4	12.4	2.0
Former Main	PZ-12-10, SHM-93-01A, SHL-3	88.0	68.3	19.7	1.30E-02	8.68E-03	8.8	10.7	-1.9
Former Main	PZ-12-09, SHL-19, SHL-10	31.6	25.2	6.4	5.47E-03	7.18E-03	13.5	11.8	1.7
Former Main	SHL-19, PZ-12-07, SHL-4	301.3	332.9	-31.6	4.03E-03	5.61E-03	15.7	13.4	2.4
Former Main	SHM-11-07, PZ-12-06, SHM-10-07	30.3	19.8	10.4	4.79E-03	5.15E-03	14.5	13.9	0.5
Former Main	PZ-12-08, SHM-10-07, PZ-12-06	358.6	4.8	-6.2	6.19E-03	5.86E-03	12.7	13.1	-0.3
Former Main	SHL-4, PZ-12-05, SHP-01-38A	55.4	341.5	73.9	2.82E-03	2.19E-03	18.8	21.4	-2.5
Former Main	PZ-12-06, SHM-11-07, PZ-12-04	325.4	336.7	-11.4	1.74E-03	2.81E-03	24.0	18.9	5.1
Former Main	SHP-01-38A, PZ-12-03, SHL-11	302.9	56.9	-114.0	3.86E-04	5.92E-04	50.9	41.1	9.8
Former Main	SHL-8D, SHL-21, EPA-PZ-2012-2B	319.4	299.5	20.0	9.50E-03	5.26E-03	10.3	13.8	-3.5
Former Main	SHL-8D, SHP-05-47B, SHP-99-34A	357.0	14.9	-17.8	8.01E-03	8.02E-03	11.2	11.2	0.0
Former Main	SHL-13, SHP-05-47B, SHL-8D	346.7	348.3	-1.6	1.07E-02	1.37E-02	9.7	8.5	1.1
Former Main	SHL-13, SHL-21, SHL-8D	335.3	299.7	35.6	7.33E-03	5.20E-03	11.7	13.9	-2.2
Former Main	N1-P1, SHL-21, SHL-13	341.0	298.3	42.7	6.16E-03	4.49E-03	12.7	14.9	-2.2
Former Main	SHM-05-42A, SHM-05-41B, SHM-99-31C	337.9	336.3	1.7	7.49E-03	6.05E-03	11.6	12.9	-1.3
Former Main	SHM-99-32X, SHM-05-42A, SHM-99-31C	326.9	326.3	0.7	7.42E-03	6.02E-03	11.6	12.9	-1.3
Former Main	SHM-13-06, SHM-05-40X, SHM-07-03	277.2	279.4	-2.2	5.82E-03	5.75E-03	13.1	13.2	-0.1
Former Main	SHM-10-15, SHP-99-01B, SHP-99-29X	21.8	26.5	-4.6	6.82E-02	5.60E-02	3.8	4.2	-0.4
Former Main	SHM-10-12, SHP-99-01B, SHM-10-15	81.1	80.5	0.6	8.81E-02	7.32E-02	3.4	3.7	-0.3
Former Main	SHM-11-07, SHM-10-13, SHM-10-14	12.3	8.9	3.3	6.56E-03	6.52E-03	12.3	12.4	0.0
Former Main	SHM-11-07, SHM-10-14, SHM-11-06	6.8	3.0	3.8	4.03E-03	4.38E-03	15.8	15.1	0.7
Former Main	SHM-05-40X, SHM-13-08, SHM-13-05	342.6	324.0	18.5	4.18E-03	5.18E-03	15.5	13.9	1.6
Former Main	SHM-10-10, SHM-13-06, SHM-10-01	266.7	281.8	-15.2	2.43E-03	2.69E-03	20.3	19.3	1.0
Former Main	SHM-10-01, SHM-13-06, SHM-07-03	310.8	311.0	-0.2	3.94E-03	4.06E-03	15.9	15.7	0.2
Former Main	SHL-12, SHL-17, 32Z-99-02X	349.3	359.9	-10.6	1.61E-02	1.38E-02	7.9	8.5	-0.6
Former Main	SHL-12, SHL-17, N7-P2	346.3	19.4	-33.0	3.65E-03	4.75E-03	16.6	14.5	2.1
Former North	G6M-02-06X, XSA-12-95X, G6M-04-07X	302.2	247.0	55.2	1.57E-02	2.48E-03	8.0	20.1	-12.1
Former North	G6M-18-01, G6M-18-02, 31PZ-19-01	294.5	279.6	14.9	4.73E-03	3.12E-03	14.5	17.9	-3.4
Former North	G6M-13-01X, G6M-03-10X, G6M-97-05B	210.2	244.8	-34.6	1.12E-02	2.49E-03	9.4	20.0	-10.6
Former North	XSA-12-95X, G6M-97-05B, G6M-03-10X	212.3	240.5	-28.2	4.93E-03	2.78E-03	14.2	19.0	-4.7
Former North	G6M-18-02, G6M-02-07X, 31PZ-19-01	310.9	285.3	25.6	3.21E-03	2.24E-03	17.7	21.2	-3.5
Former North	31PZ-19-01, G6M-02-07X, 31PZ-19-02S	316.3	272.1	44.1	1.51E-03	1.42E-03	25.8	26.5	-0.8
Former North	G6M-04-01X, G6M-04-03X, G6M-02-01X	244.7	247.2	-2.5	4.28E-03	4.17E-03	15.3	15.5	-0.2
Former North	G6M-04-22X, G6M-04-01X, G6M-04-11X	214.2	228.1	-13.9	4.86E-03	4.15E-03	14.3	15.5	-1.2
Former North	G6M-95-19X, G6M-03-01X, G6M-96-22A	241.7	207.7	34.0	1.90E-02	7.39E-03	7.3	11.6	-4.4
Former North	G6M-95-20X, G6M-04-10X, G6M-95-19X	217.3	230.0	-12.7	1.85E-02	5.21E-03	7.3	13.9	-6.5
Former North	G6M-95-19X, G6M-96-22A, G6M-95-20X	221.9	221.0	0.9	1.29E-02	8.44E-03	8.8	10.9	-2.1

Table E.3

Three-Point Gradient Method – Magnitudes and Directions

Post	Definition Monitoring Wells	Estimated Direction (degrees)	Calculated Direction (degrees)	Direction Difference[1,3] (degrees)	Estimated Magnitude	Calculated Magnitude	Transformed[2] Estimated Magnitude	Transformed[2] Calculated Magnitude	Transformed Magnitude Residual[3]
Former North	G6M-95-19X, G6M-04-10X, G6M-03-01X	229.6	224.5	5.1	2.21E-02	4.76E-03	6.7	14.5	-7.8
Former North	G6M-04-22X, G6M-04-11X, G6M-13-05X	220.8	226.8	-6.0	6.57E-03	3.69E-03	12.3	16.5	-4.1
Former North	30PZ-19-02, 30PZ-19-03, 30PZ-19-01	256.9	256.7	0.2	7.06E-03	6.63E-03	11.9	12.3	-0.4
Former North	30PZ-19-02, 30PZ-19-04, 30PZ-19-03	291.4	289.0	2.4	5.60E-03	5.27E-03	13.4	13.8	-0.4
Former North	30PZ-19-05, 30PZ-19-02, 30PZ-19-01	259.3	259.1	0.2	1.11E-02	1.02E-02	9.5	9.9	-0.4
Former North	31PZ-19-01, 31PZ-19-02D, 50PZ-19-07	336.0	304.3	31.7	1.71E-03	1.71E-03	24.2	24.2	0.0
Former North	MW-7_(IT), 50PZ-19-02, 30PZ-19-02	226.4	225.5	0.9	5.87E-03	6.01E-03	13.1	12.9	0.2
Former North	30PZ-19-02, G6M-18-01, 30PZ-19-04	274.2	269.8	4.4	5.16E-03	4.90E-03	13.9	14.3	-0.4
Former North	31PZ-19-01, 50PZ-19-07, 30PZ-19-04	276.2	279.4	-3.1	3.64E-03	2.74E-03	16.6	19.1	-2.5
Former North	G6M-18-01, 31PZ-19-01, 30PZ-19-04	277.6	279.9	-2.3	4.48E-03	3.13E-03	14.9	17.9	-2.9
Former North	50PZ-19-01, 50PZ-19-02, MW-7_(IT)	219.6	212.6	7.0	5.10E-03	4.76E-03	14.0	14.5	-0.5
Former North	50PZ-19-05, 50PZ-19-06, 50PZ-19-04	246.0	251.0	-5.0	6.44E-03	6.01E-03	12.5	12.9	-0.4

Notes:

[1] For calibration purposes the residual difference was calculated as the square root of the absolute value of the direction difference. The untransformed difference is tabulated here.

[2] Magnitude values were transformed for calibration purposes.
Transformation: square root of the reciprocal $\sqrt{\frac{1}{magnitude}}$

[3] The difference or residual value is calculated as the corresponding Estimated Value - Calculated Value.

Table E.4

Head Differences Across the Barrier Wall

Piezometer 1	Piezometer 2	Target Water Level Piezometer 1 (feet/MSL)	Target Water Level Piezometer 2 (feet/MSL)	Target Difference (feet)	Calculated Water Level Piezometer 1 (feet/MSL)	Calculated Water Level Piezometer 2 (feet/MSL)	Calculated Difference (feet)	Residual[1] (feet)
PZ-12-02	PZ-12-01	217.3	216.8	0.44	217.4	216.5	0.53	-0.09
PZ-12-04	PZ-12-03	217.9	216.8	1.12	217.8	216.6	0.99	0.13
PZ-12-06	PZ-12-05	218.1	217.1	0.96	218.1	216.7	0.96	0.003
PZ-12-08	PZ-12-07	218.8	217.1	1.74	218.7	217.2	1.64	0.10
PZ-12-10	PZ-12-09	219.6	217.9	1.66	219.5	218.3	1.53	0.13

Note:

[1] Residual is calculated as Target Difference - Calculated Difference.

Table E.5a

Soft Target Types - Surface Water Levels, Staff Gages and LIDAR Based

Surface Water Levels - Staff Gages					
Location	**Easting**	**Northing**	**Target Stage (feet/MSL)**	**Calculated Stage (feet/MSL)**	**Residual[1]**
SG-GP	634260.6	3026110.9	217.3	216.7	0.6
Staff_1	630628.0	3027223.0	216.5	216.3	0.2
SWEL-104	631343.6	3026803.0	216.1	216.3	-0.2
SWEL-105	626227.1	3027437.5	203.5	203.2	0.3
SWEL-106	630639.8	3028173.6	216.1	216.0	0.0
SWEL-107	630578.0	3028240.0	211.8	210.6	1.3
SWEL-108	630303.3	3028573.5	211.4	209.6	1.9
SWEL-109	629992.6	3028591.5	211.9	210.6	1.3
SWEL-110	630091.0	3029100.0	208.1	207.9	0.2
SWEL-111	630000.0	3029360.0	207.9	207.7	0.2
SWEL-112	628297.0	3028320.0	204.7	204.6	0.1
SWEL-16	627192.9	3025167.0	219.2	218.4	0.8
26M-14-SWEL1	614017.8	3008904.6	281.9	278.9	3.0
26M-14-SWEL2	614288.1	3008340.4	282.0	282.5	-0.5
26SWEL-17-01	613956.4	3008959.3	278.6	277.2	1.5
26SWEL-17-02	614309.5	3008598.4	282.2	281.5	0.7
SWEL-12	620746.2	3005451.1	225.3	219.9	5.5
SWEL-13	613870.3	2996919.9	237.2	236.4	0.8
CPSG-01swel	627621.7	3018744.8	244.1	244.5	-0.4
CPSG-02swel	629358.3	3018918.8	242.8	242.6	0.3
CSBSG-01swel	630022.5	3019399.0	234.5	233.1	1.3
MLSG-01swel	625779.1	3016884.8	241.6	240.2	1.4
RPSG-01swel	627951.3	3021370.2	244.6	243.4	1.2
SHSG-14-01Gswel	630568.5	3028212.9	210.5	210.6	0.0

Surface Water Levels - LIDAR Based						
Location	**Easting**	**Northing**	**Target Stage (feet/MSL)**	**Calculated Stage (feet/MSL)**	**Residual[1]**	**Description**
LIDAR01	629202.1	3018876.8	243.0	243.1	-0.1	Headwaters of Cold Spring Brook
OakHWLND	609571.6	3009282.2	371.0	370.0	1.0	Mapped wetland east of Oak Hill Pond
LIDAR10	621018.8	3016918.6	289.0	289.6	-0.6	Mapped water body west of Mirror Lake
LIDAR08	620972.8	3017758.7	314.3	315.9	-1.6	Mapped wetland west of Mirror Lake
LIDAR09	621893.5	3019446.4	347.7	349.8	-2.1	Mapped wetland west of Mirror Lake

Note:

[1] Residual is calculated as Target Stage - Calculated Stage.

Table E.5b

Soft Target Types – Estimated Hydraulic Conductivity and Pumping Rate Reductions

Hydraulic Conductivity Constraint		
Short Name	**Estimated Hydraulic Conductivity (feet/day)**	**Model Hydraulic Conductivity (feet/day)**
Shabokin_Inactive	274.8	271.0
Shabokin Well	267.4	263.4
MacPherson Well	406.3	361.7
Patton Well	271.7	258.3
Grove Pond Well #1	327.1	308.6
Grove Pond Well #2	325.5	331.2
Grove Pond Well #6	328.4	336.4
Grove Pond Well #7	332.6	313.6
Grove Pond Well #8	327.9	317.3
EW-01	28.5	36.3
EW-04	32.2	29.1

Pumping Rate Reductions			
Short Name	**Specified Pumping Rate (gpm)**	**Actual Model Rate (gpm)**	**Rate Reduction**
Walker Well	94.1	92.6	2%
MCI Shirley GP Well 1	94.7	0.0	100%
MCI Shirley GP Well 2	66.6	18.6	72%
Primrose Car Wash	40.0	22.0	45%

Project:	SHL
Location:	SHL12-SHL17-32Z9902X
Date:	For Report Verification

Well Location			
Well Name	X Coordinate (L)	Y Coordinate (L)	
SHL 12	630,003.0	3,025,341.6	1
SHL 17	630,287.5	3,025,390.8	1
32Z-99-02X	629,874.1	3,024,769.1	1

Principal Hydraulic Conductivity Components		
K_{max} =	50.0000	(L/T)
K_{min} =	50.0000	(L/T)
Orientation of K_{max} =	90.00	(degrees from N)
θ =	0.00	(degrees from X axis)

Effective Porosity =	0.25	(-)

Vector Inspector Row of Interest: 22
Must be between 22 and 21

Statistics			
Head (L)	SHL 12	SHL 17	32Z-99-02X
Maximum =	226.46	226.53	235.15
Minimum =	226.46	226.53	235.15
Average =	226.46	226.53	235.15
Range =	0.00	0.00	0.00

	Hyd. Grad. (L/L)	Velocity (L/T)
Maximum =	0.016118	3.223659
Minimum =	0.016118	3.223659
Average =	0.016118	3.223659

User input cells are shaded green.

HYDRAULIC HEAD DATA SET MUST NOT CONTAIN BLANK LINES

	Hydraulic Head (L)			Hydraulic Gradient		Groundwater Velocity	
Date/Time	SHL 12	SHL 17	32Z-99-02X	Magnitude (L/L)	Direction (deg)	Magnitude (L/T)	Direction (deg)
Target	226.46	226.53	235.15	0.016118	349.31	3.223659	349.31
Simulated	226.53	225.86	234.40	0.013757	359.89	2.751490	359.89

Figure E.1 Output from the USEPA 3PE Tool with the Calculated Magnitude and Direction for an Example Well Triad

Appendix F

Maps of Hydraulic Conductivity and Bedrock Thickness Scalar

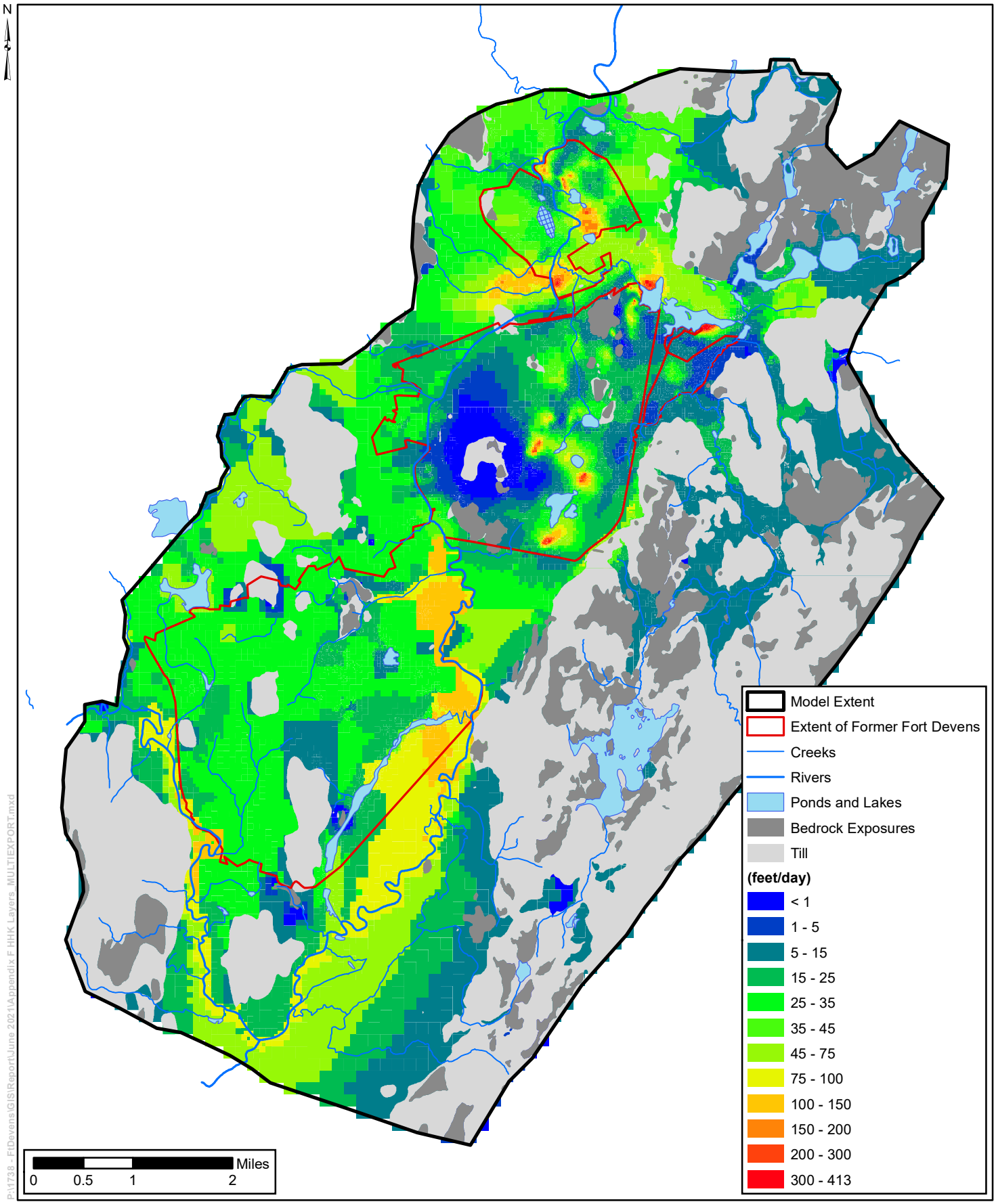


Figure F.1 Horizontal Hydraulic Conductivity - Overburden

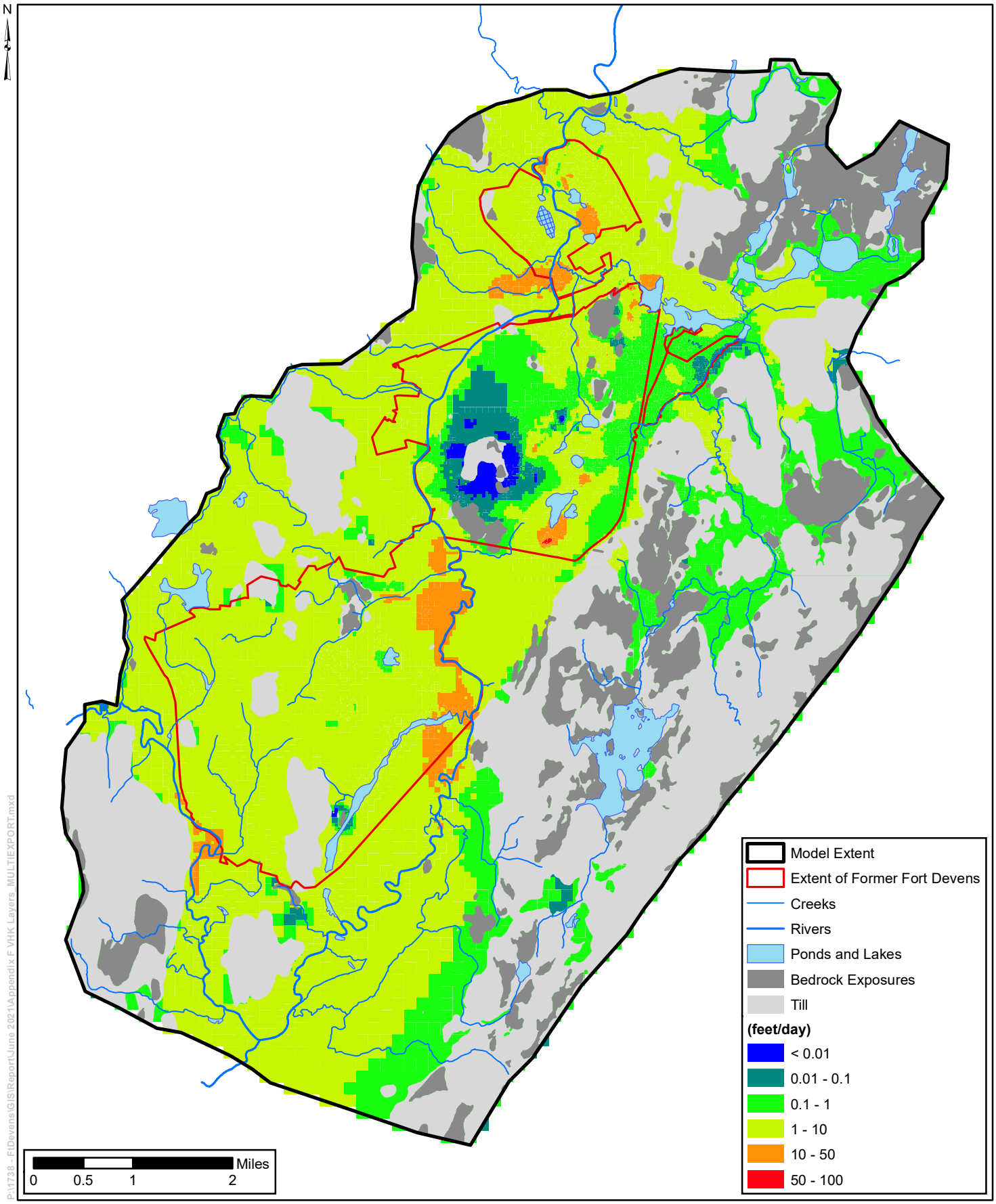


Figure F.2 Vertical Hydraulic Conductivity - Overburden

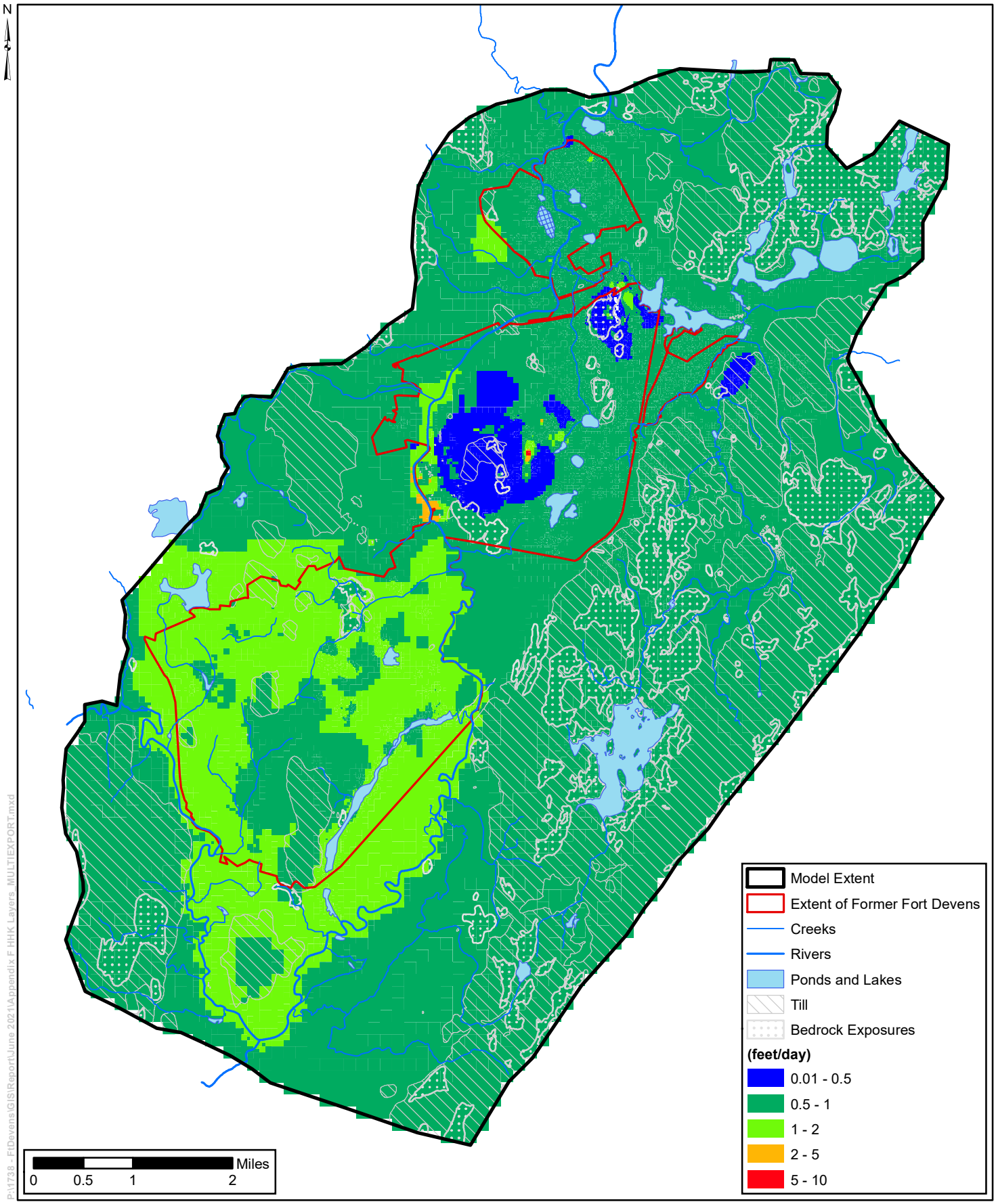


Figure F.3 Horizontal Hydraulic Conductivity - Upper Bedrock

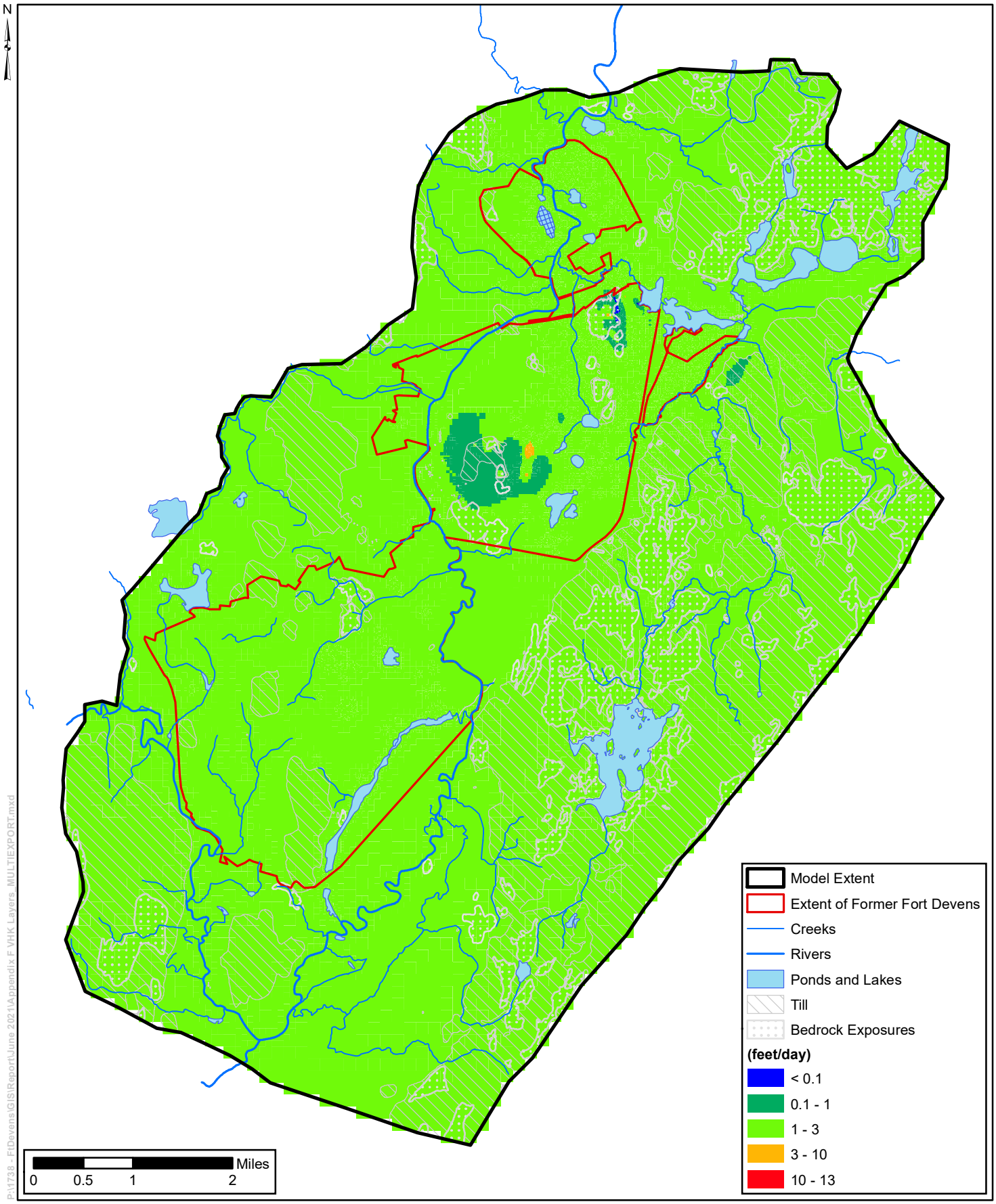


Figure F.4 Vertical Hydraulic Conductivity - Upper Bedrock

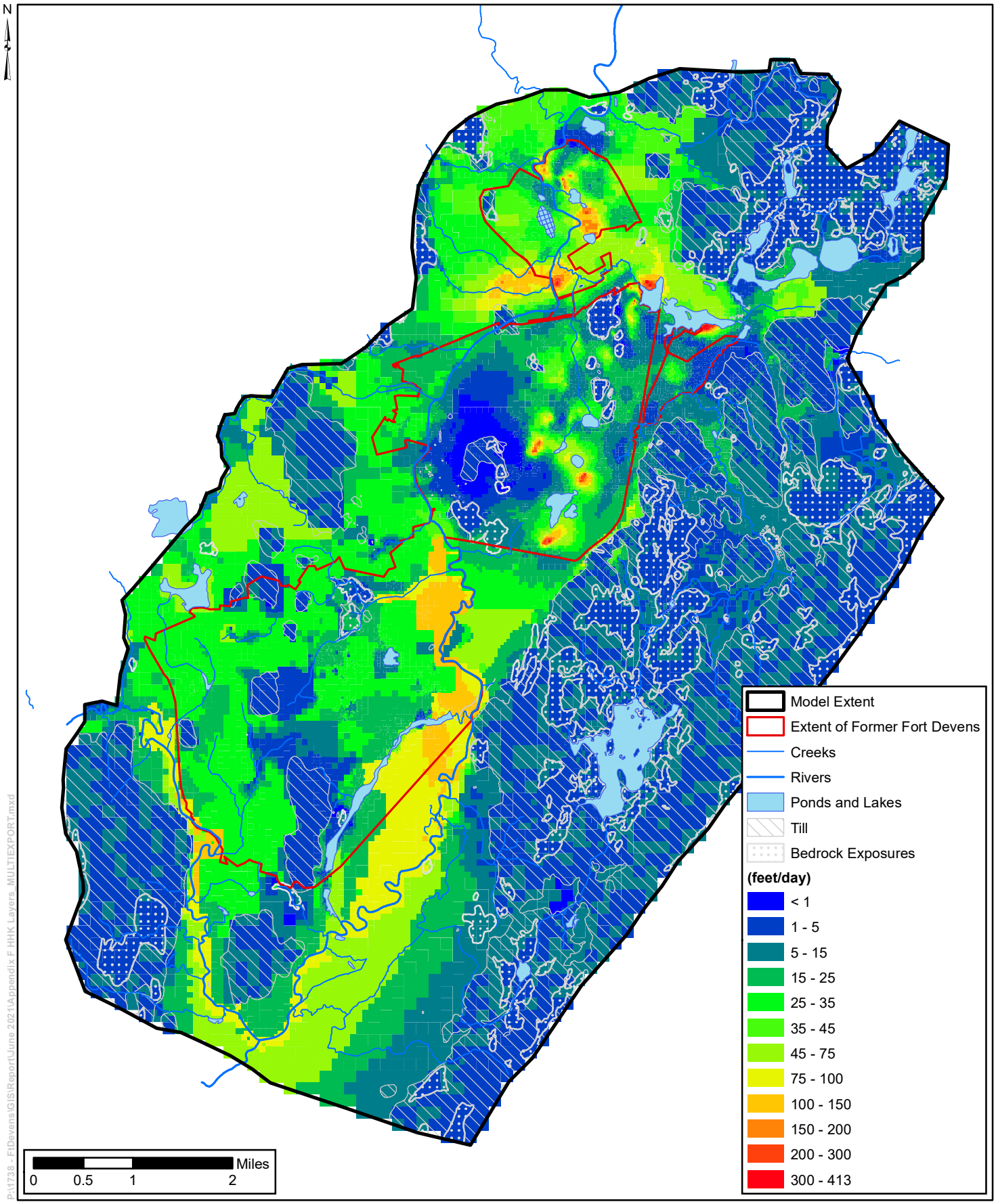


Figure F.5 Horizontal Hydraulic Conductivity - Model Layer 1

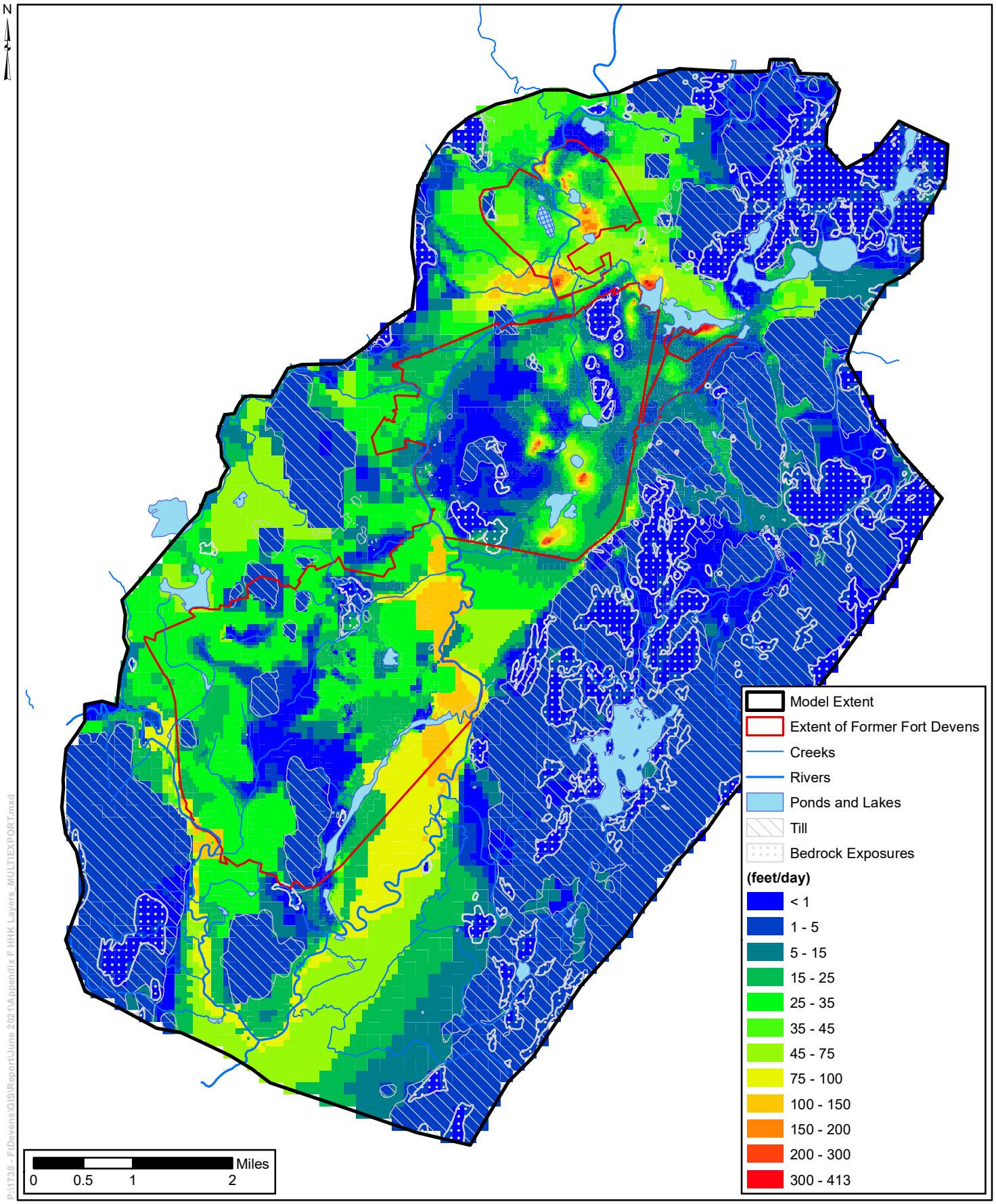


Figure F.6 Horizontal Hydraulic Conductivity - Model Layer 2

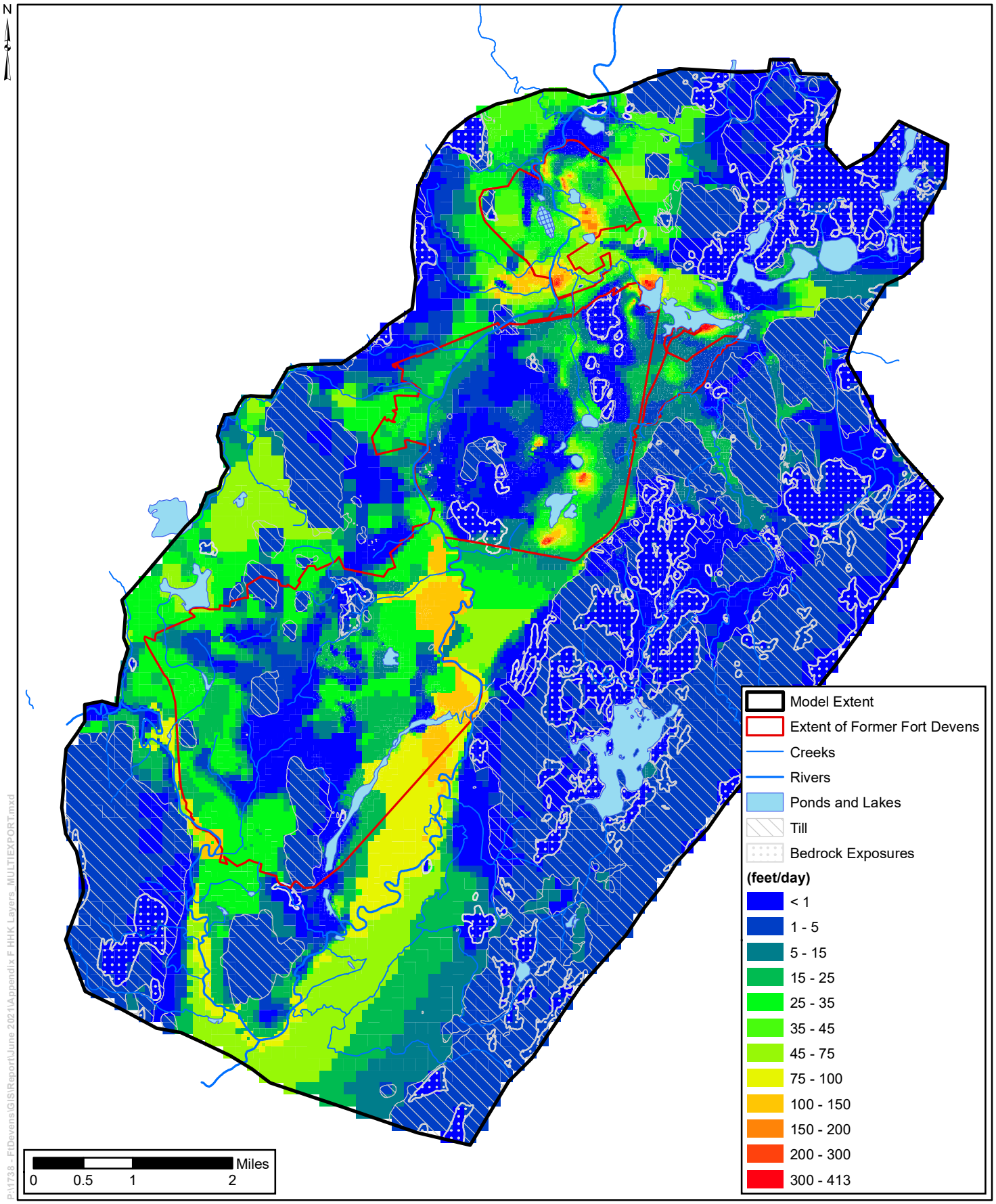


Figure F.7 Horizontal Hydraulic Conductivity - Model Layer 3

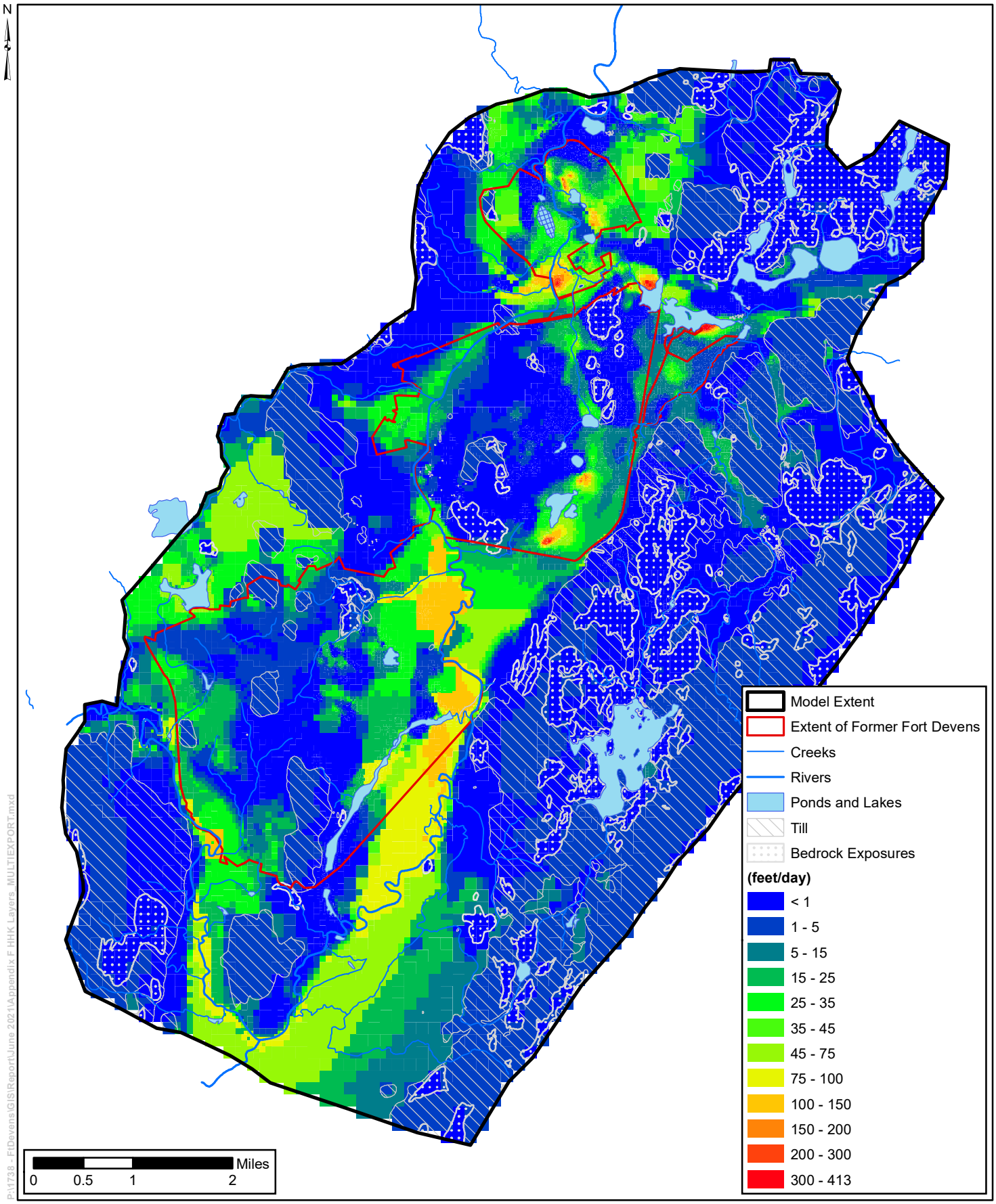


Figure F.8 Horizontal Hydraulic Conductivity - Model Layer 4

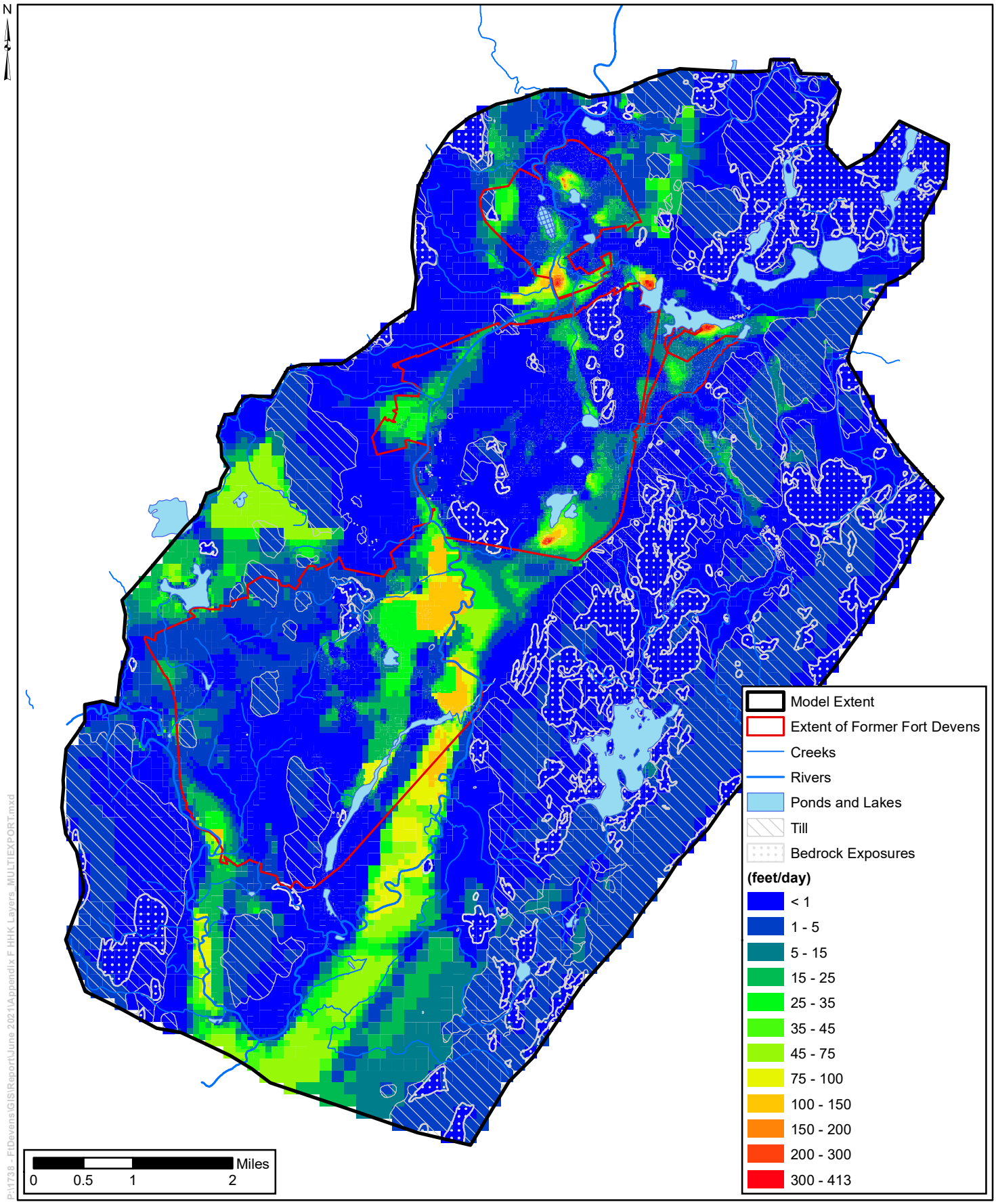


Figure F.9 Horizontal Hydraulic Conductivity - Model Layer 5

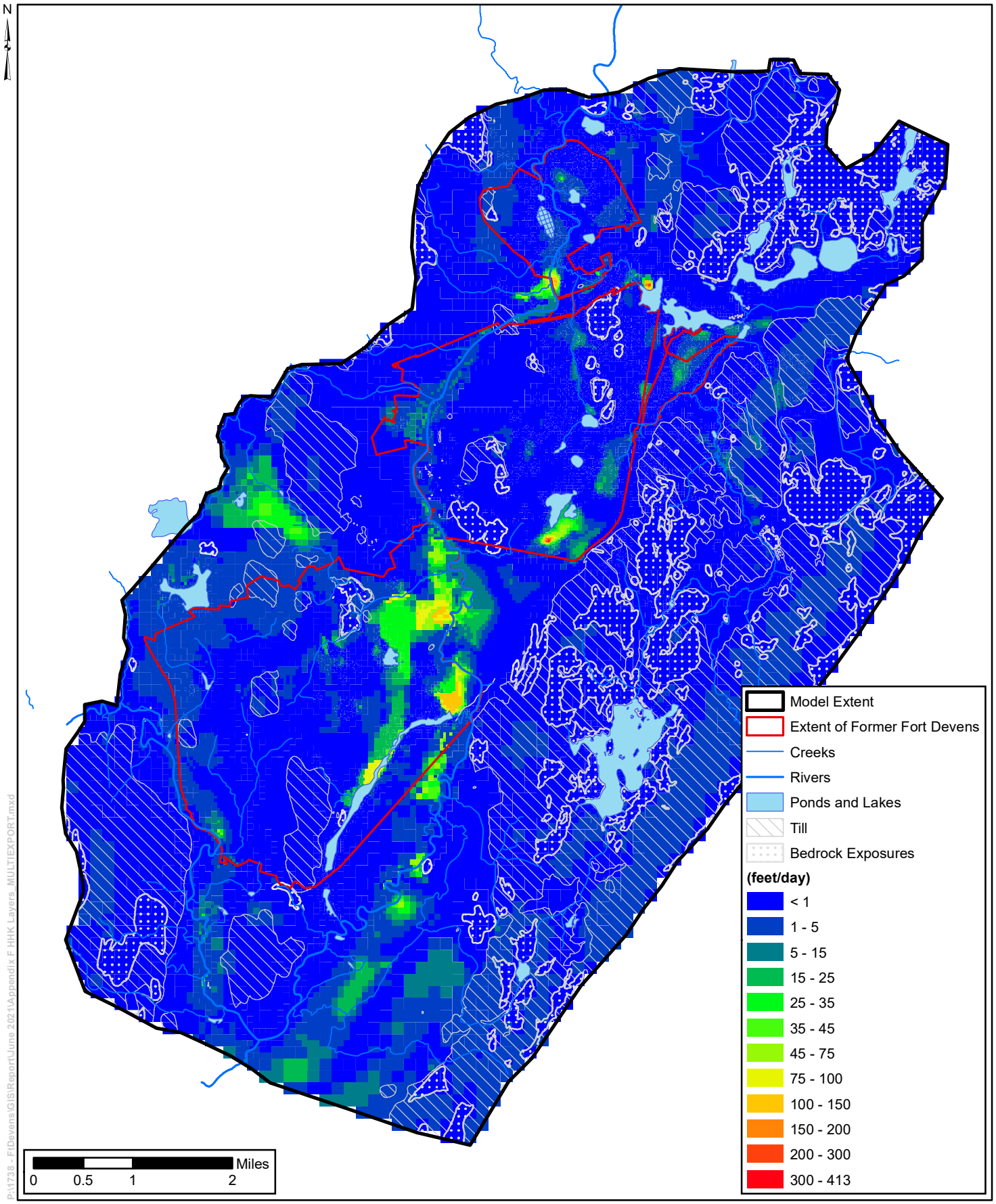


Figure F.10 Horizontal Hydraulic Conductivity - Model Layer 6

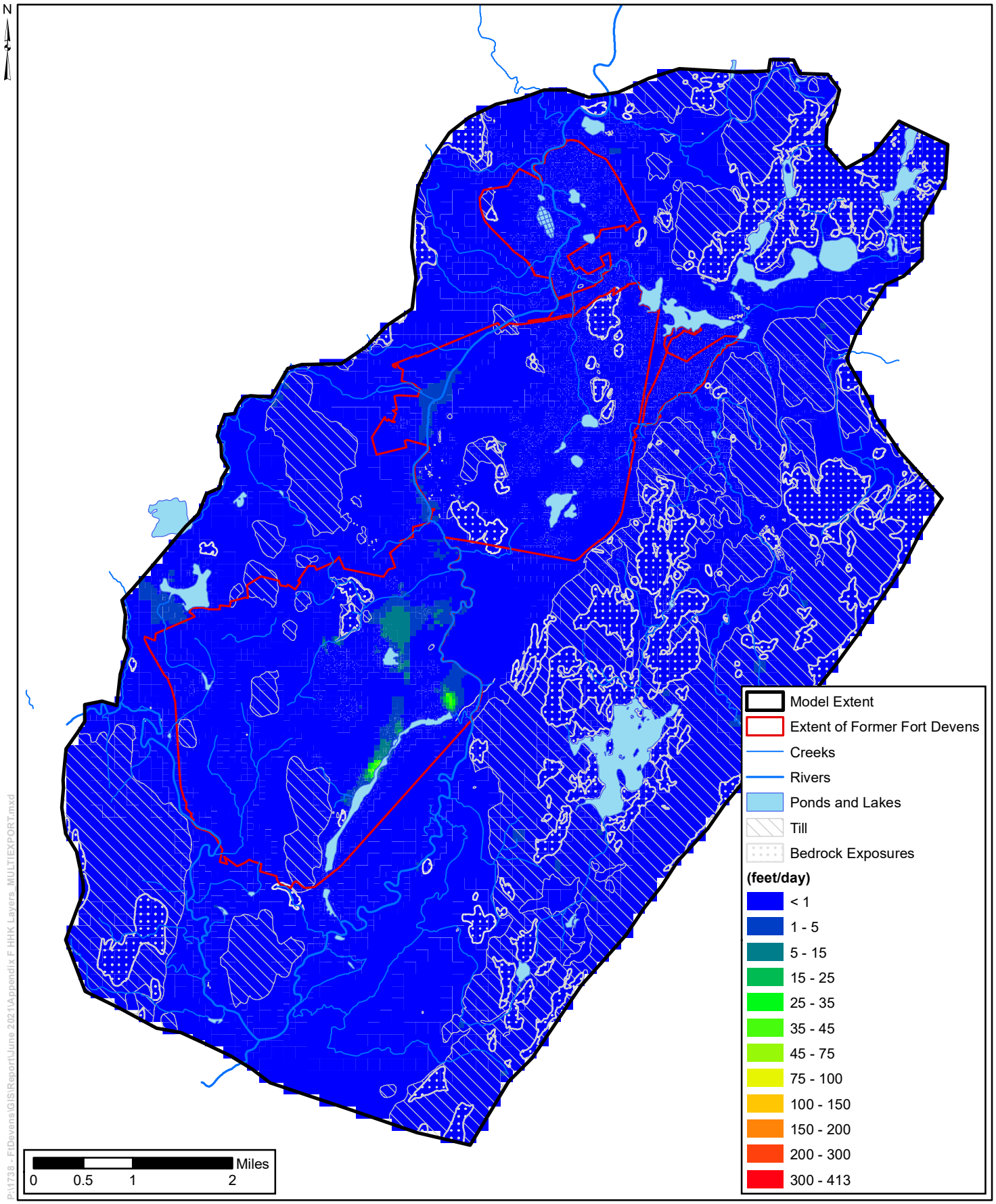


Figure F.11 Horizontal Hydraulic Conductivity - Model Layer 7

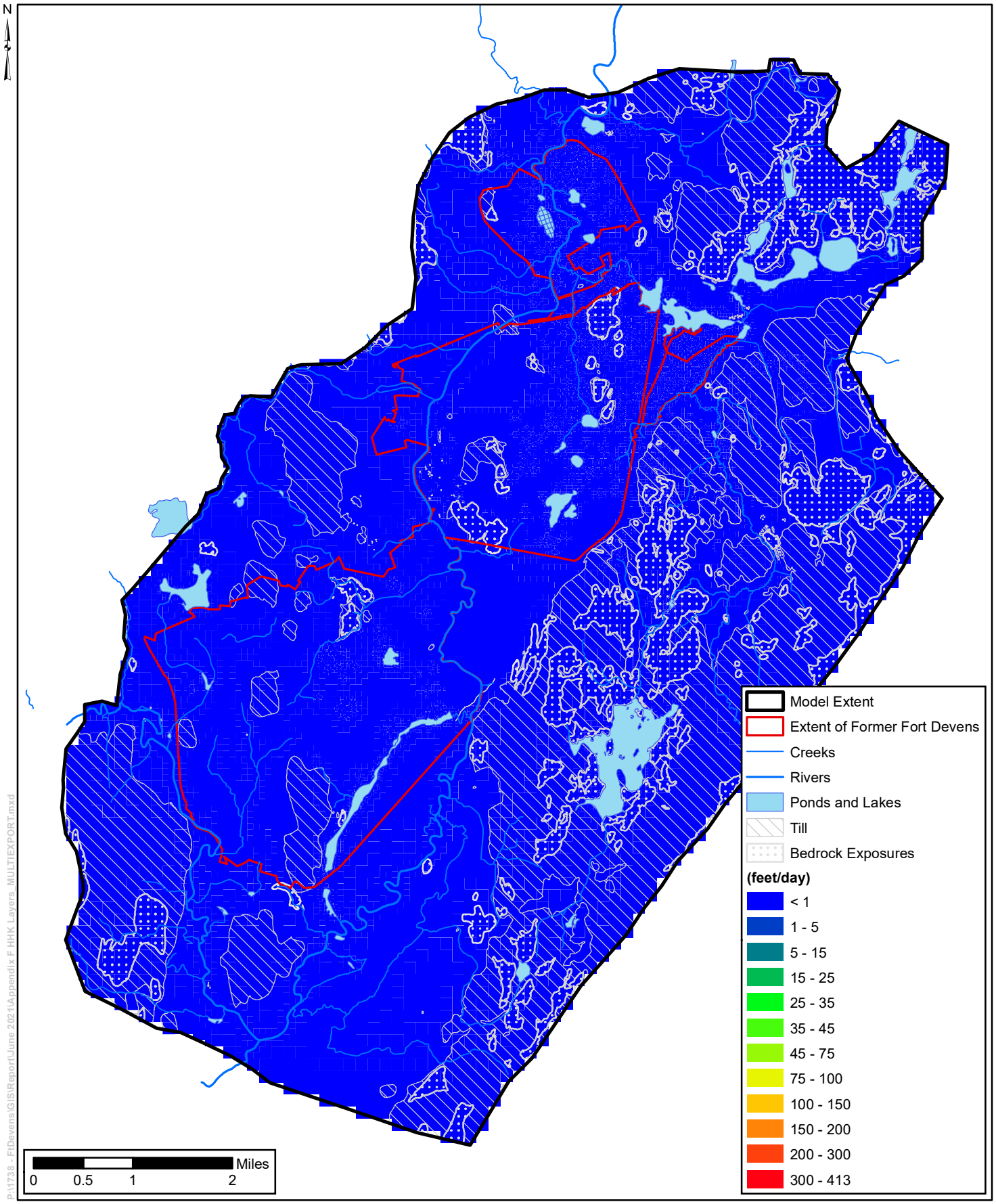


Figure F.12 Horizontal Hydraulic Conductivity - Model Layer 8

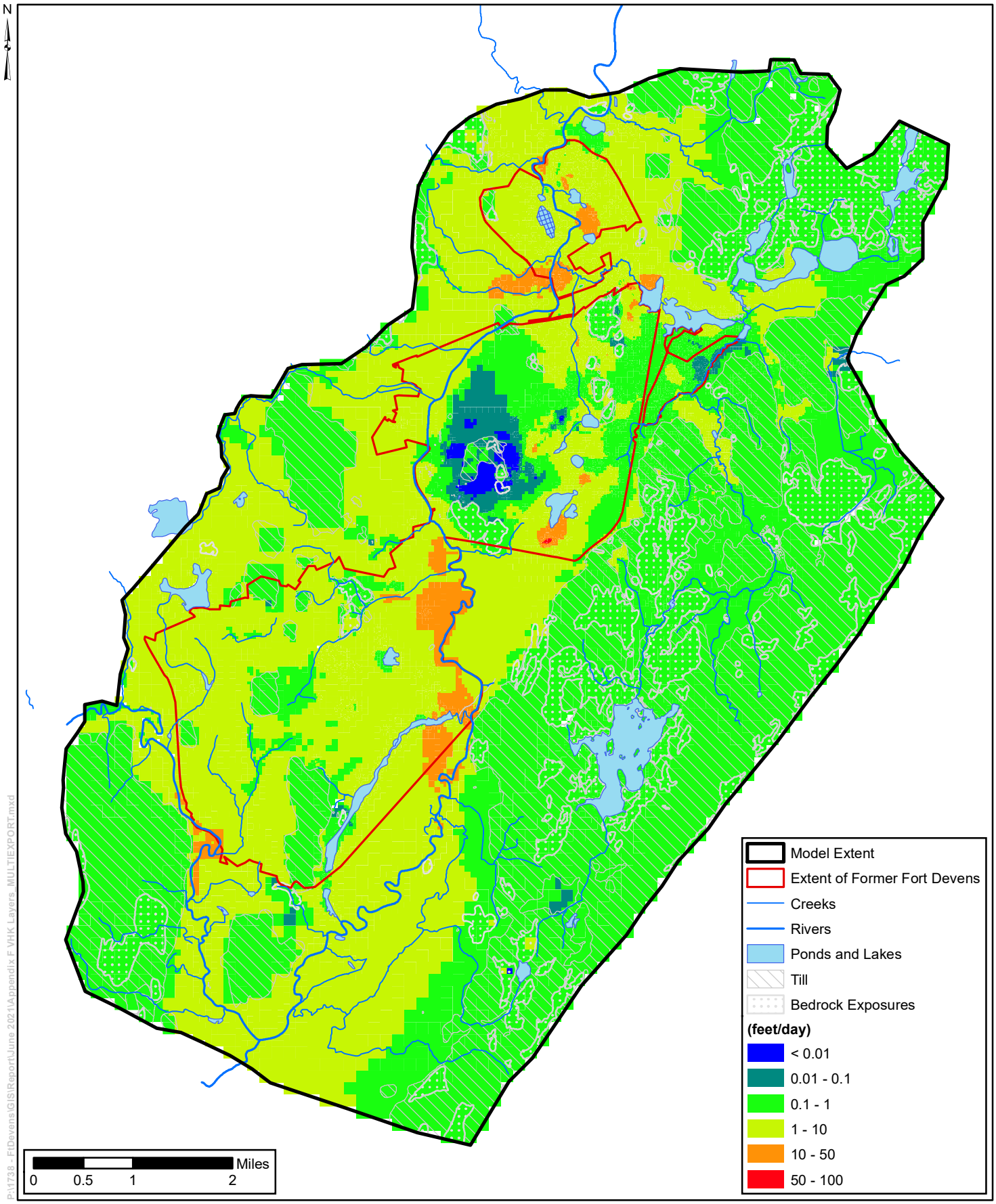


Figure F.13 Vertical Hydraulic Conductivity - Model Layer 1

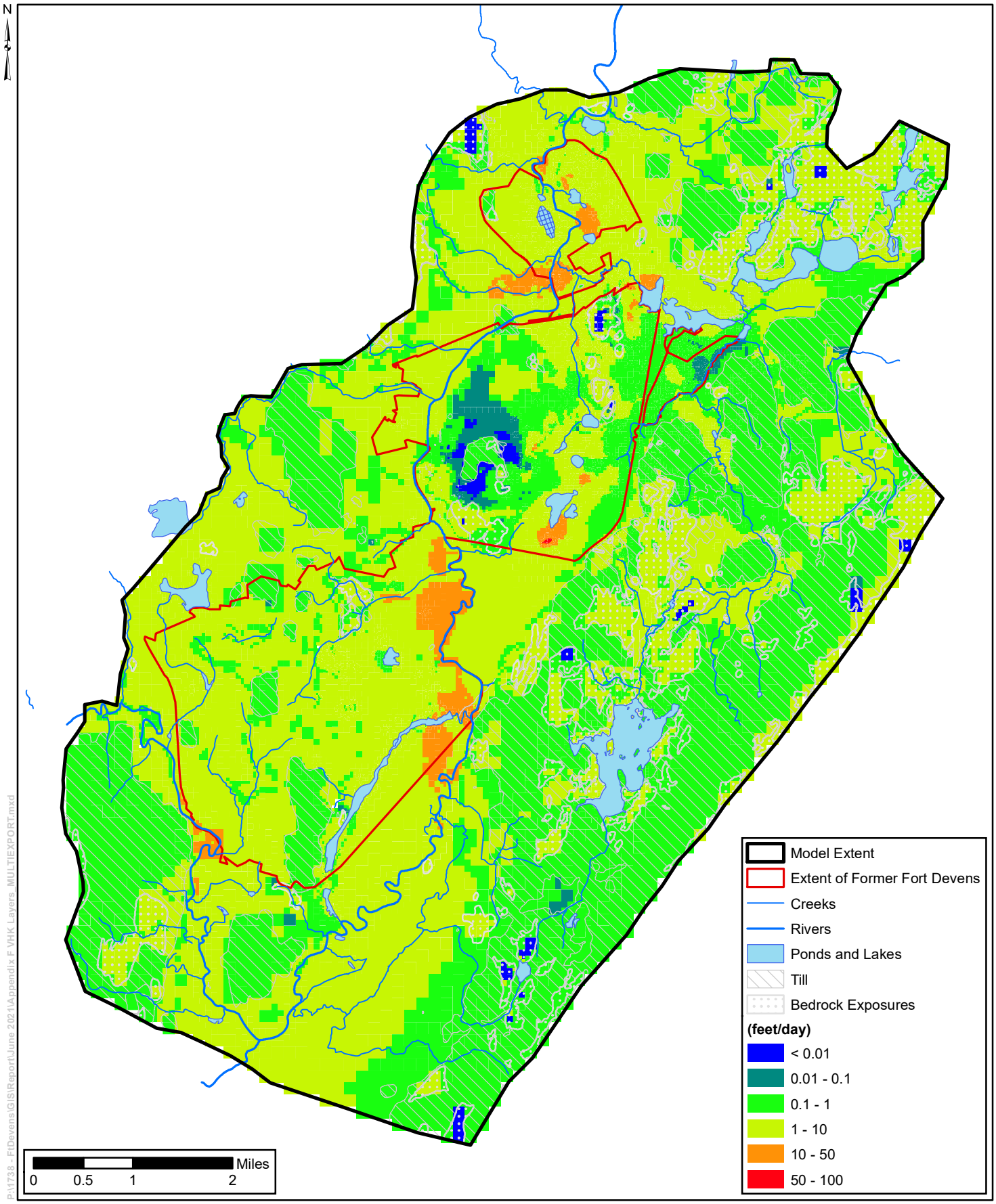


Figure F.14 Vertical Hydraulic Conductivity - Model Layer 2

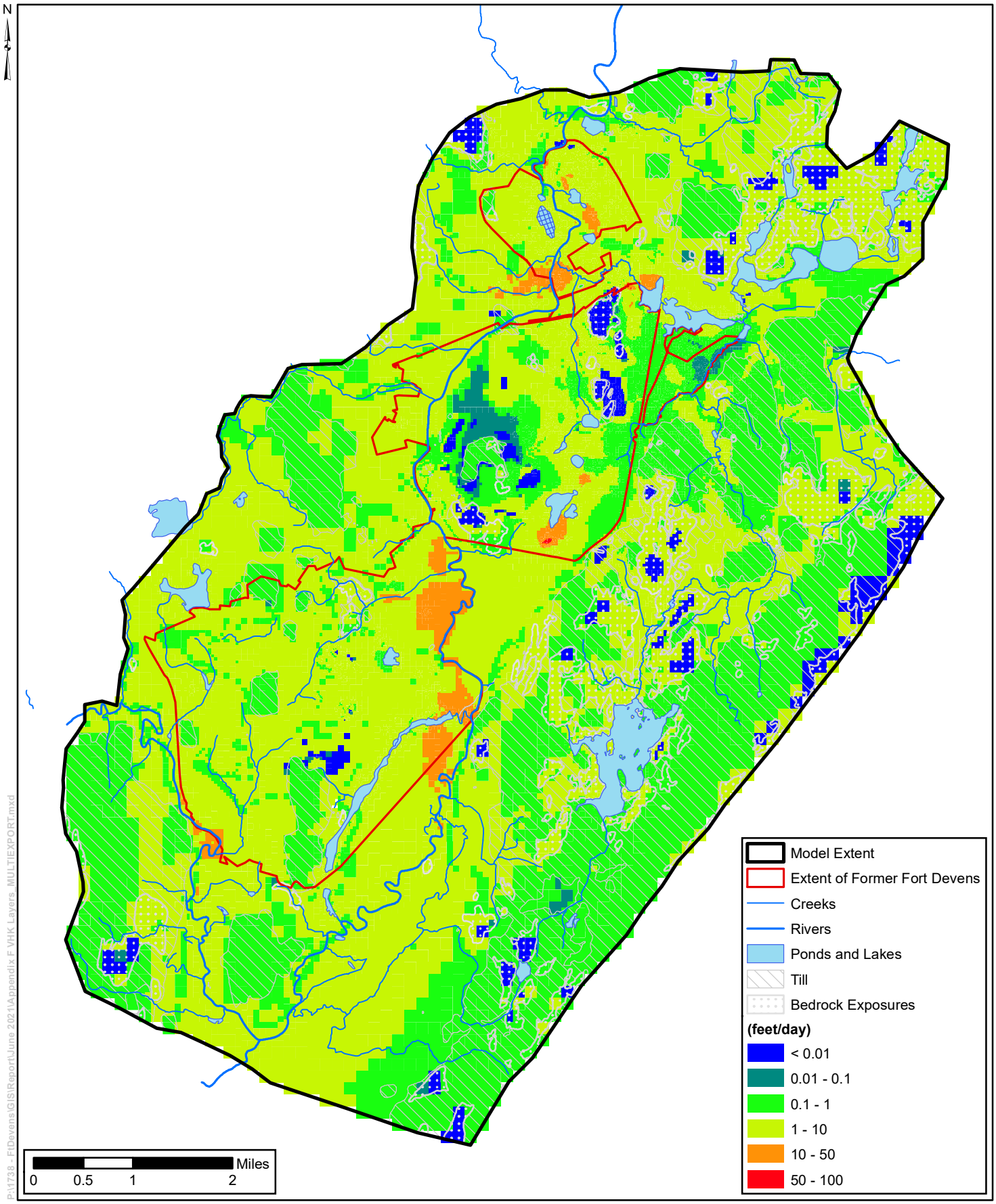


Figure F.15 Vertical Hydraulic Conductivity - Model Layer 3

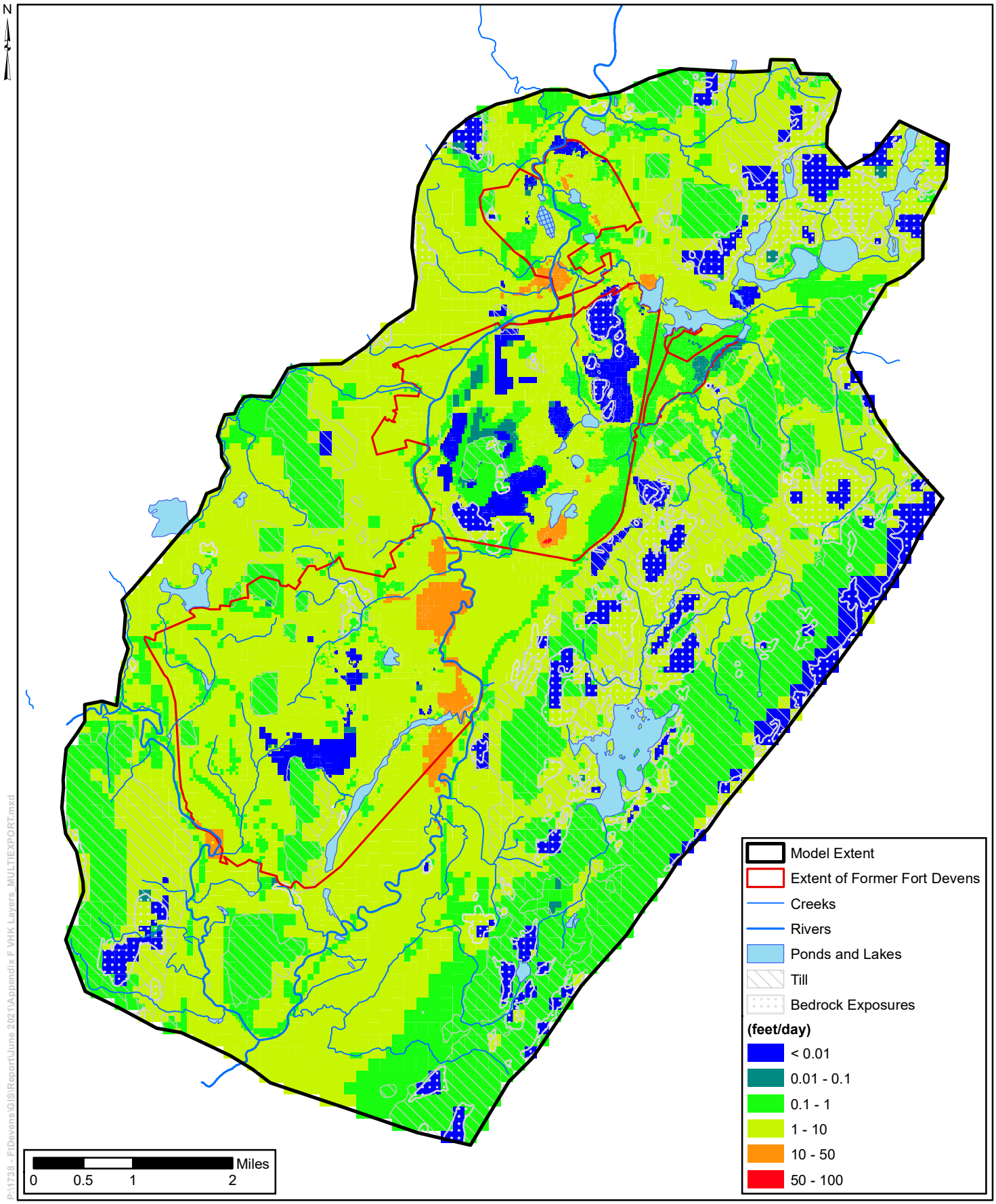


Figure F.16 Vertical Hydraulic Conductivity - Model Layer 4

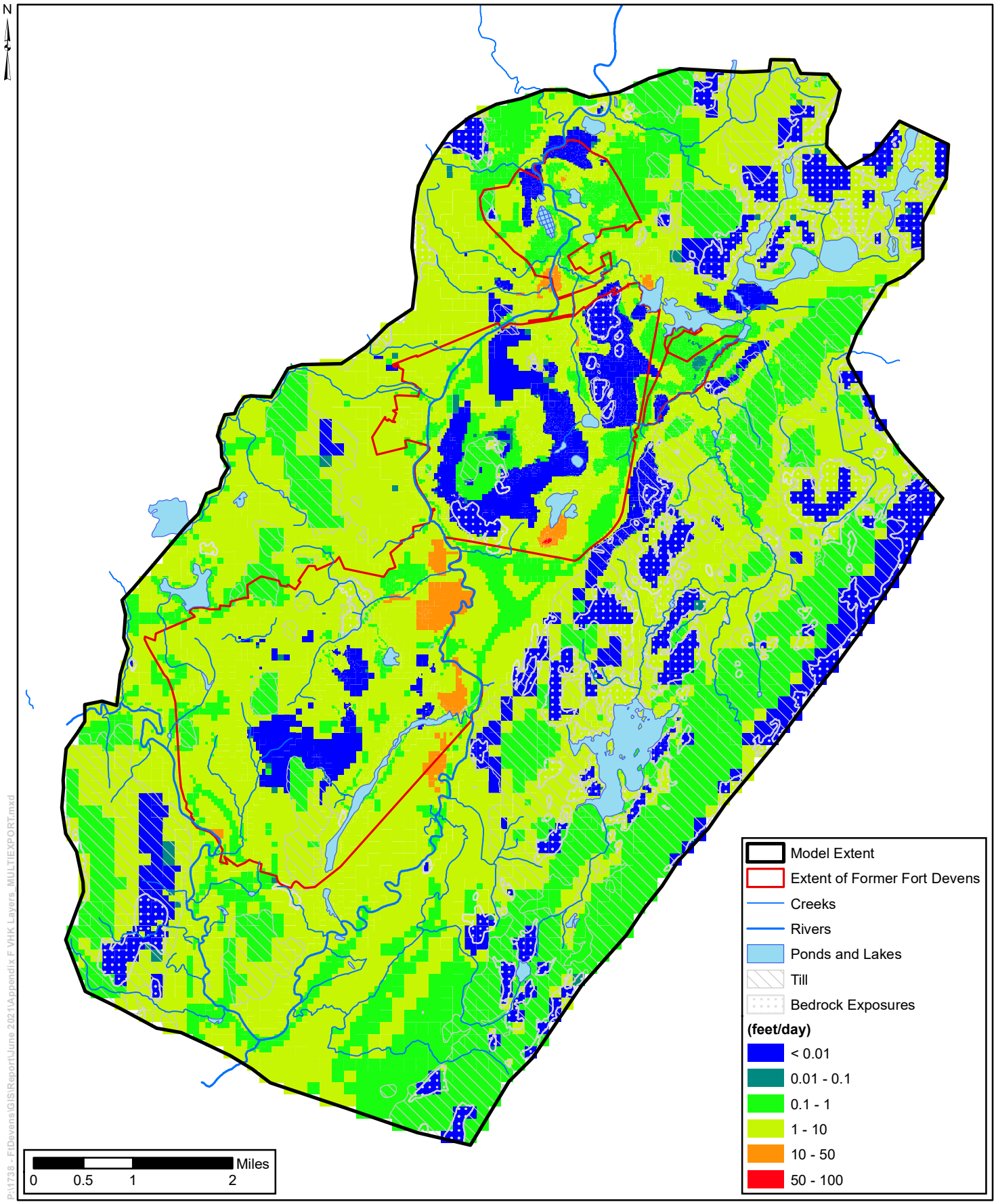


Figure F.17 Vertical Hydraulic Conductivity - Model Layer 5

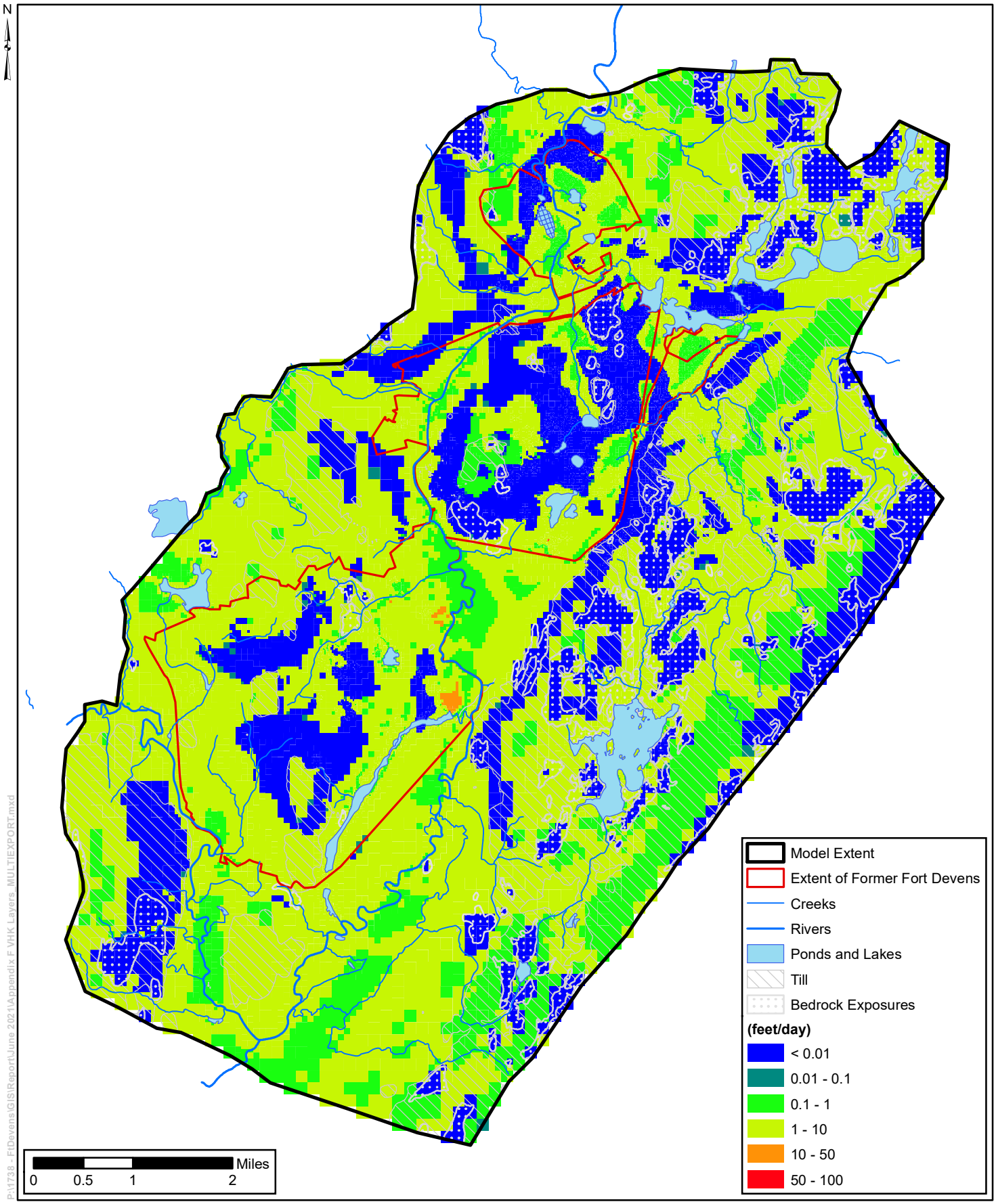


Figure F.18 Vertical Hydraulic Conductivity - Model Layer 6

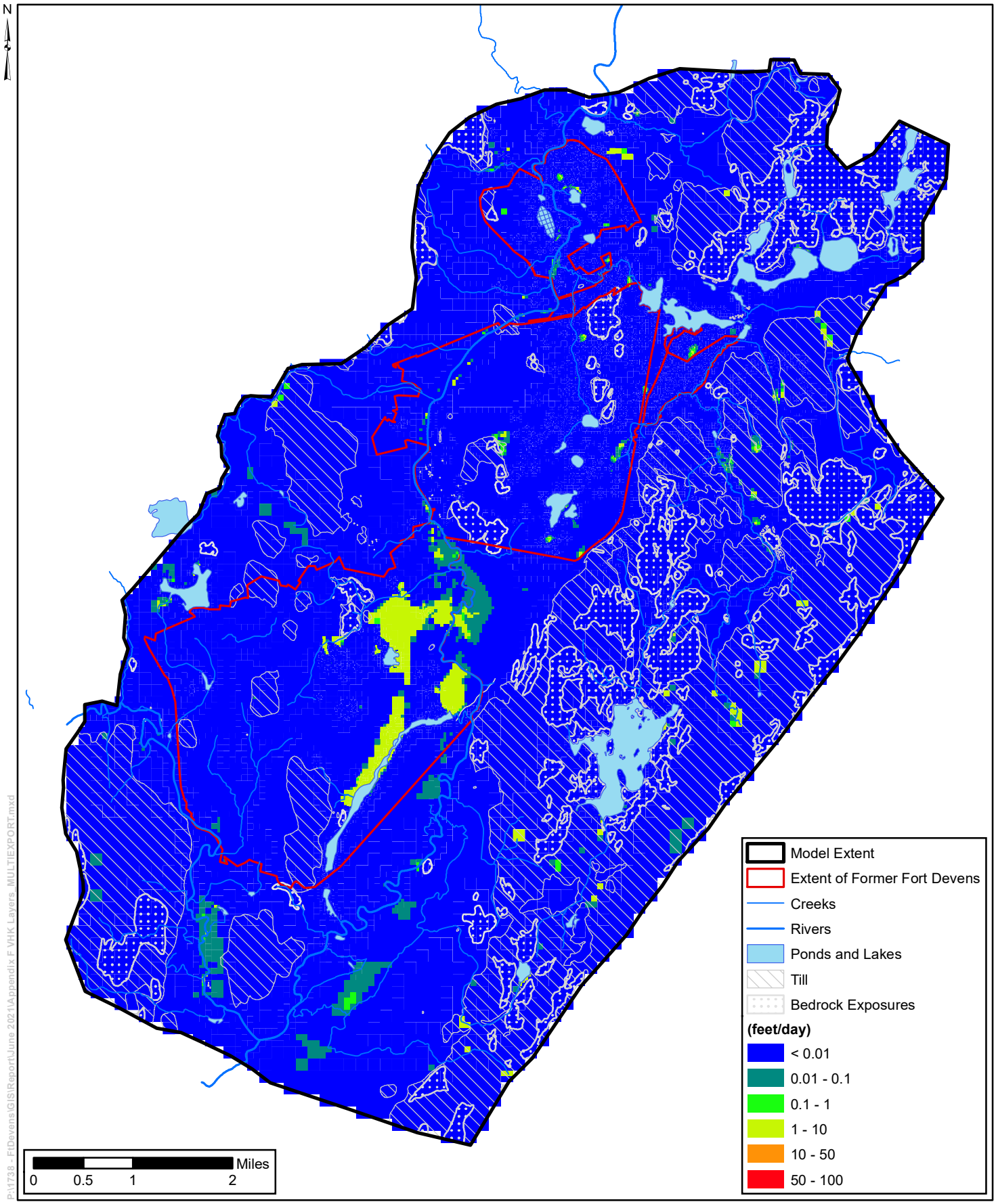


Figure F.19 Vertical Hydraulic Conductivity - Model Layer 7

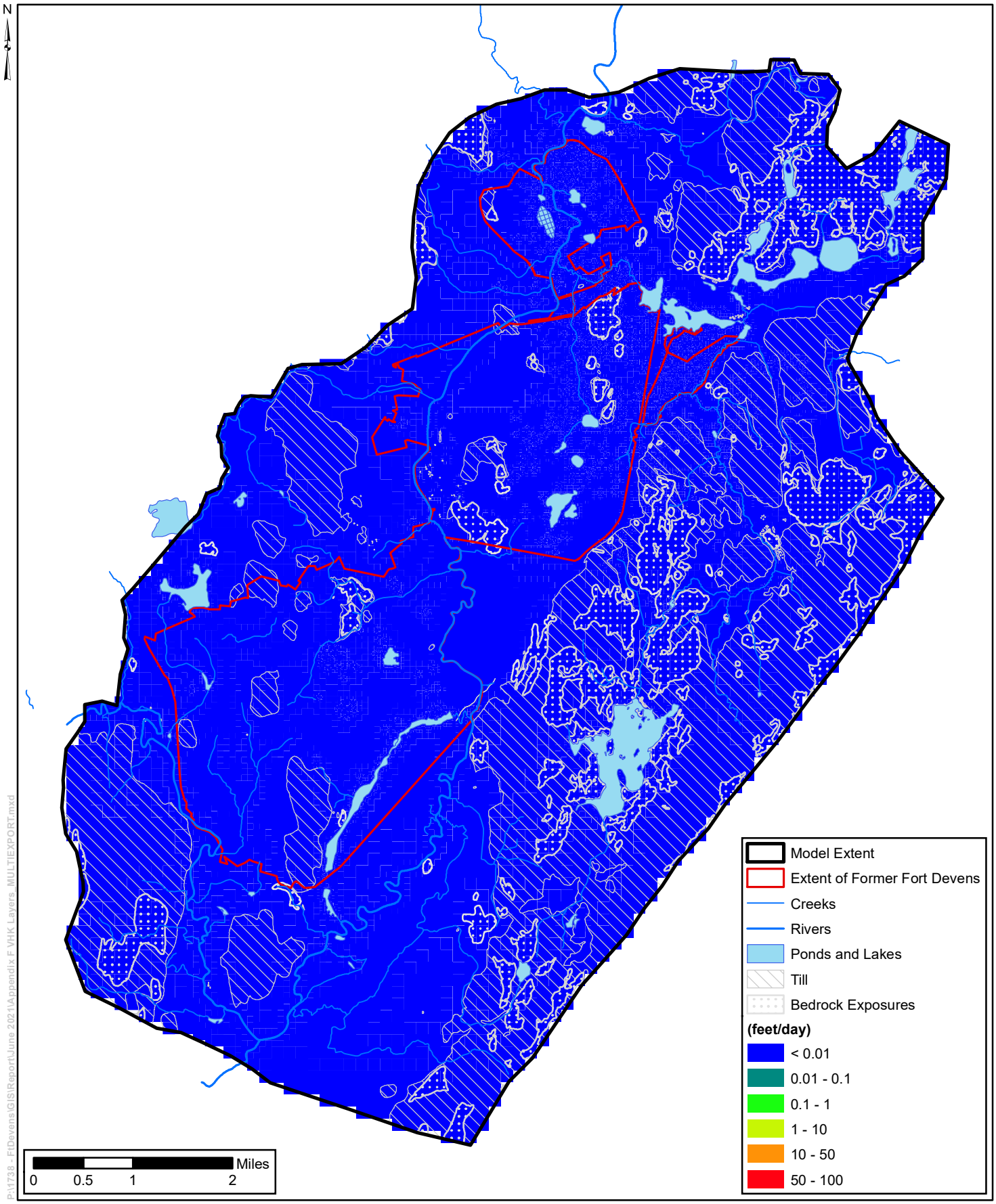


Figure F.20 Vertical Hydraulic Conductivity - Model Layer 8

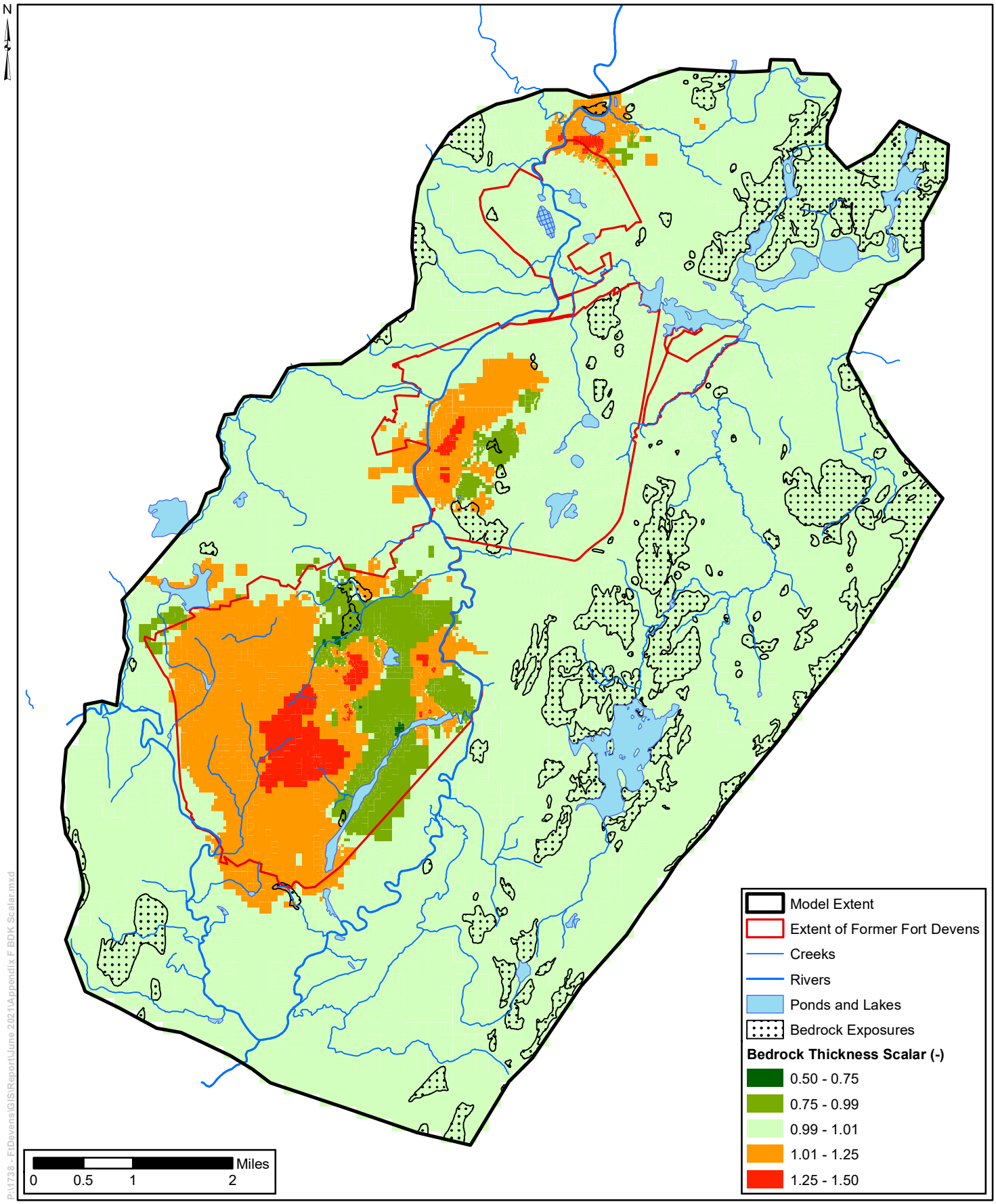


Figure F.21 Bedrock Thickness Scalar

Appendix G

Surface Water Properties

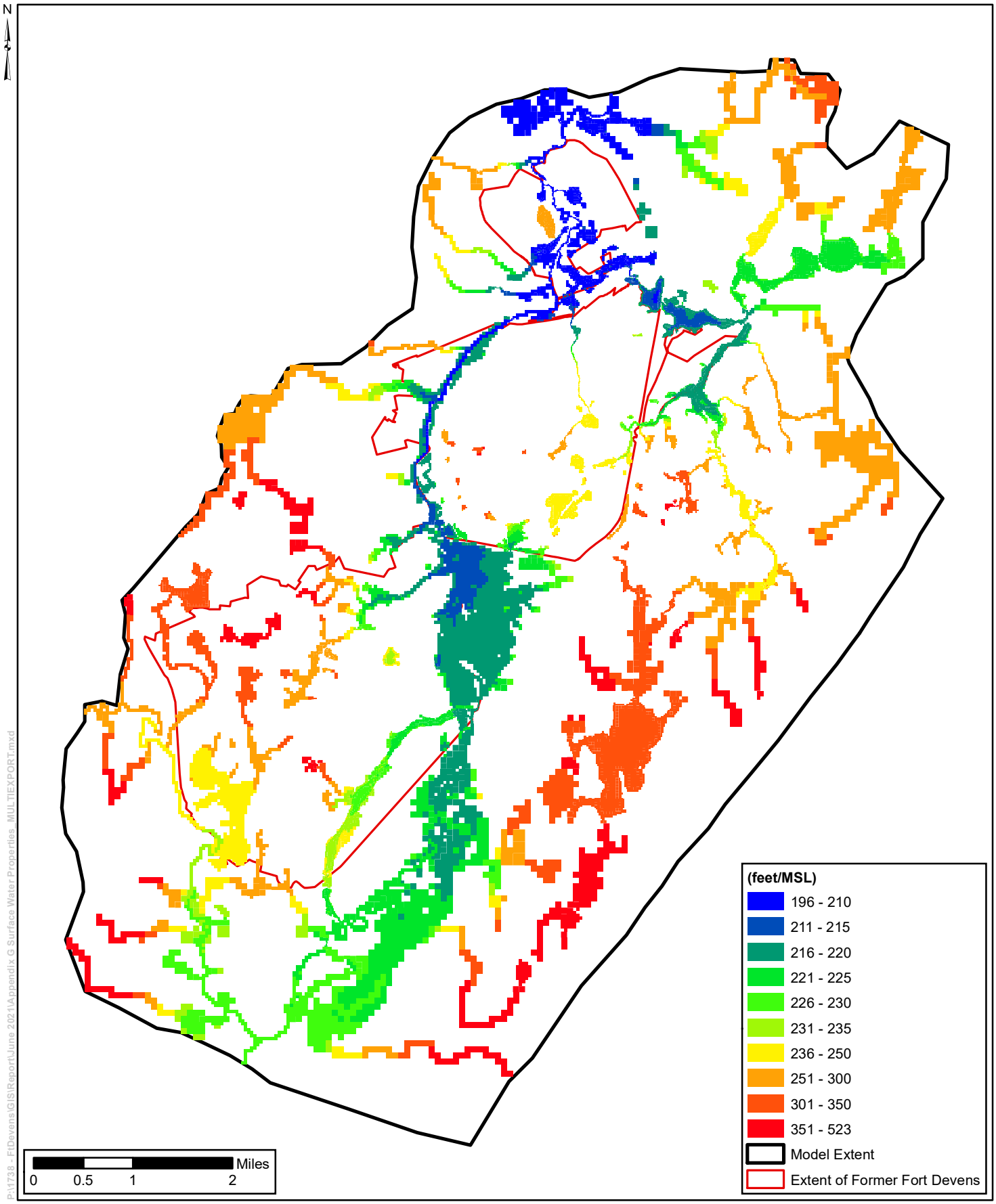


Figure G.1 Surface Water Bed Elevation

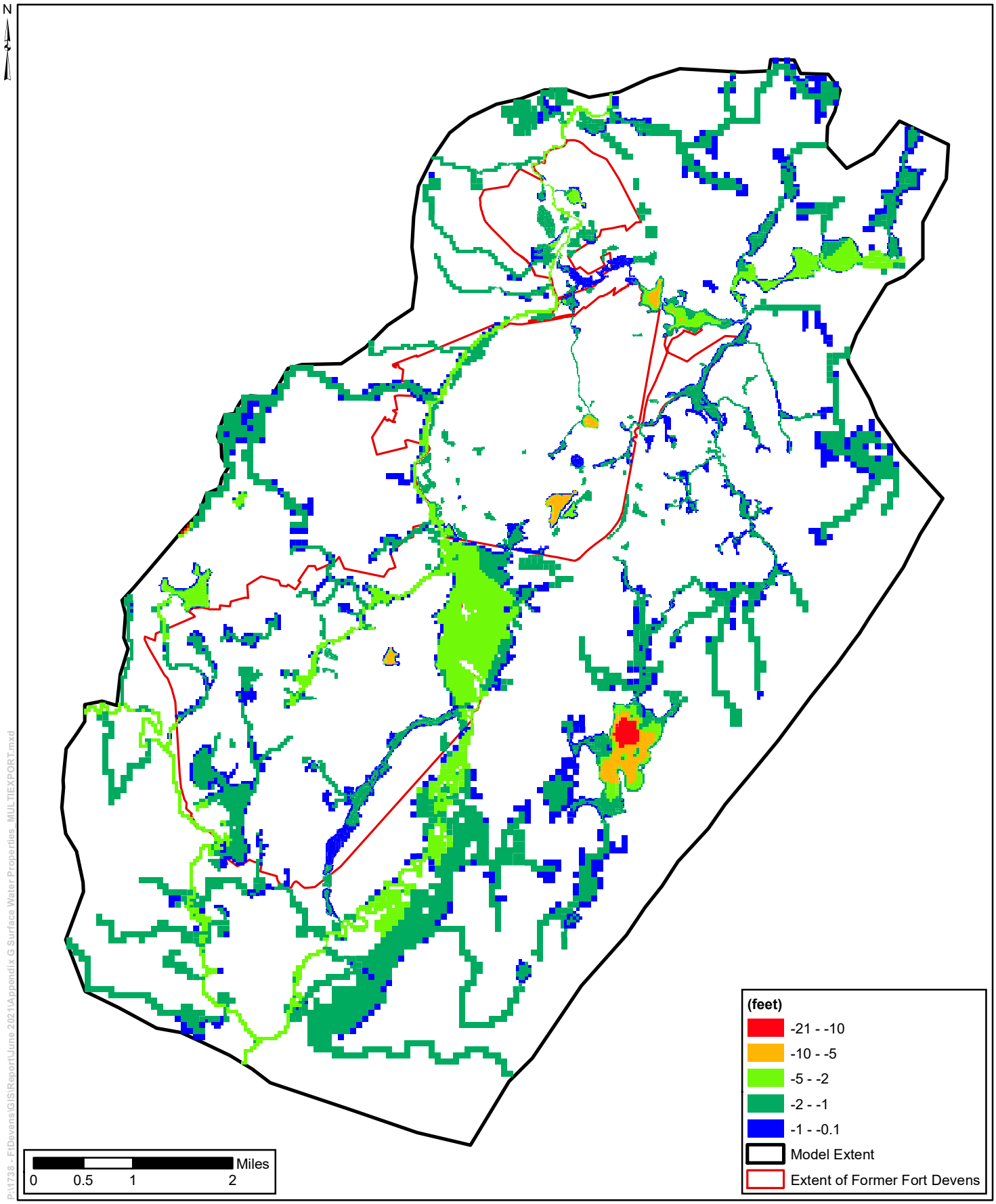


Figure G.2 Surface Water Bed Offset

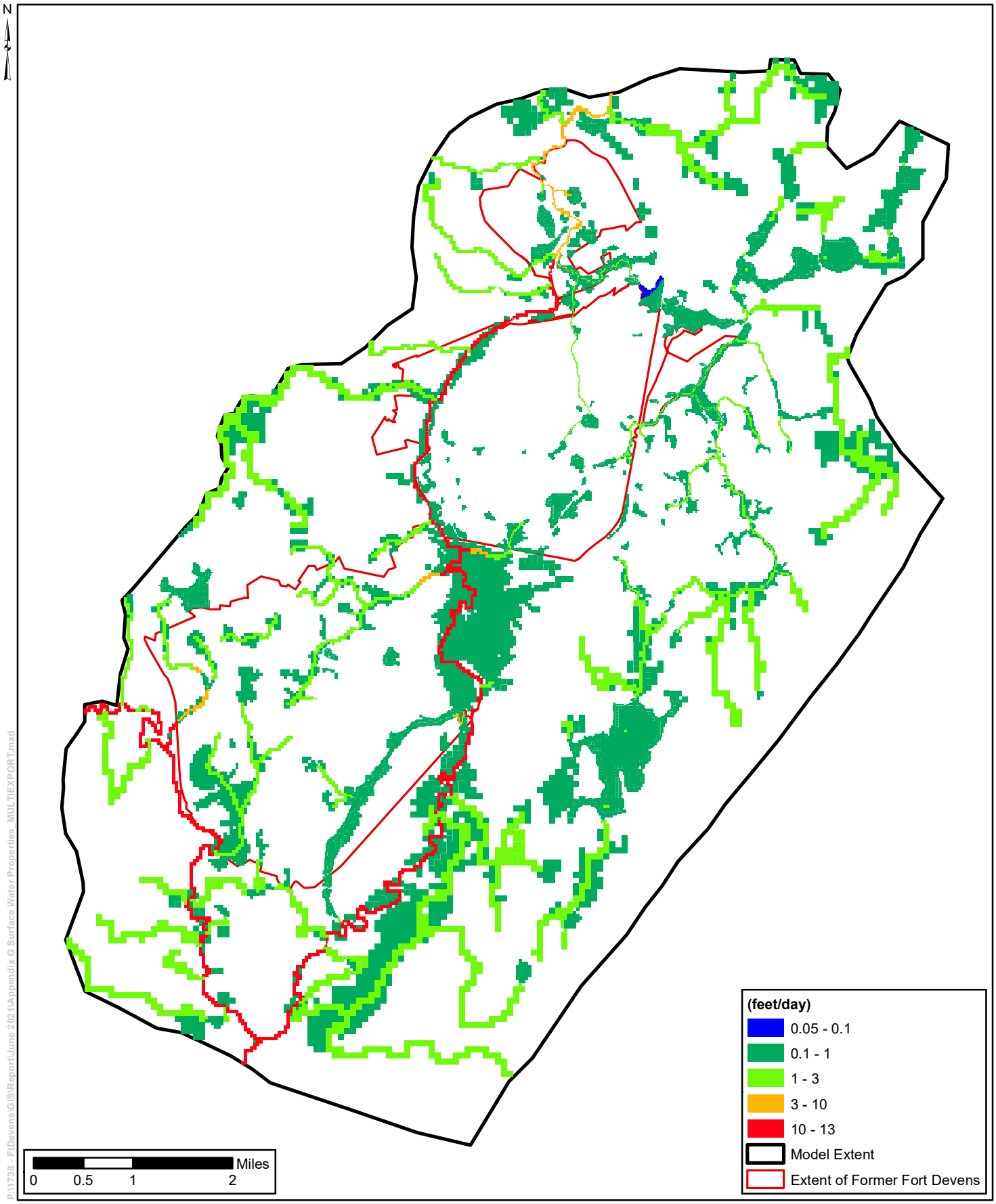


Figure G.3 Surface Water Bed (Normalized) Vertical Hydraulic Conductivity

Appendix H

Surfaces Developed by Seres-Arcadis

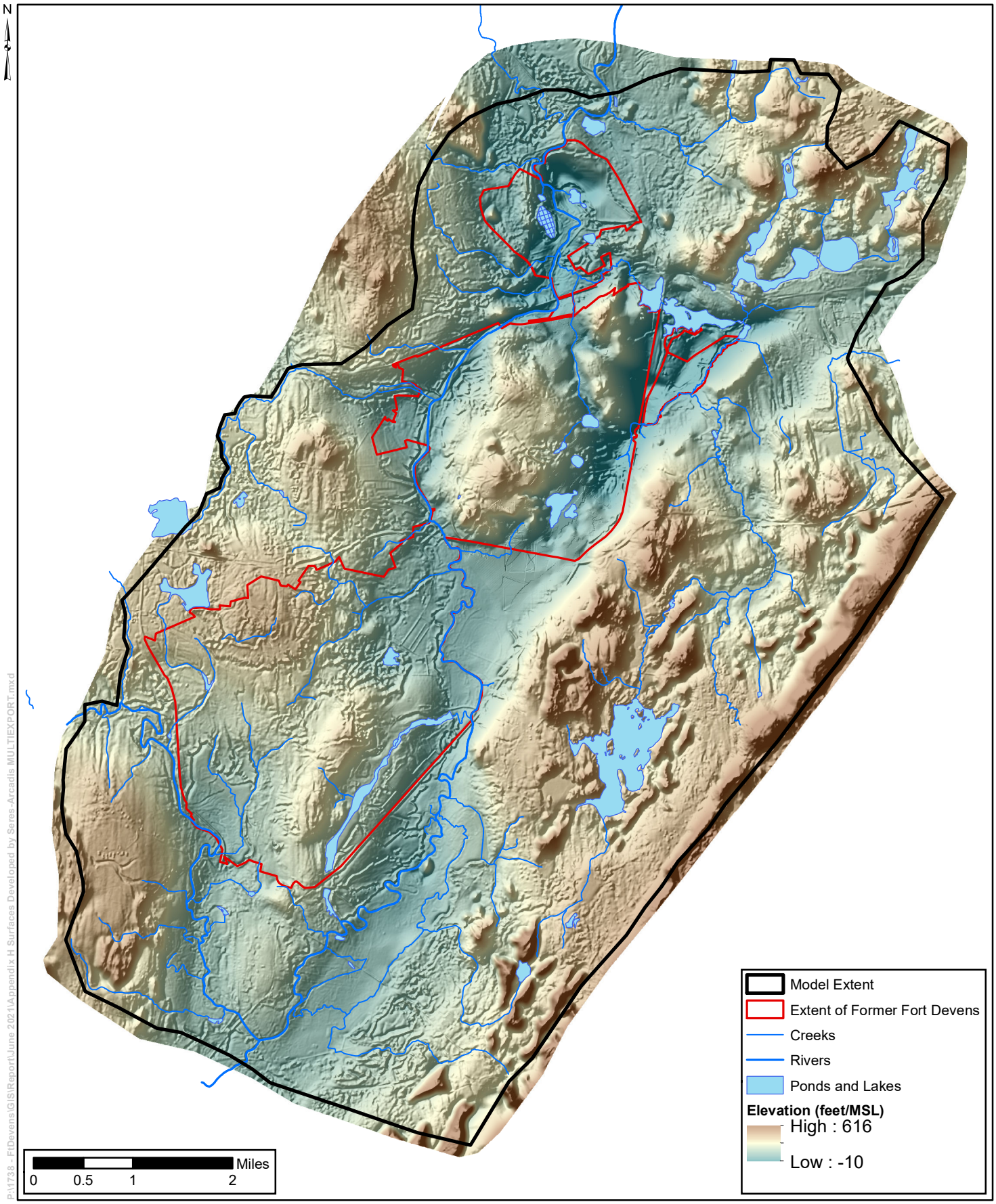


Figure H.1 Bedrock Surface

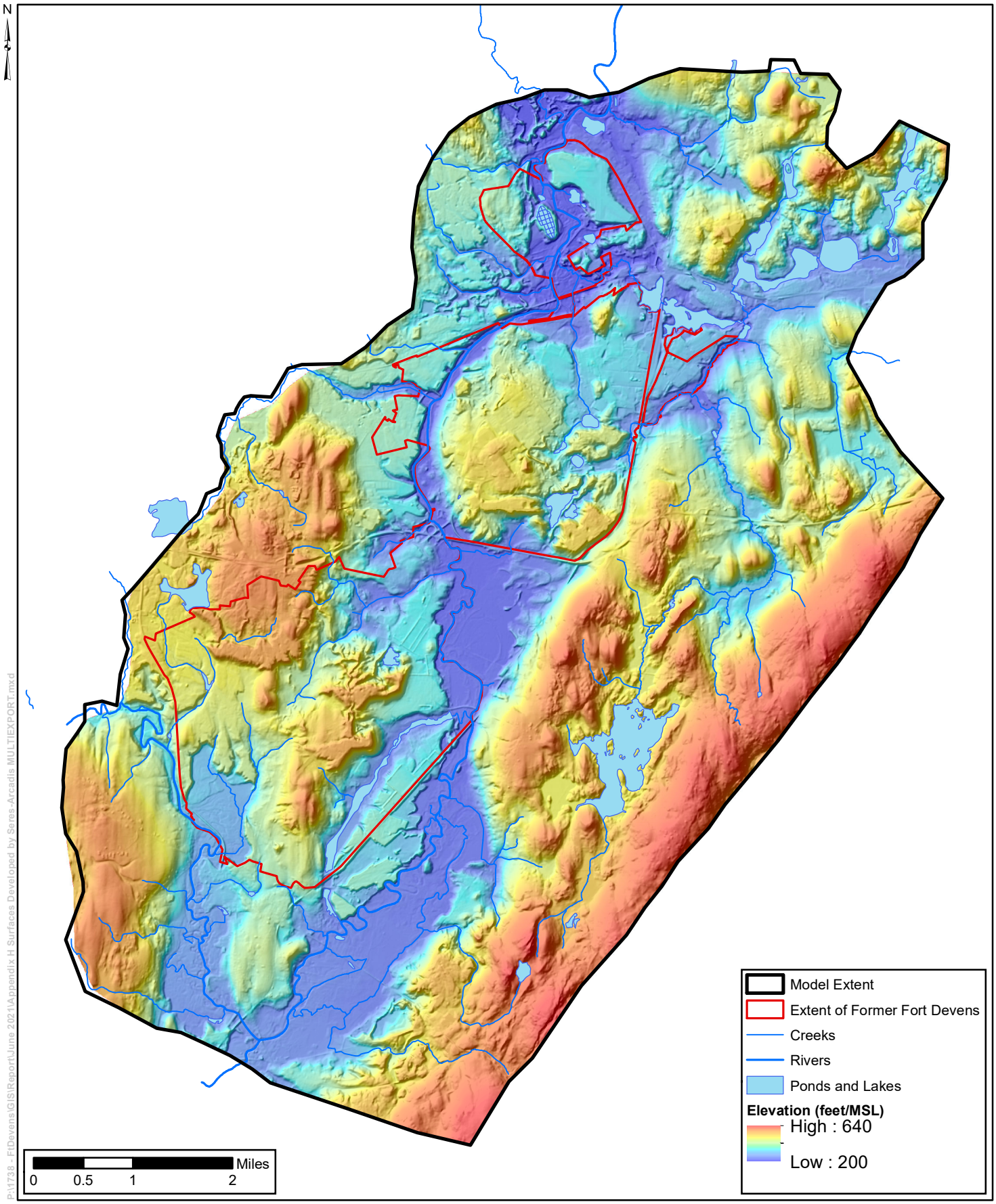


Figure H.2 LIDAR Surface

Appendix I

Evapotranspiration Calculations from ETA (1995)

Appendix D

Evapotranspiration Calculations

MEMO

TO: File 93318.10

FROM: Donald Koch

DATE: March 15, 1994

SUBJECT: Estimation of Potential Evapotranspiration at Fort Devens

Potential evapotranspiration is an important hydrologic parameter that is used in developing estimates of recharge. Previous ground water modeling projects at Fort Devens have used potential evapotranspiration estimates calculated using the Blaney-Criddle equation and average temperatures for central Massachusetts. The annual value estimated, 42.4 inches/year, may be too large causing recharge to be underestimated.

The Irrigation Water Requirements Committee of the American Society of Civil Engineers prepared a manual summarizing state-of-the-art techniques for estimation of evapotranspiration (ASCE, 1990). Computer software (REF-ET) is available to apply some of the techniques discussed (Utah State, 1989). Given the importance of potential evapotranspiration estimates to the ground water modeling at Fort Devens, new estimates of potential evapotranspiration were made using these state-of-the-art techniques.

Potential evapotranspiration "is the rate at which water, if available, would be removed from wet soil and plant surfaces expressed as the rate of latent heat transfer per unit area, or as a depth of water per unit time" (ASCE, 1990). This definition and the discussion in the ASCE manual (1990) differentiate between potential evaporation from a free water surface, potential evapotranspiration, and reference crop evapotranspiration, which is essentially evapotranspiration for a specific crop. Grass and alfalfa are the two widely used reference crops. For the purposes of ground water modeling at Fort Devens, potential evapotranspiration was defined as the reference crop evapotranspiration for grass. The differences are minor (ASCE, 1990). Potential evaporation is slightly larger because of the differing aerodynamic roughness and albedo of a free water surface (Penman, 1963 as cited in ASCE, 1990).

The REF-ET program (Utah State, 1989) uses averaged weather data to make the estimates. Data on diskettes was obtained from the National Climatic Data Center (1993). These Comparative Climatic Data are averages and normals for first order weather stations in the U.S. The nearest first order weather station to Fort Devens is at Worcester so these data

were used. The following data were extracted into a file for use with REF-ET program.

Normal daily maximum temperature (1951-1980)
Normal daily minimum temperature (1951-1980)
Normal daily mean temperature (1951-1980)
Sunshine - average percent of possible for period of record at Boston, MA, since no data were available for Worcester (57 years of record)
Wind - average speed in miles per hour converted to miles per day (MPD) for period of record (29 years of record)
Relative Humidity - averages in percent for AM and PM - daily average was computed by averaging AM and PM values (37 years of record)

The following table shows the weather data used in the estimates.

Mon	Max Temp deg F	Min Temp deg F	Mean Temp deg F	% Sunshine	Avg RelHum %	Avg Wind MPD	Avg Precip in
1	30.9	15.6	23.3	53	65.0	285.6	3.82
2	32.9	16.6	24.8	56	64.0	278.4	3.29
3	41.1	25.2	33.1	57	62.0	273.6	4.16
4	54.5	35.4	45.0	56	58.5	264.0	3.90
5	65.9	45.5	55.7	58	60.0	240.0	3.86
6	74.4	54.8	64.6	63	64.5	213.6	3.46
7	79.0	60.7	69.9	65	66.5	201.6	3.58
8	77.0	59.0	68.0	65	69.0	199.2	4.42
9	69.4	51.3	60.3	63	71.0	206.4	4.25
10	59.3	41.3	50.3	60	67.0	225.6	4.21
11	46.9	32.0	39.5	50	69.0	244.8	4.43
12	34.7	20.1	27.4	52	68.5	261.6	4.22

all data is from Worcester first order station except % sunshine which is from Boston

Temperatures and Precipitation are 30 year normals for Worcester, remaining data are averages for period of record.

These data were used to calculate reference crop evapotranspiration (grass) by REF-ET. As previously mentioned, potential evapotranspiration was considered equal to this reference crop evapotranspiration for the ground water modeling purposes.

Monthly ET Estimates
by Various Procedures
(all values in inches)

Month	Pmon	KPen	FcPen	63Pen	Harg	FRad	FB-c	Avg	Avg w/o outliers
1	1.24	0.93	1.24	1.24	0.62	0.62	0	0.84	0.81
2	1.12	1.12	1.68	1.4	0.84	1.12	0.28	1.08	1.01
3	2.17	2.17	3.1	2.79	1.55	2.48	1.55	2.26	2.23
4	3.6	3.6	5.1	4.2	3	3.9	3.3	3.81	3.72
5	4.96	5.27	7.13	5.58	4.65	5.89	5.58	5.58	5.46
6	5.4	6.3	7.8	6.3	5.4	6.6	6.6	6.34	6.24
7	5.89	6.51	8.37	6.51	5.89	7.13	7.13	6.78	6.63
8	5.27	5.58	7.13	5.89	4.96	5.89	6.2	5.85	5.77
9	3.6	3.9	4.8	4.2	3.3	4.2	4.2	4.03	4.02
10	2.79	2.79	3.41	2.79	2.17	2.48	2.79	2.75	2.73
11	1.5	1.5	1.8	1.8	0.9	1.2	1.2	1.41	1.44
12	1.24	0.93	1.24	1.24	0.62	0.62	0	0.84	0.81
Total	38.78	40.6	52.8	43.94	33.9	42.13	38.83	41.57	40.86

All the procedures are documented in the ASCE Manual (1990) and the REF-ET documentation (Utah State, 1989). The procedures used and their abbreviations in the above table are:

Pmon -- Penman-Monteith (Allen et al, 1989, ASCE, 1990)
Kpen -- 1982 Kimberly Penman (Wright, 1982; 1987)
FcPn -- FAO-ID-24 Corrected Penman (Doorenbos & Pruitt, 1977)
63Pn -- 1963 Version of Original Penman (Penman, 1963)
Harg -- 1985 Hargreaves (Hargreaves et al, 1985)
FRad -- FAO-ID-24 Radiation (Doorenbos & Pruitt, 1977)
FB-C -- FAO-ID-24 Blaney-Criddle (Doorenbos & Pruitt, 1977)

The calculated potential evapotranspiration rates range from 33.9 inches/year to 52.8 inches/year with an average of the seven methods of 41.6 inches/year. Inspection of the results and review of the ASCE Manual indicated that the outliers, those of the corrected Penman and Hargreaves methods, were likely erroneous. An average of the five remaining methods resulted in an average potential evapotranspiration rate of 40.9 inches/year. This value and the associated average monthly rates are recommended for use at Fort Devens. The attached figure shows the five results of the five methods graphically. The estimate should be considered plus or minus about two inches/year.

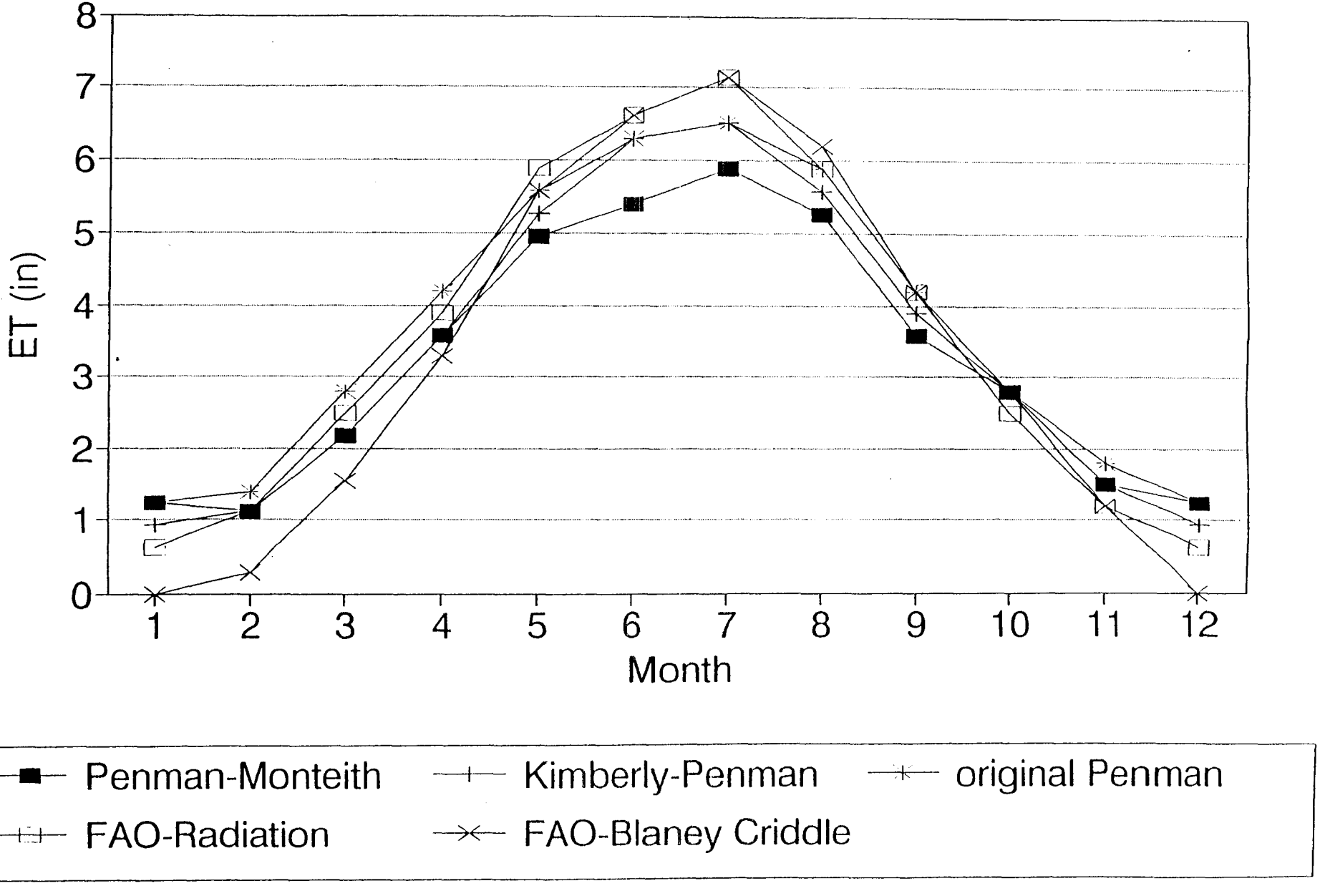
References

1. Utah State University, 1989, REF-ET, Reference Evapotranspiration Calculator Version 2.0, Computer program and documentation.

2. American Society of Civil Engineers, 1990, Evapotranspiration and Irrigation Water Requirements, Manual and Report on Engineering Practice No. 70.

3. National Climatic Data Center Comparative Climatic Data, 1993, diskettes and documentation.

Potential Evapotranspiration Estimates
Fort Devens, MA



Appendix J

Parameter Sensitivity

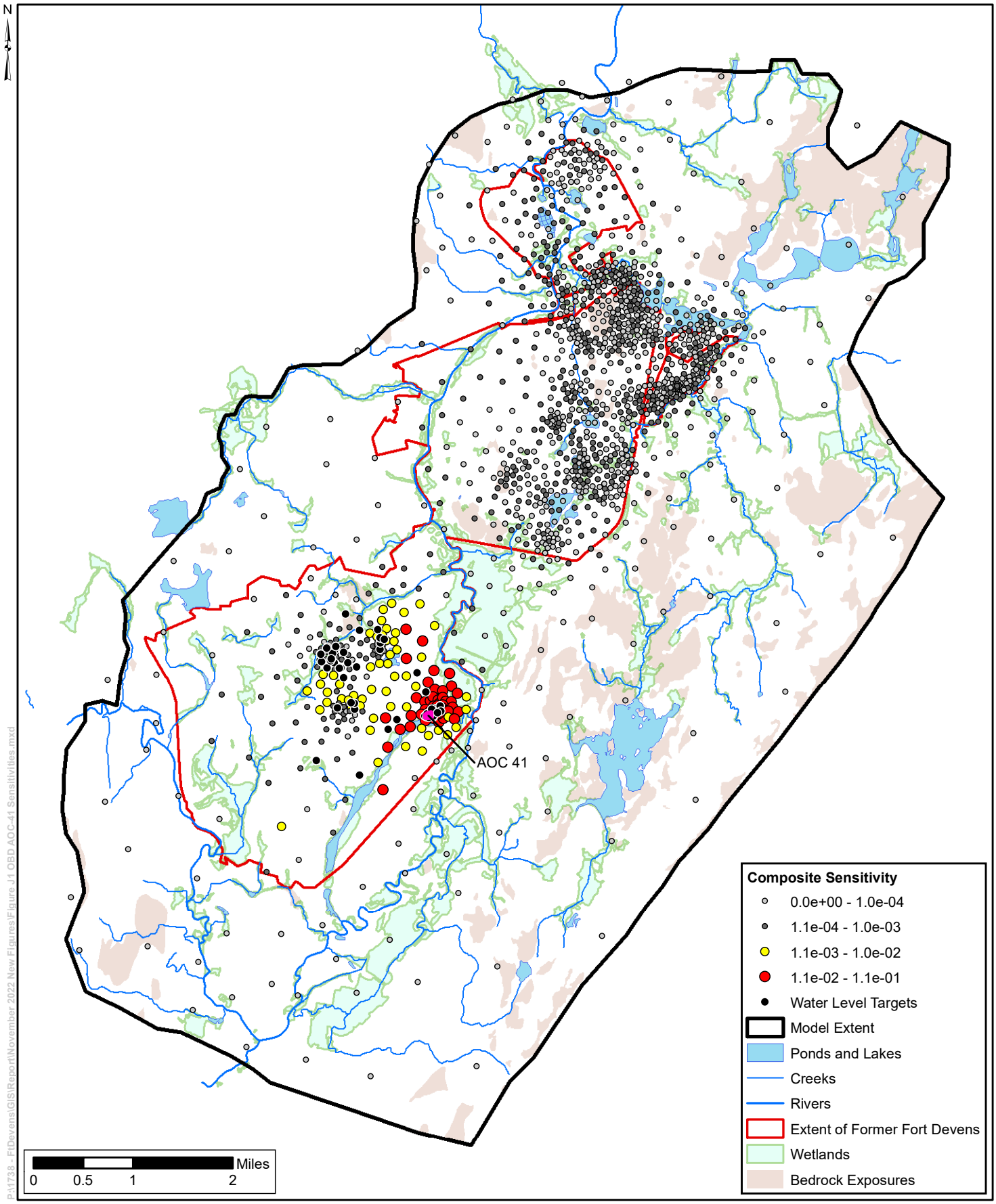


Figure J.1 Pilot Point Composite Sensitivity to AOC-41 Water-Level Targets - Overburden Horizontal Hydraulic Conductivity

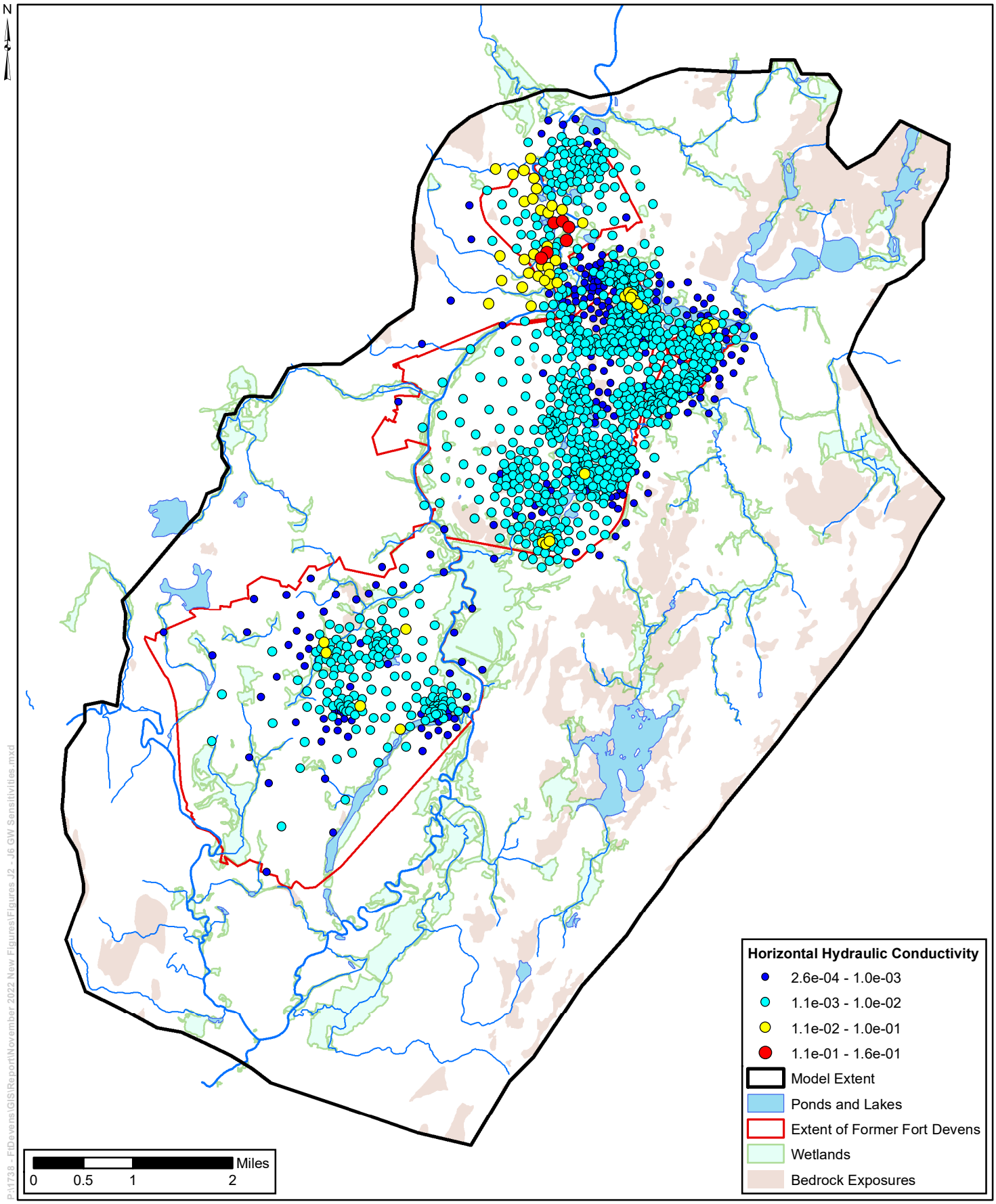


Figure J.2 Pilot Point Sensitivity - Overburden Horizontal Hydraulic Conductivity

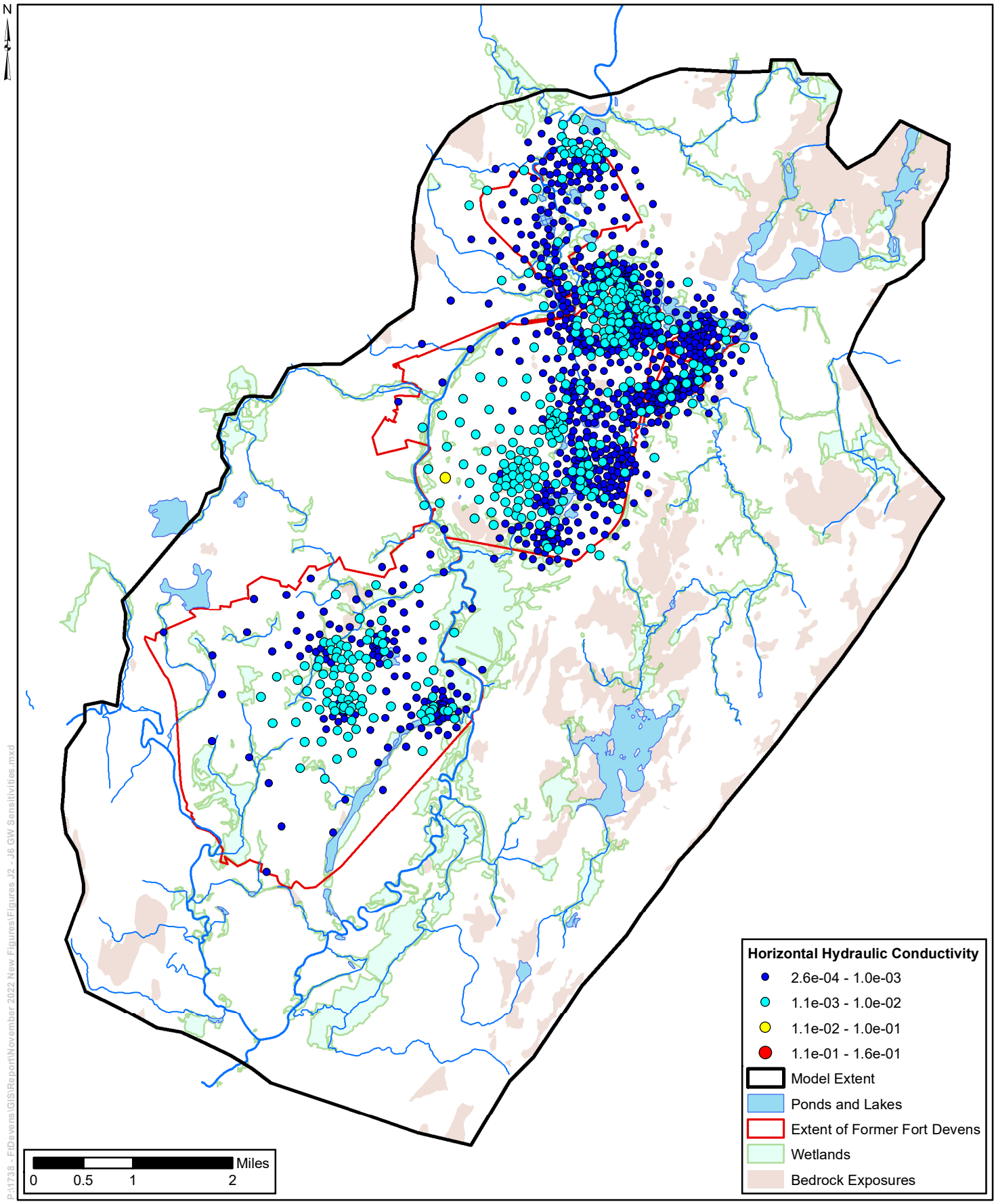


Figure J.3 Pilot Point Sensitivity - Weathered Bedrock Horizontal Hydraulic Conductivity

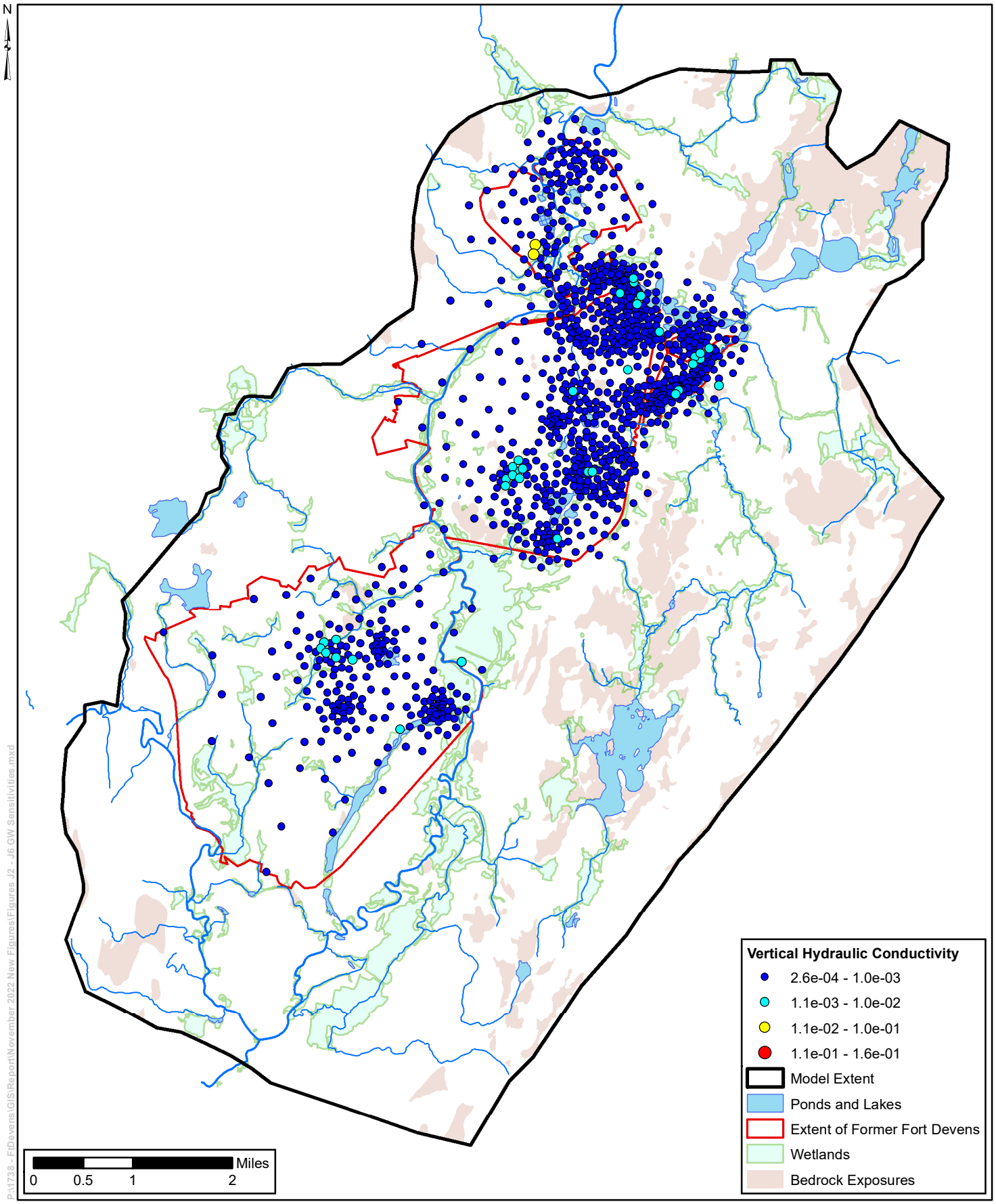


Figure J.4 Pilot Point Sensitivity - Overburden Vertical Hydraulic Conductivity

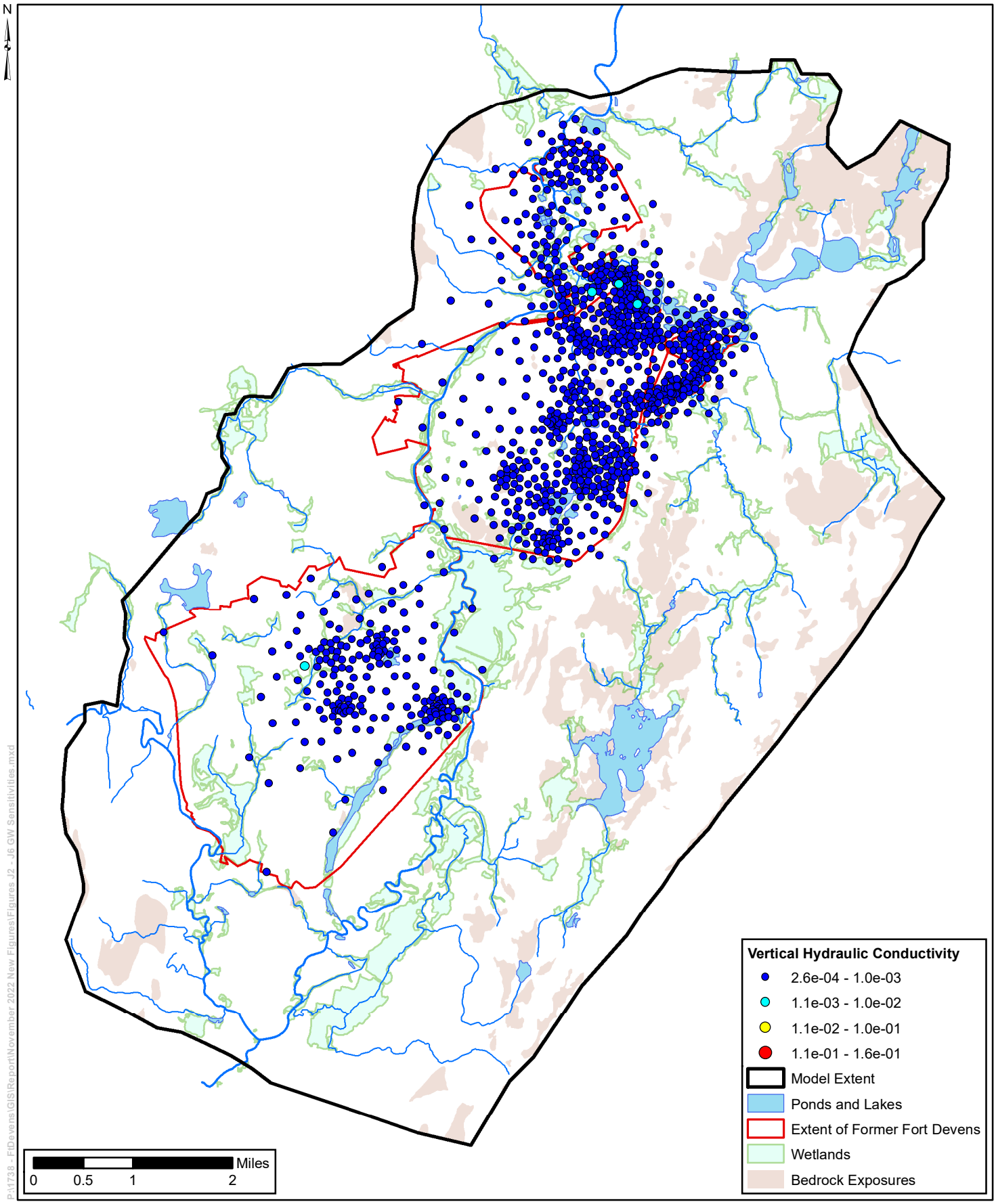


Figure J.5 Pilot Point Sensitivity - Weathered Bedrock Vertical Hydraulic Conductivity

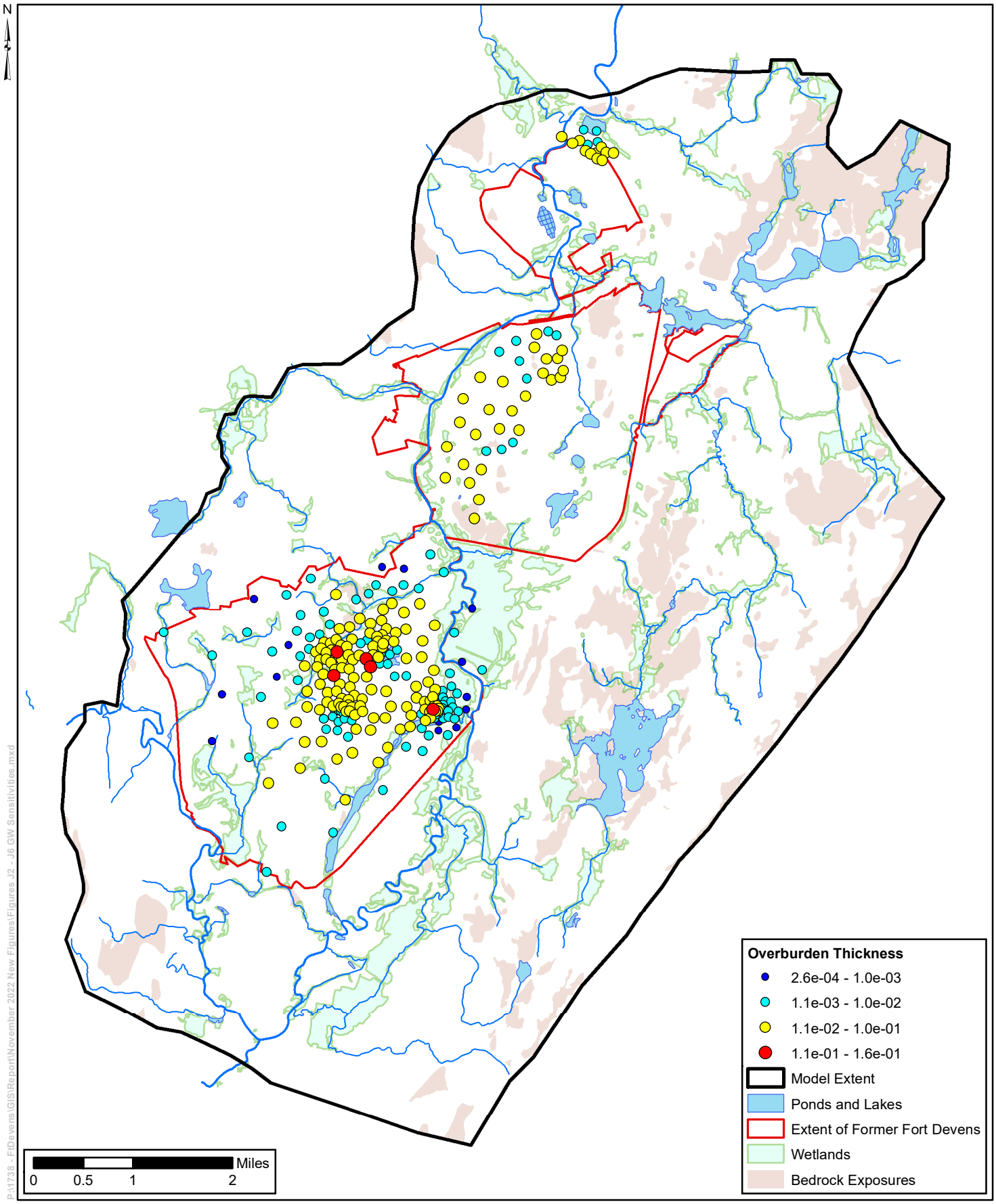


Figure J.6 Pilot Point Sensitivity - Overburden Thickness

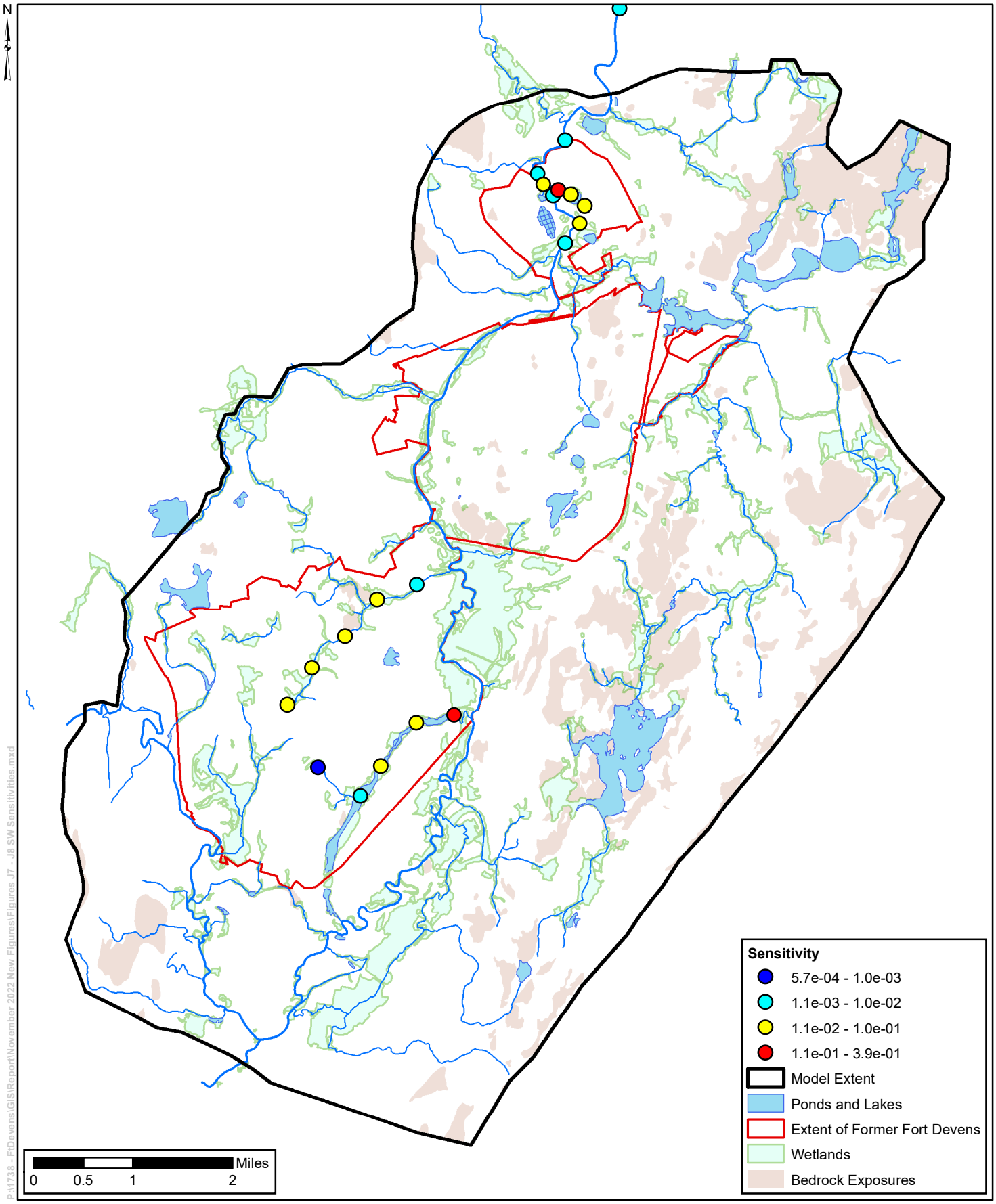


Figure J.7 Pilot Point Sensitivity - Surface Water Bed Elevation Offset

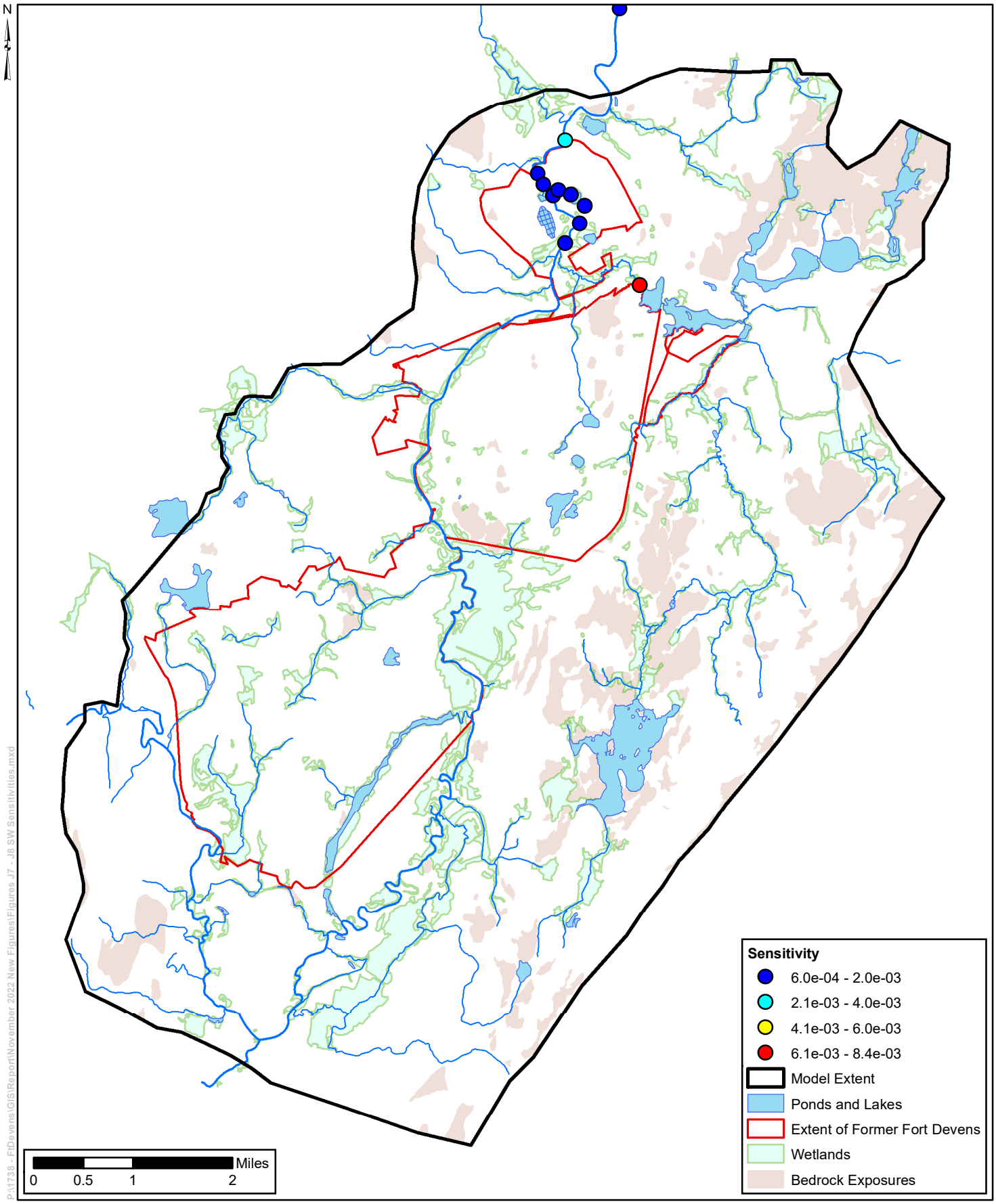


Figure J.8 Pilot Point Sensitivity - Surface Water Bed Conductance

Appendix K

Capture Zones by Hydrostratigraphic Unit

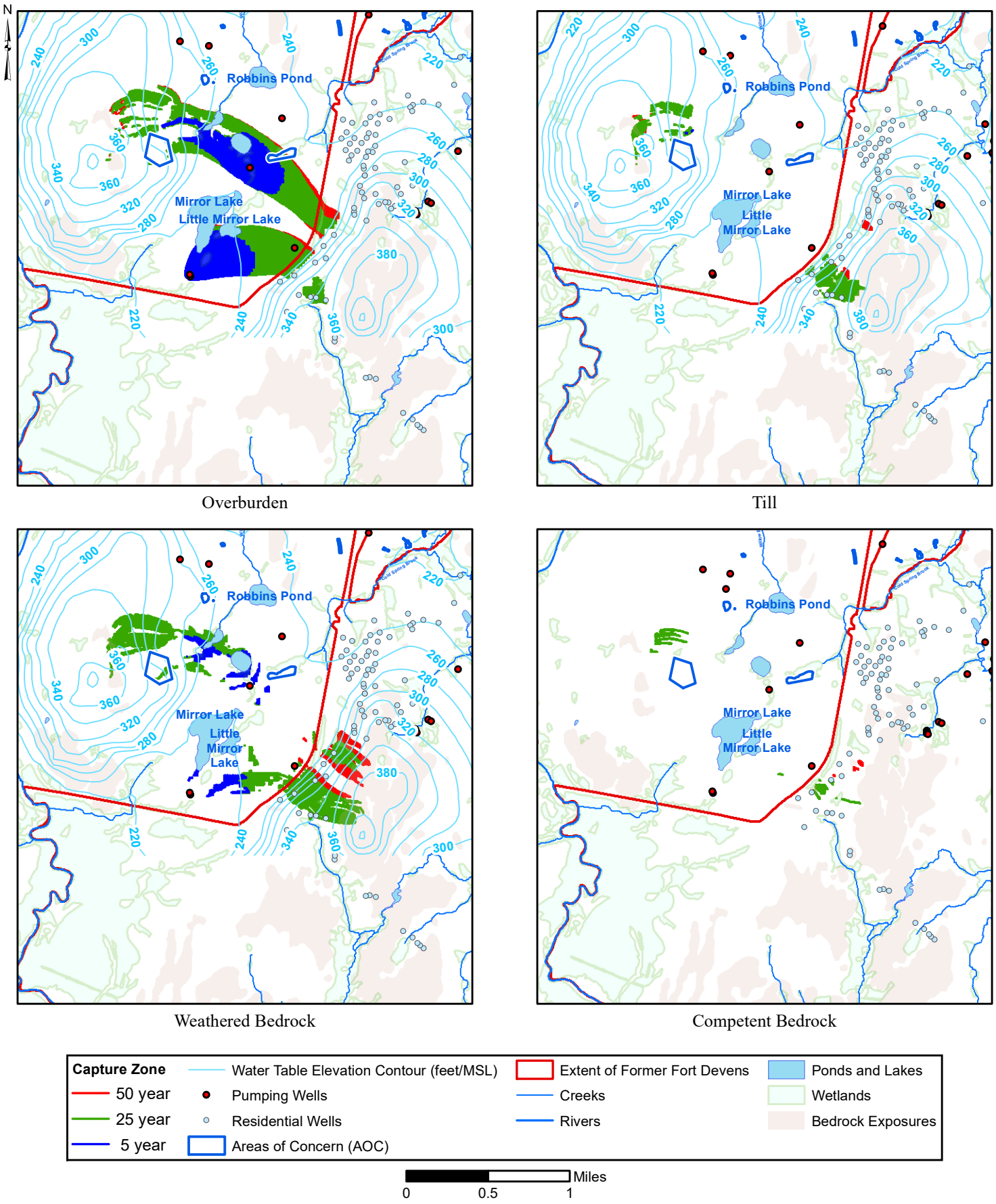


Figure K.1 Five-, Twenty-five-, and Fifty-year Capture Zones for Patton and Shabokin Wells – Base Effective Porosity

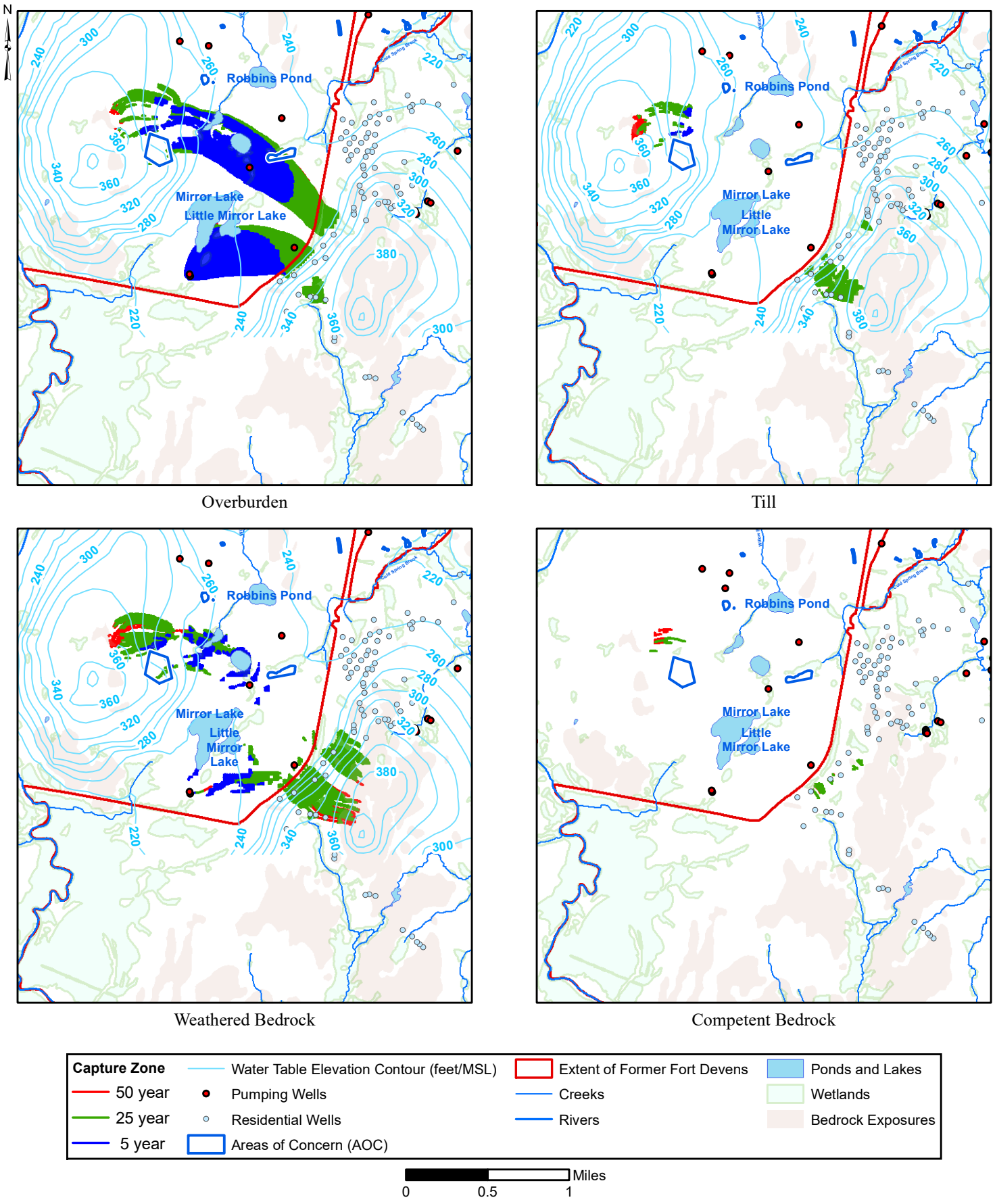


Figure K.2 Five-, Twenty-five-, and Fifty-year Capture Zones for Patton and Shabokin Wells – Alternate Effective Porosity

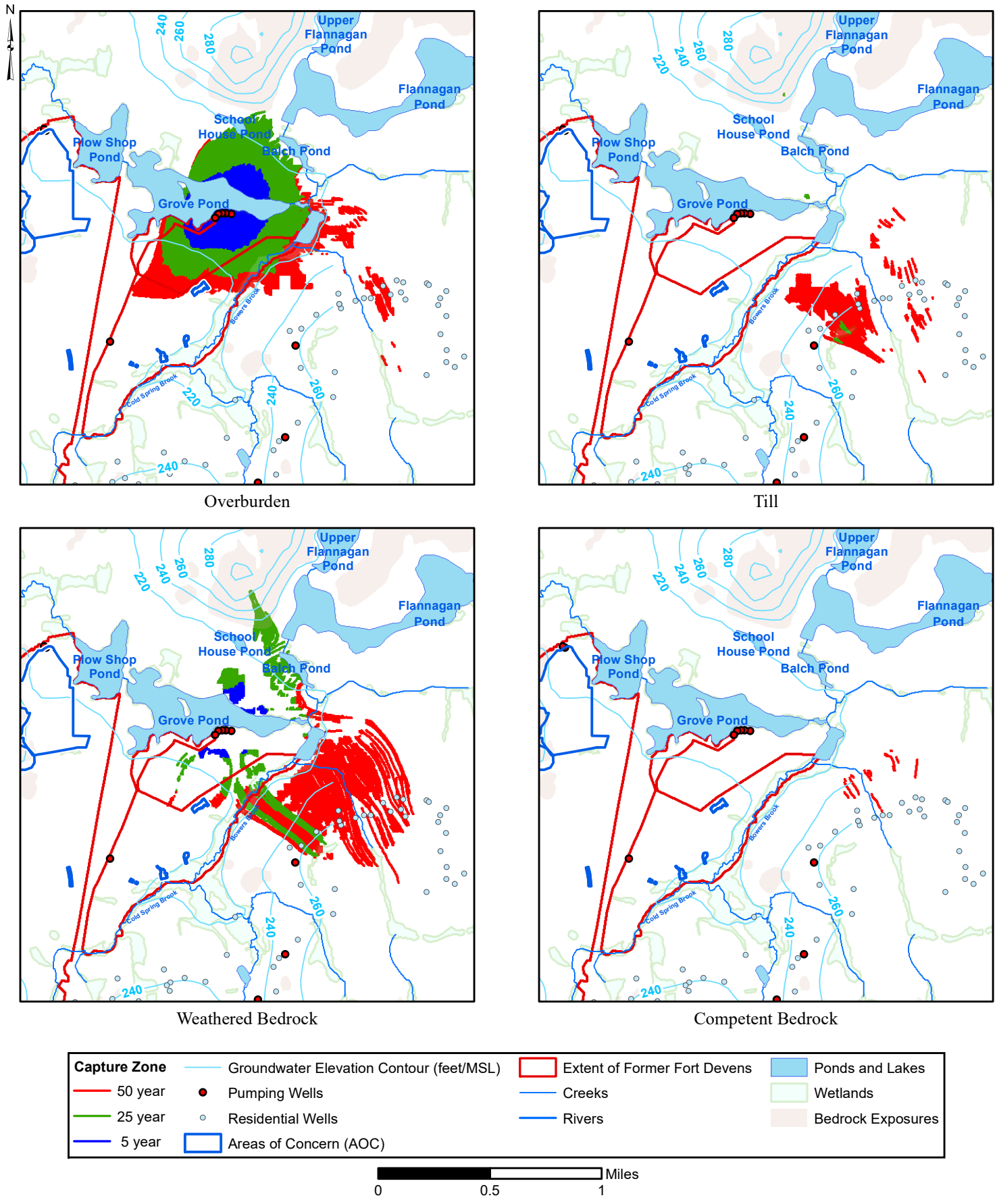


Figure K.3 Five-, Twenty-five-, and Fifty-year Capture Zones for the Grove Pond Well Field – Base Effective Porosity

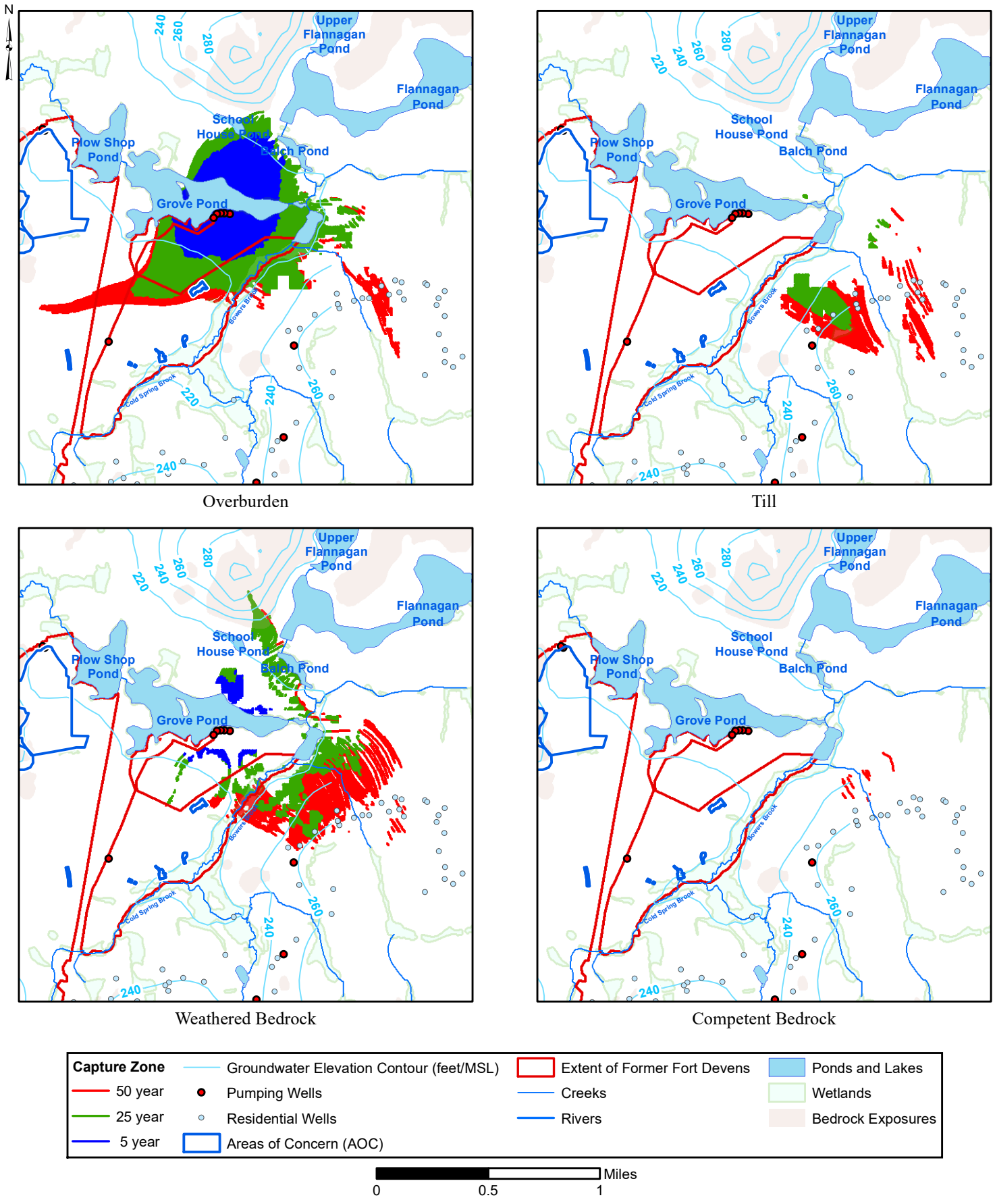
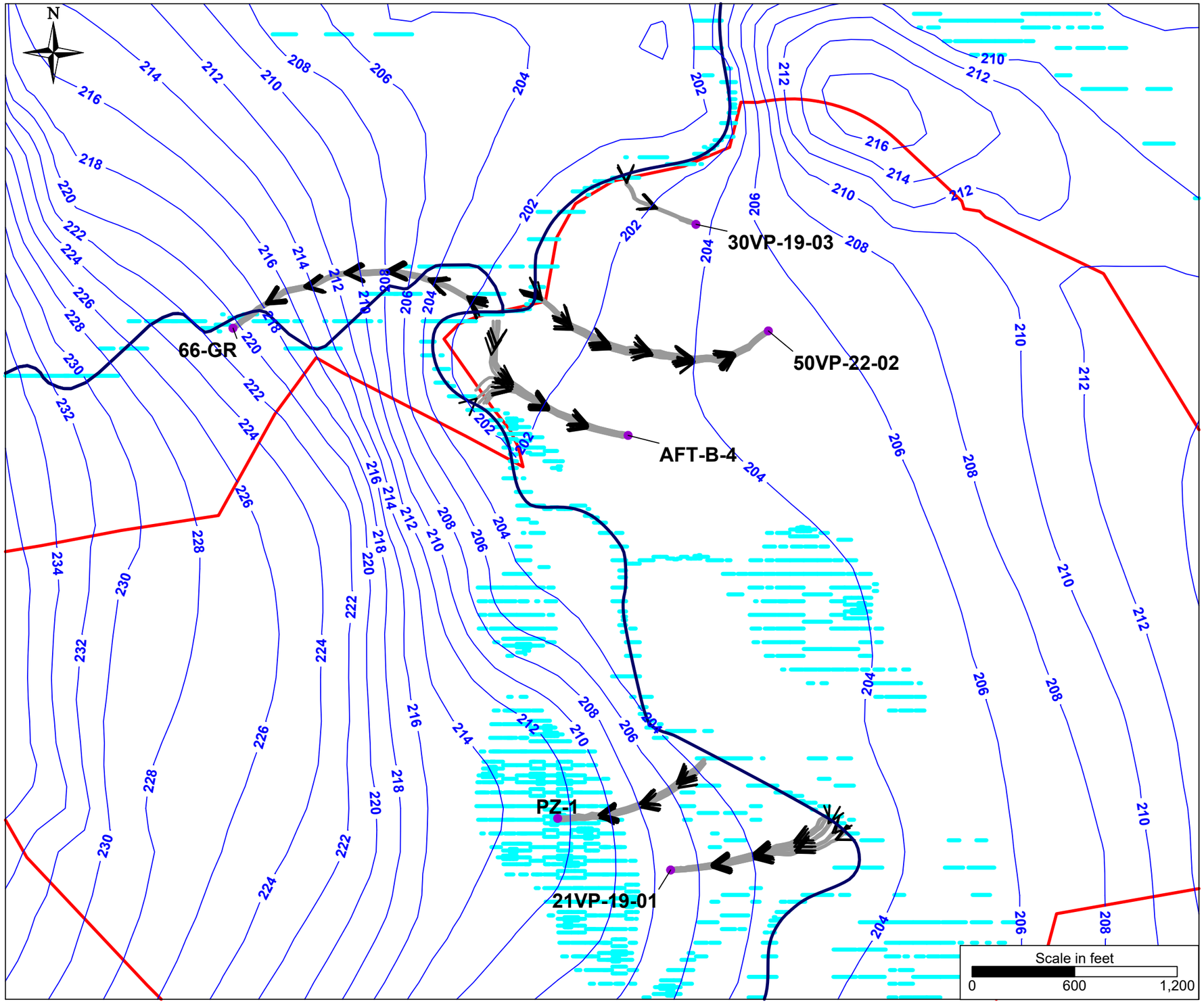


Figure K.4 Five-, Twenty-five-, and Fifty-year Capture Zones for the Grove Park Well Field – Alternate Effective Porosity

Appendix C – Supplemental Material

Area 3 Flow Path Analysis: Forward and Backward Particle Paths



Legend

- Groundwater Elevation Contour
- Particle Paths
- Creeks/Rivers
- Ponds/Wetlands
- Extent of Former Fort Devens
- Particle Starting Location

FORMER FORT DEVENS

FLOW PATH ANALYSIS
FORWARD PARTICLE PATHS

ARCADIS

FIGURE
A

N

30VP-19-03

50VP-22-02

66-GR

AFT-B-4

PZ-1

21VP-19-01

Legend

- Groundwater Elevation Contour
- Particle Paths
- Creeks/Rivers
- Ponds/Wetlands
- Extent of Former Fort Devens
- Particle Starting Location

Scale in feet

0 600 1,200

FORMER FORT DEVENS

FLOW PATH ANALYSIS
BACKWARD PARTICLE PATHS

ARCADIS

FIGURE
B

Appendix E

Response to Regulatory Comments

US Army Corps of Engineers ®

New England District
696 Virginia Road
Concord, Massachusetts
01742-2751

Project Name:	Former Fort Devens Army Installation		
Location:	Devens, Massachusetts	Reviewers:	Shawn Lowry (USEPA) and Joanne Dearden (MassDEP)
Document Name: Draft Area 3 Phase II Remedial Investigation Work Plan for Per- and Polyfluoroalkyl Substances – Stage 1 – Operable Units 8 and 14, Former Fort Devens, MA			

No.	COMMENT	RESPONSE
	USEPA – Shawn Lowry (11 August 2025)	
1.	Exhibit 4-1 presents the Soil Sampling Data Gap Analysis. The discussion of delineating soil exceedances is inconsistent. For example, the discussion for AOC 20 states that "contamination is vertically and laterally delineated by nearby samples", while the discussion for AOC 21 states, "the area of SSSL exceedances are not yet bounded". The discussion for other AOCs, including AOC 30, does not mention whether exceedances are bound or unbounded. Please revise for consistency, identifying whether exceedances at each AOC are bounded or unbounded. Please also clarify whether Army will seek full delineation of these exceedances as part of this Phase II RI. Please also add this to the discussion of data gaps in Section 4.	The text for AOCs 21 and 30 has been updated to indicate the extent to which PFAS in soil has been bounded to applicable screening level. The data gap text has also been updated accordingly. Also, see responses to Comments Nos. 24 and 25 below. The Army intends to delineate soil contamination to the extent necessary to complete a risk assessment in accordance with USEPA guidance.
2.	Given that the proportion of individual PFAS compounds vary both laterally and vertically, please add PFAS "pie charts" to the cross-sections.	The PFAS fingerprint charts will be added to the cross-sections; however, due to space constraints it was not possible to add the charts to every depth interval on some of the sections. Note that the pie charts depict the maximum concentration of each PFAS compound the given location/depth interval.
3.	The report suggests that in some areas, the pattern of PFAS impacts show multiple plumes with different PFAS compounds dominating. Recommend including a figure that shows these separate plumes and mixing areas.	Figure 2-4 has been modified to show this information.
4.	Cross sections have not been provided for Area of Concern (AOC) 20/21. Please include at least one cross-section for this area perpendicular to groundwater flow in order to evaluate potential PFAS transport and additional sample locations. A cross-section should also be included along the direction of flow.	Cross-sections for AOC 20/21 (both along flow and perpendicular to it) are provided on Figures 3-7 and 3-8 of the PSCS (Appendix B).

No.	COMMENT	RESPONSE
5.	Surface water sample locations should be provided in all figures that show previous sample locations so that they can be compared to groundwater results and evaluated to determine if the previous sample locations appropriately covered potential groundwater discharge locations.	The previous surface water sample locations have been added to the figures per the comment.
6.	Please include figures depicting all previous soil sampling results in AOCs 20, 21, 30, 31 and 50. Some of these may not require supplemental sampling, but the figures should be included for reference. The report does include the previous preliminary site characterization summary (PSCS) as Appendix B, but it is difficult to locate specific figures.	As noted in the comment, the PSCS presented in Appendix B contains the requested information. References to the relevant PSCS figures have been added to the text to facilitate review.
7.	Several figures do not depict the pond north of AOC 20 as a surface water body. This feature was sampled previously and PFAS detections and is shown in Figure 4-7. Please add to the other figures.	The pond is shown as a surface water body in Figures 1-2 and 4-1, but is overlain by PFAS isocontours. The surface water bodies have been brought forward to be in front of the contours to make the surface water bodies more visible. The pond is shown as a surface water body in Figures 2-1, 2-3, and 4-2.
8.	Figure 4-5 depicts proposed sample 50MW-24-02 (no VAP location) and 50VP-24/01/50MW-24-01. Please revise either Exhibit 4-2 or Figure 4-5 so they are consistent.	Exhibit 4-2 has been revised per the comment.
9.	Please add the existing well planned for AOC 31 to Figure 4-4, using a different symbology than the planned new wells. Recommend install two monitoring wells at the planned location AFT-B-4, one at the depth of the highest concentration and one at the deepest location with elevated concentrations for bounding (about 120 feet NGVD).	The symbols for the existing wells have been changed on Figure 4-4 per the comment. As noted in Exhibit 5-4, there are two wells planned for this location: an overburden well at the depth of highest concentration detected during Phase I, and a bedrock well. A deeper overburden well is not necessary to define the vertical extent of contamination as Phase I sampling indicated that PFAS concentrations at the bedrock surface exceeded screening levels (see PSCS Figure 5-5). The bedrock well is necessary to define the vertical extent of PFAS in groundwater. Additional wells have recently been installed in this area as part of the AOC 31 groundwater pilot study for treatment of PFAS; this data will supplement what will be provided by the proposed wells in this work plan.

No.	COMMENT	RESPONSE
10.	Lines 286-287: The text states that the majority of the PFAS detected in Area 3 was attributed to aqueous film-forming foam (AFFF). Please list other PFAS sources, if known.	There are no other known sources of PFAS at Area 3. However, as discussed in Section 2, and presented on Figure 2-4, there are PFAS present in groundwater at locations not known to have been associated with AFFF use/storage (i.e., industrial/commercial products that contain PFAS may have been used and discharged to the WWTP).
11.	Lines 287-288: The text states that AFFF was developed in response to a need for AFFF better suited to extinguish class B fires. Please revise for clarity; recommend “firefighting foam” or another word/phrase as appropriate.	The text has been revised per the comment.
12.	Lines 315-316: For readability, please separate the multiple activities into two or more bullets. Also, determining groundwater flow direction requires synoptic water level measurement in addition to installation and sampling. Please add a discussion to the text.	The text has been revised per the comment.
13.	Line 322: The text states that the data collected in this Phase II RI will “evaluate potential impacts to the Nashua River”. Are there surface water bodies of concern besides the Nashua River? If so, please add a discussion to the text.	The Nashua River is the only surface water body of concern at Area 3 for human health exposure scenarios. However, all surface water bodies sampled as part of the Phase I RI are being resampled during the Phase II RI.
14.	Line 741: The text states, “Bedrock areas that are most likely to be impacted are areas where there is a thin overburden cover and areas where the water table is within the bedrock”. The term “water table” is generally not applicable in fractured crystalline rock. Suggested revision: “observed well water level is below the top of bedrock” or “overburden is unsaturated at many locations.”	The text has been revised per the comment.

No.	COMMENT	RESPONSE
15.	Lines 744-746: The text states, “Pumping from bedrock may induce localized gradient reversals; however, the flow rates attainable from bedrock supply wells are unlikely to alter overburden flow patterns and induce vertical migration to any meaningful degree”. The generalization that bedrock well pumping does not affect overburden groundwater is not reliably true. Although the average bedrock supply well has low yield, many higher yield bedrock wells exist. Further, except where the bedrock is exposed at the surface, bedrock groundwater is recharged by overburden groundwater. When a bedrock well is pumped, a cone of depression is typically created in the overburden, although the cone may be small and its location unpredictable. Please revise for clarity and provide site-specific information to support this conclusion if appropriate.	The text has been revised to state: “Pumping from bedrock may induce localized gradient reversals; however, the flow rates attainable from the off-site residential bedrock water supply wells in the area are unlikely to alter overburden flow patterns and induce vertical migration to any meaningful degree at Area 3.”
16.	Line 795: Please define the term “zwitterionic” as it is likely unfamiliar to many readers.	The term “zwitterionic” has been defined per the comment.
17.	Lines 801-802: The text refers to Figure 2-6a through Figure 2-6b, but the report contains only a single Figure 2-6. The text appears to refer to Figure 2-4 through 2-18; please reconcile.	The text has been revised to reference Figures 2-4 through 2-12.
18.	Lines 827-831: The text identifies a downstream surface water sample in the Nashua River. Have any surface water samples been collected upstream of these sites? Please explain in the text.	Numerous surface water samples have been collected upstream of AOC 20 as part of the PFAS Area 1 and Area 2 investigations – most of which contain PFAS. The text has been revised to note this.
19.	Lines 844-848: The text indicates that perfluorooctanesulfonate (PFOS) concentrations increase relative to perfluorooctanoic acid (PFOA) with depth, but that PFOS is dominant in Area A and PFAS is dominant in Area A. It is not clear if the changes with depth are applicable to Area A or Area B. Please clarify in the text and add Areas A and B to Figure 2-6.	Areas A and B have been labeled on Figure 2-6. The text has been revised for clarity.

No.	COMMENT	RESPONSE
20.	Lines 885-887: Please provide more information in the text regarding the 31VP-19-05 sampling depths. Does Army believe that the PFAS-impacted groundwater continues to flow at depth beneath the Nashua River, or does it rise to discharge upward through the riverbed? If unknown, please propose an investigation to resolve this data gap.	The analytical results for the groundwater samples collected from 31-VP-19-05 are presented in Appendix H-2 of the PSCS (WP Appendix B). Groundwater samples were collected from depths of 4-8 ft bgs; 14-18 ft bgs; 24-28 ft bgs; and 33.5-37.5 ft bgs. PFOS and PFOA results from these samples were either non-detect or less than screening levels. Based on this information, PFAS-impacted groundwater does not migrate beneath the Nashua River at this location.
21.	Line 988: Please make the following revision (changes emphasized): “The scope of the Stage 2 investigation will be presented in a Work Plan Addendum with concurrence from EPA and MassDEP”.	The text has been revised to state: ”The scope of the Stage 2 investigation will be presented in a Work Plan Addendum that will be submitted to EPA and MassDEP for review prior to implementation.”
22.	Lines 1190-1191: Please make the following revision (changes emphasized): “The SLERA prepared as part of the RI Report will consider relevant and appropriate PFAS ESVs current at the time the SLERA is prepared.	The text has been revised as requested.
23.	Lines 1205-1206: The text states, “Decisions for soil investigation will be based on the LODs and the USEPA RSLs for PFOA, PFOS, PFBS, PFNA, and PFHxS, PFHxA, and PFBA in soil for commercial/industrial worker exposure to soil”. Please clarify whether soil leachability potential to groundwater will also be evaluated.	The RSL for soil leachability to groundwater will not be evaluated as this RSL has not been accepted by the Department of Defense (DOD).
24.	Line 1282 (Exhibit 4-1): EPA disagrees that the existing soil data are sufficient at AOC 21. Given that locations SA21-19-01 and 21SB-19-03 do not have any samples further from the sludge beds, at least one step out boring should be installed east of 21SB-19-01 and two step out borings installed north and east of 21SB-19-03 and a PFAS sample collected at the depth of the highest concentration for each.	Three additional soil boring locations have been added to the RI scope per the comment. Figure 4-8 has been revised to include the requested soil borings.

No.	COMMENT	RESPONSE
25.	Line 1282 (Exhibit 4-1): EPA disagrees that the existing soil data are sufficient at AOC 30. Elevated PFAS concentrations should be laterally defined with the following additional sample locations, with consideration for multiple samples if only one surface sample was collected: a. West or northwest of 30SB-19-06 (extremely high PFOS concentrations) b. East or southwest of 30SB-19-05 to evaluate off-pavement impacts (moderate PFAS concentrations) c. West or southwest of SA-30-17-04 (high PFOS concentrations) d. Southeast of SA-30-17-06 (moderate PFOS concentrations) e. East of 30SB-19-01 (moderate PFAS concentrations)	Two additional soil boring locations have been added to Drum Storage Area A to address the comments regarding borings 30SB-19-05/06 and Exhibit 4-1 has been revised accordingly. Two additional soil boring locations have been added to Drum Storage Area B to address the comments regarding borings SA-30-17-04/06 and 30SB-19-01. A new Figure 4-9 has been prepared to show the requested soil borings.
26.	Line 1282 (Exhibit 4-1): For AOC 31, the table states that 281 soil samples were collected during the Phase I RI and supplemental sampling, but the total samples for the previous investigations total to 468 soil samples. Please reconcile.	For clarity, references to the date of collection and sample location have been removed and the text has been revised to state that a total of 532 soil samples, consisting of 482 environmental samples and 50 QA/QC samples, have been collected and analyzed for PFAS analysis to date.
27.	Line 1282 (Exhibit 4-1): For AOC 50, the table states that 72 soil samples were collected, but the total samples collected were 133. Please reconcile. Please also install an additional boring southeast (across the pavement from location 50SB-22-12, which exceeded the site-specific screening level (SSSL).	For clarity, references to the date of collection and sample location have been removed and the text has been revised to state that a total of 127 soil samples, consisting of 115 environmental samples and 12 QA/QC samples, have been collected and analyzed for PFAS analysis to date. An additional soil boring has been added per the comment.
28.	Line 1292 (Exhibit 4-2): For AOC 50, given the extremely high PFAS concentrations detected at 50VP-22-02, recommend installing three monitoring wells: one at the depth of the maximum concentration, one at the next highest concentration, and one just above bedrock.	The purpose of the monitoring well at the location of 50VP-22-02 (50MW-24-02) is to establish exposure point concentrations (EPCs) in the area of highest PFAS groundwater concentrations upgradient of the former fire training area (AOC 31). The vertical extent of PFAS in groundwater will be determined at 31MW-24-01/01BR, which is just downgradient of the former fire training area (see Response to Comment No. 9). The area between these locations contains PFAS in groundwater exceeding screening levels in the overburden.

No.	COMMENT	RESPONSE
29.	Line 1307 (Exhibit 4-3): For AOCs 20 and 21, the cross-sections available in the PSCS do not include MW-02A, but based on cross-section B-B' (Figure 3-8 in the PSCS) this area may have 100 feet of overburden. Recommend installing a deep overburden well in the vicinity of MW-02A in addition to the planned bedrock well. Additionally, the highest concentration of the groundwater plume (Figure 4-2) appears to intercept the stream to the east between surface water samples NR-19-05 and NR-19-04. Recommend adding a surface water sample close to 21VP-19-02.	Based on the results of the VAPs upgradient of MW-02A (20VP-19-06/07), overburden groundwater contains PFAS at concentrations greater than screening levels at the bedrock surface. Therefore, only a bedrock well is necessary to define the vertical extent of PFAS in groundwater at the MW-02A location. Surface water sampling on the Nashua River will be conducted at the same locations as previous studies to provide repeatable data over time. The PFAS contribution from groundwater discharging from AOC 20/21 will be evaluated by comparing the PFAS concentrations from upstream sample location NR-19-03 to those from the downstream sample location NR-19-07.
30.	Line 1307 (Exhibit 4-3): For AOC 31, the core of the groundwater plume appears to intercept the Nashua River between 31VP-19-06 and 31VP-19-07. There are no planned surface water samples in this area. Recommend adding a surface water sample where the core of the plume appears to intercept surface water.	Surface water sampling on the Nashua River will be conducted at the same locations as previous studies to provide repeatable data over time. The PFAS contribution from groundwater discharging from AOC 31 will be evaluated by comparing the PFAS concentrations from upstream sample location NR-19-08 to those from the downstream sample location NR-19-10.
31.	Line 1307 (Exhibit 4-3): For AOC 50, the table describes installation of 50VP-24-01 and 50MW-24-01. Given the expected elevated concentrations in this area and anticipated thickness of saturated overburden (potentially 80 feet), recommend planning for installation of two monitoring wells in this area.	The Army (in consultation with EPA and MassDEP) will consider the installation of an additional monitoring well at this location if the VAP data from this location and others indicates the need to do so. The text has been updated accordingly.
32.	Line 1412: The text states that data gaps will be addressed through 8 additional VAPs and 10 additional monitoring wells. Only 7 of the proposed VAPs and 9 of the proposed overburden wells are included in Exhibit 5-3: 50VP-24-01 and 50MW-24-01 are both missing; please reconcile.	50VP-24-01 and 50MW-24-01 have been added to the exhibit.
33.	Line 1428 (Exhibit 5-4): Please specify the yield test/recovery rate threshold to either extend or abandon a bedrock borehole either in this exhibit or in the text of Section 5.4.	A total borehole recovery rate of 0.25 gallons per minute will be considered insufficient yield for testing or well construction. This information is presented in QAPP Worksheet #17 (Appendix A – Section 17.6.2.1); therefore, no changes have been made to Exhibit 5-4 (now Exhibit 5-5) or the text of Section 5.4.

No.	COMMENT	RESPONSE
34.	Figure 1-2: The figure depicts the approximate extent of areas with concentrations above SSSLs but does not indicate what media this is for (groundwater, soil, etc.). Please add this information to either the title or the legend.	The SSSLs are for groundwater. The figure has been revised per the comment.
35.	Figures 2-2 and 2-3: The color gradation for the deeper groundwater elevations is difficult to distinguish from the middle elevations. Recommend a consistent “hot to cold” color scheme or a different scheme that does not duplicate colors for different portions of the spectrum.	The color gradations have been adjusted to the extent possible given the software used to produce the images.
36.	Figure 2-19a through 2019f and Figure 2-20a through Figure 2-20c: It is not clear that the analytical results shown are for groundwater and soil, respectively. Please add the media to the figure title.	The analytical results are for groundwater. The figures have been revised per the comment.
37.	Figure 2-19: Please show the plume map overlay on this figure so that the cross-section locations can be compared to overall PFAS concentrations.	The PFAS isocontours have been added to the figure.
38.	Figure 4-7: Please show flow directions on the figure. Please also show the pond southwest of the airfield (with sample locations AFW-19-01 and AFW-19-02) as a water body, similar to Figure 1-2.	Arrows indicating the general direction of groundwater flow have been added to the figure. The waterbody with sample locations AFW-19-01 and AFW-19-02 have been shaded to be consistent with the other water bodies shown on the figure.
	MassDEP – JoAnn Dearden (24 July 2025)	
1.	There is no mention of fish tissue analysis as part of the Phase II Stage 1 investigation. Please clarify if it has been determined that fish tissue analysis is not required for Area 3 or if fish tissue analysis is to be determined, pending the results of the Phase II Stage 1 surface water results or other results.	The fish tissue sampling conducted during the Area 1 Phase II RI in 2024 was inclusive of all relevant water bodies in Devens PFAS Areas 1, 2, and 3 – including areas of the Nashua River upstream and downstream of Area 3.
2.	It is not clear which SSSLs (2022 or 2023) were used to assess the Phase I investigation results and to develop the proposed Phase II investigation activities. Please clarify in the text, exhibits, and on figures which SSSLs are the comparison criteria. Also, please include a summary of the SSSLs used for the evaluation in a table or exhibit.	The SSSLs utilized in the Work Plan are presented on Tables 1-1a and 1-1b, which are first referenced in Section 1.2.2 Regulatory Framework.

No.	COMMENT	RESPONSE
3.	Section 1.2.1.1, Page 1-4, Second Paragraph, Lines 385–386: "Before 1985, the supernatant was discharged to an adjacent wetland area located on the east bank of the Nashua River." Please clarify if this wetland area was investigated. Also, please identify this wetland area on a figure.	The exact location of the discharge is not known as no records could be found that show the location.
4.	Section 1.2.2, Page 1-6, Fourth Paragraph, Lines 477–481: a. Please add that the Phase II groundwater results will also be compared to the USEPA Maximum Contaminant Levels (MCL) for PFAS and the Massachusetts public drinking water standard or Massachusetts Maximum Contaminant Level (MMCL) for the group of six Per- and Polyfluoroalkyl Substances (PFAS), otherwise referred to as "PFAS6". These six PFAS include: perfluorooctane sulfonic acid (PFOS); perfluorooctanoic acid (PFOA); perfluorohexane sulfonic acid (PFHxS); perfluorononanoic acid (PFNA); perfluoroheptanoic acid (PFHpA); and perfluorodecanoic acid (PFDA). This PFAS6 standard was promulgated on October 2, 2020, in 310 CMR 22.00. b. MassDEP has also established reportable concentrations (RCs) and reportable quantities (RQs) for PFAS6 in 310 CMR 40.00 for groundwater categories GW-1 (drinking water) and GW-2 (shallow groundwater) and soil categories S-1 (residential exposure) and S-2 (incidental exposure). Please add that the Phase II soil results will also be compared to the MCP category S-1/GW-1 soil standards (310 CMR 40.0975(6)(a)) which are applicable to soil associated with unrestricted use. c. Please also add that Phase II surface water results will be compared to 310 CMR 40.00 MCP GW-3 (surface water bodies receiving groundwater discharge) standards.	a. In accordance with DoD policy, the Army will compare the results to the DoD accepted USEPA RSLs for decision-making purposes. However, the results will also be compared to the state standard for informational purposes. b. See above.

No.	COMMENT	RESPONSE
5.	Section 1.2.2, Page 1-6, Sixth Paragraph, Lines 488–490: "As noted on the DoD PFAS website (DoD 2024), HFPO-DA was manufactured and used after 1995, after Fort Devens ceased operations. Therefore, HFPO-DA data will not be screened against the corresponding RSL or SSSL." Please clarify if the data should not be screened against the HFPO-DA RSL or SSSL, e.g. is it possible that PFAS containing substances could have been used after 1995 in the areas that were retained by the Army.	HFPO-DA data, if detected, will be compared to the screening levels. The Army has not conducted operations involving the use of foam since the base was closed. Gen X compounds were not introduced until 2009; therefore, Gen X compounds (if detected) are not associated with Army activities.
6.	Section 1.2.3.3, Page 1-10: Please clarify if the supplemental sampling results have already been reported in a document. Please clarify which SSSLs (2022 or 2023) were used to evaluate the supplemental sampling data.	These data were discussed with EPA and MassDEP upon receipt of analytical data, but were not reported in a separate document. The results were also included in the *Final In Situ Activated Carbon Adsorbent Injection Pilot Test Work Plan for Treatment of Per- and Polyfluoroalkyl Substances in Groundwater, Operable Unit 14, Area of Contamination 31 – Former Fire Training Area, Former Fort Devens Army Installation, Devens, Massachusetts,* dated June 2025. The 2023 screening levels were used to review the data for this work plan.
7.	Section 1.2.3.3, Page 1-10, First Paragraph, Line 576: Please clarify if Figure 1-3 referenced here is correct, as the AOC 50 soiling borings and VAPs are shown on Figure 1-5.	The text has been revised to reference Figure 1-5.
8.	Section 1.2.3.3, Page 1-10, Second Paragraph, Line 586: Please provide the water table depth in feet bgs.	The water table depth has been added to the text.
9.	Section 1.2.3.3, Page 1-10, Third Paragraph, Line 590: Soil boring 50SB-22-04 is listed twice. Please clarify if this is correct or if 50SB-22-05 or another soil boring should also be listed here.	The repeated soil boring reference has been revised to 50SB-22-05.
10.	Section 2.1.2, Page 2-1, First Paragraph, Lines 654–656: Figure 2-1 is referenced here, however, Areas 1 and 2 and their adjacent water bodies are not shown on the figure. Please clarify if another figure should be referenced here. Also, please label the listed water bodies on Figure 2-1 and/or on the appropriate figure.	The figure reference has been revised to Figure 1-1.

No.	COMMENT	RESPONSE
11.	Section 2.1.3.2, Page 2-3, First Paragraph, Line 724: Please describe the function of the Devens Pathfinder and Ayer Pathfinder wells.	The Pathfinder Wells were installed in 2009 as part of a geothermal heating/cooling study conducted by the US Army Reserve. They are not associated with the Army's environmental investigations at Devens; however, information from the wells has been used to evaluate site-specific bedrock conditions in the area.
12.	Section 2.2, Page 2-4: Please provide a figure with all Area 3 SI and RI Phase I PFAS sample locations.	Please see Response to EPA Comment No. 6. In addition, a single figure with all previous locations would not be readable. However, the Army can provide the agencies with an electronic file (i.e., Google Earth .kml or GIS .shp file) that shows all locations if desired.
13.	Section 2.2, Page 2-5, Fourth Paragraph, Line 800: Please describe how the bedrock surface elevation shown on the cross section profiles was determined. Also add a note to the cross section profile figures describing how the bedrock surface elevation was determined.	Bedrock surfaces shown in the cross-sections were determined based on drill refusal during overburden drilling operations. A note has been added to the cross-section figures.
14.	Section 2.2, Page 2-5, Fourth Paragraph, Line 802: Figure 2-6a through 2-6c are referenced here but they are not included in the figure section. Please clarify if the reference here is correct and either add Figures 2-6a through 2-6c to the figure section or revise to reference the appropriate figures.	The text has been revised to reference Figures 2-4 through 2-12.
15.	Section 2.2.1, Page 2-6. First and Second Bullets: Are the results described in these bullets displayed on Figure 2-14? If so, please refer to Figure 2-14 here.	The text has been revised to reference Figure 2-14 for the bullets discussing soil sample results.
16.	Section 2.2.1, Page 2-6, Last Bullet: Please add a reference to a figure that shows the locations of the two surface water samples described in this bullet.	A reference to PSCS Figure 3-10 (Appendix B) has been added to the bullet.

No.	COMMENT	RESPONSE
17.	Section 2.2.2, Page 2-6, First and Second Bullets: a. Please label AOC 30 Area A and AOC 30 Area B on Figure 2-6 and Figure 2-15. b. PFHpA is included as one of the three primary PFAS analytes detected. However, the pie charts displayed on Figure 2-6 indicate that PFOS and PFHxA were detected in many of the AOC 30 groundwater samples. Please confirm if PFHpA is one of the three primary PFAS compounds as stated. c. Please add a reference to Figure 2-19a as VAP 30VP-19-03 and the associated PFAS results are displayed on this figure. d. Please add a data table or refer to a data table that has the PFAS results at the various sample depth intervals.	a. The AOCs have been labeled in the figure. b. Table 4-2 of the PSCS (Appendix B) shows that PFHpA was detected in 21 of the 23 AOC groundwater samples collected with a maximum concentration of 300 ng/L. c. A reference to the figure has been added. d. A reference to the tables in PSCS Appendix H-2 has been added to the text.
18.	Section 2.2.3, Page 2-7, First Bullet: a. PFHxS and PFOA are mentioned as the second most detected PFAS analytes in soil at AOC 31. However, the pie charts displayed on Figure 2-16 indicate that PFDoA was detected in many of the AOC 31 soil samples. Please confirm if PFDoA should also be mentioned here. b. Please refer to Figure 2-16 in this bullet. c. Please add the footprint of the former FTA to Figure 2-16. d. Please clarify that results shown on Figures 2-20a through 2-20c are PFOS results.	a. PFDoA has been detected in only 33 of the 532 (6%) soil samples (including QA/QC samples) collected from AOC 31 to date. It should be noted that the pie charts show the maximum PFAS concentration for the entire borehole. b. A reference to Figure 2-16 has been added to the bullet. c. The FTA footprint has been added to Figure 2-16. d. The text has been revised per the comment.
19.	Section 2.2.3, Page 2-7, Second Sub-bullet: a. Please add a reference to Figure 2-19c as VAP 31VP-19-01 and the associated PFAS results are displayed on this figure. b. Please add a reference to Figure 2-19d and Figure 2-19e as VAPs AFT-B-3 and AFT-B-4 and the associated PFAS results are displayed on these figures. c. Please add the location of the former FTA on Figure 2-19e. d. Also to note is that higher PFAS concentrations were detected at AFT-A-3 located along the runway, upgradient of the FTA.	a. A reference to Figure 2-19c has been added to the bullet. b. References to Figures 2-19d and 2-19e have been added. c. The FTA footprint has been added to Figure 2-16. d. Noted.
20.	Section 2.2.4, Page 2-7, First Bullet: Please add a reference to Figure 2-17 and Figure 2-18. Please clarify why there are no soil samples in the PCE source area.	A reference to Figures 2-17 and 2-18 has been added. The PCE source area is not an area of concern for PFAS releases associated with Army activities; therefore, soil sampling is not required.

No.	COMMENT	RESPONSE
21.	Section 2.2.4, Page 2-7: a. First Sub-bullet: Please clarify which SSSLs are referred to here. b. Second Sub-bullet: Please clarify which criteria have been exceeded. c. Third Sub-bullet: Please clarify why there is no cross section provided for the northeast portion of AOC 50. d. Third Sub-bullet: Please add a data table or refer to a data table that has the PFAs results at the various sample depth intervals. e. Fourth Sub-bullet: Please add a reference to Figure 2-19f as VAPs 50VP-22-02 and 50VP-22-03 and the associated PFAS results are displayed on this figure.	a. Screening levels used in the document are discussed in Section 1.2.2 and presented on Tables 1-1a and 1-1b. b. Please see 'a.' above. c. Please clarify the location in question. d. A reference to the tables in PSCS Appendix H-2 has been added to the text. e. A reference to Figure 2-19f has been added to the text.
22.	Section 2.3.2, Page 2-9, First Paragraph, Lines 958 and 959: "Most of Area 3 is developed into buildings, paved areas, and maintained grassed areas. These areas provide limited habitat for ecological receptors." Please clarify if the USFWS areas located west and south of the former airfield as described in Section 1.2.1.4 are within Area 3, and if so, please clarify why these areas are not considered habitat areas for ecological receptors in Area 3.	USFWS areas located west and south of the airfield are located in Area 3. The text has been revised to include these areas.
23.	Section 3.2.1.1, Page 3-2, First Paragraph: Please clarify if the 2022 Supplemental Sampling should be added to this paragraph since soil and groundwater samples were collected for PFAS analysis.	Text referencing the 2022 supplemental sampling has been added to the paragraph.
24.	Section 3.2.1.1, Page 3-2, Second Paragraph, Lines 1021–1023: "Surface water and sediment sampling results were compared to USEPA PFAS SSSLs for Former Fort Devens (USEPA Region 1 2018)." Please clarify that the SSSLs were updated in 2023 and the results are compared to the 2023 SSSLs in the following results subsections.	Screening levels used in the document are discussed in Section 1.2.2 and presented on Tables 1-1a and 1-1b.
25.	Section 3.2.1.1, Page 3-2, Third Paragraph: Add a reference to a figure(s) with PFAS sample locations for the SI and Phase I investigations.	A reference to the applicable figures in the PSCS (Appendix B) has been added to the bullet.

No.	COMMENT	RESPONSE
26.	Section 3.2.1.2, Page 3-4, First Paragraph: Please clarify if the 2022 Supplemental Sampling should be added to this paragraph since soil and groundwater samples were collected for PFAS analysis.	Text referencing the 2022 supplemental sampling has been added to the paragraph.
27.	Section 3.2.2, Page 3-5: a. First Bullet, Line 1125: "(sediment is characterized by Phase I sampling)". Please clarify that the nature and extent of PFAS in sediment is characterized. b. Please include a discussion on fish tissue sampling.	a. Sediment samples were collected upstream, within, and downstream of Area 3 during the previous studies. b. Text referencing the fish tissue sampling has been added to the text.
28.	Section 3.2.5.1, Page 3-6, Second Paragraph: See Specific Comment #2. Please add that the Phase II groundwater results will also be compared to USEPA MCLs for PFAS and Massachusetts MMCLs for the PFAS6. Additionally, please add the Phase II soil results will also be compared to the MCP S-1/GW-1 standards and Phase II surface water results will be compared to MCP GW-3 standards for the PFAS6.	Please see Response to Comment No. 4.
29.	Section 3.2.5.1, Page 3-6, Fifth Paragraph: Please define ESV and SLERA.	ESV has been defined in Section 3.2.5.1 and SLERA has been defined in Section 3.2.3, which is where it is first referenced.
30.	Section 3.2.5.2, Page 3-6, First Paragraph: a. Please clarify why PFAS analytes PFPrA and TFSI ae not included in the list, since they are included in Table 1-1a and 1-1b. b. Please clarify if Table 1-1b should be referenced here since tapwater is not included in this table.	a. PFPrA and TFSI have been added to the text. b. The reference to Table 1-1b has been removed.
31.	Section 3.2.5.4, Page 3-7: a. First Paragraph and bullets: Please clarify if Table 1-1a should be referenced here since surface water is not included in this table. b. First Bullet: Please confirm the decision will be based all of the PFAS Analytes listed in Table 1-1b.	a. The reference to Table 1-1a has been removed. b. Correct, the decision will be based on the PFAS analytes listed in Table 1-1b.
32.	Section 3.2.5: Please add a bullet to address the status of fish tissue.	Section 3.2.5.6 has been added to the Work Plan to address fish tissue sampling.

No.	COMMENT	RESPONSE
33.	Section 4, Page 4-1, First Paragraph: Please specify what criteria were used as part of the data gap evaluation. Also, note the SSL source on Section 4 Exhibits and Figures.	Screening levels used in the document are discussed in Section 1.2.2 and presented on Tables 1-1a and 1-1b.
34.	Section 4.1, Pages 4-1 and 4-2, Exhibit 4-1: a. AOC 21: It is noted that the SSSLs exceedances are not yet bound, but there are no proposed soil samples to delineate the limits of the exceedances. Please clarify what the plan is to delineate the PFAS exceedances in soil at this AOC. b. AOC 50: Figure 4-9 shows soil boring 50SB-22-01 with PFAS results detected above SSSLs. Please add 50SB-24-01 to this section and describe the exceedances at this soil boring.	a. Please see Response to EPA Comment No. 24. b. Boring 50SB-24-01 is a proposed soil boring; therefore, there are no results for this location.
35.	Section 4: The proposed groundwater investigations address data gaps to evaluate vertical extent, identify areas of highest PFAS concentrations (source areas), and identify migration pathways, but the proposed groundwater investigations do not completely define the lateral extent of the PFAS plume for Area 3 (e.g., northeast and east area of AOC 50, south - southwest area of AOC 50, south and west area of AOC 20/21). Please clarify what the plan is for assessing lateral extent and defining plume boundaries. Will this be the focus of the Phase II Stage 2 investigation?	Correct, this will be a focus of the Stage 2 investigation.
36.	Section 4.3, Page 4-5, Exhibit 4-3: AOC 30 - Please clarify if proposed VAP A3VP-24-05 and monitoring well A3MW-24-05 are intended to assess underflow. These locations are not very close to the Nashua River.	These locations are intended to evaluate PFAS concentrations in groundwater upgradient of Area 3.
37.	Section 5.1, Page 5-1, First Bullet, Line 1341: Please clarify if Site Preparation will also include coordination and access notification to property owners and lessees.	Property owners and lessees will be notified. Access agreements, if not already in place, will be obtained upon approval of the Final Work Plan.

No.	COMMENT	RESPONSE
38.	Section 5.1, Page 5-2: a. First Bullet, Line 1354: Please clarify if soil samples will be collected for visual inspection and analysis during the overburden drilling. b. Second Bullet, Line 1358: Please clarify if soil and/or bedrock samples (cuttings and/or bedrock core) will be collected for visual inspection and/or analysis during the bedrock drilling.	a. Please refer to QAPP Worksheet #17 Section 17.6.1 which notes that overburden soil will be logged at select locations. Those locations will be where soil has not been logged during previous investigations. b. Please refer to QAPP Worksheet #17 Section 17.6.2 which discusses the bedrock well drilling methodology. Rock cuttings will not be logged for lithology; however, borehole geophysical logging will be conducted in each borehole to evaluate the nature and structure of the bedrock.
39.	Section 5.2.1, Page 5-2, First Paragraph: Please clarify if Exhibit 4-3 should also be added to this paragraph.	The Section 5.2 text has been revised to also reference Exhibit 4-3.
40.	Section 5.2.1, Page 5-3, First Paragraph, Lines 1391–1393: a. Please identify the existing monitoring wells proposed for sampling on a figure. b. Please clarify if there are dedicated pumps with Teflon™ components installed in the existing monitoring wells (used for other LTM groundwater sampling programs), and if so, is there a plan to develop the wells prior to sampling for the PFAS investigation. c. It is noted the existing monitoring wells will be sampled twice. Please clarify if the sampling will be done seasonally or on some other schedule.	a. All existing wells will be sampled in AOC 20. b. There are no dedicated pumps installed in the existing monitoring wells. c. Sampling will be conducted approximately 6 months apart to account for seasonal changes.
41.	Section 5.3.1, Page 5-3, Exhibit 5-2: Please provide the rationale for the proposed sampling intervals. Please clarify if soil samples will be collected to the depth of the water table.	The proposed sampling intervals were selected to evaluate the potential exposure pathways (i.e., incidental contact with surface soil and utility/construction worker contact). Soil borings will be advanced to 15 feet bgs as this is the maximum depth for characterization of the utility/construction worker exposure pathway scenario per USEPA risk assessment guidelines.
42.	Section 5.3.2, Page 5-4, Exhibit 5-3: VAP 50VP-24-01 and monitoring well 50MW-24-01 are missing from this exhibit.	The exhibit has been revised to include these locations.
43.	Section 8, Page 8-1 and Page 8-2: Please clarify if the Arcadis, March 2022 Phase II RI Work Plan for Area 1, and S-A JV, September 2023 Area 1 Phase II RI Work Plan are cited correctly.	The March 2022 reference has been removed from the text.

No.	COMMENT	RESPONSE
44.	Appendix A Quality Assurance Project Plan: a. The "Area 3 PFAS RI WP" is mentioned in many parts of the QAPP. Please clarify if the work plan referred to is the Area 3 Phase II RI WP. b. Worksheet #10, Section 10.3: "An overview of PFAS uses and presence in the environment, qualities of PFAS compounds that contribute to their persistence in the environment, and potential routes of migration is presented in the Area 3 PFAS RI WP and is not repeated here." Please clarify which RI WP includes the PFAS overview, as it is not in the Area 3 Phase II RI WP. c. Worksheet #15-2: Please clarify if the Project Action Limit/DoD Screening Level for PFOA is 0.7 µg/kg, as the SSSL provided for PFOA in Table 1-1a of the Area 3 Phase II RI WP is 0.07 µg/kg. d. Worksheet #18, Surface Water: Please clarify which document includes Table 4-1, as there is no Table 4-1 in the Area 3 Phase II RI WP. e. Worksheet #24: Please clarify if the instrument calibration for the pH and corrosivity analysis should also be included in this worksheet.	a. Yes, the reference is to the Area 3 Phase II RI WP. The text has been revised where applicable. b. The CSM is presented in Section 2 of the Area 3 Phase II RI WP. c. Worksheet #15-2 has been revised to 0.07 ug/kg. d. Worksheet #18 has been revised to state Exhibit 5-7. e. The instrument calibration for pH and corrosivity analysis has been added to Worksheet #24.
END OF COMMENTS		