FINAL
Site Inspection Report
Muscatatuck Urban Training Center
Butlerville, Indiana

Site Inspection for Perfluorooctanoic acid (PFOA), Perfluorooctanesulfonic acid (PFOS), Perfluorohexanesulfonic acid (PFHxS), Perfluorononanoic acid (PFNA), Hexafluoropropylene oxide dimer acid (HFPO-DA), and Perfluorobutanesulfonic acid (PFBS) at ARNG Installations, Nationwide

February 2023

Prepared for:

Army National Guard Bureau
111 S. George Mason Drive
Arlington, VA 22204

UNCLASSIFIED

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Acronyms and Abbreviations

%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
µg/kg	micrograms per kilogram
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film-forming foam
AOI	Area of Interest
ARNG	Army National Guard
ATV	all-terrain vehicle
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoC	chain of custody
CSM	conceptual site model
DA	Department of the Army
DoD	Department of Defense
DQO	data quality objective
DUA	data usability assessment
EDR™	Environmental Data Resources, Inc.™
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer Manual
FedEx	Federal Express
FTA	Fire Training Area
GRPS	Ground Penetrating Radar Systems
HA	Health Advisory
HDPE	high-density polyethylene
HFPO-DA	hexafluoropropylene oxide dimer acid
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IDW	investigation-derived waste
INARNG	Indiana Army National Guard
ITRC	Interstate Technology Regulatory Council
LC/MS/MS	liquid chromatography with tandem mass spectrometry
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
MUTC	Muscatatuck Urban Training Center
ND	non-detect
NELAP	National Environmental Laboratory Accreditation Program
ng/L	nanograms per liter
NOAA	National Oceanic and Atmospheric Administration
ORP	oxidation-reduction potential
OSD	Office of the Secretary of Defense

PA	Preliminary Assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PID	photoionization detector
PQAPP	Programmatic UFP-QAPP
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual
SI	Site Inspection
SL	screening level
SOP	standard operating procedure
TOC	total organic carbon
TPP	Technical Project Planning
UCMR3	Third Unregulated Contaminant Monitoring Rule
UFP	Uniform Federal Policy
US	United States
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

Executive Summary

The Army National Guard (ARNG) G-9 is performing Preliminary Assessments (PAs) and Site Inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on the six compounds presented in the memorandum from the Office of the Secretary of Defense (OSD) dated 6 July 2022 (Assistant Secretary of Defense, 2022). The six compounds listed in the OSD memorandum include perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), hexafluoropropylene oxide dimer acid (HFPO-DA)[1], and perfluorobutanesulfonic acid (PFBS). These compounds are collectively referred to as “relevant compounds” throughout the document and the applicable screening levels (SLs) are provided in **Table ES-1**.

The PA identified one Area of Interest (AOI) where PFAS-containing materials may have been used, stored, disposed, or released historically (see Table ES-2 for AOI locations). The objective of the SI is to identify whether there has been a release to the environment from the AOI identified in the PA and determine whether further investigation is warranted, a removal action is required to address immediate threats, or no further action is required based on SLs for relevant compounds. This SI was completed at the Muscatatuck Urban Training Center (MUTC) in Butlerville, Indiana and determined further investigation is warranted for AOI 1: MUTC Fire Station and Bus Fire. MUTC will also be referred to as the “facility” throughout this document.

MUTC is located approximately 1.4 miles northwest of Butlerville, Indiana, in northeast Jennings County. MUTC comprises about 1,000 acres and is the Department of Defense’s (DoD’s) largest urban training facility, consisting of more than 200 physical buildings and numerous other realistic outdoor training facilities. The state-owned land on which MUTC sits was acquired in 2005 “as-is” from the Family and Social Services Administration of Indiana and transferred to the Indiana Adjutant General’s Office for use by the Indiana ARNG and others as a training facility. Prior to the transfer, the property operated as the Muscatatuck State Developmental Center from the 1920s until 2005 (AECOM Technical Services, Inc., 2020).

The PA identified one AOI for investigation during the SI phase. SI sampling results from the AOI were compared to OSD SLs. **Table ES-2** summarizes the SI results for the AOI. Based on the results of this SI, further evaluation under CERCLA is warranted in a Remedial Investigation for AOI 1: MUTC Fire Station and Bus Fire.

[1] Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI, as screening values were established after SI planning and execution. However, ARNG will add HFPO-DA to the list of constituents sampled during the next phase of CERCLA if warranted.

Table ES-1: Screening Levels (Soil and Groundwater)

Analyte[b]	Residential (Soil) (µg/kg)[a] 0-2 feet bgs	Industrial/ Commercial Composite Worker (Soil) (µg/kg)[a] 2-15 feet bgs	Tap Water (Groundwater) (ng/L)[a]
PFOA	19	250	6
PFOS	13	160	4
PFBS	1,900	25,000	601
PFHxS	130	1,600	39
PFNA	19	250	6

Notes:
bgs = below ground surface; µg/kg = micrograms per kilogram; ng/L = nanograms per liter
a.) Assistant Secretary of Defense, 2022. Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's (USEPA's) Regional Screening Level Calculator. Hazard Quotient (HQ) = 0.1. 6 July 2022.
b.) Screening values for HFPO-DA were established after SI planning and execution and thus not included as an analyte. Future CERCLA phases will include HFPO-DA if warranted.

Table ES-2: Summary of Site Inspection Findings and Recommendations

AOI	Potential Release Area	Soil – Source Area	Groundwater – Source Area	Future Action
1	MUTC Fire Station & Bus Fire	●	●	Proceed to RI

Legend:
● = detected; exceedance of the screening levels
◐ = detected; no exceedance of the screening levels
○ = not detected

1

1. Introduction

1.1 Project Authorization

The Army National Guard (ARNG) G-9 is the lead agency in performing Preliminary Assessments (PAs) and Site Inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on the six compounds presented in the memorandum from the Office of the Secretary of Defense (OSD) dated 6 July 2022 (Assistant Secretary of Defense, 2022). The six compounds listed in the OSD memorandum will be referred to as “relevant compounds” throughout this document and include perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorohexanesulfonic acid (PFHxS), perfluorononanoic acid (PFNA), hexafluoropropylene oxide dimer acid (HFPO-DA)[1], and perfluorobutanesulfonic acid (PFBS) at ARNG facilities nationwide. The ARNG performed this SI at Muscatatuck Urban Training Center (MUTC) in Butlerville, Indiana. MUTC is also referred to as the “facility” throughout this document.

The SI project elements were performed in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; United States [US] Environmental Protection Agency [USEPA], 1980), as amended, the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations Part 300; USEPA, 1994), and in compliance with US Department of the Army (DA) requirements and guidance for field investigations.

1.2 SI Purpose

A PA was performed at MUTC (AECOM Technical Services, Inc. [AECOM], 2020) that identified one Area of Interest (AOI) where PFAS-containing materials may have been used, stored, disposed, or released historically. The objective of the SI is to identify whether there has been a release to the environment from the AOI identified in the PA and determine whether further investigation is warranted, a removal action is required to address immediate threats, or no further action is required based on screening levels (SLs) for the relevant compounds.

[1] Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI, as screening values were established after SI planning and execution. However, ARNG will add HFPO-DA to the list of constituents sampled during the next phase of CERCLA if warranted.

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2. Facility Background

2.1 Facility Location and Description

MUTC is located approximately 1.4 miles northwest of Butlerville, Indiana, in northeast Jennings County (**Figure 2-1**). MUTC, along with the separate Camp Atterbury facility, is part of the Atterbury-Muscatatuck Training Complex. The complex encompasses more than 35,000 acres, combined, of which MUTC comprises about 1,000 acres. The facility is the Department of Defense's (DoD's) largest urban training facility, consisting of more than 200 physical buildings, an integrated cyber-infrastructure, a combined arms collective training facility, and a "live-fire" cyber warfare range (Atterbury-Muscatatuck, 2018).

Prior to its use as an urban training facility, the property operated as the Muscatatuck State Developmental Center from the 1920s until 2005. Based on information received from the Indiana ARNG (INARNG), the state-owned land was acquired in 2005 "as-is" from the Family and Social Services Administration of Indiana and transferred to the Indiana Adjutant General's Office for use by the INARNG.

MUTC was designated by INARNG as a "non-service-centric entity" capable of serving the needs of civilian first responders as well as tactical training for each branch of the US military, whose individual branch facilities tend to be molded to a particular service (Atterbury-Muscatatuck, 2018). The abandoned buildings of the former developmental center now serve as part of the realistic training facility alongside newly constructed buildings. Training scenarios include emergency response and tactical training in a variety of urban environments including, but not limited to, downed planes, derailed trains, flooded neighborhoods, and school lockdowns.

2.2 Facility Environmental Setting

MUTC is located in the Muscatatuck Regional Slope physiographic province of Indiana. The Muscatatuck Regional Slope is a gently westward-dipping structural plain covering much of southeastern Indiana from above the Wisconsin Glacial Boundary to as far south as the Ohio River (Murray, 1955). This sloping region of southeastern Indiana is covered by a thin layer of glacial sediments that overlie predominately carbonate bedrock.

MUTC is situated on a topographic high above the Vernon Fork Muscatatuck River and the Brush Creek Reservoir, at an elevation range of approximately 700-800 feet above sea level (**Figure 2-2**). MUTC is surrounded on all sides by agricultural land, and the nearest town, Butlerville, is 1.4 miles to the southeast and is the only development within a 4-mile radius.

2.2.1 Geology

The geology of the Muscatatuck Regional Slope is dominated by Paleozoic carbonate bedrock overlain by Quaternary glacial sediments. While Indiana experienced several glaciations during the Quaternary period, Jennings County was glaciated only by pre-Wisconsin glaciers, which left behind complex deposits of till.

The Jessup Formation is the surficial unit at the facility and throughout much of the southern third of Indiana, and it is identified as predominantly unconsolidated Pleistocene till comprised of interbedded calcareous conglomeratic mudstone and lenses of clay, silt, sand, gravel, marl, and peat. Weathering has removed carbonates from the top of the unit to a depth of up to 13 feet. Weathered sediments are described as loess-like clayey silt (Wayne, 1963). The thickness of the

Jessup Formation is variable because the unit is bounded by erosional unconformities at both the top and the base.

In Jennings County, bedrock consists of up to 100 feet of Devonian and Mississippian black shale (New Albany Shale) resting on a Silurian-Devonian limestone-dolomite sequence. At the facility, the New Albany Shale is absent, and the uppermost bedrock units are Devonian carbonates (**Figure 2-3**). However, the Silurian carbonates may be the uppermost bedrock unit at the northern portion of the facility, around the Vernon Fork of the Muscatatuck River (Gray et al., 1972). The Silurian and Devonian carbonates are grouped into two sequences, the upper and the lower, and are separated by the discontinuous Silurian Waldron Shale, which has a thickness up to 12 feet. The Silurian lower sequence aquifer is underlain by thin beds of interbedded Ordovician limestone and shale (Murray, 1955). MUTC lies in a transitional zone on the eastern edge Muscatatuck Regional Slope, where bedrock and overlying till thickness depend heavily on whether regional erosion occurred before deposition.

At the Brush Creek Reservoir spillway, near the northern border of MUTC, local geologic stratigraphy can be observed to a depth of 75 feet below ground surface (bgs) (Murray, 1955). The glacial till, extending 25 feet bgs, overlies 2.8 feet of unconsolidated quartz sand, which is the weathered remnant of a silicified bed of the upper limestone-dolomite sequence just below. The sands rest on a unit of the lower limestone-dolomite sequence, the Laurel Limestone member of the Salamonie unit. The Laurel Limestone is a bluish-gray dolomitic limestone containing chert. The upper Silurian-Devonian sequence and the Waldron Shale are not present due to erosion.

The November 2021 SI borings encountered the carbonate bedrock at all five boring locations, at depths ranging between 11.5 feet bgs and 17.5 feet bgs. Low-to-moderate permeability soils dominated by silt and clay were observed to make up the overlying unconsolidated material in the borings. A poorly graded sand was also present in all borings just above the limestone bedrock. Boring Logs are presented in **Appendix E**.

The lithological observations made in the SI soil borings are consistent with the known depositional history of MUTC. The silt and clay that dominate the unconsolidated overburden section are representative of glacial till deposits common within the Jessup Formation that overlies bedrock in the region. Sand and gravel in the borings are a result of higher energy facies of the till. Coarser-grained material observed just above the bedrock contact may be the weathered remnants of the upper limestone surface. The intact limestone bedrock encountered in SI borings was noted to be well-cemented and granular, with signs of chemical sedimentary structures. The bedrock is likely the Laurel Limestone, known to be present at MUTC based on observations made in the nearby reservoir rock cut. The cementation noted in the rock grains may be explained by the dolomitic nature of the Laurel Limestone.

2.2.2 Hydrogeology

Groundwater near the facility is first encountered at approximately 8 to 30 feet bgs in the dissected till and residuum aquifer system, which resides within the till deposits and weathered bedrock residuum. The total thickness of this aquifer system ranges from 15 to 40 feet in Jennings County; however, water production potential is typically low, and most of the wells targeting this aquifer system are large-diameter wells screened within thin sands (<2 feet thick) (Schrader, 2004b). A 2005 environmental assessment of MUTC surveyed the area with approximately 24 soil borings. These borings found bedrock refusal at an average of 8 to 10 feet bgs, with the deepest at 26 feet bgs. Recovered soil samples ranged from dry to moist, or were wet directly above bedrock surface, indicating that groundwater is contained primarily within the bedrock aquifer below (Risch et al., 2007). Temporary monitoring wells installed at select borings showed that in some locations, groundwater water was present at the bedrock contact at sufficient volume to sample. Surficial groundwater flow on and around the facility was inferred to the southwest.

The SI results are consistent with the 2005 study findings, as depths to water in the temporary monitoring wells installed during the SI ranged between 8.10 feet bgs and 17.69 feet bgs. Groundwater was observed in four of the five SI borings, where in each case, groundwater was encountered just above the contact with the component limestone bedrock. Review of these boring logs shows the presence of poorly graded sand above the bedrock, suggesting that the downward migration of shallow groundwater may be inhibited by the bedrock, and near-surface groundwater flow may be controlled largely by the bedrock surface, where it is transmitted through the more permeable sand. The irregularity of the bedrock surface makes the surficial groundwater flow atop the bedrock difficult to determine on a small-scale; however, groundwater is expected to be primarily controlled by topography, flowing from elevated areas down towards river valleys. Groundwater elevations calculated using depth to water measurements taken during the SI show a northwesterly flow direction in the SI study area (**Figure 2-4**).

The primary water bearing unit sourced for groundwater in the region is the Silurian-Devonian carbonates aquifer system, which is made up of a Silurian and Devonian dolomite-limestone sequence. The total thickness of the aquifer system ranges up to 250 feet and typically yields 2 to 15 gallons per minute (Fenelon and Greeman, 1994; Schrader, 2004a); the majority of potable water wells in Jennings County draw from this sequence (Fenelon and Greeman, 1994; Risch et al., 2007). The groundwater wells within the vicinity of the facility are mainly situated to the east/southeast of the facility.

Regionally, the Silurian-Devonian carbonate aquifer system is separated into two sequences, an upper Silurian-Devonian sequence and a lower Silurian sequence that is often separated by approximately 12 feet of the Waldron Shale. In the eastern section of Jennings County where MUTC is situated, the Waldron Shale and overlying Silurian-Devonian upper aquifer sequence have been locally eroded (Greeman, 1981; Schrader, 2004a). The Silurian lower sequence aquifer is capped by a siliceous dolomitic unit that prevents intersequential flow, and it is underlain by thin beds of interbedded Ordovician limestone and shale. Because the limestone has low porosity, these aquifers rely primarily on secondary porosity caused by dissolution, jointing, and faulting within the bedrock. To that effect, the upper sequence, absent at MUTC, is noted for having a higher secondary porosity than the lower sequence (Greeman, 1981).

An Environmental Data Resources, Inc.™ (EDR™) report conducted a well search for a 1-mile radius surrounding the facility (AECOM, 2020). Using additional online resources, such as state and local Geographic Information System databases, wells were researched to a 4-mile radius of the facility and are shown on **Figure 2-3**. Several wells were identified in the vicinity of the facility, the nearest of which is approximately 1.7 miles northwest of the facility and screened within the bedrock at a depth of 70 feet bgs (Indiana Department of Natural Resources [IDNR], 2021a). Information provided by INARNG indicated the presence of two existing wells located on MUTC. Both wells are designated for agricultural use only as livestock water supply wells and are manually operated (i.e., hand pump and windmill). The nearest on-facility well is approximately 0.15 miles east of the AOI. The depths of the wells are thought to exceed 300 feet bgs.

2.2.3 Hydrology

MUTC sits on a watershed divide between the Long Branch-Vernon Fork Muscatatuck River Watershed and the Brush Creek Reservoir-Brush Creek Watershed (**Figure 2-5**). The majority of the developed section of the facility lies within the Muscatatuck River Watershed. The portion of the facility within the Brush Creek Reservoir-Brush Creek Watershed is almost entirely forested and undeveloped.

Municipal water, from which MUTC draws its drinking water supply, is taken from an intake on the Muscatatuck River, near the City of North Vernon, located 5.25 miles southwest of the facility

(IDNR, 2021b). The 2005 MUTC environmental assessment referenced in the PA Report identified a drinking water intake located on the Vernon Fork Muscatatuck River, just upstream from the developed section of the facility at the northern boundary of MUTC (Risch et al., 2007). Additionally, the environmental assessment noted that the northern section of MUTC property lies within the water-supply emergency-management zone (within 0.25 miles from a shoreline that drains into the river from within 1,000 feet upriver of a potable water intake). Information received from facility personnel since the PA was submitted indicates that this intake and associated on-facility water treatment facility still exist but are not currently in use as a water supply source. The Brush Creek Reservoir was created in 1953 as a water-supply reservoir that has a surface area of approximately 150-acres during normal conditions. The Brush Creek Reservoir services the City of North Vernon as a supplemental water source during dry periods.

MUTC is bordered by the Vernon Fork of the Muscatatuck River to the west and northwest. Brush Creek flows into Brush Creek Reservoir at the northeast facility boundary. Pleasant Run is located along the southern border of the facility and ultimately discharges to the Vernon Fork of the Muscatatuck River. Although topography is relatively flat, surface drainage from the western portion of MUTC generally flows northwest into the Vernon Fork of the Muscatatuck River. Surface runoff from the eastern portion of the facility that lies within the Brush Creek Watershed flows into Brush Creek Reservoir. Ultimately, all drainage from the facility flows to the Muscatatuck River.

US Geological Survey (USGS) streamflow gauge #03369000 is stationed on the Vernon Fork Muscatatuck River west of MUTC. Operational from 1942 to 2001, the gauge's historical data show that the mean daily streamflow ranged from a low of 5.37 cubic feet per second (ft^3/s) in the fall to a high of 318 ft^3/s in the winter and spring (USGS, 2006).

2.2.4 Climate

MUTC lies within southeastern Indiana, an area categorized as hot-summer humid continental. Average climate data for the past 5 years were found for North Vernon, approximately 5 miles to the southwest of MUTC. The average annual temperature of North Vernon is 55 degrees Fahrenheit (°F). Summer has an average maximum temperature of 84.2 °F, with July being the hottest month. Winter has an average minimum temperature of 25.3 °F, with January being the coldest month.

Total annual precipitation is 69.08 inches of which 19.2 inches are snowfall. Rainfall is fairly evenly distributed throughout the year, with the wettest month, June, receiving 5.47 inches of rain, and the driest month, September, receiving 3.16 inches of rain. Snowfall occurs from late November to March, the majority of which falls in January and February. Monthly snowfall varies considerably from year to year, ranging from fractions of an inch to over 14 inches (National Oceanic and Atmospheric Administration, 2022).

2.2.5 Current and Future Land Use

The land for MUTC was acquired for use by INARNG in 2005. The Urban Training Center is a little over a decade old and serves as a "real city" in which all aspects, from the buildings and surrounding property to the people and animals, are considered "in play" for training scenarios. Training scenarios consist of tactical military maneuvers and response to emergencies in the wide variety of urban environments that agencies encounter in the modern world. Land surrounding the facility is heavily forested and/or agricultural land. There is a public access point to the Brush Creek Reservoir for fishing and water-based recreation. A Purdue University Agricultural Research Center is located approximately 1.5 miles to the southwest. Reasonably anticipated future land use is not expected to change from the current land use.

2.2.6 Sensitive Habitat and Threatened/ Endangered Species

The following birds, plants, mammals, and reptiles are federally endangered, threatened, proposed, and/ or are listed as candidate species in Jennings County, Indiana (US Fish and Wildlife Service [USFWS], 2021).

- **Insects:** Monarch butterfly, *Danaus plexippus* (candidate)
- **Mammals**: Northern long-eared bat, *Myotis septentrionalis* (threatened); Indiana Bat, *Myotis* sodalis (endangered)

2.3 History of PFAS Use

One AOI was identified during the PA at MUTC at a location where aqueous film-forming foam (AFFF) has been stored or released historically. This area encompasses the MUTC Fire Station and Bus Fire, which were grouped based on proximity into a single AOI (AECOM, 2021a).

The MUTC Fire Station houses a total of three firetrucks and an all-terrain vehicle (ATV) brush-truck known to have carried AFFF historically. During the 2018 PA site visit, two firetrucks and the brush-truck were stored inside the Fire Station's bays, and the third, out of commission firetruck was staged on the gravel pad just behind, and west of, the Fire Station building. Additionally, AFFF has been staged in 5-gallon containers within the Fire Station bays. AFFF has not been discharged from the trucks since they were purchased in 2008, nor have there been reports of leaks from the trucks or storage containers. The AFFF present at the AOI 1 during the 2018 PA site visit has since been removed from MUTC and was donated to local jurisdictions. Because AFFF was stored at the facility, there is potential for it to have been incidentally released to the environment during handling or via leaks. Additionally, the local volunteer fire department responded to a bus fire at AOI 1 on 22 April 2021. Approximately 200 gallons of foam, mixed using 1 gallon of AFFF concentration and water, were used by the fire department to extinguish the bus fire.

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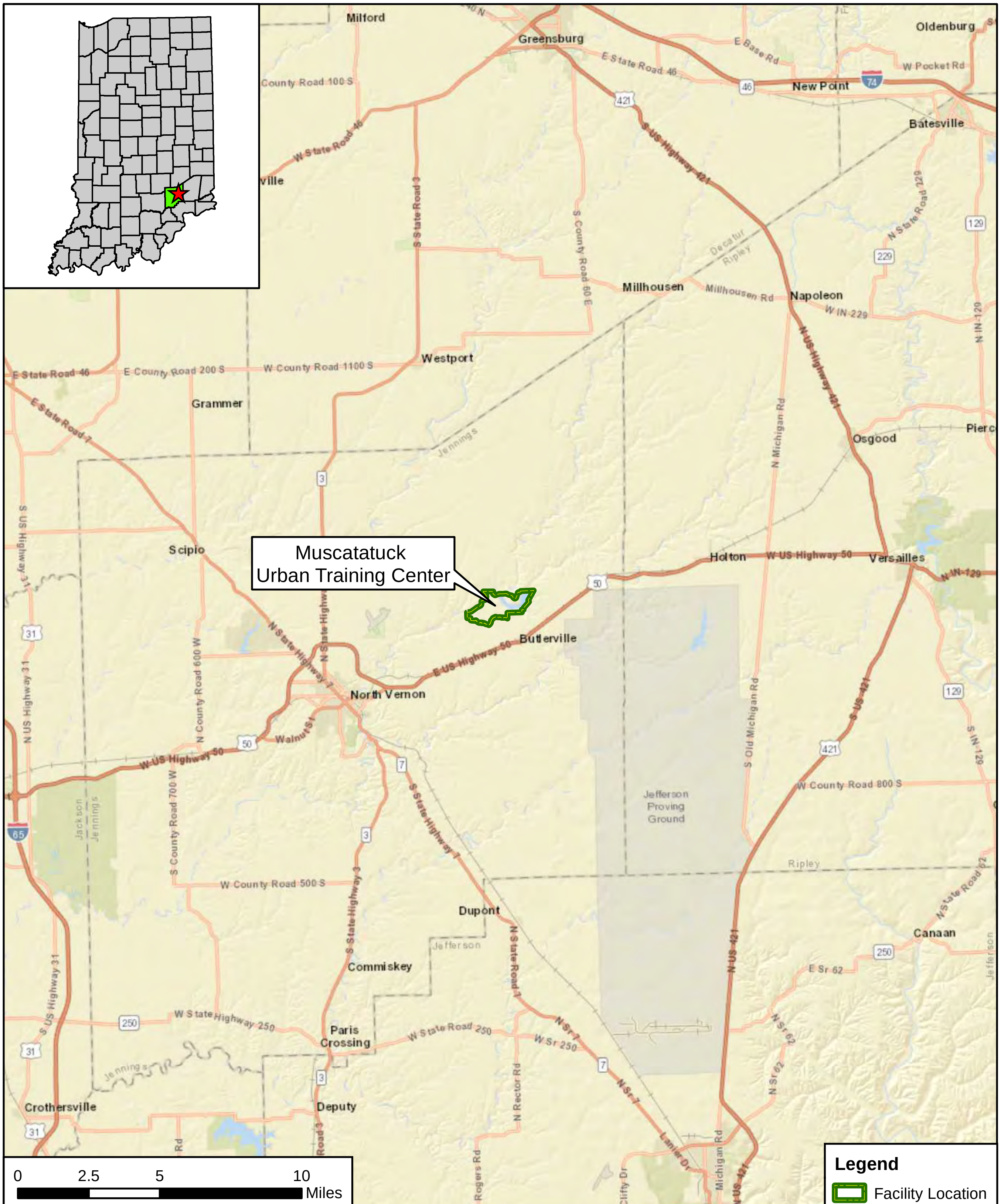

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Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	8/17/2022

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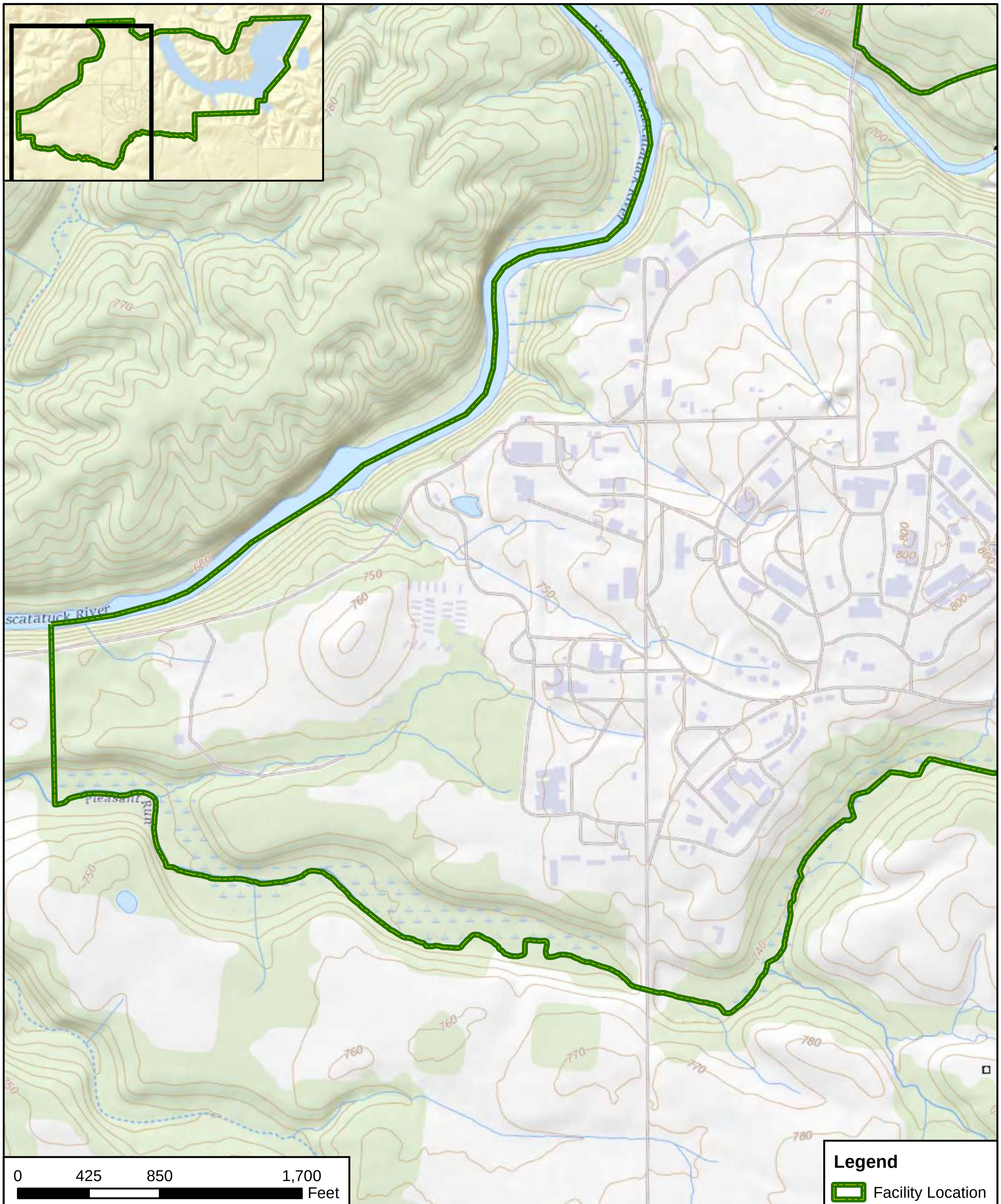
Facility Location

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-1



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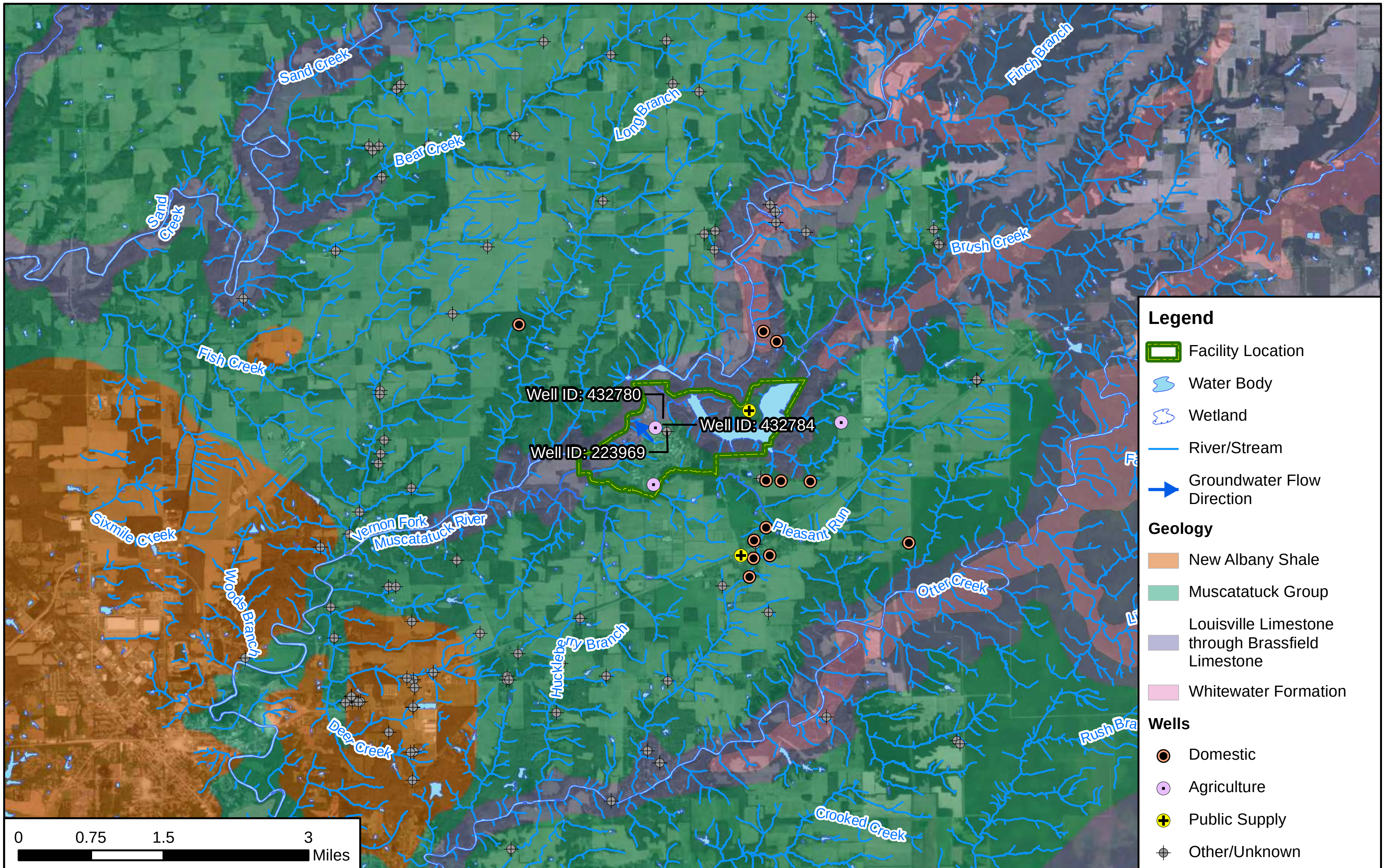
Base Map: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program,		PM	CM	8/17/2022			



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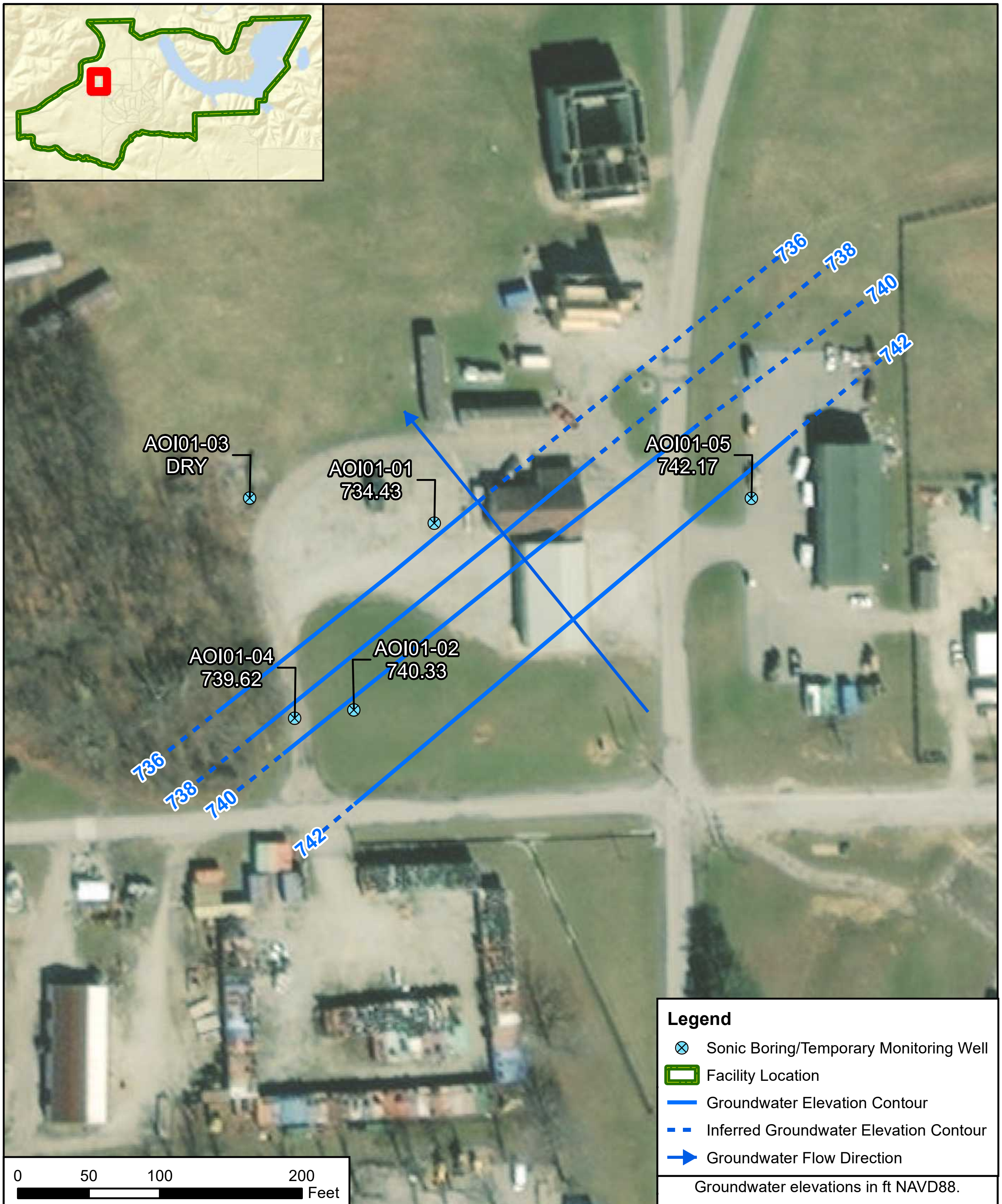
Groundwater Features

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-3



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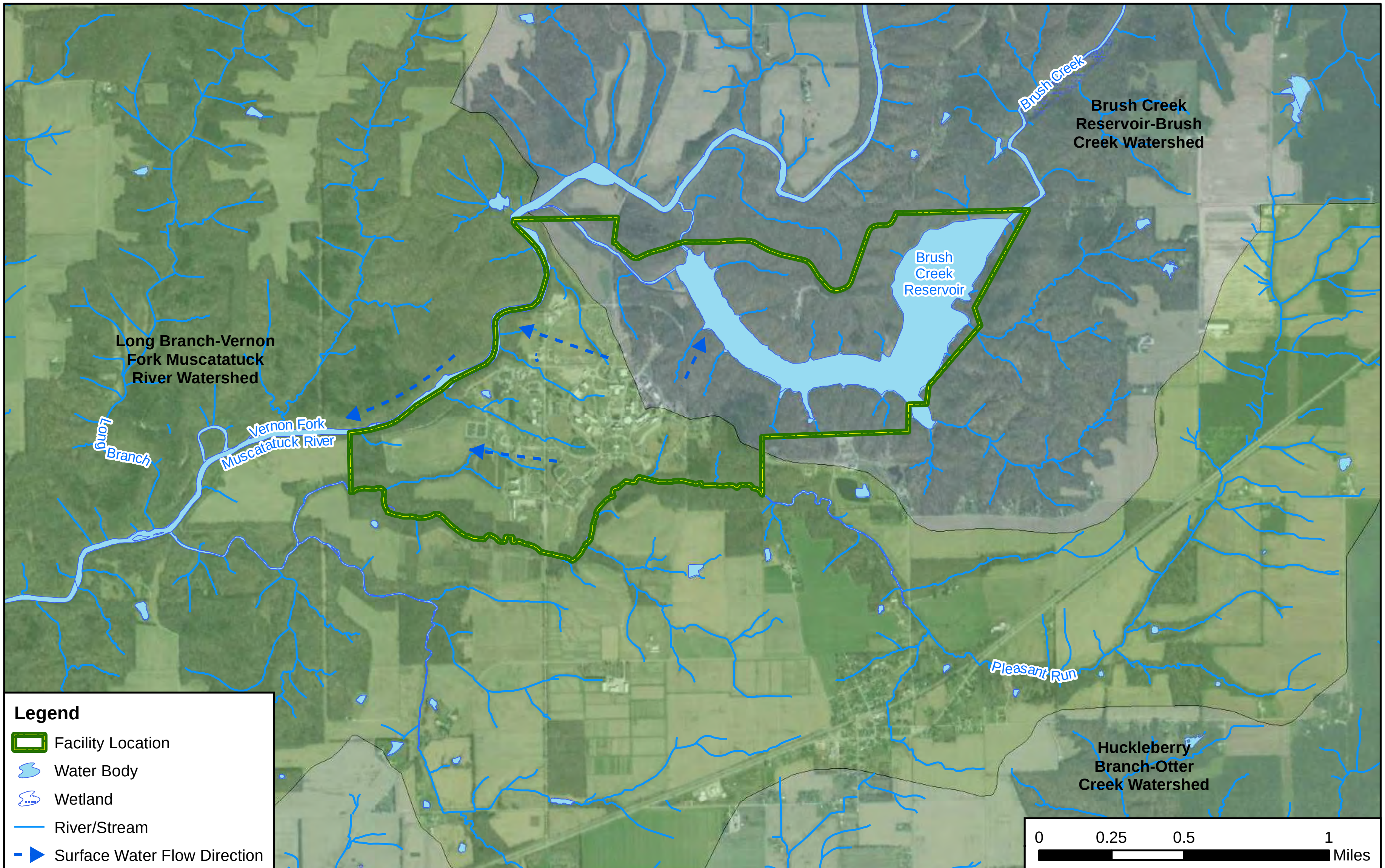

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N

Surface Water Features

AECOM

12420 Milestone Center Drive
Germantown, MD 20876

Figure 2-5

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3. Summary of Areas of Interest

The PA evaluated areas where PFAS-containing materials may have been used, stored, disposed, or released historically. Based on the PA findings, AFFF was stored at the facility and created the potential for it to have been incidentally released to the environment during handling or via leaks. Additionally, recent fire response activities resulted in the known release of AFFF to the ground surface. These areas were grouped into one AOI: MUTC Fire Station & Bus Fire (AECOM, 2021a). These potential release areas are shown on **Figure 3-1**.

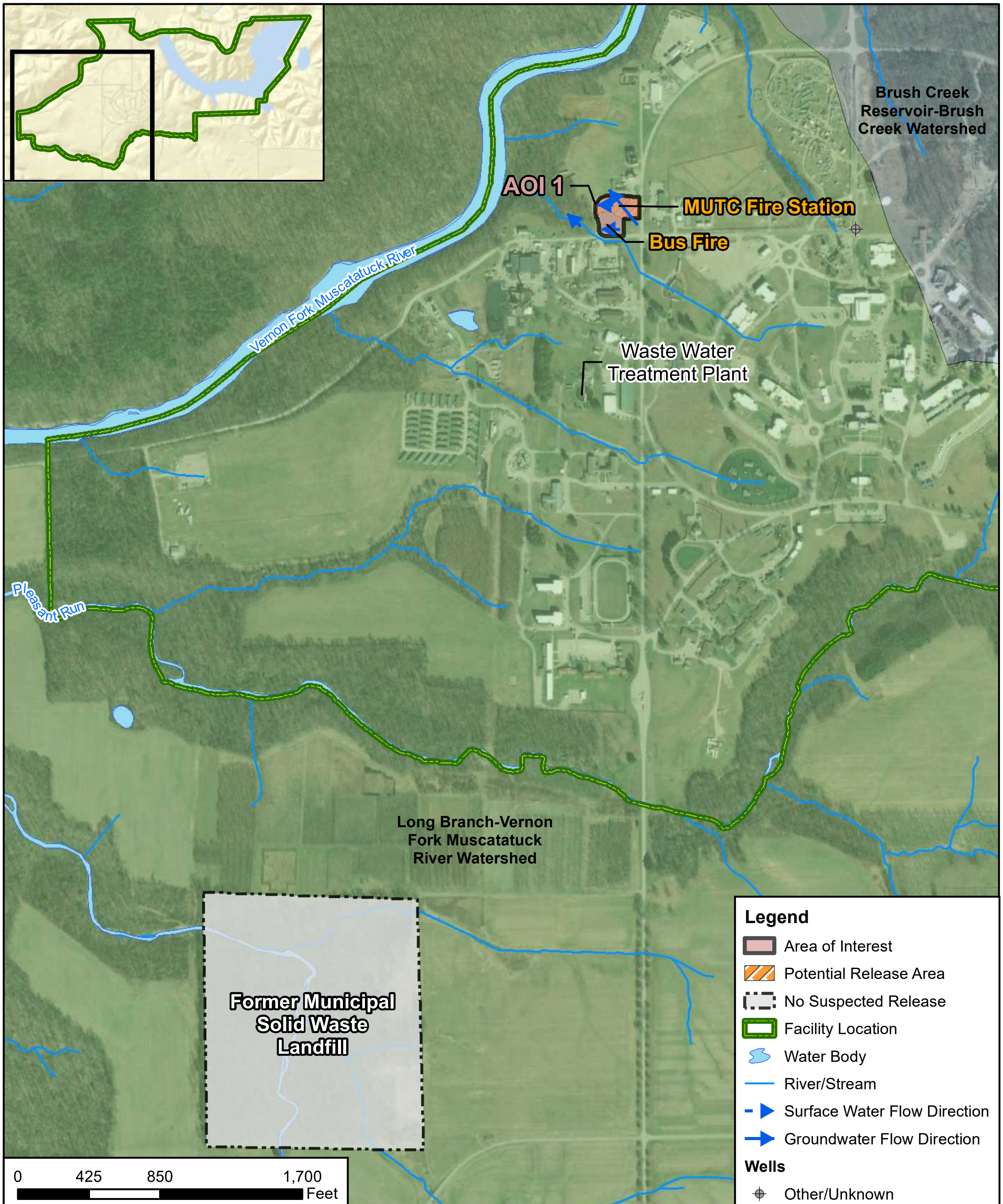
Two additional potential source areas were identified in the PA (AECOM, 2020), but were determined at that time not to be suspected release areas. An adjacent off-facility former municipal solid waste landfill is located 0.21 miles southwest of MUTC. Landfills are not usually a primary source of PFAS; however, PFAS-containing materials disposed of in landfills may leach the compounds into the environment over time. The on-facility Wastewater Treatment Plant (WWTP) is located about 0.22 miles south of the MUTC Fire Station. WWTPs, like landfills, can be secondary sources of PFAS, potentially receiving PFAS impacted wastewater and redistributing within sludge generated during the treatment process. The locations of the landfill and WWTP are shown in **Figure 3-1** for informational purposes but were not evaluated as part of this SI.

3.1 AOI 1: MUTC Fire Station Bus Fire

The MUTC Fire Station is located in the northwestern corner of the facility. The Fire Station historically housed three firetrucks and a “brush truck”, which is a small fire-fighting ATV; these firetrucks were acquired in 2008 and 2009. At the time of the PA site visit in 2018, two of the firetrucks and the brush truck were stored inside the Fire Station’s bays. A third, out of commission firetruck was stored on the gravel pad immediately behind, and west of, the Fire Station building. Each truck has the capacity to hold 40 gallons of AFFF, but at the time of the PA site visit, each only held approximately 20 gallons within their tanks. The out of commission firetruck, located on the gravel pad behind the Fire Station, carried an additional 44 5-gallon buckets of 3 percent (%) to 6% AFFF within the storage areas on the truck. The ATV brush truck contained 5 gallons of a 3% to 6% AFFF solution in its tank. Additionally, 16 5-gallon buckets of 3% to 6% alcohol-resistant AFFF concentrate were located in the loft storage area of the Fire Station bays along with 17 empty buckets, whose contents were confirmed by interviewees to be used to fill the firetrucks onsite. According to interviewees during the PA, AFFF was not discharged since the firetrucks were purchased in 2008, and there are no records of any AFFF leaks or spills from the AFFF stored at the Fire Station. After the PA site visit was conducted in 2018, the out of commission firetruck was reported to have been taken off MUTC, but it was later returned to the facility without AFFF on the truck, and at the time of the SI, it was parked near the original location, west of the Fire Station building. Additionally, facility personnel indicated that since the PA site visit, AFFF that was present at MUTC was removed from the facility and donated to local jurisdictions.

Early on the morning of 22 April 2021, the Campbell Township Volunteer Fire Department from Butlerville, Indiana responded to a transportation bus fire that occurred in the adjacent grass lot immediately southwest of the MUTC Fire Station. According to the Fire Department’s incident report, the cause of the bus fire was not known, and MUTC personnel at the scene had attempted to extinguish the fire using handheld fire extinguishers prior to contacting the Fire Department. Records indicate that the Campbell Township Volunteer Fire Department responded with foam from their fire engine and brush apparatus, using a total of 1 gallon of FireAde® AFFF concentrate mixed with approximately 200 gallons of water. The AFFF applied to the MUTC bus fire was not contained. The bus fire occurred after the PA report was finalized and was included as a potential release area within AOI 1 prior to the finalization of the SI Quality Assurance Project Plan (QAPP) Addendum.

AOI 1 encompasses the Fire Station, the 0.25-acre gravel pad west of the Fire Station, and the 0.45-acre grass lot immediately southwest of the Fire Station. The emergency response activities associated with the April 2021 bus fire resulted in a known release of AFFF to the ground surface at the AOI. Although there are no documented releases of the AFFF stored at the Fire Station, because AFFF was stored within both the station and firetrucks within and around the buildings, it is possible that AFFF may have historically been spilled or released during routine activities or product handling. Firetrucks containing/equipped with AFFF also have the potential to leak due to corrosion of fittings and gaskets. Details of fire training or fire-fighting activities at the facility between the years 2005 and 2008 are not known.



CLIENT	ARNG				N	**Area of Interest**
PROJECT	Site Inspection at Muscatatuck UTC, IN					
REVISED	9/15/2022	GIS BY	MS	9/15/2022		AECOM 12420 Milestone Center Drive Germantown, MD 20876 — **Figure 3-1**
SCALE	1:10,200	CHK BY	MC	9/15/2022		
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	9/15/2022		

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4. Project Data Quality Objectives

As identified during the Data Quality Objective (DQO) process and outlined in the SI QAPP Addendum (AECOM, 2021a), the objective of the SI is to identify whether there has been a release to the environment at the AOIs identified in the PA. For each AOI, ARNG determines if further investigation is warranted, a removal action is required to address immediate threats, or whether no further action is warranted. This SI evaluated groundwater and soil for presence or absence of relevant compounds at each of the sampled AOIs.

4.1 Problem Statement

ARNG will recommend an AOI for Remedial Investigation (RI) if related soil and groundwater samples have concentrations of the relevant compounds above the OSD risk-based SLs. The SLs are presented in **Section 6.1** of this report.

4.2 Information Inputs

Primary information inputs included:

- The PA for MUTC (AECOM, 2020);
- Analytical data from groundwater and soil samples collected as part of this SI in accordance with the site-specific Uniform Federal Policy (UFP)-QAPP Addendum (AECOM, 2021a); and
- Field data collected during the SI, including groundwater elevation and water quality parameters measured at the time of sampling.

4.3 Study Boundaries

The scope of the SI was bounded by the property limits of the facility (**Figure 2-2**). Off-facility sampling was not included in the scope of this SI. If future off-facility sampling is required, the proper stakeholders will be notified, and necessary rights of entry will be obtained by ARNG with property owner(s). The SI scope was bounded vertically by the observed depths of the surficial groundwater table. Temporal boundaries of the study were limited by seasonal conditions present during the Fall 2021 field work.

4.4 Analytical Approach

Samples were analyzed by Pace Analytical Gulf Coast, accredited under the DoD Environmental Laboratory Accreditation Program (ELAP; Accreditation Number 74960) and the National Environmental Laboratory Accreditation Program (NELAP; Certificate Number 01955). Data were compared to applicable SLs within this document and decision rules as defined in the SI QAPP Addendum (AECOM, 2021a).

4.5 Data Usability Assessment

The Data Usability Assessment (DUA), which is provided in **Appendix A**, is an evaluation at the conclusion of data collection activities that uses the results of both data verification and validation in the context of the overall project decisions or objectives. Using both quantitative and qualitative methods, the assessment determines whether project execution and the resulting data have met installation-specific DQOs. Both sampling and analytical activities are considered to assess whether the collected data are of the right type, quality, and quantity to support the decision-making (DoD, 2019a; DoD, 2019b; USEPA, 2017).

Based on the DUA, the environmental data collected during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUA and its associated data validation reports. These data are of sufficient quality to meet the objectives and requirements of the SI QAPP Addendum (AECOM, 2021a).

5. Site Inspection Activities

This section describes the environmental investigation and sampling activities that occurred as part of the SI. The SI sampling approach was based on the findings of the PA and implemented in accordance with the following approved documents:

- *Final Site Inspection Programmatic Uniform Federal Policy-Quality Assurance Project Plan (PQAPP)* dated March 2018 (AECOM, 2018a);
- *Final Programmatic Accident Prevention Plan* dated July 2018 (AECOM, 2018b);
- *Final Preliminary Assessment Report, Muscatatuck Urban Training Center, Indiana* dated October 2020 (AECOM, 2020);
- *Final Site Inspection Uniform Federal Policy-Quality Assurance Project Plan Addendum, Muscatatuck Urban Training Center, Butlerville, Indiana* dated October 2021 (AECOM, 2021a); and
- *Final Site Safety and Health Plan, Muscatatuck Urban Training Center, Butlerville, Indiana* dated November 2021 (AECOM, 2021b).

The SI field activities were conducted from 8 to 12 November 2021 and consisted of utility clearance, sonic boring, soil sample collection, temporary monitoring well installation, grab groundwater sample collection, and land surveying. Field activities were conducted in accordance with the SI QAPP Addendum (AECOM, 2021a), except as noted in **Section 5.8**.

The following samples were collected during the SI and analyzed for a subset of 18 compounds by liquid chromatography with tandem mass spectrometry (LC/MS/MS) compliant with Quality Systems Manual (QSM) 5.3 Table B-15 to fulfill the project DQOs:

- Nineteen (19) soil samples from nine boring locations;
- Four grab groundwater samples from five temporary wells (one well was dry);
- Twelve (12) quality assurance (QA)/quality control (QC) samples.

Figure 5-1 provides the sample locations for all media across the facility. **Table 5-1** presents the list of samples collected for each media. Field documentation is provided in **Appendix B**. A Log of Daily Notice of Field Activity was completed throughout the SI field activities, which is provided in **Appendix B1**. Sampling forms are provided in **Appendix B2**. A Field Change Report is provided in **Appendix B3**. Field survey data are provided in **Appendix B4**. Additionally, a photographic log of field activities is provided in **Appendix C**.

5.1 Pre-Investigation Activities

In preparation for the SI field activities, project team members participated in Technical Project Planning (TPP) meetings, performed utility clearance, and sampled decontamination source water. Details for each of these activities are presented below.

5.1.1 Technical Project Planning

The US Army Corps of Engineers (USACE) TPP Process, Engineer Manual (EM) 200-1-2 (USACE, 2016) defines four phases to project planning: 1.) defining the project phase; 2.) determining data needs; 3.) developing data collection strategies; and 4.) finalizing the data collection plan. The process encourages stakeholder involvement in the SI, beginning with defining overall project objectives, including DQOs, and formulating a sampling approach to address the AOIs identified in the PA.

A combined TPP Meeting 1 and 2 was held on 30 August 2021, prior to SI field activities. The combined TPP Meeting 1 and 2 was conducted in general accordance with EM 200-1-2. The stakeholders for this SI included the ARNG, INARNG, USACE, and Indiana Department of Environmental Management (IDEM). Stakeholders were provided the opportunity to make comments on the technical sampling approach and methods at the combined TPP Meeting 1 and 2. The outcome of the combined TPP Meeting 1 and 2 was memorialized in the SI QAPP Addendum (AECOM, 2021a).

A TPP Meeting 3 was held on 17 January 2023 to discuss the results of the SI. Meeting minutes for TPP 3 are included in **Appendix D** of this report. Future TPP meetings will provide an opportunity to discuss the results and findings, and future actions, where warranted.

5.1.2 Utility Clearance

Both AECOM and their drilling subcontractor, Cascade Technical Services, LLC, contacted Indiana 811 one-call utility clearance contractor prior to mobilization to notify them of intrusive work. Because Indiana 811 locators do not locate private utilities, such as those belonging to Muscatatuck UTC, AECOM contracted Ground Penetrating Radar Services, LLC (GPRS) to perform utility clearance for private utilities in the vicinity of the boring locations at MUTC. GPRS performed utility clearance on 29 October 2021 with input from the AECOM field team and INARNG. Additionally, the first 5 feet of each boring were advanced using hand augering methods to verify utility clearance in shallow subsurface where utilities would typically be encountered.

5.1.3 Source Water and Sampling Equipment Acceptability

The potable water source used for decontamination of drilling equipment was confirmed to be acceptable for use in a PFAS investigation prior to the start of field activities. A sample from a potable water source at MUTC was collected on 29 June 2021, prior to mobilization, and analyzed for PFAS by LC/MS/MS compliant with QSM 5.3 Table B-15. The results of the decontamination water sample are provided in **Appendix F**. A discussion of the results is presented in the DUA in **Appendix A**.

Materials that were used within the sampling zone were confirmed as acceptable for use in the sampling environment. The checklist of acceptable materials for use in the sampling environment was provided in the Standard Operating Procedures (SOPs) appendix to the SI QAPP Addendum (AECOM, 2021a). Prior to the start of field work each day, a Sampling Checklist was completed as an additional layer of control. The checklist served as a daily reminder to each field team member regarding the allowable materials within the sampling environment.

5.2 Soil Borings and Soil Sampling

Soil samples were collected via hand auger and roto-sonic (sonic) drilling methods, in accordance with the SI QAPP Addendum (AECOM, 2021a). A hand auger was used to collect soil from the top 5 feet of the boring, in accordance with AECOM utility clearance procedures. A GeoProbe® 8140DT sonic drilling sampling system with 4-inch diameter core barrel and 6-inch diameter override casing was used to collect continuous soil cores to the target depth. The soil boring locations are shown on **Figure 5-1** and depths are provided **Table 5-1**.

In general, three discrete soil samples were collected from the vadose zone for chemical analysis from each sonic soil boring: one surface soil sample (0 to 2 feet bgs), one subsurface soil sample approximately 1 foot above the observed groundwater table, and one subsurface soil sample at the mid-point between the surface and the groundwater table. If groundwater was not encountered before bedrock refusal, a sample was collected from the unconsolidated soil interval immediately above the bedrock contact.

The soil cores were continuously logged for lithological descriptions by an AECOM field geologist using the Unified Soil Classification System (USCS). A photoionization detector (PID) was used to screen the breathing zone during boring activities as part of personal safety requirements. Observations and measurements were recorded on the boring logs (**Appendix E**) and in a non-treated field logbook (i.e., composition notebook). Depth interval, recovery thickness, PID concentrations, moisture, relative density, color (using a Munsell soil color chart), and texture (using the USCS) were recorded.

SI soil boring depths ranged in depth from 12 to 19 feet bgs. The unconsolidated section of the borings was predominately composed of lean clay and silt. Minor amounts of sand were present within the clay-silt matrix throughout. Occasional thin intervals (inches) of lean clay were also observed. A grain size analysis performed on soil collected over one of these intervals found the material consisted of predominately silt (47%) with lesser amounts of clay (37%) (**Appendix F**). Gravel inclusions were observed at deeper intervals, as were occasional cobble-sized limestone fragments near the bedrock contact. A 1- to 2-foot-thick section of poorly graded sand was encountered at or just above the bedrock contact in each of the borings. Bedrock cores recovered from the borings varied slightly in degree of weathering, but overall showed a well-cemented granular limestone. In boring AOI01-03, the limestone core was notably unweathered and contained visible styolites near the bedrock surface. These lithological observations are consistent with the understood depositional history of MUTC. The silt and clay observed are representative of the glacial till deposits common within the Jessup Formation that overlies bedrock in the region. Gravel in the borings may be a result of higher energy facies of the till or, where encountered closer to the bedrock contact, like the cobbles and poorly graded sand, the weathered remnants of the upper limestone surface. The depths to bedrock observed in SI borings ranged between 11.5 feet bgs at AOI01-04 to 17.5 feet bgs at AOI01-01. The bedrock surface beneath AOI 1 appears to slope northwest, based on approximate bedrock surface elevations calculated using observed bedrock depths and measured ground surface elevations.

Each soil sample was collected into laboratory-supplied PFAS-free high-density polyethylene (HDPE) bottles and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via Federal Express (FedEx) under standard chain of custody (CoC) procedures to the laboratory and analyzed by LC/MS/MS compliant with QSM 5.3 Table B-15, total organic carbon (TOC) (USEPA Method 9060A), pH (USEPA Method 9045D), and grain size (ASTM Method D-422) in accordance with the SI QAPP Addendum (AECOM, 2021a).

Field duplicate samples were collected at a rate of 10% and analyzed for the same parameters as the accompanying samples. Matrix spike (MS)/MS duplicates (MSDs) were collected at a rate of 5% and analyzed for the same parameters as the accompanying samples. In instances when non-dedicated sampling equipment was used, such as a hand auger for the shallow soil samples, equipment rinsate blanks were collected at a rate of 5% and analyzed for the same parameters as the soil samples. A temperature blank was placed in each cooler to ensure that samples were preserved at or below 6 degrees Celsius (°C) during shipment.

Sonic borings were converted to temporary wells, which were subsequently abandoned in accordance with the SI QAPP Addendum (AECOM, 2021a) using bentonite chips at completion of sampling activities. Borings were installed in grass or gravel areas to avoid disturbing concrete or asphalt surfaces.

5.3 Temporary Well Installation and Groundwater Grab Sampling

Temporary wells were installed through the drill casing of the GeoProbe® 8140DT sonic drill rig. Once the borehole was advanced to the desired depth, a temporary well was constructed of a 5-foot section of 1-inch Schedule 40 poly-vinyl chloride (PVC) screen with sufficient casing to reach ground surface. New PVC pipe and screen were used to avoid cross contamination between locations. The screen intervals for the temporary wells are provided in **Table 5-2**.

The temporary wells were allowed to recharge after installation before collection of groundwater samples. After the recharge period, groundwater samples were collected using a peristaltic pump with PFAS-free HDPE tubing. Each sample was collected into laboratory-supplied PFAS-free HDPE bottles and labeled using a PFAS-free marker or pen. The temporary wells were purged at a rate determined in the field to reduce turbidity and draw down prior to sampling. Water quality parameters (e.g., temperature, specific conductance, pH, dissolved oxygen, and oxidation-reduction potential) were measured using a water quality meter and recorded on the field sampling form (**Appendix B2**) after each grab sample was collected. Additionally, a subsample of each groundwater sample was collected in a separate container, and a shaker test was completed to identify if there were any foaming. No foaming was noted in any of the groundwater samples.

Samples were packaged on ice and transported via FedEx under standard CoC procedures to the laboratory and analyzed by LC/MS/MS compliant with QSM 5.3 Table B-15 in accordance with the SI QAPP Addendum (AECOM, 2021a).

Field duplicate samples were collected at a rate of 10% and analyzed for the same parameters as the accompanying samples. MS/MSDs were collected at a rate of 5% and analyzed for the same parameters as the accompanying samples. One field reagent blank was collected in accordance with the PQAPP (AECOM, 2018a). A temperature blank was placed in each cooler to ensure that samples were preserved at or below 6 °C during shipment.

Following well surveying (described below in **Section 5.5**), the temporary wells were abandoned in accordance with the SI QAPP Addendum (AECOM, 2021a) by removing the PVC and backfilling the hole with bentonite chips. Temporary wells were installed in grass areas to avoid disturbing concrete or asphalt.

5.4 Synoptic Water Level Measurements

A synoptic groundwater gauging event was performed on 12 November 2021, after sufficient time was allowed for groundwater levels to equilibrate within the wells. Groundwater level measurements were collected from the four temporary monitoring wells by measuring from the northern side of the well casing. A groundwater flow contour map is provided in **Figure 2-4**. Groundwater elevation data are provided in **Table 5-2**.

5.5 Surveying

The northern side of each well casing was surveyed by Indiana-licensed land surveyors following the guidelines of the SOPs provided in the SI QAPP Addendum (AECOM, 2021a). Survey data from the newly installed wells on the facility were collected on 12 November 2021 in the applicable Universal Transverse Mercator zone projection with World Geodetic System 84 datum (horizontal) and North American Vertical Datum 1988 (vertical). The surveyed well data are provided in **Appendix B4**.

5.6 Investigation-Derived Waste

As of the date of this report, the disposal of investigation-derived waste (IDW) is not regulated federally. IDW generated during the SI is considered non-hazardous waste and was managed in accordance with the SI QAPP Addendum (AECOM, 2021a) and with the DA Guidance for Addressing Releases of PFAS, Q18 (DA, 2018).

Soil IDW (i.e., soil cuttings) were generated during the SI activities from the five soil boring locations associated with the temporary wells. No soil IDW was generated at the surface soil sample locations. All soil IDW were containerized in labeled 55-gallon drums. The IDW drums were segregated by location and stored inside the MUTC Fire Barn in the northwest corner of the garage, as designated by INARNG, pending laboratory analysis. Based on laboratory results, containerized soil cuttings will be managed and disposed of off-facility by ARNG, under a separate contract held by EA Engineering, Science, and Technology, Inc. (EA).

Liquid IDW generated during SI activities (i.e., purge water, development water, and decontamination fluids) were containerized in a labeled 55-gallon drum. The liquid IDW drum was stored inside the MUTC Fire Barn in the northwest corner of the garage, as designated by INARNG, pending laboratory analysis. ARNG will manage and dispose of the liquid IDW off-facility under a separate contract in accordance with SOP No. 042A for Treating Liquid Investigation-Derived Material (Purge water, drilling water, and decontamination fluids) (EA Engineering, Science, and Technology, Inc., 2021).

Other solids such as spent personal protective equipment, plastic sheeting, tubing, rope, unused monitoring well construction materials, and other environmental media generated during the field activities were disposed of at a licensed solid waste landfill.

5.7 Laboratory Analytical Methods

Samples were analyzed by LC/MS/MS compliant with QSM 5.3 Table B-15 at Pace Analytical Gulf Coast in Baton Rouge, Louisiana, a DoD ELAP and NELAP certified laboratory. Soil samples were also analyzed for TOC using USEPA Method 9060A, pH by USEPA Method 9045D, and grain size using ASTM Method D-422.

5.8 Deviations from SI QAPP Addendum

Two deviations from the SI QAPP Addendum were identified during review of the field documentation. The deviations are noted below and were documented in Field Change Request Forms (**Appendix B3**):

- The site walk completed during the private utility locate on 29 October 2021 showed that the actual ground slope at AOI 1, and thus, surface runoff pattern, was slightly different than inferred during development of the SI QAPP. Information provided by INARNG confirmed that surface runoff in this area flows slightly north of where originally assumed. Boring locations AOI01-02 and AOI01-04 were adjusted approximately 25 feet from where originally shown in the Final SI QAPP. Location AOI01-02 was moved approximately 25 feet W-NW, from the south side of the burned bus to the downslope corner of the bus. Location AOI01-04 was moved approximately 25 feet north, where surface runoff flow from the area around the fire station and bus fire is most concentrated. The adjustments to the sample locations better meet the DQOs. The final sample locations are shown on **Figure 5-1**. The Field Change Request documenting this is provided in **Appendix B3**.

- Soil boring and temporary well location AOI01-03 was drilled to the top of the bedrock interface on 9 November 2021. Free groundwater was not observed in the borehole, but moist to wet soil was observed in the interval just above bedrock, similar to other locations that produced groundwater. No groundwater was measured within the boring during the subsequent 2 days. On 11 November 2021, AOI01-03 was advanced an additional 1.5 feet, into the competent bedrock, to dry drilling refusal. No groundwater infiltration was observed. It was determined that perched groundwater observed above the bedrock contact at the other four locations was not present at AOI01-03, a conclusion that is supported by the findings of the 2005 environmental assessment which noted the variability of available groundwater at this contact at MUTC (Risch et al., 2007). The determination was made to not drill further into competent bedrock and evaluate the location based on the three soil samples collected from the AOI01-03 boring, including one just above the bedrock contact where water was typically encountered. Further, the conclusion was made that the groundwater data from the other four boring locations, two of which were within potential release areas, were adequate to meet the DQOs.

Table 5-1
Site Inspection Samples by Medium
Site Inspection Report, Muscatatuck Urban Training Center, Indiana

Sample Identification	Sample Collection Date/Time	Sample Depth (feet bgs)	LC/MS/MS compliant with QSM 5.3 Table B-15	TOC (USEPA Method 9060A)	pH (USEPA Method 9045D)	Grain Size (ASTM D-422)	Comments
Soil Samples							
AOI01-01-SB-00-02	11/9/2021 16:08	0-2	x				
AOI01-01-SB-12-13	11/10/2021 12:15	12-13	x				
AOI01-01-SB-16-16.5	11/10/2021 12:20	16-16.5	x				
AOI01-02-SB-00-02	11/10/2021 16:55	0-2	x	x	x		
AOI01-02-SB-00-02-D	11/10/2021 16:55	0-2	x	x	x		Duplicate
AOI01-02-SB-00-02-MS	11/10/2021 16:55	0-2	x	x	x		MS/MSD
AOI01-02-SB-00-02-MSD	11/10/2021 16:55	0-2	x	x	x		MS/MSD
AOI01-02-SB-05-06	11/10/2021 16:58	5-6	x				
AOI01-02-SB-10-10.3	11/10/2021 17:00	10-10.3	x				
AOI01-03-SB-00-02	11/9/2021 11:05	0-2	x				
AOI01-03-SB-09.25-11.25	11/9/2021 15:10	9.25-11.25	x				
AOI01-03-SB-11.25-12	11/9/2021 15:15	11.25-12				x	
AOI01-03-SB-16.5-16.75	11/9/2021 14:50	16.5-16.75	x				
AOI01-04-SB-00-02	11/10/2021 14:50	0-2	x				
AOI01-04-SB-00-02-D	11/10/2021 14:50	0-2	x				Duplicate
AOI01-04-SB-06-06.75	11/10/2021 14:55	6-6.75	x				
AOI01-04-SB-10-10.25	11/10/2021 15:00	10-10.25	x				
AOI01-05-SB-00-02	11/8/2021 15:10	0-2	x				
AOI01-05-SB-05-07	11/8/2021 16:30	5-7	x				
AOI01-05-SB-12-14	11/8/2021 16:35	12-14	x				
AOI01-06-SB-00-02	11/9/2021 17:30	0-2	x				
AOI01-07-SB-00-02	11/9/2021 17:10	0-2	x				
AOI01-08-SB-00-02	11/10/2021 14:52	0-2	x				
AOI01-09-SB-00-02	11/10/2021 12:09	0-2	x				
Groundwater Samples							
AOI01-01-GW	11/10/2021 16:57	NA	x				
AOI01-02-GW	11/11/2021 11:04	NA	x				
AOI01-04-GW	11/11/2021 9:31	NA	x				
AOI01-04-GW-D	11/11/2021 9:31	NA	x				Duplicate
AOI01-04-GW-MS	11/11/2021 9:31	NA	x				MS/MSD
AOI01-04-GW-MSD	11/11/2021 9:31	NA	x				MS/MSD
AOI01-05-GW	11/9/2021 15:47	NA	x				
Quality Control Samples							
MUTC-ERB-01	11/8/2021 10:25	NA	x				ERB
MUTC-ERB-02	11/11/2021 11:00	NA	x				ERB
MUTC-FRB-01	11/8/2021 10:14	NA	x				FRB
MUTC-DECON-01	6/29/2021 14:00	NA	x				DECON
MUTC-DECON-02	11/11/2021 11:05	NA	x				DECON

Notes:
ASTM = American Society for Testing and Materials
bgs = below ground surface
DECON = decontamination water sample
ERB = equipment rinsate blank
FRB = field reagent blank
LC/MS/MS = Liquid Chromatography Mass Spectrometry
MS/MSD = matrix spike/ matrix spike duplicate
MUTC = Muscatatuck Urban Training Center
QSM = Quality Systems Manual
TOC = total organic carbon
USEPA = United States Environmental Protection Agency

Table 5-2
Soil Boring Depths, Temporary Well Screen Intervals, and Groundwater Elevations
Site Inspection Report, Muscatatuck Urban Training Center, Indiana

Area of Interest	Boring Location	Soil Boring Depth (feet bgs)	Temporary Well Screen Interval (feet bgs)	Top of Casing Elevation (feet NAVD88)	Ground Surface Elevation (feet NAVD88)	Depth to Water (feet btoc)	Depth to Water (feet bgs)	Groundwater Elevation (feet NAVD88)
1	AOI01-01	19.0	13.9-18.9	753.77	752.12	19.34	17.69	734.43
	AOI01-02	13.5	8-13	751.84	749.37	11.51	9.04	740.33
	AOI01-03*	18.5	NA	NA	748.82	NA	NA	NA
	AOI01-04	12.0	7-12	751.00	747.72	11.38	8.10	739.62
	AOI01-05	16.5	11.5-16.5	759.48	755.53	17.31	13.36	742.17

Notes:

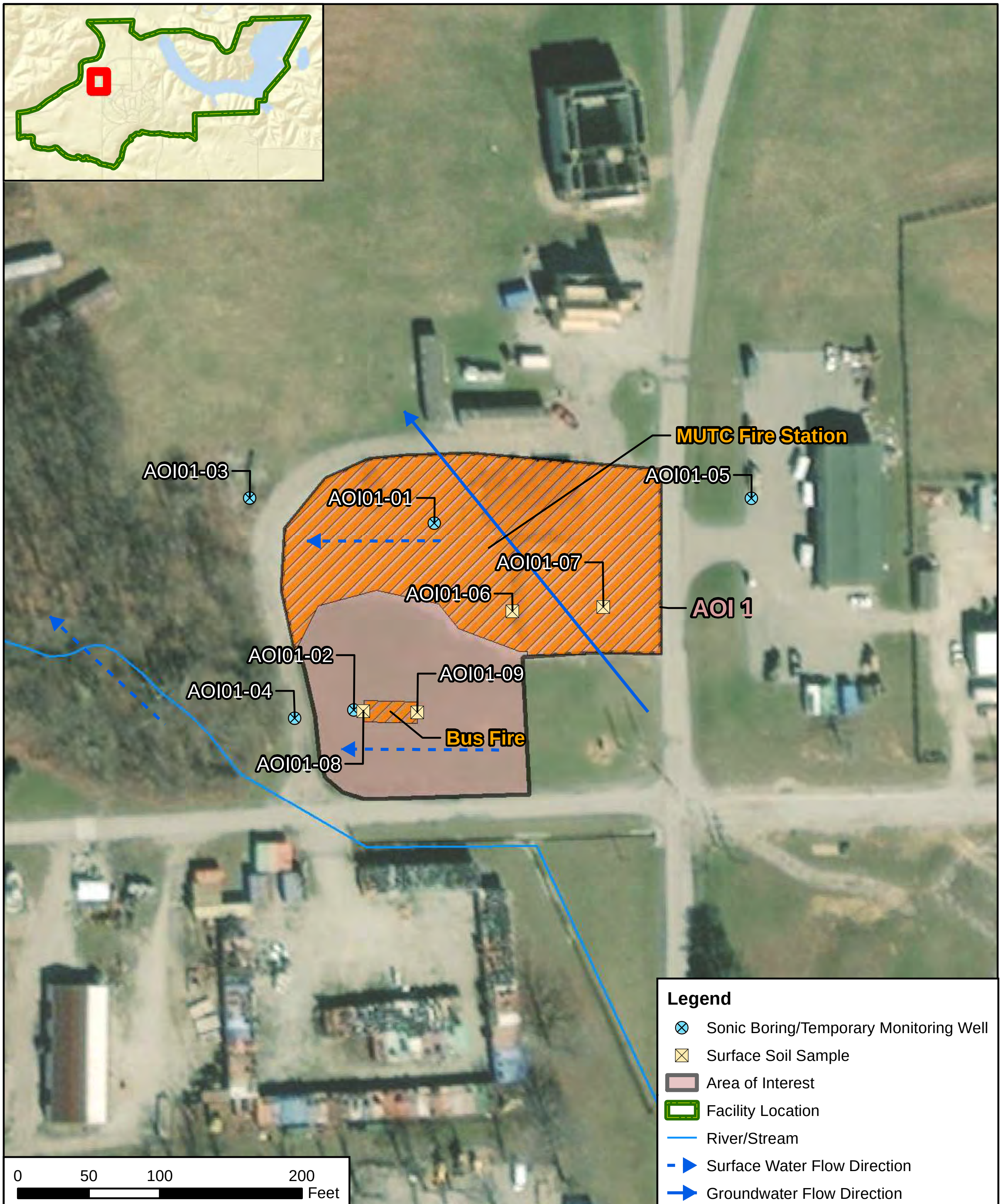
*Groundwater not encountered above bedrock refusal at location AOI01-03. No temporary well installed.

bgs = below ground surface

btoc = below top of casing

NA = not applicable

NAVD88 = North American Vertical Datum 1988



CLIENT	ARNG			
PROJECT	Site Inspection at Muscatatuck UTC, IN			
REVISED	8/17/2022	GIS BY	MS	8/17/2022
SCALE	1:1,200	CHK BY	MC	8/17/2022
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI,		PM	CM	8/17/2022

SI Sample Locations

AECOM
12420 Milestone Center Drive
Germantown, MD 20876

Figure 5-1

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6. Site Inspection Results

This section presents the analytical results of the SI. The SLs used in this evaluation are presented in **Section 6.1**. A discussion of the results for AOI 1 is provided in **Section 6.3**. **Table 6-2** through **Table 6-5** present results in soil or groundwater for the relevant compounds. Tables that contain all results are provided in **Appendix F**, and the laboratory reports are provided in **Appendix G**.

6.1 Screening Levels

The DoD has adopted a policy to retain facilities in the CERCLA process based on risk-based SLs for soil and groundwater, as described in a memorandum from the OSD dated 6 July 2022 (Assistant Secretary of Defense, 2022). The ARNG program under which this SI was performed follows this DoD policy. Should the maximum site concentration for sampled media exceed the SLs established in the OSD memorandum, the AOI will proceed to the next phase under CERCLA. The SLs established in the OSD memorandum apply to the five compounds presented on **Table 6-1** below.

Table 6-1: Screening Levels (Soil and Groundwater)

Analyte[b]	Residential (Soil) (µg/kg)[a] 0-2 feet bgs	Industrial/ Commercial Composite Worker (Soil) (µg/kg)[a] 2-15 feet bgs	Tap Water (Groundwater) (ng/L)[a]
PFOA	19	250	6
PFOS	13	160	4
PFBS	1,900	25,000	601
PFHxS	130	1,600	39
PFNA	19	250	6

Notes:
bgs = below ground surface; µg/kg = micrograms per kilogram; ng/L = nanograms per liter
a.) Assistant Secretary of Defense, 2022. Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's (USEPA's) Regional Screening Level Calculator. Hazard Quotient (HQ) = 0.1. 6 July 2022.
b.) Screening values for HFPO-DA were established after SI planning and execution and thus not included as an analyte. Future CERCLA phases will include HFPO-DA if warranted.

The data in the subsequent sections are compared against the SLs presented in **Table 6-1**. The SLs for groundwater are based on direct ingestion. The SLs for soil are based on incidental ingestion and are applied to the depth intervals reasonably anticipated to be encountered by the receptors identified at the facility: the residential scenario is applied to surface soil results (0 to 2 feet bgs) and the industrial/commercial worker scenario is applied to shallow subsurface soil results (2 to 15 feet bgs). The SLs are not applied to deep subsurface soil results (>15 feet bgs) because 15 feet is the anticipated limit of construction activities.

6.2 Soil Physicochemical Analyses

To provide basic soil parameter information, soil samples were analyzed for TOC, pH, and grain size, which are important for evaluating transport through the soil medium. **Appendix F** contains the results of the TOC, pH, and grain size sampling. Soil pH was relatively neutral at 7.83. The

TOC concentration at this location was 4,260 milligrams per kilogram (mg/kg). Grain size results are briefly discussed above in Section 5.2.

The data collected in this investigation will be used in subsequent investigations, where appropriate, to assess fate and transport. According to the Interstate Technology Regulatory Council (ITRC), several important partitioning mechanisms include hydrophobic and lipophobic effects, electrostatic interactions, and interfacial behaviors. At relevant environmental pH values, certain PFAS are present as organic anions and are therefore relatively mobile in groundwater (Xiao et al., 2015), but tend to associate with the organic carbon fraction that may be present in soil or sediment (Higgins and Luthy 2006; Guelfo and Higgins, 2013). When sufficient organic carbon is present, organic carbon normalized distribution coefficients (K_{oc} values) can help in evaluating transport potential, though other geochemical factors (for example, pH and presence of polyvalent cations) may also affect PFAS sorption to solid phases (ITRC, 2018).

6.3 AOI 1

This section presents the analytical results for soil and groundwater in comparison to SLs for AOI 1: MUTC Fire Station & Bus Fire. The soil and groundwater results are summarized on **Table 6-2** through **Table 6-5**. Soil and groundwater results are presented on **Figure 6-1** through **Figure 6-7**.

6.3.1 AOI 1 Soil Analytical Results

Soil was sampled in the vicinity of the MUTC Fire Station at three soil borings (AOI01-01, AOI01-03, and AOI01-05) and two surface soil sample locations (AOI01-06 and AOI01-07). Soil was sampled in the vicinity of the Bus Fire at two soil borings (AOI01-02 and AOI01-04) and two surface sample locations (AOI01-08 and AOI01-09). Three soil samples were collected at each AOI 1 boring location. Soil was sampled from the surface (0 to 2 feet bgs), the shallow subsurface (5 to 14 feet bgs), and the deep subsurface (16-17 feet bgs). Depths of the subsurface sample intervals varied between locations depending on the observed depth of saturated soil, bedrock, or potential local confining layers observed in the boring. **Figure 6-1** through **Figure 6-5** present the ranges of detections in soil. **Table 6-2** through **Table 6-4** summarize the soil results.

PFOS exceeded the SL in surface soil at AOI 1 but did not exceed the SL in shallow subsurface soil. PFOA, PFHxS, PFNA, and PFBS did not exceed their respective SLs in either surface or shallow subsurface soil at AOI 1 and, with the exception of PFOA, were detected at least an order of magnitude below their SLs.

In surface soil, PFOA was detected at three of nine locations, with concentrations ranging between 0.104 J micrograms per kilogram (µg/kg) (AOI01-04) to 1.04 µg/kg (AOI01-07). The laboratory “J” qualifier associated with some results indicates that the analyte was detected, but the reported value is estimated because the concentration is below the Limit of Detection or QC criteria were not fully met. Additional detail on laboratory qualifiers and data usability is provided in **Appendix A**. PFOS was detected at all nine locations, with concentrations ranging between 0.156 J µg/kg (AOI01-03) to 125 µg/kg (AOI01-01), resulting in exceedances of the SL at AOI01-01 and AOI01-07 (16.7 µg/kg). PFHxS was detected at seven of nine locations, with concentrations ranging from 0.076 J µg/kg (AOI01-08) to 18.3 µg/kg (AOI01-07). PFNA was detected at eight of nine locations, with concentrations ranging from 0.025 µg/kg (AOI01-02) to 0.230 µg/kg (AOI01-01). PFBS was detected at three of nine locations, with concentrations ranging between 0.032 µg/kg (AOI01-04) to 1.19 µg/kg (AOI01-07).

In shallow subsurface soil, PFOA was detected at one of five locations, AOI01-01, at a concentration of 0.169 J µg/kg. PFOS was detected at three of five locations, with concentrations ranging from 0.098 J µg/kg (AOI01-04) to 19.5 µg/kg (AOI01-01). PFHxS was detected at the same three locations, with concentrations ranging from 0.051 µg/kg (AOI01-02) to 1.78 µg/kg (AOI01-01). PFNA and PFBS were detected only at AOI01-01, at concentrations of 0.036 J µg/kg and 0.146 J µg/kg, respectively.

PFOS, PFHxS, and PFBS were detected in deep subsurface soil only at AOI01-01. Detected concentrations were 0.838 J µg/kg, 0.204 J µg/kg, and 0.026 J µg/kg, respectively. PFOA and PFNA were not detected in deep subsurface soil.

6.3.2 AOI 1 Groundwater Analytical Results

Groundwater was sampled from temporary wells installed at AOI01-01, AOI01-02, AOI01-04, and AOI01-05. Groundwater was not sampled at AOI01-03 because it was not encountered in the borehole. **Figure 6-6** and **Figure 6-7** present the ranges of detections in groundwater. **Table 6-5** summarizes the groundwater results.

PFOA, PFOS, and PFHxS exceeded the SLs in groundwater at AOI 1. PFNA and PFBS did not exceed their respective groundwater SLs.

PFOA was detected in groundwater at all four sampled locations at concentrations ranging between 0.995 J nanograms per liter (ng/L) (AOI01-05) to 10.7 ng/L (AOI01-01), with one exceedance of the 6 ng/L SL at AOI01-01. PFOS was detected at all four sampled locations at concentrations ranging between 2.15 J ng/L (AOI01-05) and 353 ng/L (AOI01-01), with three exceedances of the 4 ng/L SL at AOI01-01, AOI01-02 (12.4 ng/L), and AOI01-04 (7.98 ng/L). PFHxS was detected at all four locations at concentrations ranging between 1.90 J ng/L (AOI01-05) and 296 ng/L (AOI01-01), with two exceedances of the 39 ng/L SL at AOI01-01 and AOI01-02 (253 ng/L). PFBS was detected at all four locations samples with concentrations ranging between 0.975 J ng/L (AOI01-05) and 35.6 ng/L (AOI01-01). PFNA was not detected in groundwater at AOI 1.

6.3.3 AOI 1 Conclusions

PFOA, PFOS, PFHxS, PFNA, and PFBS were detected in soil at AOI 1; however, PFOS was the only compound detected above its SL. PFOA, PFOS, PFHxS, and PFBS were detected in groundwater from all four wells sampled at the AOI, with PFOA, PFOS, and PFHxS exceeding their SLs at multiple locations in groundwater at the AOI. PFNA was not detected in groundwater at AOI.

The maximum PFOA, PFOS, PFHxS, PFNA, and PFBS concentrations in soil were observed in the gravel lot adjacent to the Fire Station Building, consistent with the area where the maximum PFOA, PFOS, PFHxS, and PFBS concentrations were detected in groundwater at AOI01-01. This area is where AFFF was known to have been stored historically. Based on the exceedance the soil and groundwater SLs, further evaluation at AOI 1 is warranted.

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Table 6-2
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Soil
Site Inspection Report, Muscatatuck Urban Training Center

	Area of Interest	AOI01																			
	Sample ID	AOI01-01-SB-00-02		AOI01-02-SB-00-02		AOI01-02-SB-00-02-D		AOI01-03-SB-00-02		AOI01-04-SB-00-02		AOI01-04-SB-00-02-D		AOI01-05-SB-00-02		AOI01-06-SB-00-02		AOI01-07-SB-00-02		AOI01-08-SB-00-02	
	Sample Date	11/09/2021		11/10/2021		11/10/2021		11/09/2021		11/10/2021		11/10/2021		11/08/2021		11/09/2021		11/09/2021		11/10/2021	
	Depth	0-2 ft		0-2 ft		0-2 ft		0-2 ft		0-2 ft		0-2 ft		0-2 ft		0-2 ft		0-2 ft		0-2 ft	
Analyte	OSD Screening Level [a]	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
PFBS	1900	0.988	J	ND	U	ND	U	ND	U	0.032	J	0.056	J	ND	U	ND	U	1.19		ND	U
PFHxS	130	10.1		0.139	J	0.133	J	ND	U	0.535	J	0.758	J	ND	U	0.154	J	18.3		0.076	J
PFNA	19	0.230	J	0.031	J	0.025	J	0.069	J	0.092	J	0.120	J	0.056	J	ND	U	0.033	J	0.032	J
PFOA	19	0.970	J	ND	U	ND	U	ND	U	0.104	J	0.147	J	ND	U	ND	U	1.04		ND	U
PFOS	13	125		1.29	J-	0.682	J-	0.156	J	9.58		13.0		0.444	J	0.649	J	16.7		0.944	J

Grey Fill — Detected concentration exceeded OSD Screening Levels

References

a. Assistant Secretary of Defense, July 2022. Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1, May 2022. Soil screening levels based on residential scenario for incidental ingestion of contaminated soil.

Interpreted Qualifiers

J = Estimated concentration

J- = Estimated concentration, biased low

U = The analyte was not detected at a level greater than or equal to the adjusted DL

Notes

ND = Analyte not detected above the LOD. LOD values are presented in Appendix F.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
D	duplicate
DL	detection limit
ft	feet
HQ	hazard quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
ND	analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	interpreted qualifier
SB	soil boring
USEPA	United States Environmental Protection Agency
μg/kg	micrograms per kilogram

Table 6-2
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Soil
Site Inspection Report, Muscatatuck Urban Training Center

	Area of Interest	AOI01	
	Sample ID	AOI01-09-SB-00-02	
	Sample Date	11/10/2021	
	Depth	0-2 ft	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**
[redacted]			
PFBS	1900	ND	U
PFHxS	130	0.151	J
PFNA	19	0.027	J
PFOA	19	ND	U
PFOS	13	0.482	J

Grey Fill — Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, July 2022. Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1, May 2022. Soil screening levels based on residential scenario for incidental ingestion of contaminated soil.

Interpreted Qualifiers
J = Estimated concentration
J- = Estimated concentration, biased low
U = The analyte was not detected at a level greater than or equal to the adjusted DL

Notes
ND = Analyte not detected above the LOD. LOD values are presented in Appendix F.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
D	duplicate
DL	detection limit
ft	feet
HQ	hazard quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
ND	analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	interpreted qualifier
SB	soil boring
USEPA	United States Environmental Protection Agency
µg/kg	micrograms per kilogram

Table 6-3
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Shallow Subsurface Soil
Site Inspection Report, Muscatatuck Urban Training Center

	Area of Interest	AOI01															
	Sample ID	AOI01-01-SB-12-13		AOI01-02-SB-05-06		AOI01-02-SB-10-10.3		AOI01-03-SB-09.25-11.25		AOI01-04-SB-06-06.75		AOI01-04-SB-10-10.25		AOI01-05-SB-05-07		AOI01-05-SB-12-14	
	Sample Date	11/10/2021		11/10/2021		11/10/2021		11/09/2021		11/10/2021		11/10/2021		11/08/2021		11/08/2021	
	Depth	12-13 ft		5-6 ft		10-10.3 ft		9.25-11.25 ft		6-6.75 ft		10-10.25 ft		5-7 ft		12-14 ft	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Soil, LCMSMS compliant with QSM 5.3 Table B-15 (µg/kg)																	
PFBS	25000	0.146	J	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFHxS	1600	1.78		0.053	J	0.051	J	ND	U	0.056	J	0.063	J	ND	U	ND	U
PFNA	250	0.036	J	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFOA	250	0.169	J	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U	ND	U
PFOS	160	19.5		0.143	J	0.158	J	ND	U	0.158	J	0.098	J	ND	U	ND	U

Grey Fill — Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, July 2022. Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1, May 2022. Soil screening levels based on industrial/commercial composite worker scenario for incidental ingestion of contaminated soil.

Interpreted Qualifiers
J = Estimated concentration
U = The analyte was not detected at a level greater than or equal to the adjusted DL

Notes
ND = Analyte not detected above the LOD. LOD values are presented in Appendix F.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
DL	detection limit
ft	feet
HQ	hazard quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
ND	analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	interpreted qualifier
SB	soil boring
USEPA	United States Environmental Protection Agency
µg/kg	micrograms per kilogram

Table 6-4
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Deep Subsurface Soil
Site Inspection Report, Muscatatuck Urban Training Center

Area of Interest	AOI01			
Sample ID	AOI01-01-SB-16-16.5		AOI01-03-SB-16.5-16.75	
Sample Date	11/10/2021		11/09/2021	
Depth	16-16.5 ft		16.5-16.75 ft	
Analyte	**Result**	**Qual**	**Result**	**Qual**
Soil, LCMSMS compliant with QSM 5.3 Table B-15 (µg/kg)				
PFBS	0.026	J	ND	U
PFHxS	0.204	J	ND	U
PFNA	ND	U	ND	U
PFOA	ND	U	ND	U
PFOS	0.838	J	ND	U

Interpreted Qualifiers

J = Estimated concentration

U = The analyte was not detected at a level greater than or equal to the adjusted DL

Notes

ND = Analyte not detected above the LOD. LOD values are presented in Appendix F.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
DL	detection limit
ft	feet
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
ND	analyte not detected above the LOD
QSM	Quality Systems Manual
Qual	interpreted qualifier
SB	soil boring
µg/kg	micrograms per kilogram

Table 6-5
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Groundwater
Site Inspection Report, Muscatatuck Urban Training Center

	Area of Interest	AOI01									
	Sample ID	AOI01-01-GW		AOI01-02-GW		AOI01-04-GW		AOI01-04-GW-D		AOI01-05-GW	
	Sample Date	11/10/2021		11/11/2021		11/11/2021		11/11/2021		11/09/2021	
Analyte	**OSD Screening Level [a]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Water, LCMSMS compliant with QSM 5.3 Table B-15 (ng/l)											
PFBS	601	35.6		32.0		9.48		9.54		0.975	J
PFHxS	39	296		253		37.7		38.1		1.90	J
PFNA	6	ND	U	ND	U	ND	U	ND	U	ND	U
PFOA	6	10.7		5.84		2.48	J	2.35	J	0.995	J
PFOS	4	353		12.4		7.98		7.10		2.15	J

Grey Fill — Detected concentration exceeded OSD Screening Levels

References
a. Assistant Secretary of Defense, July 2022. Risk Based Screening Levels Calculated for PFOA, PFOS, PFBS, PFHxS, and PFNA in Groundwater or Soil using USEPA's Regional Screening Level Calculator. HQ=0.1, May 2022 Groundwater screening levels based on residential scenario for direct ingestion of groundwater.

Interpreted Qualifiers
J = Estimated concentration
U = The analyte was not detected at a level greater than or equal to the adjusted DL

Notes
ND = Analyte not detected above the LOD. LOD values are presented in Appendix F.

Chemical Abbreviations

PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations

AOI	Area of Interest
D	duplicate
DL	detection limit
GW	groundwater
HQ	hazard quotient
ID	identification
LCMSMS	liquid chromatography with tandem mass spectrometry
LOD	limit of detection
ND	analyte not detected above the LOD
OSD	Office of the Secretary of Defense
QSM	Quality Systems Manual
Qual	interpreted qualifier
USEPA	United States Environmental Protection Agency
ng/l	nanogram per liter

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J = Estimated concentration

CLIENT	ARNG				
PROJECT	Site Inspection at Muscatatuck UTC, IN				
REVISED	8/18/2022	GIS BY	MS	8/18/2022	
SCALE	1:1,200	CHK BY	MC	8/18/2022	
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	CM	8/18/2022	

Legend

Facility Location

River/Stream

0 50 100 200 Feet

N

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFOA Detections in Soil

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-1

J = Estimated concentration

CLIENT	ARNG				
PROJECT	Site Inspection at Muscatatuck UTC, IN				
REVISED	8/18/2022	GIS BY	MS	8/18/2022	
SCALE	1:1,200	CHK BY	MC	8/18/2022	
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	CM	8/18/2022	

Legend

- Facility Location
- River/Stream

0 50 100 200 Feet

N

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFOS Detections in Soil

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-2

CLIENT	ARNG				
PROJECT	Site Inspection at Muscatatuck UTC, IN				
REVISED	8/18/2022	GIS BY	MS	8/18/2022	
SCALE	1:1,200	CHK BY	MC	8/18/2022	
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	CM	8/18/2022	

J = Estimated concentration

Legend

Facility Location

River/Stream

0 50 100 200 Feet

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

N

PFBS Detections in Soil

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-3

J = Estimated concentration

CLIENT	ARNG			
PROJECT	Site Inspection at Muscatatuck UTC, IN			
REVISED	8/24/2022	GIS BY	MS	8/24/2022
SCALE	1:1,200	CHK BY	MC	8/24/2022
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	CM	8/24/2022

Legend

Facility Location

River/Stream

0 50 100 200 Feet

N

Exceedances of the OSD SL are depicted with a yellow halo.
Depth intervals shown represent respective sampling position within a given soil boring location.

PFHxS Detections in Soil

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-4

CLIENT	ARNG				
PROJECT	Site Inspection at Muscatatuck UTC, IN				
REVISED	8/24/2022	GIS BY	MS	8/24/2022	
SCALE	1:1,200	CHK BY	MC	8/24/2022	
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	CM	8/24/2022	

J = Estimated concentration

Legend

Facility Location

River/Stream

0 50 100 200 Feet

Exceedances of the OSD SL are depicted with a yellow halo.

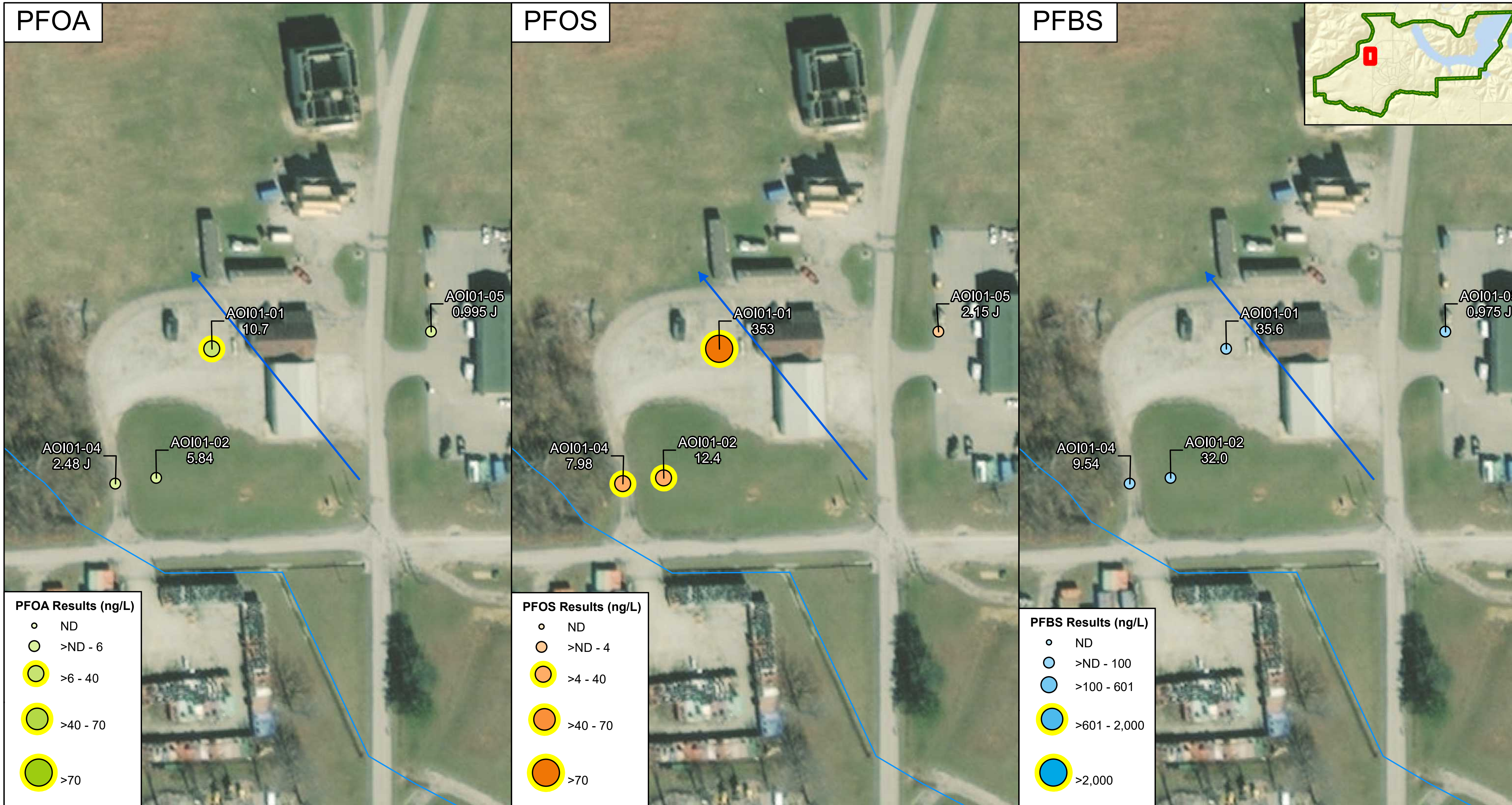
Depth intervals shown represent respective sampling position within a given soil boring location.

N

PFNA Detections in Soil

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-5



J = Estimated concentration

CLIENT	ARNG			
PROJECT	Site Inspection at Muscatatuck UTC, IN			
REVISED	10/5/2022	GIS BY	MS	10/5/2022
SCALE	1:1,200	CHK BY	MC	10/5/2022
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	CM	10/5/2022

Legend

- Facility Location
- River/Stream
- Groundwater Flow Direction

0 50 100 200 Feet

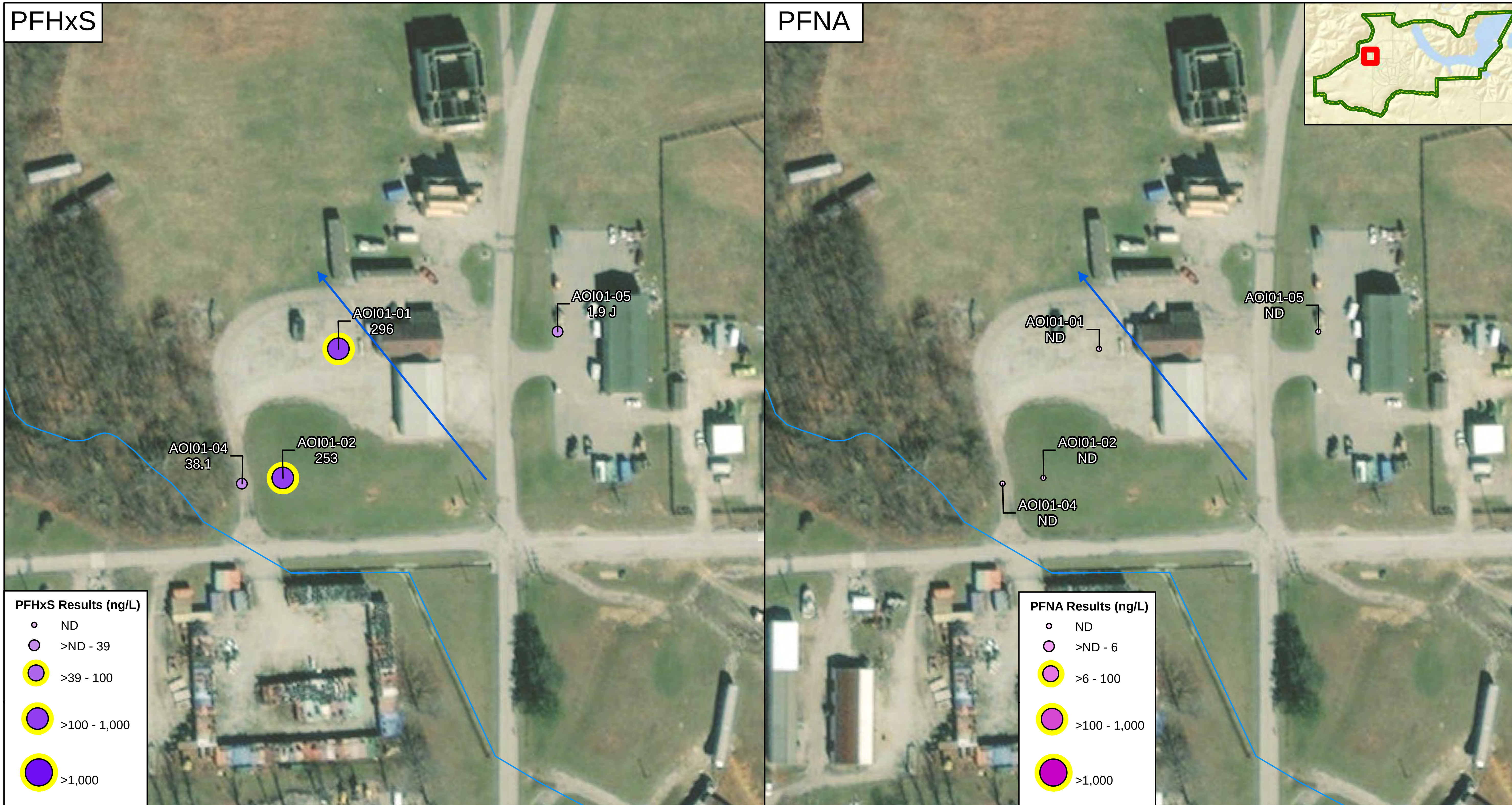
N

Exceedances of the OSD SL are depicted with a yellow halo.

PFOA, PFOS, and PFBS Detections in Groundwater

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-6



CLIENT	ARNG				
PROJECT	Site Inspection at Muscatatuck UTC, IN				
REVISED	8/23/2022	GIS BY	MS	8/23/2022	
SCALE	1:1,200	CHK BY	MC	8/23/2022	
Base Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)		PM	CM	8/23/2022	

J = Estimated concentration

Legend

- Facility Location
- River/Stream
- Groundwater Flow Direction

0 50 100 200 Feet

N

Exceedances of the OSD SL are depicted with a yellow halo.

PFHxS and PFNA Detections in Groundwater

AECOM 12420 Milestone Center Drive Germantown, MD 20876

Figure 6-7

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7. Exposure Pathways

The conceptual site model (CSM) for AOI 1, revised based on the SI findings, is presented on **Figure 7-1**. Please note that while the CSM discussion assists in determining if a receptor may be impacted, the decision to move from SI to RI or interim action is determined based upon exceedances of the SLs for the relevant compounds and whether the release is more than likely attributable to the DoD. A CSM presents the current understanding of the site conditions with respect to known and suspected sources, potential transport mechanisms and migration pathways, and potentially exposed human receptors. A human exposure pathway is considered potentially complete when the following conditions are present:

1. Contaminant source;
2. Environmental fate and transport;
3. Exposure point;
4. Exposure route; and
5. Potentially exposed populations.

If any of these elements are missing, the pathway is incomplete. The CSM figure uses an empty circle symbol to represent an incomplete exposure pathway. Areas with an incomplete pathway generally warrant no further action. However, the pathway is considered potentially complete if the relevant compounds are detected, in which case the CSM figure uses a half-filled circle symbol to represent a potentially complete exposure pathway. Additionally, a completely filled circle symbol is used to indicate when a potentially complete exposure pathway has detections of relevant compounds above the SLs. Areas with an identified potentially complete pathway that have detections of the relevant compounds above the SLs may warrant further investigation. Although the CSM indicates whether potentially complete exposure pathways may exist, the recommendation for future study in an RI or no action at this time is based on the comparison of the SI analytical results for the relevant compounds to the SLs.

In general, the potential routes of exposure to the relevant compounds are ingestion and inhalation. Human exposure via the dermal contact pathway may occur, and current risk practice suggests it is an insignificant pathway compared to ingestion; however, exposure data for dermal pathways are sparse and continue to be the subject of toxicological study. The receptors evaluated are consistent with those listed in USEPA guidance for risk screening (USEPA, 2001). Receptors at the facility include site workers (e.g., facility staff and visiting soldiers), construction workers, trespassers, residents outside the facility boundary, and recreational users outside of the facility boundary.

7.1 Soil Exposure Pathway

The SI results in soil were used to determine whether a potentially complete pathway exists between the source and potential receptors at AOI 1 based on the aforementioned criteria.

7.1.1 AOI 1

AFFF was stored at the MUTC Fire Station dating back until at least 2008, when the first of several AFFF-equipped firetrucks were purchased for the facility, up until it was reported to have been removed at some point after the 2018 PA visit. There were no reported releases or spills of the stored AFFF during that time; however, it is possible that AFFF may have historically been spilled or released during routine activities or product handling. A confirmed AFFF release was later documented during emergency response activities for the 2021 Bus Fire that occurred adjacent to the MUTC Fire Station.

PFOS in surface soil was the only compound detected above its SL; however, PFOA, PFOS, PFHxS, PFNA, and PFBS were all detected in surface and subsurface soil at AOI 1. Site workers, trespassers, or future construction workers could contact these compounds in surface soil via incidental ingestion and inhalation of dust. Additionally, off-facility recreational users of the nearby Vernon Fork Muscatatuck River may potentially be exposed to these compounds via inhalation of dust. In the subsurface, ground-disturbing activities could result in future construction worker exposure to these compounds via ingestion of subsurface soil. At the time of the SI, there was no ongoing construction at AOI 1. Therefore, the soil exposure pathway for site workers, future construction workers, trespassers and off-facility recreational users is potentially complete. AOI 1 is not located adjacent to off-facility residential areas; therefore, the residential exposure pathway is considered incomplete. The CSM for AOI 1 is presented on **Figure 7-1**.

7.2 Groundwater Exposure Pathway

The SI results in groundwater were used to determine whether a potentially complete pathway exists between the source and potential receptors based on the aforementioned criteria.

7.2.1 AOI 1

PFOA, PFOS, and PFHxS were detected above their respective SLs in groundwater at AOI 1. PFBS was also detected in groundwater, but below its SL. MUTC is supplied with public water sourced from a surface water intake on the Muscatatuck River over 5 miles downstream from the facility. Two deep supply wells were identified on MUTC in the upgradient direction of AOI 1. These wells are designated for agricultural use only but could result in a potentially complete ingestion pathway for the site worker or trespasser if they were ever inadvertently used as a potable supply. Due to the presence of off-facility potable wells, the ingestion pathway for off-facility residents is also potentially complete. The shallow groundwater evaluated under this SI was encountered at depths between 8 and 18 feet bgs, in the unconsolidated overburden above bedrock. These intervals are likely shallower than those at which the supply wells are screened; however, downward infiltration into the bedrock may be possible where the primary or secondary (i.e., voids, fractures) porosity allow. The ingestion pathway for future construction workers is considered potentially complete because groundwater at AOI 1 was observed at three of the five locations at depths above 15 feet bgs. The CSM for AOI 1 is presented on **Figure 7-1**.

7.3 Surface Water and Sediment Exposure Pathway

The SI results for PFOA, PFOS, PFHxS, PFNA, and PFBS in soil and groundwater, in combination with knowledge of the fate and transport properties of these compounds, were used to determine whether a potentially complete pathway exists between the source and potential receptors.

7.3.1 AOI 1

PFAS are water soluble and can migrate readily from soil to surface water via leaching and run-off. Surface water run-off at AOI 1 is conveyed overland or via ravines towards the nearby Vernon Fork Muscatatuck River, just west of the AOI. Because PFOA, PFOS, PFHxS, PFNA, and PFBS were detected in soil and groundwater at AOI 1, it is possible that those compounds may have migrated to the ravines and river from soil via surface runoff or potentially via shallow groundwater discharge migrating along the bedrock contact. The surface water and sediment ingestion exposure pathway for site workers, future construction workers, and trespassers is considered potentially complete at MUTC.

The Vernon Fork Muscatatuck River serves as the facility boundary downslope from AOI 1 and for much of the west side of MUTC, and it is the primary surface water drainage for the area. MUTC is supplied with public water sourced from a surface water intake on the river near North Vernon, Indiana, over 5 miles downstream from the facility. The initial decontamination water source sample collected from the MUTC Fire Station water source – considered to be from the public water supply – did contain a trace detection of PFOS (0.945 J ng/L), although a second decontamination water source sample collected during the SI field activities showed all compounds were non-detect. Therefore, the surface water ingestion exposure pathway for site workers, future construction workers, and trespassers is considered potentially complete. The Vernon Fork Muscatatuck River is also used for recreation (e.g., fishing and swimming). Therefore, the ingestion exposure pathways for surface water and sediment are potentially complete for off-facility recreational users of the river. The CSM for AOI 1 is presented on **Figure 7-1**.

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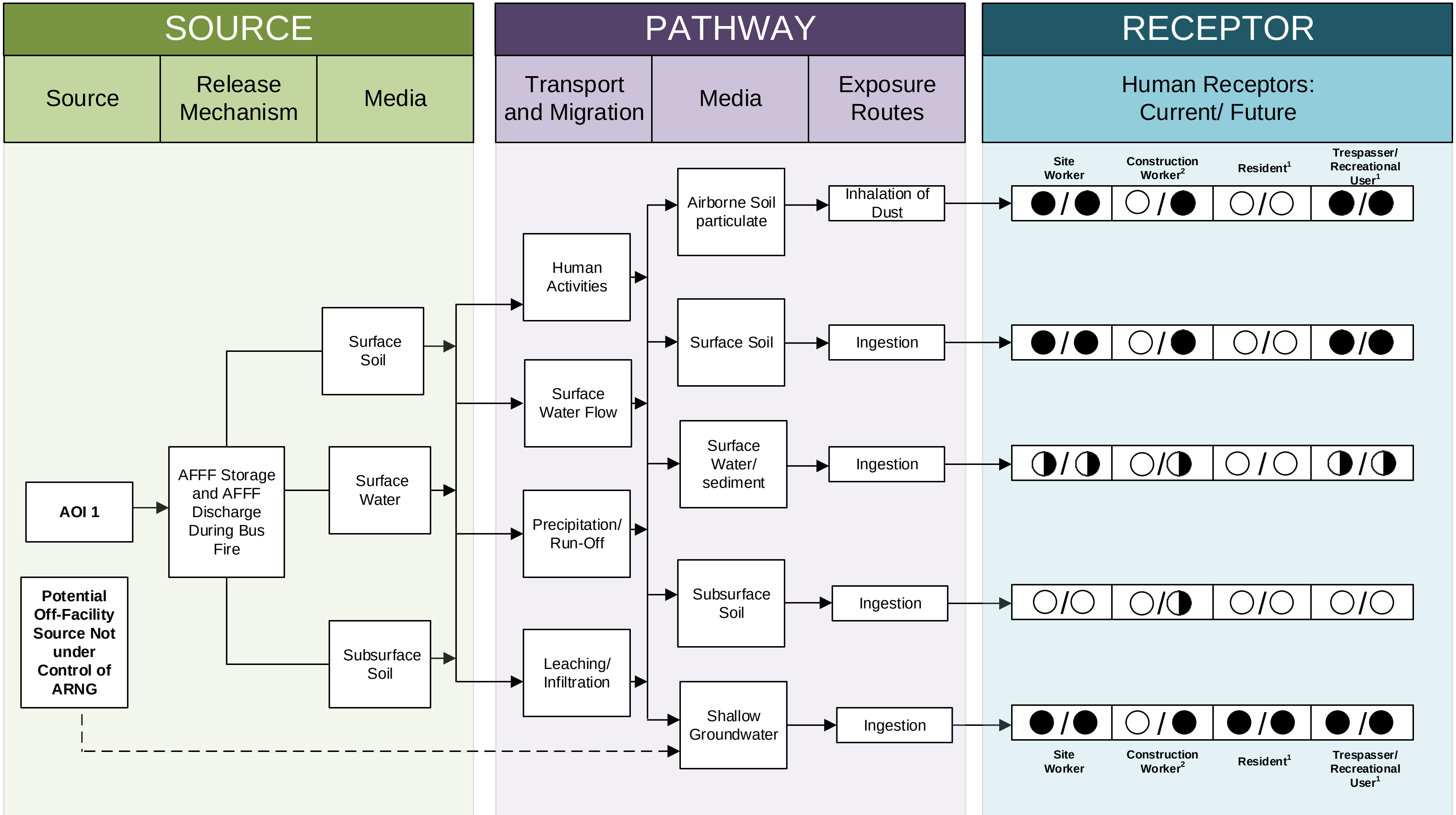

LEGEND

Flow-Chart Stops

Flow-Chart Continues

Partial / Possible Flow

Incomplete Pathway

Potentially Complete Pathway

Potentially Complete Pathway with Exceedance of SL

NOTES

1. The resident and recreational users refer to off-facility receptors.

2. No active construction was occurring within AOI 1 as of the date of SI field work.

Figure 7-1
Conceptual Site Model, AOI 1
Muscatatuck Urban Training Center, Butlerville, Indiana

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8. Summary and Outcome

This section summarizes SI activities and findings. The most significant findings are summarized in this section and are reproduced directly or abstracted from information contained in this report. The outcome provides general and comparative interpretations of the findings relative to the SLs.

8.1 SI Activities

The SI field activities were conducted from 8 to 12 November 2021 and consisted of utility clearance, sonic soil and rock borings, soil sample collection, temporary monitoring well installation, grab groundwater sample collection, and land surveying. Field activities were conducted in accordance with the SI QAPP Addendum (AECOM, 2021a), except as previously noted in **Section 5.8**.

To fulfill the project DQOs set forth in the approved SI QAPP Addendum (AECOM, 2021a), samples were collected and analyzed for a subset of 18 compounds by LC/MS/MS compliant with QSM 5.3 Table B-15 as follows.

- Nineteen (19) soil samples from nine boring locations;
- Four grab groundwater samples from five temporary wells (one well was dry);
- Twelve (12) QA/QC samples.

An SI is conducted when the PA determines an AOI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multi-media sampling at AOI 1 to determine whether or not a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required. Additionally, the CSM was refined to assess whether a potentially complete pathway exists between the source and potential receptors for potential exposure at the AOI, as described in **Section 7**.

8.2 Outcome

Based on the results of this SI, further evaluation is warranted in an RI for AOI 1: MUTC Fire Station & Bus Fire. Based on the CSM developed and revised in light of the SI findings, there is potential for exposure to receptors from AOI 1 from sources on the facility resulting from historical DoD activities. Sample analytical concentrations collected during the SI were compared against the project SLs in soil and groundwater, as described in **Table 6-1**. A summary of the results of the SI data relative to the SLs is as follows:

- PFOS in surface soil exceeded the SL of 13 µg/kg at AOI01-01 and AOI01-07, with concentrations of 125 µg/kg and 16.7 µg/kg, respectively. The detected concentrations of PFOA, PFHxS, PFNA, and PFBS were below their respective SLs.
- PFOA, PFOS, and PFHxS exceeded the SLs in groundwater at AOI 1. PFOA exceeded the SL of 6 ng/L at AOI01-01, with a concentration of 10.7 ng/L. PFOS exceeded the SL of 4 ng/L at multiple locations, with a maximum concentration of 353 ng/L at AOI01-01. PFHxS exceed the SL of 39 ng/L at multiple locations, with a maximum concentration of 296 ng/L at AOI01-01. PFNA and PFBS did not exceed their respective groundwater SLs.

Of the six PFAS compounds presented in the 6 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI, as screening values were established after SI planning and execution. However, ARNG will add HFPO-DA to the list of constituents sampled during the next phase of CERCLA if warranted.

Table 8-1 summarizes the SI results for soil and groundwater used to determine if an AOI should be considered for further investigation under CERCLA and undergo an RI.

Table 8-1: Summary of Site Inspection Findings and Recommendations

AOI	Potential Release Area	Soil – Source Area	Groundwater – Source Area	Future Action
1	MUTC Fire Station & Bus Fire	●	●	Proceed to RI

Legend:

● = detected; exceedance of the screening levels

◐ = detected; no exceedance of the screening levels

○ = not detected

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