FINAL
Site Inspection Report
Boone National Guard Center
Frankfort, Kentucky

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)
ARNG Installations, Nationwide

April 2023

Prepared for:

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

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
%	percent
µg/kg	microgram(s) per kilogram
AASF	Army Aviation Support Facility
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film forming foam
amsl	above mean sea level
AOI	Area of Interest
ARNG	Army National Guard
bgs	below ground surface
BNGC	Boone National Guard Center
btoc	below top of casing
CCA	Capital City Airport
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
DQI	Data quality indicator
DQO	Data quality objectives
EA	EA Engineering, Science, and Technology, Inc., PBC
EB	equipment blank
EIS	extraction internal standards
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer Manual
FB	field blank
FedEx	Federal Express
FTS	fluorotelomer sulfonic acid
HDPE	high-density polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid
HQ	Hazard Quotient
IDW	investigation-derived waste
ITRC	Interstate Technology Regulatory Council
KYARNG	Kentucky Army National Guard
LC/MS/MS	Liquid chromatography tandem mass spectrometry

LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOQ	limit of quantification
MIL-SPEC	military specification
MS	matrix spike
MSD	matrix spike duplicate
NELAP	National Environmental Laboratory Accreditation Program
ng/L	nanogram(s) per liter
No.	number
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
PVC	polyvinyl chloride
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QSM	Quality Systems Manual
RI	remedial investigation
RPD	relative percent difference
SI	site inspection
SL	screening level
Sonic	Sonic drilling technology
TCRA	time-critical removal action
TOC	total organic carbon
TPP	Technical Project Planning
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
Wood	Wood Environment & Infrastructure Solutions, Inc.
WSP	WSP USA Environment & Infrastructure Inc.

EXECUTIVE SUMMARY

The Army National Guard (ARNG) G-9 is performing Preliminary Assessments (PAs) and Site Inspections (SIs) at ARNG facilities nationwide based on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS), with a focus on the six compounds presented in the memorandum regarding Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program (Assistant Secretary of Defense, 2022) from the Office of the Secretary of Defense (OSD) dated 6 July 2022. The six compounds listed in the OSD memorandum are perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA)[1]. These compounds are collectively referred to as "relevant compounds" throughout this document, and the applicable Screening Levels (SLs) are provided below in **Table ES-1**.

The PA identified three Areas of Interest (AOIs) where PFAS-containing materials were used, stored, and/or 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 AOIs 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 a comparison of SI results to SLs for the relevant compounds. This SI was completed at the Boone National Guard Center (BNGC) in Frankfort, Kentucky and determined that further evaluation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is warranted for AOI 1, AOI 2, and AOI 3. BNGC will also be referred to as the "Facility" throughout this document.

The Facility is operated by the Kentucky ARNG (KYARNG) and encompasses 373.6 acres and approximately 71 buildings of various sizes and functions (e.g., aviation, training, logistical, administrative, and maintenance support). BNGC is the headquarters for the Kentucky National Guard (AECOM Technical Services, Inc. [AECOM], 2020).

The PA identified three primary AOIs for investigation during the SI phase. SI sampling results from the three AOIs were compared to OSD SLs. **Table ES-2** summarizes the SI results for each AOI. Based on the results of this SI, further evaluation under CERCLA is warranted in a Remedial Investigation (RI) for AOI 1, AOI 2, and AOI 3.

[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. Based on the conceptual site model (CSM) developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

Table ES-1. Screening Levels for Soil and Groundwater

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

Notes:
1. Assistant Secretary of Defense. July 2022. Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient =0.1. May 2022.
2. 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. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

Abbreviations:
µg/kg = microgram(s) per kilogram
bgs = below ground surface
ng/L = nanogram(s) per liter

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

AOI	Potential Release Area	Soil – Source Area	Groundwater – Source Area	Groundwater – Facility Boundary[1]	Surface Water[2]	Future Action
1	Old AASF	●	●	●	NA	Proceed to RI
2	New AASF	◐	●	◐	NA	Proceed to RI
3	Unnamed Tributary	NA	NA	●	◐	Proceed to RI

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

Notes:
1. Surfacing groundwater associated with AOI 1 was located within the AOI 3 stream channel.
2. There is no screening level for surface water.

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) at ARNG facilities nationwide based on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on the six compounds presented in the memorandum regarding Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program (Assistant Secretary of Defense, 2022) from the Office of the Secretary of Defense (OSD) dated 6 July 2022. The six compounds listed in the OSD memorandum are referred to as "relevant compounds" throughout this document and include perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA)[1]. The ARNG performed this SI at the Boone National Guard Center (BNGC) in Frankfort, Kentucky. The BNGC is also referred to as the "Site" or "Facility" throughout this report.

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

1.2 SITE INSPECTION PURPOSE

A PA was performed at the BNGC (AECOM Technical Services, Inc. [AECOM] 2020) that identified three Areas of Interest (AOIs) 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 AOIs 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. Based on the conceptual site model (CSM) developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

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2. FACILITY BACKGROUND

2.1 FACILITY LOCATION AND DESCRIPTION

The Site is located in a semi-urban setting approximately 1.5 miles west of the State Capital Building in Frankfort, Kentucky (**Figure 2-1**). The Site was established in the early 1950s in conjunction with the Commonwealth of Kentucky's development of the adjoining Capital City Airport (CCA). The Site consists of 373.6 acres and approximately 71 buildings of various sizes and functions (e.g., aviation, training, logistical, administrative, and maintenance support). The Site is the headquarters for the Kentucky National Guard (KYARNG) (AECOM, 2020).

The Site is surrounded by a mixture of developed areas and open land in a natural state. Rolling hills traverse the Site. The majority of the Site's eastern areas are developed, whereas the remaining portion of the Site is open grassland with sporadic trees. Woodland areas have developed adjacent to creeks transecting the Site. The entire property is fenced with personnel and vehicular access restricted to two, manned entrance gates (AECOM, 2020).

The former Army Aviation Support Facility (AASF) at the Site is located on the northern edge of the BNGC property. It consists of a 31,184-square foot (ft) building constructed in 1972; an aircraft maintenance hangar, comprising 10,560 square feet, was added in 1997. Other facilities serving the AASF include a 985-square feet covered storage area, fuel storage and dispensing facilities, storage, parking aprons, and a landing pad. The KYARNG aviation unit's Readiness Center is also located at BNGC (AECOM, 2020).

A New AASF was completed in 2015 to increase hangar space and accommodate all aircraft types operated and maintained by the KYARNG. The New AASF is located on approximately 30 acres of land in the western area of the Site. When the New AASF was completed, all aviation activities and assets were transferred to the New AASF. The Old AASF was converted into an Armory Building (AECOM, 2020).

2.2 FACILITY ENVIRONMENTAL SETTING

The Site is situated within an upland limestone area, fairly well-dissected by normal stream drainage. The topography is rolling to hilly. The most conspicuous topographic features within the vicinity of the Site are the entrenched meandering valleys of the Kentucky River and Benson and Elkhorn Creeks (AECOM, 2020). Elevations within the Old AASF area range between approximately 745 feet above mean sea level (amsl) to 785 feet amsl while elevations within the New AASF area range between approximately 790 feet amsl and 830 feet amsl (**Figure 2-2**).

The Site is bounded to the north and east by residential property, to the west by the Kentucky Department of Fish and Wildlife Resources Salato Wildlife Education Center and Game Farm, and to the south by the CCA. The Education Center and Game Farm and airport provide a buffer from the encroachment of residential and commercial development along the western and southern borders, respectively, of the Site. The 132-acre Kentucky Department of Fish and Wildlife Salato Wildlife Center complex includes two fishing lakes with an accessible pier and a shaded picnic area with grills and shelters. It includes trails, a marsh, and several gardens. The 355-acre CCA is a public use airport that is owned by the Commonwealth of Kentucky and

operated by the Kentucky Transportation Cabinet. The Westridge Elementary School is located on Devil Hollows Road approximately 1.3 miles north of the New AASF in the Choateville neighborhood. Westridge Elementary School opened in August 2004. Approximately 450 students attend the school. Approximately 10 churches also exist in the vicinity of the New AASF along Devil Hollows Road. In addition, numerous single-family residences occur to the east of the Site and single-family residences are continuing to develop north and southwest of the Site and CCA (AECOM, 2020).

2.2.1 Geology

The Site is underlain by the Clays Ferry Formation, which is up to 35 feet thick and is comprised of interbedded limestone and shale. The limestone and shale occur in about equal amounts. The Lexington Limestone Formation, which is approximately 300 feet thick, underlies the Clays Ferry Formation. All of the stratigraphic units are nearly horizontal in the project area. The soils within the Site are a mix of topsoil and silty clay with limestone fragments. In some areas soil is thin allowing bedrock to be exposed at the surface and in other areas soils are moderately deep (AECOM, 2020).

Soil encountered during SI activities was largely consistent with the above expected lithology, with lean to fat clay with some silts and limestone or shale fragments observed overlying shallow bedrock within the borings. Depth to bedrock in the borings ranged from approximately one to eight feet below ground surface (bgs), and borings were completed at depths between 0.8 and 32.4 feet bgs. Bedrock underlying the soils consisted of limestone, shale, or interbedded limestone and shale. The bedrock was mostly weak/weathered at the top and became less weathered and more competent with depth. The bedrock was generally slightly porous with fossil fragments and iron staining. Samples for grain size analyses were collected at two locations, AOI01-05 and AOI02-14, and analyzed via American Society for Testing and Materials (ASTM) Method D-422. The results indicate that the soil samples are comprised primarily of silt (52.26% to 66.47%), clay (25.5% to 28%), and sand (7.27% to 14.77%). These results and Facility observations are consistent with the reported depositional environment of the region.

In poorly drained areas and along established drainage ways, the limestone erosion has created a karst landscape. Karst landscapes at the Site form when rainwater seeps through the soil cover and dissolves the soluble limestone beneath. Karst features at the Site can include sinkholes, caves, sinking streams, or springs. Sinkholes at the Site are closed depressions at the land surface that form where soil has subsided into an enlarged opening in the limestone where water drains underground. The majority of the Site is drained to existing sinkholes. Minor sinkholes and continually changing sinkholes also develop along the intermittent creeks and swales within the property (AECOM, 2020).

Due to hazards related to karst features, the KYARNG environmental staff has restricted certain portions of the property to development. A primary sinkhole is located just east of the Old AASF. This sinkhole accommodates a significant portion of the storm water runoff from the Site. This sinkhole, along with a low area further to the east and northeast, must be preserved and protected from grading and development. Further to the north of the sinkhole, a creek bed, which accommodates drainage from the neighboring residential properties, has exposed the

limestone and shows karst characteristics. This creek bed is also protected from development with a similar disturbance free zone. A karst feature exists in the western portion of the Site around the New AASF. However, this feature has not shown significant changes in 20 years (AECOM, 2020).

2.2.2 Hydrogeology

Water yields from wells drilled within the Clays Ferry Formation range from approximately 100 to 500 gallons per day in the valley bottoms, but almost no water yields from wells located on hillsides or ridgetops. Water is hard in valley bottoms and may contain salt or hydrogen sulfide. Shale has small, poorly connected openings, and groundwater circulation is slow; as a result, little water is available to wells and springs. On ridgetops the shale prevents downward percolation of water, and creates small, semi-perched water bodies in the lower part of the soil and the upper part of the weathered bedrock (AECOM, 2020).

At least one-half of Kentucky's aquifers occur in karst regions. Groundwater in karst areas is highly susceptible to pollution from surface activities. As discussed above, karst features are located within the Site property, including the AASF areas (AECOM, 2020). Based on the known Site hydrogeology, it was anticipated that shallow groundwater may not be encountered above bedrock, and therefore Sonic drilling technology (Sonic) was used to reach groundwater within bedrock at the Site. During the SI, depth to groundwater at AOI 1 ranged from 8.67 feet bgs to 18.5 feet bgs while depth to groundwater at AOI 2 ranged from 0.74 feet bgs to 20.41 feet bgs. Groundwater flow at the Site (**Figure 2-3**) is variable due to the presence of karst features. Based on groundwater elevations calculated using depth to groundwater measurements and survey data collected during the SI, groundwater flow at AOI 1 (Old AASF) is variable but is generally westward towards an unnamed tributary (AOI 3) at the Site boundary. Groundwater flow at AOI 2 (New AASF) is generally northeastward towards AOI 3 (**Figure 2-4**).

The Frankfort Plant Board (FPB) provides potable water to the Site and the City of Frankfort. The FPB Water Treatment Facility, located at 200 Coffeetree Road, Frankfort, KY, withdraws surface water from pool #4 on the Kentucky River (AECOM, 2020). Review of online sources indicates the intake point for pool #4 is located near the water treatment plant, approximately 2 miles southeast of the Facility and upstream from the confluence with Benson Creek.

WSP USA Environment & Infrastructure Inc. (WSP), formerly doing business as Wood Environment & Infrastructure Solutions, Inc. (Wood), reviewed a document titled *Drainage Determination for the Boone National Guard Center, Franklin County, Kentucky* (Thrailkill, Dinger, Scanlon, and Kipp, 1985) provided by the ARNG. This document provides results of an assessment, by water dye tracing and other methods, of the hydrogeology of the BNGC. Pertinent information provided in the report includes the following:

- Site sinkholes may occur singly or be so closely spaced as to capture the entire drainage of an area.
- Subsurface flows generally emerge as inconspicuous seeps or small ephemeral springs a short distance downslope. Larger flows from areas of sinkholes and swallets may flow underground for distances as great as 10 miles before emerging at a major spring or a number of nearby springs, which may be in the bed of a surface stream.

- Groundwater moves through a dendritic system of narrow solution conduits, and contamination is very unlikely to be detected by monitoring wells.
- Major springs were sought for the placement of detectors since these have been found to be the destination of most of the water traces that have been conducted in the Inner Bluegrass Karst Region. Because only two major springs were located in the area, much of the sub-surface flow from the Site and elsewhere in the area of the investigation was concluded to be emerging in the bed of streams within and at the margin of the area.
- One trace showed that the water which sinks in Tracy Creek emerges in South Benson Creek.
- Portions of Tracy Creek discharge underground while the remainder flows on the surface to South Benson Creek. Surface and subsurface drainage from the Tracy Creek portion of the site flows by a combination of surface and subsurface flow to South Benson Creek.
- Four domestic water wells were identified in the vicinity of BNGC. Three of the wells were located approximately 1.2 to 1.4 miles north to north-northwest of AOI 1 and where the AOI 3 unnamed tributary flows off the Site, and 2.1 to 2.2 miles north-northeast of AOI 2. The depths of these three wells were listed as 40 feet, 80 feet, and unknown. The 4-mile receptor survey performed as part of this SI identified two domestic wells and three wells of unknown use near these locations. The fourth well identified in the 1985 report was shown to be approximately 0.8 to 0.9 miles west-southwest of AOI 1 and where the AOI 3 unnamed tributary flows off the Site and approximately 0.6 miles north-northwest of AOI 2. The depth of this well was listed as 3.8 feet. This well was not identified during the 4-mile desktop receptor survey performed as part of this SI.
- Underground conduits identified during the tracer study are depicted on **Figure 2-3**.

WSP initiated a desktop survey of potential private and public water supply wells within a four-mile distance of the BNGC boundary to identify potential receptor pathways and down-stream and/or downgradient receptors. The desktop survey included a review of a list of water supply wells provided by the Kentucky Geological Survey records (https://kgs.uky.edu/kgsweb/datasearching/water/waterwellsearch.asp) and Kentucky Division of Water Maps Portal (https://watermaps.ky.gov). A total of 222 wells were identified within a four-mile distance of the installation (**Figure 2-3**). The 222 wells were comprised of 14 domestic wells, four agricultural/irrigation wells, 136 monitoring wells, 51 remediation wells, and 17 wells of unknown use. No municipal supply wells were identified.

As detailed in **Section 6.0**, surface water in AOI 3 (unnamed tributary) flows off the Site just beyond the location of the seep that is downgradient of AOI 1 and was sampled as part of the SI. This unnamed tributary flows into Tracy Creek and then into South Benson Creek to the northwest, which flows into Benson Creek further northwest. From this confluence Benson Creek flows generally eastward and discharges into the Kentucky River approximately 1.7 miles northeast of where AOI 3 flows off the Site. Eight domestic wells and one agricultural/irrigation well are in the vicinity of this surface water flow regime and within four miles of BNGC. As described above, there is interaction between surface water and groundwater through sinks, seeps, and springs, and flow can be variable due to the presence of karst features.

2.2.3 Hydrology

The Site is part of the Lower Kentucky watershed. The New AASF is located adjacent to an unnamed tributary of South Benson Creek. There are no known permanent surface water features within the New AASF footprint, and the property is not located in the 100-year or 500-year flood hazard zone (AECOM, 2020). According to the National Wetlands Inventory, there are no wetlands or other surface water features within the Old or New AASF footprints; however, there is a freshwater pond approximately 0.2 mile southeast of the Old AASF footprint, and several freshwater ponds and an intermittent, seasonally flooded riverine habitat within approximately 0.3 mile of the New AASF footprint. The KYARNG also stated that groundwater periodically surfaces in varying locations at the Site (KYARNG, 2021).

Leading nonpoint source pollutants within the Lower Kentucky watershed include siltation, nutrients, pathogens, habitat alteration, and organic enrichment. Benson Creek is listed as impaired as a result of sedimentation, nutrient loading, and low-flow conditions due to habitat alteration. A total of 73 waterbodies are considered impaired within this watershed (AECOM, 2020).

The majority of the Site is drained to existing sinkholes. Minor sinkholes and continually changing sinkholes also develop along the intermittent creeks and swales within the property. A primary sinkhole is located just east of the Old AASF and accommodates a significant portion of the storm water from the Site (AECOM, 2020). Surface water features are presented on **Figure 2-5**.

2.2.4 Climate

Data from the CCA immediately south of the Facility indicate that the average annual temperature between 1981 and 2010 was 55.3 degrees Fahrenheit (ºF). The warmest months are July and August, with normal average temperatures of 76.3ºF and 75.2ºF, respectively. January is the coldest month, with an average monthly temperature of 32.5ºF. Average annual precipitation measured between 1981 and 2010 at the CCA was 45.62 inches. Rainfall is heaviest during the months of May through July, averaging over 4 inches per month. Average monthly precipitation ranges from 3.54 inches in October to 4.85 inches in May (AECOM, 2020).

2.2.5 Current and Future Land Use

Land use at the Site includes natural conditions and human-modified conditions, including the following land use categories: commercial, industrial, transportation, communications, utilities, agricultural, institutional, recreational, and other developed use areas. Management plans and zoning regulations at the Site are often intended to protect specially designated or environmentally sensitive areas (AECOM, 2020).

BNGC was initially established in the early 1950s in conjunction with the Commonwealth of Kentucky's development of the adjoining CCA. At the time of the Airport's initial development, a total of 33 acres were donated by the Commonwealth to the Department of Military Affairs for the construction of National Guard facilities. Since then, the Site has steadily expanded. The Whippoorwill Golf Course (formerly the western portion of the Site) was acquired by BNGC

both as a necessary part of the airport's safety zone and for its development potential (AECOM, 2020).

The entire Site is fenced, and personnel and vehicular access is restricted to two, manned entrance gates, one on Minuteman Parkway off US 127 and one at US Highway 60. The area south of the Old AASF houses a variety of training, logistical, administrative and maintenance support activities. The western area, (the former Whippoorwill Golf Course which currently comprises the New AASF footprint), was once considered as a location for additional development including a new armory, billets, annex, bivouac, vehicle testing and maintenance facilities. The Site currently includes a former golf course club house converted to house Site personnel functions, adjoining storage buildings, and a connecting road to these facilities from the eastern area of the Site (AECOM, 2020).

2.2.6 Sensitive Habitat and Threatened/Endangered Species

A wildlife survey has not occurred at the Facility. The following species are listed as federally endangered, threatened, proposed, and/or candidate species that could potentially be present in Franklin County, Kentucky (USFWS 2021):

Clams:
- Longsolid, *Fusconaia subrotunda* (proposed threatened)
- Rayed Bean, *Villosa fabalis* (endangered)

Flowering Plants:
- Braun's Rock-cress, *Arabis perstellata* (endangered)
- Short's Bladderpod, *Physaria globosa* (endangered)

Mammal:
- Northern Long-Eared Bat, *Myotis septentrionalis* (threatened)
- Gray Bat, *Myotis grisescens* (endangered)
- Indiana Bat, *Myotis sodalis* (endangered)
- Tricolored bat *Perimyotis subflavus* (proposed endangered)
- Little brown bat, *Myotis lucifugus* (under review)

Insects:
- Monarch Butterfly, *Danaus plexippus* (candidate)

2.3 HISTORY OF PFAS USE

Based on the PA findings (AECOM 2020), two potential release areas were identified: AOI 1 - Old AASF and AOI 2 - New AASF. A possible secondary area (AOI 3 - Unnamed Tributary) is a potential migration route for AFFF from AOIs 1 and 2.

AOI 1 is the Old AASF area. The Old AASF area includes a maintenance hangar north of the armory, parking aprons and a helicopter landing pad. KYARNG staff confirmed that no crashes have occurred at the Old AASF; however, no KYARNG staff familiar with AFFF practices,

training or other uses at the Old AASF was available to be interviewed during the site visit. There are no documented uses of AFFF at the Old AASF, but undocumented historic releases remain an uncertainty. No current maintenance, washing, or testing of AFFF containing materials occurs at the Old AASF. Mobile AFFF-containing fire extinguishers were stored at the Site before the completion of the New AASF. Four Amerex Model 630 mobile fire extinguishers transferred from the Old AASF to the New AASF were emptied at an unknown location suspected to have been the Old AASF. The time and place where these units were emptied are unknown (AECOM 2020).

AOI 2 is the New AASF. BNGC staff previously confirmed that no crashes or incidents requiring emergency response have occurred at the New AASF. There are no documented uses of AFFF at the New AASF; however, four AFFF mobile fire extinguishers, emptied at an unknown location as described above, are now stored at the New AASF. The empty units were brought from the Old AASF to the New AASF after construction was complete. These extinguishers are currently empty but were known to have contained Amerex AFFF, which contains PFAS. During the PA, on the western edge of the New AASF area, a storage unit contained eleven 5-gallon pails of Amerex Model 534 AFFF concentrate, two 5-gallon pails of Chemguard AFFF concentrate, and one 5-gallon pail of National Foam AFFF concentrate (all of which contain PFAS). One 55-gallon drum of Chemguard AFFF solution, two 55-gallon drums of National Foam AFFF solution, and one 55-gallon drum of Monsanto Fire Resistant Foam were also stored in the separate secondary containment storage area (AECOM, 2020). Additionally, the KYARNG recently learned that two handheld wall-mounted fire extinguishers in the new AASF hanger area are believed to contain 3% AFFF, although it is believed they have never been used (KYARNG, 2022)

AOI 3 is the Unnamed Tributary of South Benson Creek that traverses the Site from the New AASF to the Old AASF and continues off the Facility. Potential AFFF releases to the Unnamed Tributary AOI surface water by KYARNG may have occurred in 2015 during the transfer of materials from the Old AASF to the New AASF (AECOM, 2020).
A more detailed description of each AOI is presented in **Section 3**.

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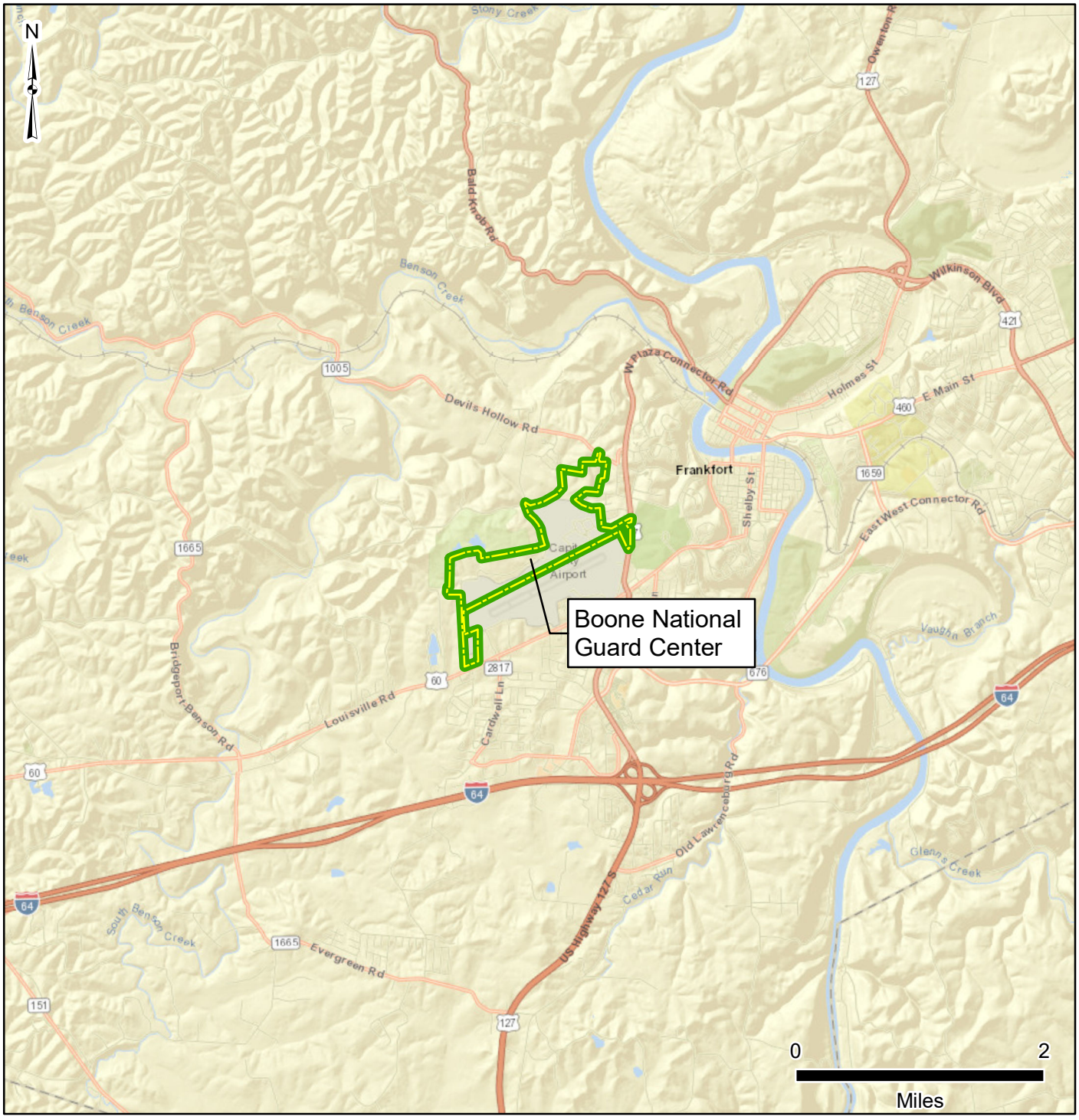
Figure 2-1
Facility Location



Facility Data

Facility Boundary

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

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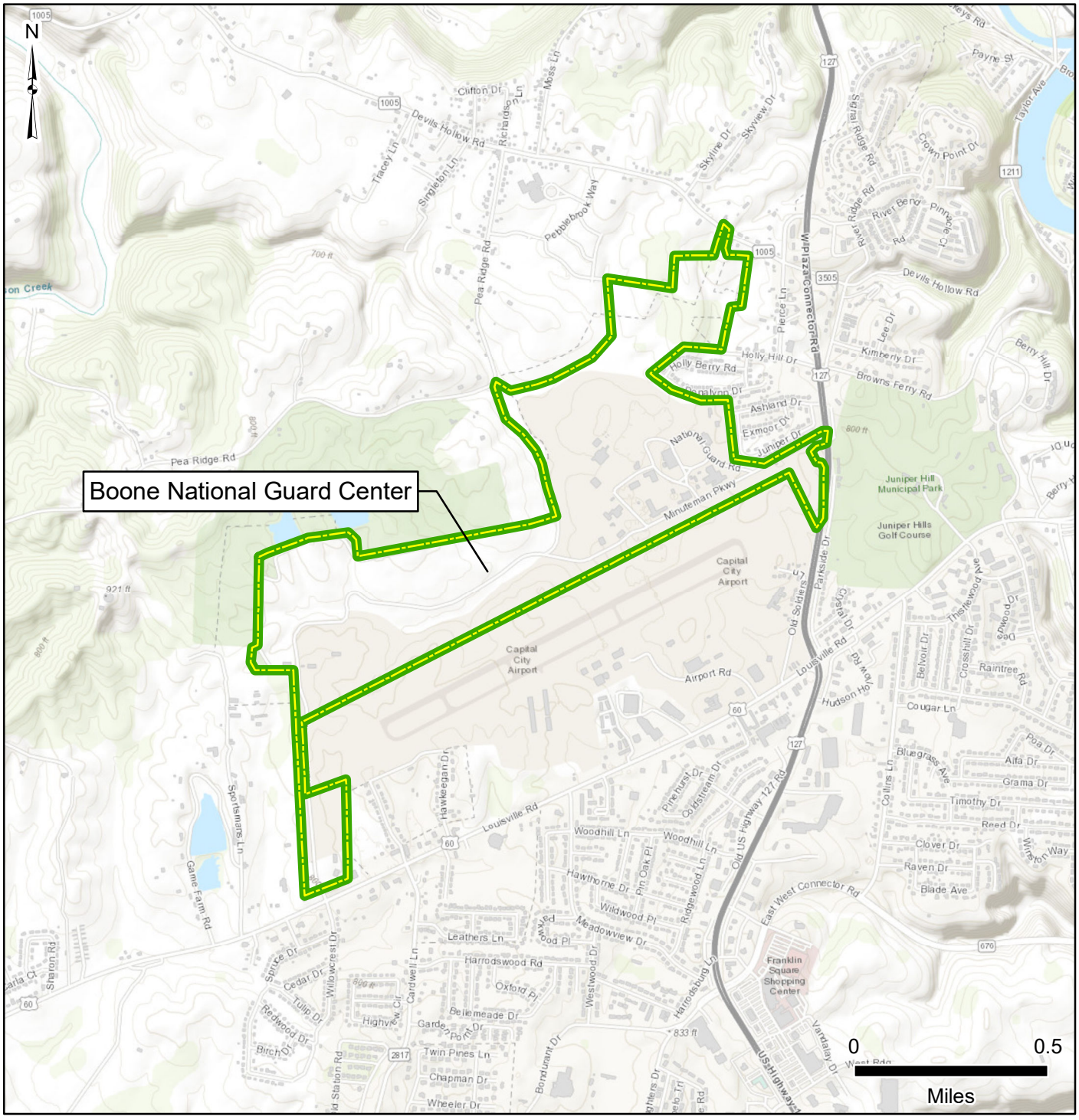
Figure 2-2
Facility Topography



Facility Data

Facility Boundary

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

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Army National Guard Site Inspections
Site Inspection Report
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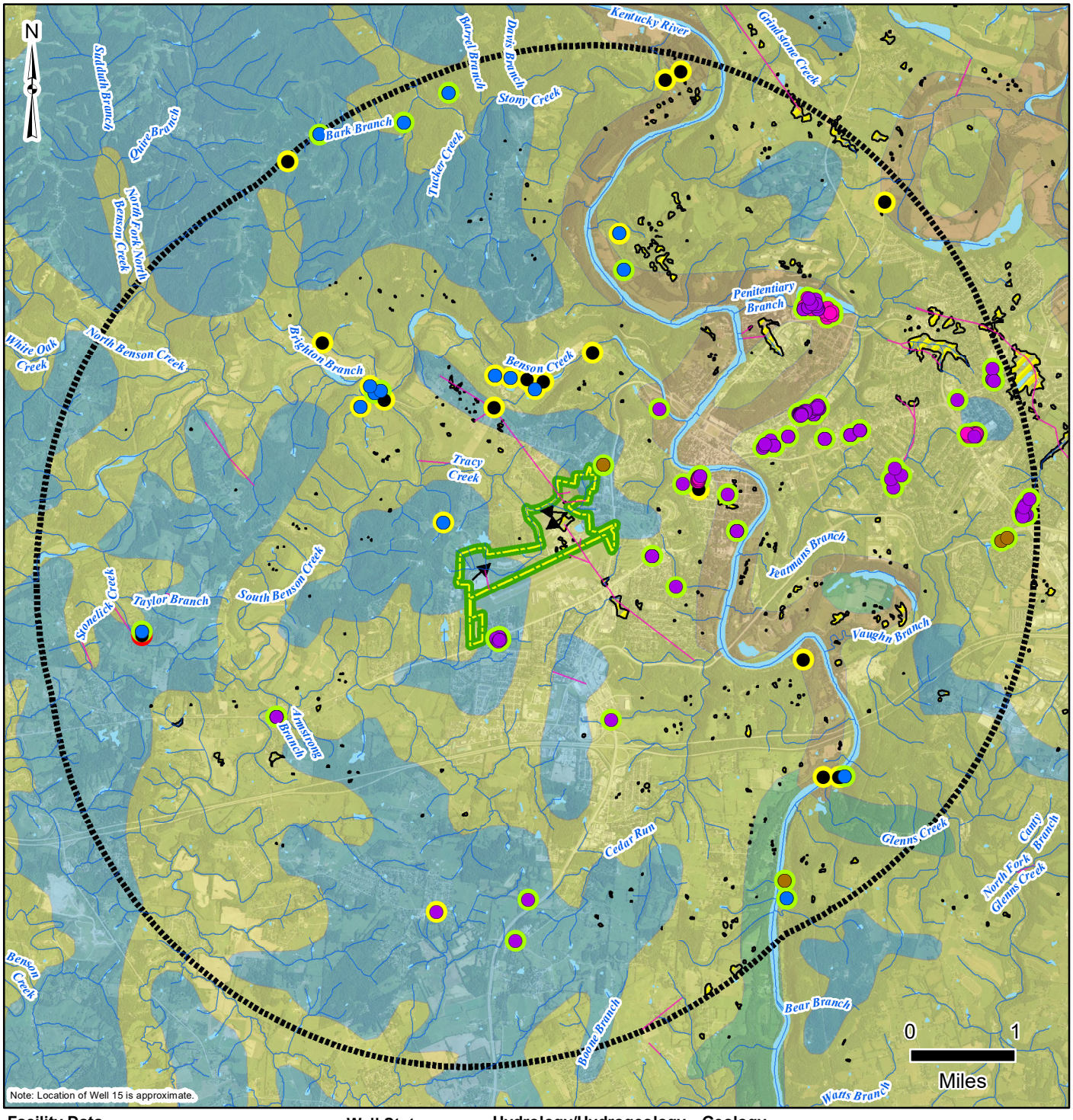
Frankfort, Kentucky

Figure 2-3
Groundwater Features



Facility Data
- 4-Mile Well Search Radius
- Facility Boundary

Well Type
Well Primary Use
- Domestic - Single Household
- Agriculture
- Monitoring Well
- Remediation
- Well Use Unknown

Well Status
- Active
- Inactive
- Status Unknown

Hydrology/Hydrogeology
- River/Stream
- Underground Conduit
- Inferred Groundwater Flow Direction
- Water Body

Geology
- High Bridge Group
- Limestone
- Sandstone
- Shale
- Sinkhole

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

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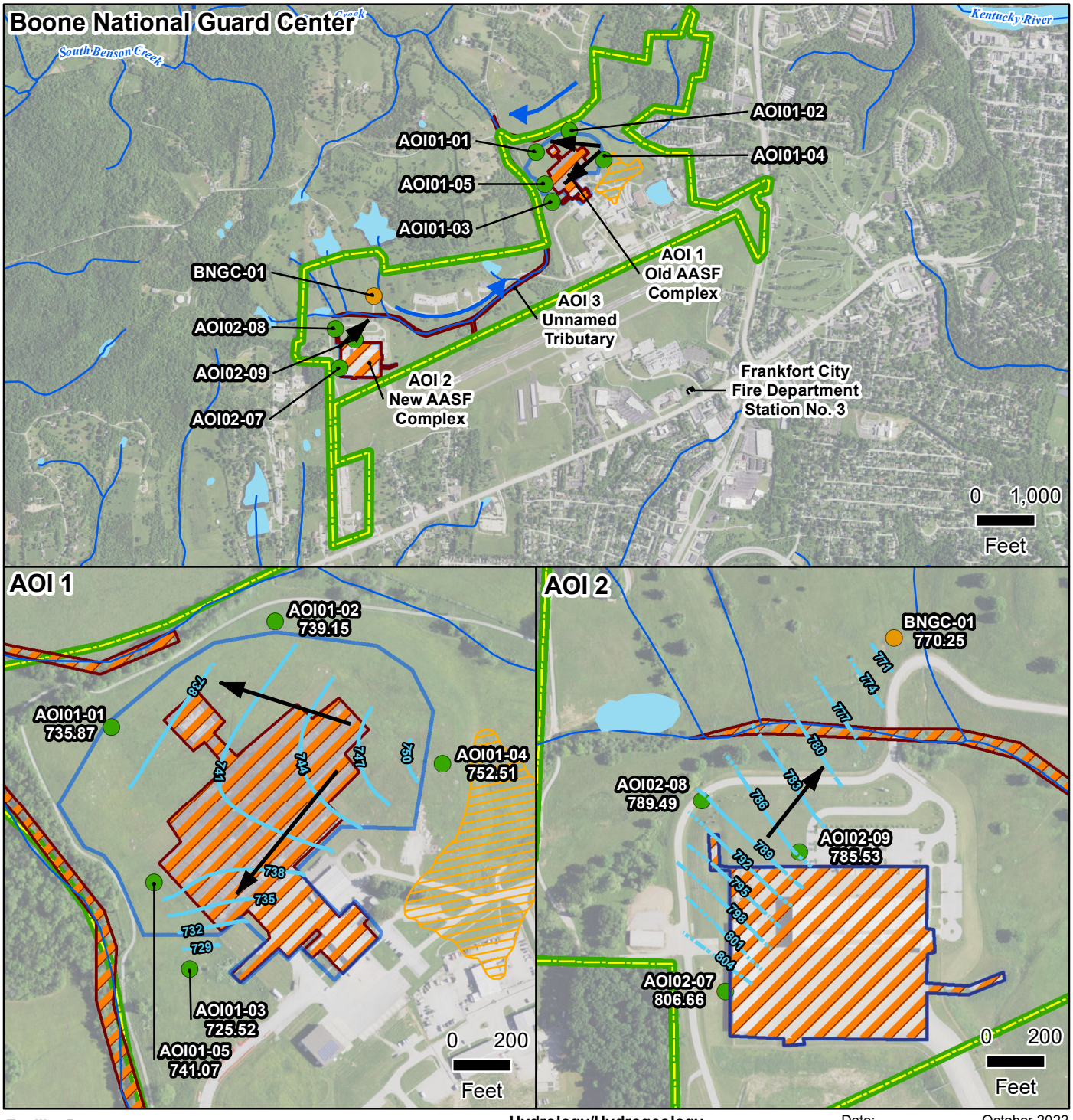
Army National Guard Site Inspections
Site Inspection Report
Boone National Guard Center
Frankfort, Kentucky

Figure 2-4
Groundwater Elevations, November 2021



Facility Data
- Facility Boundary
- Potential PFAS Release
- No Suspected Release
- Area of Interest (AOI)
- Approximate Sinkhole Area

Sample Type
- Soil Boring/Temporary Monitoring Well
- Temporary Monitoring Well

Hydrology/Hydrogeology
- Inferred Groundwater Flow Direction
- Surface Water Flow Direction
- Groundwater Elevation Contour (3 feet)
- Inferred Groundwater Elevation Contour (3 feet)
- River/Stream
- Water Body

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

Note: Certain features digitized from georeferenced AECOM Preliminary Assessment Report (2020) figures.

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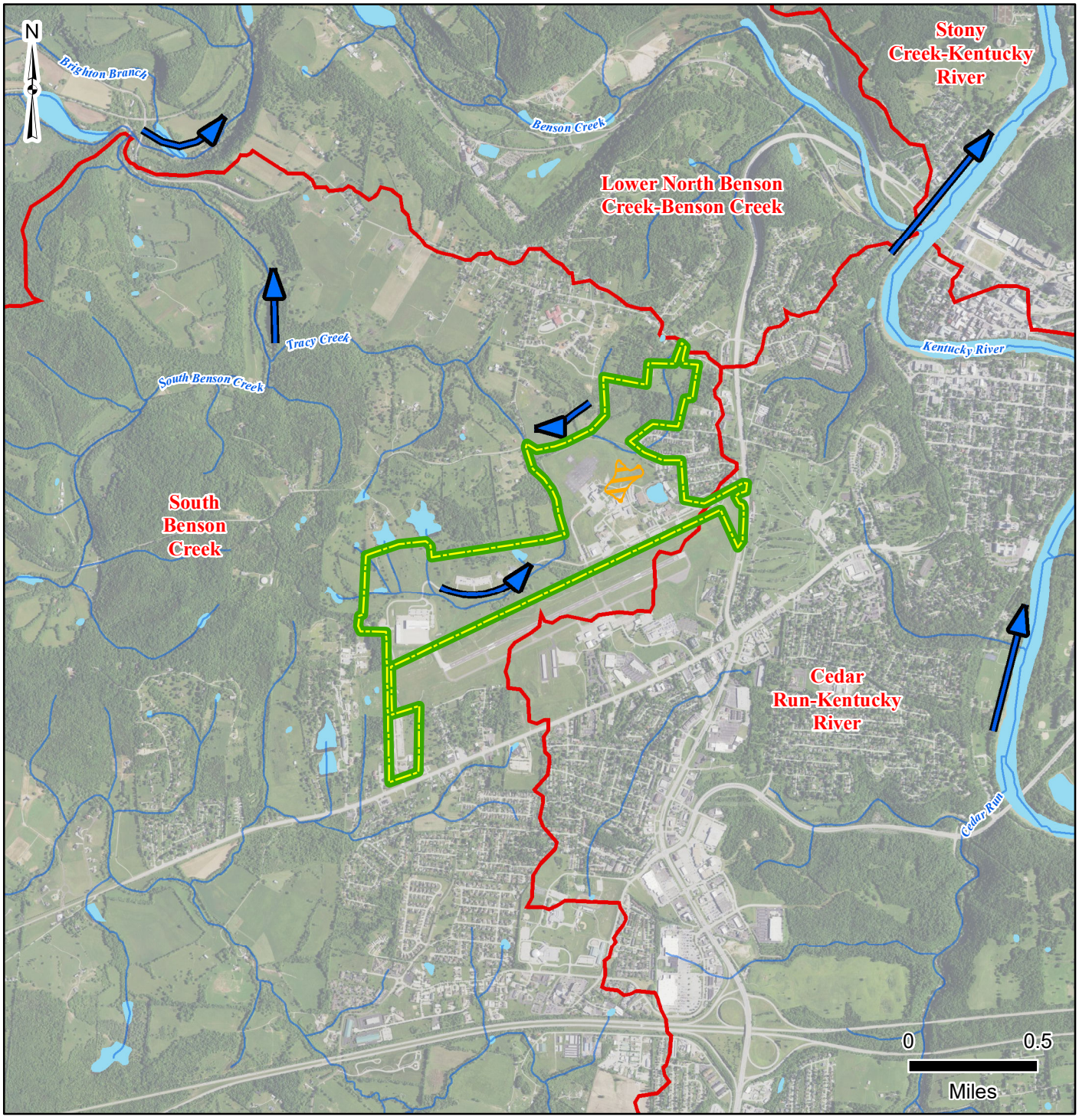
Army National Guard Site Inspections
Site Inspection Report
Boone National Guard Center
Frankfort, Kentucky

Figure 2-5
Surface Water Features



Facility Data

- Facility Boundary
- Approximate Sinkhole Location

Hydrology

- Surface Water Flow Direction
- River/Stream
- Water Body
- Watershed Boundary

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

Note: Certain features digitized from georeferenced AECOM Preliminary Assessment Report (2020) figures.

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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, three potential release areas were identified at BNGC and grouped into three AOIs identified as: AOI 1 – Old AASF, AOI 2 – New AASF, and AOI 3 – Unnamed Tributary. The AOIs are shown on **Figure 3-1**.

3.1 AOI 1 – OLD AASF

AOI 1 is the Old AASF area. The Old AASF area includes a maintenance hangar north of the armory, parking aprons and a helicopter landing pad. KYARNG staff confirmed that no crashes have occurred at the Old AASF; however, no KYARNG staff familiar with AFFF practices, training or other uses at the Old AASF was available to be interviewed during the site visit. There are no documented uses of AFFF at the Old AASF, but undocumented historic releases remain an uncertainty. No current maintenance, washing, or testing of AFFF containing materials occurs at the Old AASF, but historical AFFF activities are unknown. Mobile AFFF-containing fire extinguishers were stored at the Site before the completion of the New AASF. Four Amerex Model 630 mobile fire extinguishers transferred from the Old AASF to the New AASF were emptied at an unknown location suspected to have been the Old AASF. The time and place where these units were emptied are unknown (AECOM 2020).

According to the PA report, one Amerex Model 630 mobile fire extinguisher was stored northeast of the maintenance hangar and armory in the outside heavy equipment staging area and was relocated to the new AASF with ten additional Amerex Model 630 fire extinguishers containing a total of 140 gallons of AFFF solution, and six Amerex Model 469 (Purple K) fire extinguishers. All Model 630 and Model 469 Amerex units await future disposal by the KYARNG. No fire suppression system exists at the Old AASF. Dry chemical fire extinguishers may be present inside the armory and hangar area. No other fire suppression devices exist at the Old AASF (AECOM 2020).

The Frankfort City Fire Department has performed training events at the Old AASF. The Fire Department Assistant Chief stated that no AFFF is used during training events, and that no AFFF has been used for any purpose by Frankfort City Fire Department at the Old AASF (AECOM, 2020).

3.2 AOI 2 – NEW AASF

AOI 2 is the New AASF. After the New AASF was completed in 2015, mobile fire extinguishers were transferred from the Old AASF to the New AASF. BNGC staff previously confirmed that no crashes or incidents requiring emergency response have occurred at the New AASF. There are no documented uses of AFFF at the New AASF; however, four AFFF mobile fire extinguishers, emptied in an unknown location as described in **Section 2.3**, are now stored at the New AASF. The empty units were brought from the Old AASF to the New AASF after construction was complete. These extinguishers are currently empty but were known to have contained Amerex AFFF, which contains PFAS. The Amerex Model 630 mobile fire extinguisher is designed for the use of Amerex Model 354 AR-AFFF solution (AECOM, 2020).

Mobile AFFF containers are kept at the Site along with AFFF in five-gallon buckets and 55-gallon drums. Six apparently full Amerex Model 630 mobile fire extinguishers are stored outside in the northern portion of the New AASF complex. Additionally, according to the PA report, ten Amerex Model B674/B675 mobile fire extinguishers containing "Halotron 1" are positioned throughout the New AASF. According to the Halotron 1 clean agent owner's service manual, the primary component of "Halotron 1" is dichlorotrifluoroethane. Six Amerex Model 469 mobile fire extinguishers containing Purple K dry chemical are also positioned throughout the New AASF (AECOM 2020).

During the PA, on the western edge of the New AASF area, a storage unit contained eleven 5-gallon pails of Amerex Model 534 AFFF concentrate, two 5-gallon pails of Chemguard AFFF concentrate, and one 5-gallon pail of National Foam AFFF concentrate (all of which contain PFAS). One 55-gallon drum of Chemguard AFFF solution, two 55-gallon drums of National Foam AFFF solution and one 55-gallon drum of Monsanto Fire Resistant Foam were also stored in the separate secondary containment storage area. Purple K powder, which does not contain PFAS, was also stored in five-gallon buckets in the storage unit. The BNGC AASF maintenance supervisor indicated that these materials were brought from the Old AASF to the New AASF once the Old AASF was transitioned to an armory (AECOM 2020).

3.3 AOI 3 – UNNAMED TRIBUTARY

AOI 3 is the Unnamed Tributary of South Benson Creek that transects the Site. The tributary is an intermittent, seasonally flooded wetland. The AOI traverses the Site from the New AASF to the Old AASF and continues off the Facility. The Unnamed Tributary ultimately discharges to the Kentucky River via connecting creeks. Potential AFFF releases to the Unnamed Tributary AOI surface water by KYARNG may have occurred in 2015 during the transfer of materials from the Old AASF to the New AASF (AECOM, 2020).

3.4 ADJACENT SOURCES

One potential off-Facility source of PFAS is adjacent to the Facility and is not under the control of the KYARNG. A description of the off-Facility source is presented below and shown on **Figure 3-1**.

3.4.1 Frankfort City Fire Department Station Number 3

Frankfort City Fire Department Station Number 3 is located approximately 0.5 miles south of the eastern area of the Site. Station Number 3 is approximately 0.7 miles southeast of the Old AASF and approximately 1 mile east of the New AASF at a location interpreted to be cross-gradient of AOI 1 and AOI 2. National Foam brand AFFF concentrate is stored in 5-gallon buckets on fire rescue trucks at the station, as well as other Frankfort City Fire Department stations. Maintenance of trucks does not include washing AFFF material from equipment due to the containerizing of AFFF until necessary mixing and spraying in the event of an emergency (AECOM, 2020).

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Army National Guard Site Inspections
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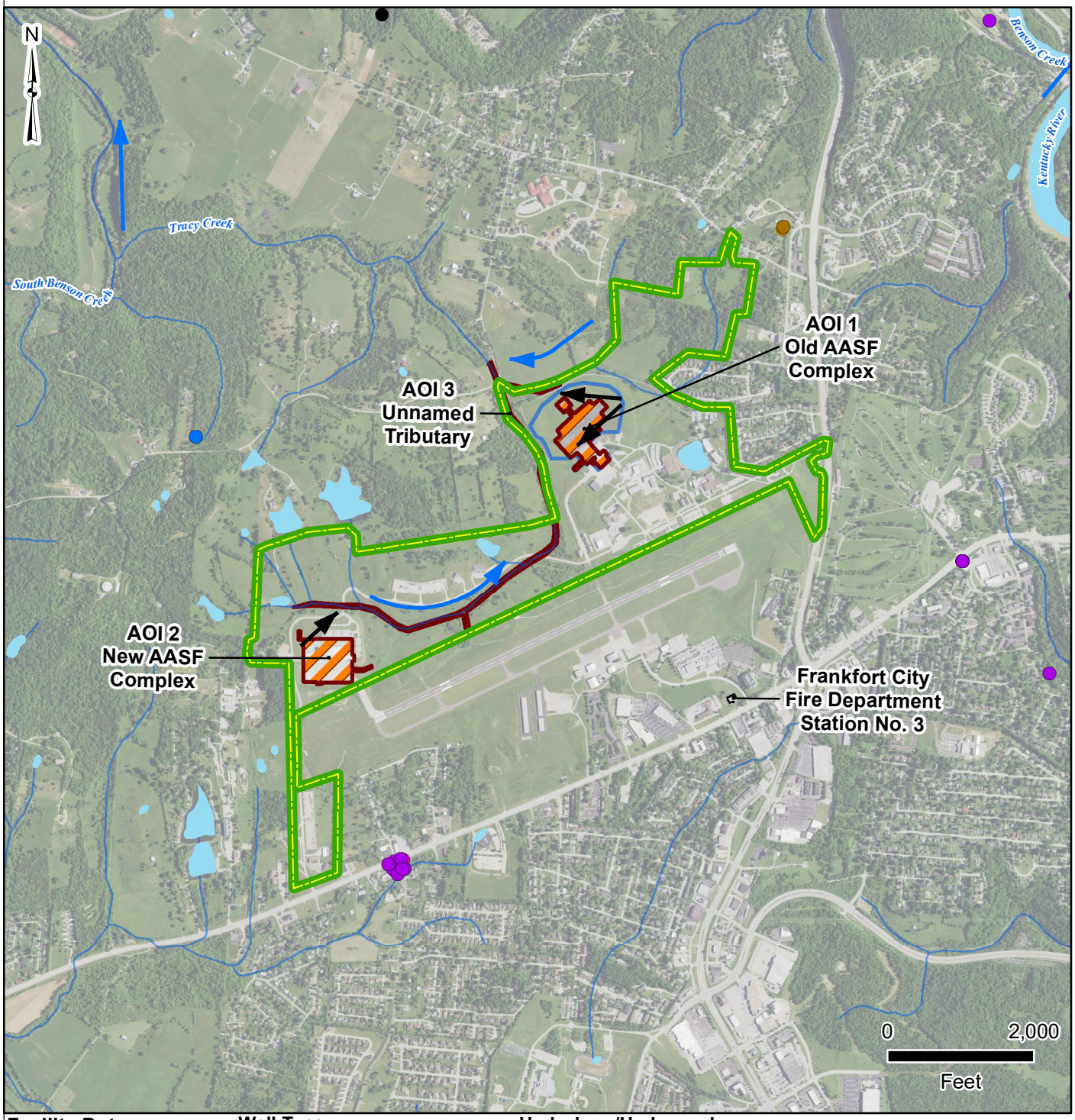
Figure 3-1
Areas of Interest



Facility Data
- Facility Boundary
- Potential PFAS Release
- No Suspected Release
- Area of Interest (AOI)

Well Type
Well Primary Use
- Domestic - Single Household
- Agriculture
- Monitoring Well
- Remediation
- Well Use Unknown

Hydrology/Hydrogeology
- Inferred Groundwater Flow Direction
- Surface Water Flow Direction
- Water Body
- River/Stream

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

Note: Certain features digitized from georeferenced AECOM Preliminary Assessment Report (2020) figures.

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4. PROJECT DATA QUALITY OBJECTIVES

As identified during the Data Quality Objective (DQO) process and outlined in the SI Uniform Federal Policy (UFP) – Quality Assurance Project Plan (QAPP) Addendum (EA/Wood, 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 the 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 for the SI include the following:

- The PA Report for BNGC (AECOM 2020);
- Analytical data from soil, groundwater and surface water samples collected as part of this SI in accordance with the site-specific UFP-QAPP Addendum (EA/Wood, 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 horizontally by the property limits of the Facility (**Figures 2-1** and **2-2**). The scope of the SI was bounded vertically by the depth of temporary monitoring wells installed within groundwater, where encountered (maximum depth of 34.2 feet bgs). Off-site sampling was not included in the scope of this SI. If future off-site sampling is required, the proper stakeholders will be notified, and necessary rights of entry will be obtained by ARNG with property owner(s). Temporal boundaries were limited to the earliest available time field resources were available to complete the study.

4.4 ANALYTICAL APPROACH

Samples were analyzed by Eurofins Lancaster, accredited under the Department of Defense (DoD) Environmental Laboratory Accreditation Program (DoD ELAP; Accreditation Number 1.01) and the National Environmental Laboratory Accreditation Program (NELAP; Certificate Number 021). Data were compared to applicable SLs within this document and decision rules as defined in the UFP-QAPP Addendum (EA/Wood, 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 UFP-QAPP (EA/Wood, 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 was implemented in accordance with the following approved documents.

- *Final Preliminary Assessment Report, Boone National Guard Center, Franklin County, Kentucky,* dated May 2020 (AECOM 2020)
- *Final Programmatic Uniform Federal Policy-Quality Assurance Project Plan, Site Inspections for Per- and Polyfluoroalkyl Substances Impacted Sites, ARNG Installations, Nationwide,* dated December 2020 (EA 2020a)
- *Final Site Inspection Uniform Federal Policy-Quality Assurance Project Plan Addendum, Boone National Guard Center, Frankfort, Kentucky,* dated August 2021 (EA/Wood, 2021a)
- *Final Programmatic Accident Prevention Plan, Revision 1,* dated November 2020 (EA 2020)
- *Final Accident Prevention Plan/Site Safety and Health Plan, Boone National Guard Center, Frankfort, Kentucky,* dated April 2021 (EA/Wood 2021b).

The SI field activities were conducted from 25 October to 4 November 2021 and consisted of utility clearance, Sonic drilling technology and hand auger boring and soil sample collection, temporary monitoring well installation, grab groundwater sample collection, surface water sample collection, and land surveying. Field activities were conducted in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a), except as noted in **Section 5.10**.

The following samples were collected during the SI and analyzed for 24 compounds via liquid chromatography/tandem mass spectrometry (LC/MS/MS) compliant with QSM Version 5.3 Table B-15 (DoD, 2020) to fulfill the project DQOs:

- 18 soil samples from 11 boring locations;
- 11 grab groundwater samples from nine temporary well locations and two surfacing groundwater (seep) locations;
- Two surface water samples from a stream on the Facility; and,
- 21 quality assurance/quality control (QA/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 medium. 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,** land survey data are provided in **Appendix B3,** a Field Change Request form is provided in **Appendix B4**, and investigation-derived waste (IDW) placement data are provided in **Appendix B5**. 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 of these activities are presented below.

5.1.1 Technical Project Planning

The USACE TPP Process, Engineers Manual (EM) 200-1-2 (DA 2016a) 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 June 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 include ARNG, KYARNG, USACE, Kentucky Department of Environmental Protection, and representatives familiar with the Facility, the regulations, and the community. 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 UFP-QAPP Addendum (EA/Wood, 2021a).

A TPP Meeting 3 will be held after the field event to discuss the results of the SI. Meeting minutes for the TPP 3 will be included in **Appendix D** of this report. Future TPP meetings will provide an opportunity to discuss results and findings, and future actions, where warranted.

5.1.2 Utility Clearance

WSP contacted the Utility Notification Center to notify them of intrusive work at the Facility. WSP contracted Blood Hound, a private utility location service, to perform utility clearance at the BNGC. Utility clearance was performed at each of the proposed boring locations on 20 October 2021 with input from the WSP field team. General locating services and ground-penetrating radar (GPR) were used to complete the clearance. Additionally, the first 5 feet of each boring were pre-cleared by WSP's drilling subcontractor, M&W Drilling, LLC, using a hand auger to verify utility clearance in shallow subsurface where utilities would typically be encountered.

5.1.3 Source Water and PFAS Sampling Equipment Acceptability

The potable water source used for drilling water and decontamination of drilling equipment was confirmed to meet acceptability criteria, as defined in the UFP-QAPP Addendum, prior to the start of field activities. A sample from a potable water source at the FPB was collected on 27 August 2021, prior to mobilization, and analyzed for PFAS by LC/MS/MS compliant with QSM 5.3 Table B-15 (DoD, 2020). The results of the sample of the potable water source used for drilling water and decontamination of drilling equipment during the SI are provided in **Appendix E**. A discussion of the results is presented in the Data Usability Assessment (**Appendix A**).

Materials that were used within the sampling zone were confirmed as acceptable for use in the PFAS sampling environment. The checklist of acceptable materials for use in the PFAS sampling environment was provided in the Standard Operating Procedures appendix to the Programmatic UFP-QAPP (PQAPP) (EA 2020a).

5.2 HAND AUGER SOIL SAMPLING

A soil sample was collected from three locations for chemical analysis from 0 to up to 2 feet bgs using a hand auger. All soil sample locations are shown on **Figure 5-1**. Hand auger location AOI01-06 was identified in the UFP-QAPP Addendum (EA/Wood, 2021a), while hand auger locations AOI02-14 and AOI02-15 were added by the KYARNG after issuance of the Final UFP-QAPP Addendum (EA/Wood, 2021a) and prior to the commencement of drilling activities. The addition of AOI02-14 and AOI02-15 to the SI is detailed in the Field Change Request Form provided in **Appendix B4**. The hand auger location AOI01-06 was selected based on the AOI information provided in the PA (AECOM 2020) and as agreed upon by stakeholders during the TPP and review of the UFP-QAPP Addendum (EA/Wood, 2021a). Non-dedicated sampling equipment (i.e., hand auger) was decontaminated between sampling locations.

Each sample was collected into a laboratory-supplied PFAS-free high-density polyethylene (HDPE) bottle 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 for PFAS (LC/MS/MS compliant with QSM Version 5.3 Table B-15 [DoD, 2020]) in accordance with the UFP-QAPP Addendum. QC samples and analysis were performed as described in the UFP-QAPP Addendum (EA/Wood, 2021a).

5.3 SOIL BORINGS AND SOIL SAMPLING

Soil samples were collected via Sonic drilling methods in accordance with Standard Operating Procedure 019 *Monitoring Well Installation* (EA 2014*).* A Geoprobe 8140 Sonic drill rig sampling system was used to collect continuous soil cores to the target depth. A hand auger was used to collect soil from the top 5 feet of the borings in compliance with utility clearance procedures. The soil boring locations are shown on **Figure 5-1**, and boring sample depths are provided in **Table 5-1**. Several boring locations were adjusted within a 50-feet offset for reasons including drill rig access, utility avoidance and bias toward sampling within observed drainage features.

Three discrete soil samples were planned to be collected for chemical analysis from each soil boring: one sample at the surface (0 to 2 feet bgs) and two subsurface soil samples. One subsurface soil sample was to be collected approximately 1 foot above the groundwater table, and one subsurface sample was to be collected at the mid-point between the surface and the groundwater table (not to exceed 15 feet bgs). However, the UFP-QAPP Addendum (EA/Wood, 2021a) specified only two samples be collected if refusal was encountered at 6 feet bgs or shallower. Because shallow bedrock was encountered less than 6 feet bgs at all but one drilling location, three soil samples were collected at only one location (AOI02-08). At all other locations only one or two soil samples were collected, as detailed below:

- AOI01-01: Only two soil samples were collected due to bedrock at 3 feet bgs.

- AOI01-02: Only two soil samples were collected due to bedrock at 5.5 feet bgs.
- AOI01-03: Only two soil samples were collected due to bedrock at 3.5 feet bgs.
- AOI01-04: Only two soil samples were collected due to intermixed limestone rock from 1.3 to 5.5 feet bgs (bedrock at 6.5 feet).
- AOI01-05: Only a surface soil sample was collected due to bedrock at 2 feet bgs.
- AOI02-07: Only a surface soil sample was collected due to bedrock at 1.1 foot bgs.
- AOI02-09: Only two soil samples were collected due to bedrock at 4.5 feet bgs.

The uppermost saturated zone was observed at depths ranging from 0.5 foot to 32 feet bgs during drilling. Following installation of temporary monitoring wells, the static groundwater depths ranged from 0.74 to 20.41 feet bgs. Locations of surfacing groundwater were observed near both AOI 1 and AOI 2. Total boring completion depths, to accommodate temporary well installation, ranged from 10 to 34.2 feet bgs.

During the drilling, the soil cores were continuously logged for lithological descriptions by a field geologist using the Unified Soil Classification System. A photoionization detector (PID) was used to screen the breathing zone during boring activities as a part of personal safety requirements. Observations and measurements were recorded on sampling forms (**Appendix B2**) and in a non-treated field logbook. Depth interval, recovery thickness, PID concentrations, moisture, relative density, Munsell color, and Unified Soil Classification System texture were recorded. The boring logs are provided in **Appendix F**.

Soil encountered during SI activities included lean to fat clays with some silts and limestone or shale fragments observed overlying shallow bedrock. Depth to bedrock in the borings ranged from approximately one to eight feet bgs, and consisted of limestone, shale, or interbedded limestone and shale. The bedrock is mostly weak/weathered at the top and becomes less weathered and more competent with depth. The bedrock was generally slightly porous with fossil fragments and iron staining. The borings were completed at depths between 0.8 and 34.2 feet bgs. These observations are consistent with the understood depositional environment of the region.

Each sample was collected into a laboratory-supplied PFAS-free high-density polyethylene (HDPE) bottle and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via FedEx under standard COC procedures to the laboratory and analyzed for PFAS (LC/MS/MS compliant with QSM Version 5.3 Table B-15 [DoD, 2020]), total organic carbon (TOC) (EPA Method 9060A), pH (EPA Method 9045D), and grain size (ASTM Method D-422) in accordance with the UFP-QAPP Addendum (EA/Wood, 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. In instances when non-dedicated sampling equipment was used, such as a hand auger for the shallow soil samples, one equipment blank was collected per day 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 after sampling and surveying in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a). After removal of the casings, boreholes were abandoned using bentonite chips. Borings were installed in grass areas to avoid disturbing concrete or asphalt surfaces.

5.4 TEMPORARY WELL INSTALLATION AND GROUNDWATER GRAB SAMPLING

Temporary wells were installed using a Geoprobe 8140 Sonic drill rig sampling system. Once the borehole was advanced to the desired depth, a temporary well was constructed of a 5-ft or 10-ft section of 1-inch Schedule 40 poly-vinyl chloride (PVC) screen with sufficient casing to reach the ground surface. New PVC pipe and screen were used at each location to avoid cross contamination between locations. The screen intervals for the temporary wells are provided in **Table 5-2**.

Groundwater samples were collected using a PFAS-free 0.85-inch Geotech Bladder pump with PFAS-free HDPE tubing. Samples were collected after a period of time following well installation to allow groundwater to infiltrate and recharge the temporary well intervals. 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**) before each grab sample was collected in a separate container. 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.

Surfacing groundwater (seep) samples were collected using a peristaltic pump by placing the tubing into the seeping water and pumping the water directly into the sample containers. Field parameters were collected by pumping the seeping water into the holding cell of the field parameter instrument.

Each sample was collected in laboratory-supplied PFAS-free HDPE bottles and labeled using a PFAS-free marker or pen. Samples were packaged on ice and transported via Federal Express (FedEx) under standard COC procedures to the laboratory and analyzed for PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15 (DoD, 2020) in accordance with the UFP-QAPP Addendum (EA/Wood, 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. Two field blanks (FBs) were collected in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a). In instances when non-dedicated sampling equipment was used, such as a bladder pump, one equipment blank was collected a day and analyzed for the same parameters as the groundwater. A temperature blank was placed in each cooler for use in confirming that samples were preserved at or below 6°C during shipment.

Following well surveying (described below in **Section 5.7**), temporary wells were abandoned in accordance with the SI UFP-QAPP Addendum (EA/Wood, 2021a) by removing the PVC and backfilling the hole with bentonite chips.

5.5 SURFACE WATER SAMPLING

Surface water samples were collected from AOI 3: Unnamed Tributary. Grab surface water samples were collected using a PFAS-free dip sampler or similar. Water quality parameters (e.g., temperature, specific conductance, pH, dissolved oxygen, oxidation-reduction potential) were measured using a water quality meter and recorded on the field sampling form (**Appendix B2**) during the collection of the grab sample.

One field duplicate sample was collected (at a rate of 10%) and analyzed for the same parameters as the accompanying sample. One MS/MSD was collected (at a rate of 5%) and analyzed for the same parameters as the accompanying samples. One equipment blank was collected and analyzed for the same parameters as the groundwater. A temperature blank was placed in each cooler for use in confirming that samples were preserved at or below 6°C during shipment.

Each sample was collected into laboratory-supplied bottles and submitted to the laboratory for analysis of selected parameters following the same procedures described for groundwater collection in **Section 5.4**.

5.6 SYNOPTIC WATER LEVEL MEASUREMENTS

A synoptic groundwater gauging event was performed on 01 November 2021. Groundwater elevation measurements were collected from the 9 new temporary monitoring wells. Water level measurements were taken from the survey mark on the northern side of the well casing. Groundwater elevation data is provided in **Table 5-3**. A groundwater flow contour map is provided as **Figure 2-4**.

5.7 SURVEYING

The northern side of each new temporary well casing was surveyed using a Carlson BRx7 GNSS Receiver and the KYTC VRS System. Positions were collected in the applicable Universal Transverse Mercator zone projection with World Geodetic System 1984 datum (horizontal) and North American Vertical Datum 1988 (vertical). Surveying data were collected on 03 November 2021 and are provided in **Appendix B3**.

5.8 INVESTIGATION-DERIVED WASTE

As of the date of this report, the disposal of PFAS IDW is not regulated federally. IDW generated during the SI is considered non-hazardous waste and was managed in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a).

Soil IDW (i.e., soil and rock cuttings) generated during the SI activities were distributed on the downgradient side of the borehole, while liquid IDW (i.e., purge water and decontamination fluids) was discharged directly to the ground surface slightly downgradient of the source of generation. Geographic coordinates were collected using a Global positioning system (GPS)

around each location where IDW was placed. A map depicting the locations of the IDW placement with coordinates is provided in **Appendix B5**.

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.

5.9 LABORATORY ANALYTICAL METHODS

Samples were analyzed by LC/MS/MS, compliant with QSM Version 5.3 Table B-15 (DoD, 2020), at Eurofins in Lancaster, Pennsylvania, a DoD ELAP and NELAP-certified laboratory. Soil samples were also analyzed for TOC using EPA Method 9060A, pH by EPA Method 9045D, and grain size by ASTM D422.

5.10 DEVIATIONS FROM SI UFP-QAPP ADDENDUM

Deviations from the UFP-QAPP Addendum occurred based on conditions encountered during field activities. These deviations were discussed between EA/WSP, ARNG, and/or USACE as applicable. Deviations from the UFP-QAPP Addendum are noted below:

- For certain temporary monitoring wells (AOI02-07 through AOI02-09), a 10-foot screen was used rather than a 5-foot screen based on observations during drilling to ensure the well was screened across the groundwater zone.
- Certain borings were relocated, and sampling locations added, per request of the ARNG, as detailed in **Section 5.2** and in the Field Change Request Form (**Appendix B4**).

Table 5-1. Site Inspection Samples by Medium
Boone National Guard Center, Kentucky
Site Inspection Report

Sample Identification	Sample Collection Date	Sample Depth (feet bgs)	PFAS[1]	TOC[2]	pH[3]	Grain Size[4]	Comments
Soil Samples							
AOI01-01-SB-(0-2)	26 Oct 2021	0-2	X				
AOI01-01-SB-(2-3)	26 Oct 2021	2-3	X				
AOI01-02-SB-(0-2)	27 Oct 2021	0-2	X				
AOI01-02-SB-(4.5-5.5)	27 Oct 2021	4.5-5.5	X				
AOI01-03-SB-(0-1)	26 Oct 2021	0-1	X				
AOI01-03-SB-(2.5-3.5)	26 Oct 2021	2.5-3.5	X				
AOI01-04-SB-(0-1.3)	28 Oct 2021	0-1.3	X				MS/MSD
AOI01-04-SB-(5.5-6.5)	28 Oct 2021	5.5-6.5	X				
AOI01-05-SB-(0-2)	28 Oct 2021	0-2	X	X	X	X	
AOI01-06-SB-(0-0.8)	29 Oct 2021	0-0.8	X				
AOI02-07-SB-(0-1.1)	30 Oct 2021	0-1.1	X				
AOI02-08-SB-(0-2)	31 Oct 2021	0-2	X				
AOI02-08-SB-(3-4)	31 Oct 2021	3-4	X				
AOI02-08-SB-(7-8)	31 Oct 2021	7-8	X				
AOI02-09-SB-(0-1)	30 Oct 2021	0-1	X				
AOI02-09-SB-(3.5-4.5)	30 Oct 2021	3.5-4.5	X				
AOI02-14-SB-(0-1.2)	03 Nov 2021	0-1.2	X	X	X	X	
AOI02-15-SB-(0-2)	03 Nov 2021	0-2	X				MS/MSD
BNGC-DUP-01	27 Oct 2021	0-2	X				Duplicate of AOI01-02-SB-(0-2)
BNGC-DUP-02	31 Oct 2021	0-2	X				Duplicate of AOI02-08-SB-(0-2)
BNGC-DUP-05	03 Nov 2021	0-1.2	X	X (TOC)	X		Duplicate of AOI02-14-SB-(0-1.2)
Groundwater Samples							
AOI01-01-GW	01 Nov 2021		X				
AOI01-02-GW	01 Nov 2021		X				
AOI01-03-GW	01 Nov 2021		X				
AOI01-04-GW	02 Nov 2021		X				
AOI01-05-GW	01 Nov 2021		X				
AOI02-07-GW	02 Nov 2021		X				
AOI02-08-GW	02 Nov 2021		X				
AOI02-09-GW	02 Nov 2021		X				
AOI02-12-SW	03 Nov 2021		X				Surfacing groundwater
AOI01-13-SW	03 Nov 2021		X				Surfacing groundwater
BNGC-01-GW	02 Nov 2021		X				MS/MSD
BNGC-DUP-03	02 Nov 2021		X				Duplicate of AOI-02-07-GW
Surface Water Samples							
AOI03-10-SW	03 Nov 2021		X				
AOI03-11-SW	03 Nov 2021		X				
BNGC-DUP-04	03 Nov 2021		X				Duplicate of AOI03-10-SW

Sample Identification	Sample Collection Date	Sample Depth (feet bgs)	PFAS[1]	TOC[2]	pH[3]	Grain Size[4]	Comments
Blank Samples							
BNGC-EB-01	26 Oct 2021		X				Equipment Blank – bowl/spoon
BNGC-EB-02	27 Oct 2021		X				Equipment Blank – hand auger/bowl
BNGC-EB-03	28 Oct 2021		X				Equipment Blank – bowl/spoon
BNGC-EB-04	29 Oct 2021		X				Equipment Blank – hand auger
BNGC-EB-05	30 Oct 2021		X				Equipment Blank – bowl/spoon
BNGC-EB-06	31 Oct 2021		X				Equipment Blank – hose/water tank
BNGC-EB-07	01 Nov 2021		X				Equipment Blank – bladder pump
BNGC-EB-08	02 Nov 2021		X				Equipment Blank – bladder pump
BNGC-EB-09	03 Nov 2021		X				Equipment Blank – hand auger
BNGC-FB-01	01 Nov 2021		X				Field Blank
BNGC-FB-02	02 Nov 2021		X				Field Blank

Notes:
1. PFAS were analyzed by LC/MS/MS compliant with QSM 5.3 Table B-15.
2. TOC was analyzed using EPA Method 9060A.
3. pH was analyzed using EPA Method 9045D.
4. Grain size was analyzed using ASTM Method D422

Abbreviations:
AOI = area of interest
bgs = below ground surface
BNGC = Boone National Guard Center
DUP = field duplicate
EB = equipment (rinseate) blank
EPA = Environmental Protection Agency
FB = field (reagent) blank
GW = groundwater
MS/MSD = matrix spike/matrix spike duplicate
PFAS = per- and polyfluoroalkyl substances
SB = soil boring
SW = surface water
TOC = total organic carbon

Table 5-2. Soil Boring Depths and Temporary Well Screen Intervals
Boone National Guard Center, Kentucky
Site Inspection Report

Area of Interest	Boring Location	Soil Boring Depth (feet bgs)	Temporary Well Screen Interval (feet bgs)
1	AOI01-01	24	19-24
	AOI01-02	18	13-18
	AOI01-03	23.5	18.5-23.5
	AOI01-04	18	12.75-17.75
	AOI01-05	18.4	13.2-18.2
	AOI01-06	0.8	NA
2	AOI02-07	10	0-10
	AOI02-08	10	0-10
	AOI02-09	34.2	24.2-34.2
Upgradient	BNGC-01	14.5	4.5-14.5

Abbreviations:
bgs = below ground surface
NA = not applicable (well not installed)

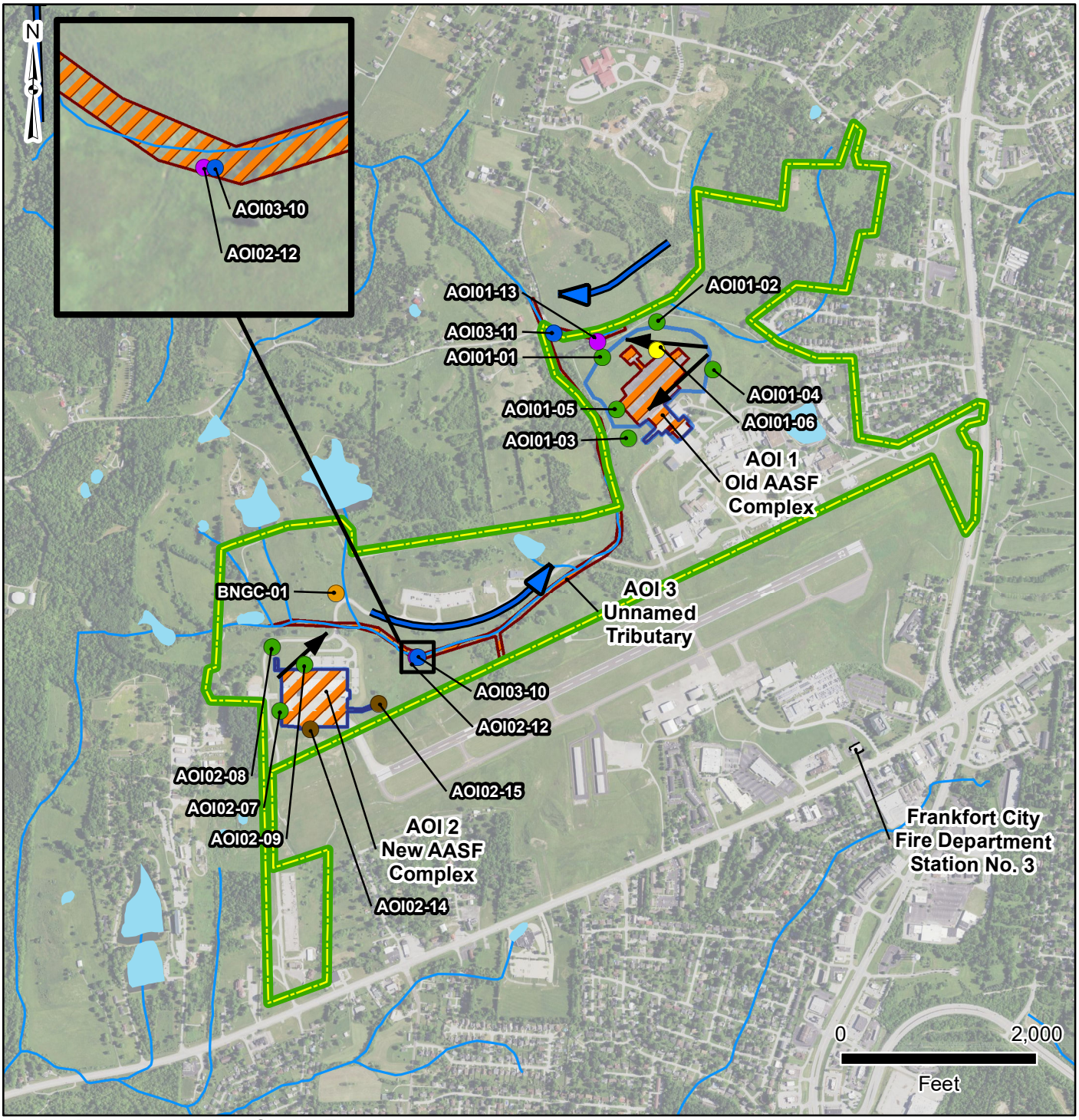
Table 5-3. Groundwater Elevation
Boone National Guard Center, Kentucky
Site Inspection Report

Monitoring Well ID	Top of Casing Elevation (feet NAVD88)	Depth to Water (feet btoc)	Groundwater Elevation (feet NAVD 88)
AOI01-01	745.71	9.84	735.87
AOI01-02	752.36	13.21	739.15
AOI01-03	745.93	20.41	725.52
AOI01-04	767.47	14.96	752.51
AOI01-05	752.47	11.4	741.07
AOI02-07	809.90	3.24	806.66
AOI02-08	791.55	2.06	789.49
AOI02-09	807.69	21.96	785.73
BNGC-01	777.80	7.55	770.25

Abbreviations:
btoc = below top of casing
NAVD88 = North American Vertical Datum 1988

Army National Guard Site Inspections
Site Inspection Report
Boone National Guard Center
Frankfort, Kentucky

Figure 5-1
Site Inspection Sample Locations



Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release
- No Suspected Release

Sample Type
- Soil Boring
- Soil Boring/Temporary Monitoring Well
- Temporary Monitoring Well
- Surface Soil Sample
- Surface Water Sample
- Surfacing Groundwater Sample

Hydrology/Hydrogeology
- Inferred Groundwater Flow Direction
- Surface Water Flow Direction
- Water Body
- River/Stream

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

Note: Certain features digitized from georeferenced AECOM Preliminary Assessment Report (2020) figures.

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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 on **Table 6-1** in **Section 6.1**. A discussion of the results for each AOI is provided in **Sections 6.3** through **Section 6.5**. **Tables 6-2** through **6-6** present results in soil, groundwater, and surface water for the relevant compounds. Tables that contain all results are provided in **Appendix E**, 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 (Assistant Secretary of Defense 2022). The ARNG program under which this SI was performed follows this DoD policy. Should the maximum 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**.

Table 6-1. Screening Levels for Soil and Groundwater

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

Notes:
1. Assistant Secretary of Defense. July 2022. Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient =0.1. May 2022.
2. 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. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

Abbreviations:
µg/kg = microgram(s) per kilogram
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
ft = feet
HFPO-DA hexafluoropropylene oxide dimer acid
ng/L = nanogram(s) per liter
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexanesulfonic acid
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

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 E** contains the results of the TOC, pH, and grain size sampling. TOC results ranged from 16,000 to 27,000 milligrams per kilogram; pH ranged from 7.5 to 7.8 Standard Units; and grain size results indicate that the soil samples are comprised primarily of silt (52.26% to 66.47%), clay (25.5% to 28%), and sand (7.27% to 14.77%).

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), important PFAS 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: the Old AASF and surrounding paved and grassed areas. The soil and groundwater results are summarized in **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 samples were collected from six boring locations associated with AOI 1 during the SI. **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.

Surface soil (0 to 2 feet bgs) was sampled from boring locations AOI01-01 through AOI01-06 (**Table 6-2**). Soil was also sampled from shallow subsurface soil (2 to 6.5 feet bgs) from boring locations AOI01-01 through AOI01-04. Deeper subsurface soil was not encountered. PFOS was detected at AOI01-03 in surface soil at a concentration (14 µg/kg) exceeding its respective SL. PFOA, PFHxS, and PFNA were detected in surface soil at concentrations below their respective SLs. PFOA was detected in three of six surface soil samples at concentrations ranging from 0.25 J µg/kg to 2.8 µg/kg; PFHxS was detected in two of six surface soil samples at concentrations

ranging from 0.25 J µg/kg to 2.1 µg/kg; and PFNA was detected in one of six surface soil samples at a concentration of 1.5 µg/kg. PFBS was not detected in the surface soil samples.

PFOS, PFOA, PFHxS, and PFNA were detected in shallow subsurface soil at concentrations below their respective SLs (**Table 6-3**). PFOS was detected in two of four shallow subsurface soil samples at concentrations ranging from 0.9 J+ µg/kg to 11 µg/kg; PFOA was detected in one of four shallow subsurface soil samples at a concentration of 1.1 µg/kg; PFHxS was detected in one of four shallow subsurface soil samples at a concentration of 1 µg/kg; and PFNA was detected in one of four shallow subsurface soil samples at a concentration of 1 µg/kg. PFBS was not detected in the shallow subsurface soil samples.

No deep subsurface soil samples were available for collection from AOI 1 due to the presence of shallow bedrock.

6.3.2 AOI 1 Groundwater Analytical Results

Groundwater samples were collected from five temporary wells and one surfacing groundwater (seep) location associated with AOI 1 during the SI. **Figure 6-6** and **Figure 6-7** present the ranges of detections in groundwater. **Table 6-5** summarizes the groundwater results.

Groundwater was sampled from temporary monitoring well locations AOI01-01 through AOI01-05. PFOS was detected at concentrations exceeding its SL. PFOS was detected in three of five groundwater samples from the temporary wells at concentrations ranging from 0.95 J nanograms per liter (ng/L) to 19 ng/L, and it exceeded SLs in one location (AOI01-03-GW). PFOA was detected below the SL in one of five groundwater samples from the temporary wells at a concentration of 5.9 ng/L. PFHxS was detected below the SL in three of five groundwater samples from the temporary wells at concentrations ranging from 6.6 ng/L to 25 ng/L. PFNA was detected below the SL in one of five groundwater samples from the temporary wells at a concentrations of 1.9 J ng/L. PFBS was detected in three of five groundwater samples from the temporary wells below its SL at concentrations ranging from 1.2 J ng/L to 4.8 ng/L.

Groundwater was also sampled from surfacing groundwater (seep) location AOI01-13. PFOS, PFOA, PFHxS, and PFNA were detected at concentrations exceeding their respective SLs in the seep groundwater sample at concentrations of 630 ng/L (PFOS), 35 ng/L (PFOA), 480 ng/L (PFHxS), and 11 ng/L (PFNA). PFBS was detected below its SL in the seep groundwater sample at a concentration of 25 ng/L.

6.3.3 Conclusions

Based on the results of the SI, PFOS was detected in soil above its respective SL, while PFOA, PFHxS, and PFNA were detected in soil below their respective SLs. PFOS, PFOA, PFHxS, and PFNA were detected in groundwater at concentrations above their respective SLs, while PFBS was detected below its respective SL. Based on the exceedances of the SLs in soil and groundwater, further evaluation at AOI 1 is warranted.

6.4 AOI 2

This section presents the analytical results for soil and groundwater in comparison to SLs for AOI 2: the New AASF and nearby paved and grassed areas. The soil and groundwater results are

summarized in **Table 6-2** through **Table 6-5**. Soil and groundwater results are presented on **Figure 6-1** through **Figure 6-7**.

6.4.1 AOI 2 Soil Analytical Results

Soil samples were collected from five boring locations associated with AOI 2 during the SI. **Figure 6-1** through **Figure 6-5** present the ranges of detections in soil. **Tables 6-2** through **Table 6-4** summarize the soil results.

Surface soil (0 to 2 feet bgs) was sampled from boring locations AOI02-07 through AOI02-09, AOI02-14, and AOI02-15. Soil was also sampled from shallow subsurface soil (3 to 4.5 feet bgs) from boring locations AOI02-08 and AOI02-09, and from deeper subsurface soil (7 to 8 feet bgs) from boring location AOI02-08.

PFOS, PFOA, and PFNA were detected in surface soil at concentrations below their respective SLs. PFOS was detected in two of five surface soil samples at concentrations ranging from 0.25 J µg/kg to 0.36 J µg/kg. PFOA was detected in four of five surface soil samples at concentrations ranging from 0.27 J µg/kg to 2.7 µg/kg; and PFNA was detected in two of five surface soil samples at concentrations ranging from 0.96 µg/kg to 2.1 µg/kg. PFBS and PFHxS were not detected in the shallow subsurface soil samples.

PFOA and PFNA were detected in shallow subsurface soil at concentrations below their respective SLs. PFOA was detected in both shallow subsurface soil samples at concentrations ranging from 0.27 J µg/kg to 1.3 J+ µg/kg; and PFNA was detected in one of two shallow subsurface soil samples at a concentration of 1.2 µg/kg. PFOS, PFBS, and PFHxS were not detected in the shallow subsurface soil samples.

The relevant compounds were not detected in the deep subsurface soil sample collected from AOI02-08.

6.4.2 AOI 2 Groundwater Analytical Results

Groundwater samples were collected from four temporary wells and one surfacing groundwater (seep) location associated with AOI 2 during the SI. **Figure 6-6** and **Figure 6-7** present the ranges of detections in groundwater. **Table 6-5** summarizes the groundwater results.

Groundwater was sampled from temporary monitoring well locations AOI02-07 through AOI02-09 and BNGC-01. The BNGC-01 temporary well was initially presumed to be upgradient of AOI 2 and was installed and sampled to assess whether potential releases associated with any off-site PFAS sources (**Section 3.3.2**) affected groundwater on the Facility. Based on groundwater elevations collected during the SI it was determined that BNGC-01 was downgradient of AOI 2, which was thought to have been caused by the variability of groundwater flow in the karst geology.

PFOA was detected in two of the four groundwater samples from the temporary wells at concentrations of 0.67 J ng/L and 6.4 ng/L, and it exceeded the SL at one temporary well location (AOI02-09). PFOS was detected in one of the four groundwater samples from the temporary wells below its SL at a concentration of 0.48 J ng/L; PFNA was detected in one of the

four groundwater samples from the temporary wells below its SL at a concentration of 1.2 ng/L; PFBS was detected in one of the four groundwater samples from the temporary wells below its SL at a concentration of 0.45 J ng/; and PFHxS was not detected in any of the four groundwater samples from the temporary wells.

Groundwater was also sampled from surfacing groundwater (seep) location AOI02-12. PFOS, PFOA, PFBS, PFHxS, and PFNA were detected in the seep groundwater below their respective SLs at concentrations of 0.6 J ng/L (PFOS), 3.1 ng/L (PFOA), 0.68 J ng/L (PFBS), 0.61 J ng/L (PFHxS), and 0.74 J ng/L (PFNA).

6.4.3 Conclusions

Based on the results of the SI, PFOS, PFOA, and PFNA were detected in soil below their respective SLs. PFOA was detected in groundwater at a concentration above its SL. PFOS, PFBS, PFHxS, and PFNA were detected in groundwater at concentrations below their respective SLs. Based on the exceedance of the SL in groundwater, further evaluation at AOI 2 is warranted.

6.5 AOI 3

This section presents the analytical results for surface water for AOI 3: an unnamed tributary of South Benson Creek that transects the Facility. The surface water results are summarized in **Table 6-6** and **Figures 6-8 and 6-9**.

Two surface water samples were collected within AOI 3. One sample (AOI03-10) was collected east-northeast (downstream) of AOI 2 and downstream of seep sample AOI02-12, while the second sample (AOI03-11) was collected from the northern branch of AOI 3 (northwest and downstream of AOI 1) prior to its confluence with the western branch of AOI 3 (which flows from AOI 2), near the installation boundary and downstream of seep sample AOI01-13. Location AOI03-11 is considered to be near the downstream end of AOI 3. PFOS was detected in both surface water samples at concentrations ranging from 0.91 J ng/L (0.86 J ng/L in the duplicate sample) to 190 ng/L; PFOA was detected in both surface water samples at concentrations ranging from 3.5 ng/L (3.6 ng/L in the duplicate sample) to 11 ng/L; PFBS was detected in both surface water samples at concentrations ranging from 0.71 J ng/L to 11 ng/L; PFHxS was detected in both surface water samples at concentrations ranging from 0.55 J ng/L (0.49 J ng/L in the duplicate sample) to 120 ng/L; and PFNA was detected in both surface water samples at concentrations ranging from 0.91 J ng/L (0.87 J ng/L in the duplicate sample) to 2.5 ng/L.

6.5.1 Conclusions

Based on the results of the SI, PFOS, PFOA, PFBS, PFHxS, and PFNA were detected in the surface water of AOI 3. Based on the surfacing groundwater (seep) result from sample AOI01-13 upgradient and proximal to AOI03-11 (downstream end of AOI 3), PFAS in groundwater from AOI 1 may have affected the surface water in AOI 3 as observed in sample location AOI03-11, which is near the Facility boundary.

Table 6-2
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Soil
Boone National Guard Center, Kentucky
Site Inspection Report

	Area of Interest	AOI1													
	Location ID	AOI01-01		AOI01-02		AOI01-02		AOI01-03		AOI01-04		AOI01-05		AOI01-06	
	Sample Name	AOI01-01-SB-(0-2)		AOI01-02-SB-(0-2)		BNGC-DUP-01		AOI01-03-SB-(0-1)		AOI01-04-SB-(0-1.3)		AOI01-05-SB-(0-2)		AOI01-06-SB-(0-0.8)	
	Parent Sample ID					AOI01-02-SB-(0-2)									
	Depth	0-2 ft		0-2 ft		0-2 ft		0-1 ft		0-1.3 ft		0-2 ft		0-0.8 ft	
	Sample Date	10/26/2021		10/27/2021		10/27/2021		10/26/2021		10/28/2021		10/28/2021		10/29/2021	
Analyte	OSD Screening Level[1,2]	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS[3] (µg/kg)															
PFBS	1900	ND		ND		ND		ND		ND		ND		ND	
PFHxS	130	ND		ND		ND		2.1		ND		0.25	J	ND	
PFNA	19	ND		ND		ND		1.5		ND		ND		ND	
PFOS	13	0.39	J	ND		ND		14		ND		0.71		0.5	J
PFOA	19	ND		ND		ND		2.8		ND		0.25	J	0.49	J

Gray Fill — Detected concentration exceeded OSD Screening Level

References

1. Assistant Secretary of Defense. July 2022. *Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1* . May 2022.

2. The Screening Levels for soil are based on a residential scenario for direct ingestion of contaminated soil.

3. PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated quantity but may bias high

Chemical Abbreviations

PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
ft	Feet
ND	analyte not detected above the LOD (LOD values are prented in Appendix E)
LOD	limit of detection
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoralkyl substances
QSM	Quality Systems Manual
Qual	interpreted qualifier
µg/kg	micrograms/kilogram

Table 6-2
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Soil
Boone National Guard Center, Kentucky
Site Inspection Report

Area of Interest		AOI2													
Location ID		AOI02-07		AOI02-08		AOI02-08		AOI02-09		AOI02-14		AOI02-14		AOI02-15	
Sample Name		AOI02-07-SB-(0-1.1)		AOI02-08-SB-(0-2)		BNGC-DUP-02		AOI02-09-SB-(0-1)		AOI02-14-SB-(0-1.2)		BNGC-DUP-05		AOI02-15-SB-(0-2)	
Parent Sample ID						AOI02-08-SB-(0-2)						AOI02-14-SB-(0-1.2)			
Depth		0-1.1 ft		0-2 ft		0-2 ft		0-1 ft		0-1.2 ft		0-1.2 ft		0-2 ft	
Sample Date		10/30/2021		10/31/2021		10/31/2021		10/30/2021		11/3/2021		11/3/2021		11/3/2021	
Analyte	OSD Screening Level[1,2]	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS[3] (µg/kg)															
PFBS	1900	ND		ND		ND		ND		ND		ND		ND	
PFHxS	130	ND		ND		ND		ND		ND		ND		ND	
PFNA	19	ND		2.1		1.1	J	ND		ND		ND		0.96	
PFOS	13	0.36	J	ND		0.28		ND		0.25	J	0.27	J	ND	
PFOA	19	0.27	J	2.7		1.5	J+	ND		0.33	J	0.34	J	1.4	

Gray Fill — Detected concentration exceeded OSD Screening Level

References

1. Assistant Secretary of Defense. July 2022. *Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1* . May 2022.

2. The Screening Levels for soil are based on a residential scenario for direct ingestion of contaminated soil.

3. PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15

Interpreted Qualifiers

J = Estimated concentration

J+ = Estimated quantity but may bias high

Chemical Abbreviations

PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
ft	Feet
ND	analyte not detected above the LOD (LOD values are prented in Appendix E)
LOD	limit of detection
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoralkyl substances
QSM	Quality Systems Manual
Qual	interpreted qualifier
µg/kg	micrograms/kilogram

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Table 6-3
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Shallow Subsurface Soil
Boone National Guard Center, Kentucky
Site Inspection Report

	Area of Interest	AOI 1								AOI 2			
	Location ID	AOI01-01		AOI01-02		AOI01-03		AOI01-04		AOI02-08		AOI02-09	
	Sample Name	AOI01-01-SB-(2-3)		AOI01-02-SB-(4.5-5.5)		AOI01-03-SB-(2.5-3.5)		AOI01-04-SB-(5.5-6.5)		AOI02-08-SB-(3-4)		AOI02-09-SB-(3.5-4.5)	
	Parent Sample ID												
	Depth	2-3 ft		4.5-5.5 ft		2.5-3.5 ft		5.5-6.5 ft		3-4 ft		3.5-4.5 ft	
	Sample Date	10/26/2021		10/27/2021		10/26/2021		10/28/2021		10/31/2021		10/30/2021	
Analyte	OSD Screening Level[1,2]	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Soil, PFAS[3] (µg/kg)													
PFBS	25000	ND		ND		ND		ND		ND		ND	
PFHxS	1600	ND		ND		1		ND		ND		ND	
PFNA	250	ND		ND		1		ND		1.2		ND	
PFOS	160	0.9	J+	ND		11		ND		ND		ND	
PFOA	250	ND		ND		1.1		ND		1.3	J+	0.27	J

Gray Fill — Detected concentration exceeded OSD Screening Level

References

1. Assistant Secretary of Defense. July 2022. *Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1* . May 2022.
2. The SL for soil is based on incidental ingestion of soil industrial/commercial worker >2 ft.
3. PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15

Interpreted Qualifiers

J = Estimated concentration
J+ = Estimated quantity but may bias high

Chemical Abbreviations

PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
ft	Feet
LOD	limit of detection
ND	analyte not detected above the LOD
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoralkyl substances
QSM	Quality Systems Manual
Qual	interpreted qualifier
µg/kg	micrograms/kilogram

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Table 6-4
PFOS, PFOA, PFBS, PFHxs, and PFNA Results in Deep Subsurface Soil
Boone National Guard Center, Kentucky
Site Inspection Report

	Area of Interest	AOI 2	
	Location ID	AOI02-08	
	Sample Name	AOI02-08-SB-(7-8)	
		7-8 ft	
	Sample Date	10/31/2021	
Analyte	**OSD Screening Level[1,2]**	**Result**	**Qual**
Soil, PFAS[3] (µg/kg)			
PFBS	25000	ND	
PFHxS	1600	ND	
PFNA	250	ND	
PFOS	160	ND	
PFOA	250	ND	

Gray Fill — Detected concentration exceeded OSD Screening Level

References

1. Assistant Secretary of Defense. July 2022. *Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1* . May 2022.

2. The SL for soil is based on incidental ingestion of soil industrial/commercial worker >2 ft.
3. PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15

Chemical Abbreviations

PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
DL	Detection limit
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromotagraphy with tandem mass spectometry
LOD	limit of detection
ND	analyte not detected above the LOD
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoralkyl substances
QSM	Quality Systems Manual
Qual	interpreted qualifier
ng/l	nanograms/liter

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Table 6-5
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Groundwater
Boone National Guard Center, Kentucky
Site Inspection Report

Area of Interest		AOI1											
Location ID		AOI01-01		AOI01-02		AOI01-03		AOI01-04		AOI01-05		AOI01-13	
Sample Name		AOI01-01-GW		AOI01-02-GW		AOI01-03-GW		AOI01-04-GW		AOI01-05-GW		AOI01-13-SW	
Parent Sample ID													
Sample Date		11/1/2021		11/1/2021		11/1/2021		11/2/2021		11/1/2021		11/3/2021	
Analyte	OSD Screening Level[1,2]	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Groundwater, PFAS[3] (ng/L)													
PFBS	601	4.8		ND		1.2	J	ND		2.1		25	
PFHxS	39	20		ND		25		ND		6.6		480	
PFNA	6	ND		ND		1.9	J	ND		ND		11	
PFOS	4	0.95	J	ND		19		ND		1.1	J	630	
PFOA	6	ND		ND		5.9		ND		ND		35	

Notes

Grey Fill — Detected concentration exceeded OSD Screening Levels

References

1. Assistant Secretary of Defense. July 2022. ***Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1*** **. May 2022.**

2. Groundwater screening levels based on residential scenario for direct ingestion of groundwater

3. PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15

Interpreted Qualifiers

J = Estimated concentration

Chemical Abbreviations

PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
DL	Detection limit
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromotagraphy with tandem mass spectometry
LOD	limit of detection
ND	analyte not detected above the LOD (LOD values are presented in Appendix E)
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoralkyl substances
QSM	Quality Systems Manual
Qual	interpreted qualifier
USEPA	United States Environmental Agency
ng/l	nanograms/liter

Table 6-5
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Groundwater
Boone National Guard Center, Kentucky
Site Inspection Report

Area of Interest		AOI2											
Location ID		AOI02-07		AOI02-07		AOI02-08		AOI02-09		AOI02-12		BNGC-01	
Sample Name		AOI02-07-GW		BNGC-DUP-03		AOI02-08-GW		AOI02-09-GW		AOI02-12-SW		BNGC-01-GW	
Parent Sample ID				AOI02-07-GW									
Sample Date		11/2/2021		11/2/2021		11/2/2021		11/2/2021		11/3/2021		11/2/2021	
Analyte	OSD Screening Level[1,2]	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Groundwater, PFAS[3] (ng/L)													
PFBS	601	ND		ND		ND		ND		0.68	J	0.45	J
PFHxS	39	ND		ND		ND		ND		0.61	J	ND	
PFNA	6	ND		ND		ND		1.2	J	0.74	J	ND	
PFOS	4	ND		0.48	J	ND		ND		0.6	J	ND	
PFOA	6	ND		ND		ND		6.4		3.1		0.67	J

Notes

Grey Fill — Detected concentration exceeded OSD Screening Levels

References

1. Assistant Secretary of Defense. July 2022. *Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1* . May 2022.

2. Groundwater screening levels based on residential scenario for direct ingestion of groundwater

3. PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15

Interpreted Qualifiers

J = Estimated concentration

Chemical Abbreviations

PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
DL	Detection limit
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromotagraphy with tandem mass spectometry
LOD	limit of detection
ND	analyte not detected above the LOD (LOD values are presented in Appendix E)
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoralkyl substances
QSM	Quality Systems Manual
Qual	interpreted qualifier
USEPA	United States Environmental Agency
ng/l	nanograms/liter

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Table 6-6
PFOA, PFOS, PFBS, PFNA, and PFHxS Results in Surface Water
Boone National Guard Center, Kentucky
Site Inspection Report

	Area of Interest	AOI 3					
	Location ID	AOI03-10		AOI03-10		AOI03-11	
	Sample Name	AOI03-10-SW		BNGC-DUP-04		AOI03-11-SW	
	Parent Sample ID			AOI03-10-SW			
	Sample Date	11/3/2021		11/3/2021		11/3/2021	
Analyte	**OSD Screening Level[1]**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Surface Water, PFAS[2] (ng/L)							
PFBS	None	0.71	J	0.71	J	11	
PFHxS	None	0.55	J	0.49	J	120	
PFNA	None	0.91	J	0.87	J	2.5	
PFOS	None	0.91	J	0.86	J	190	
PFOA	None	3.5		3.6		11	

References

1. Assistant Secretary of Defense. July 2022. *Risk Based Screening Levels in Groundwater and Soil using United States Environmental Protection Agency's Regional Screening Level Calculator. Hazard Quotient (HQ)=0.1* . May 2022.
2. PFAS by LC/MS/MS compliant with QSM Version 5.3 Table B-15

Interpreted Qualifiers

J = Estimated concentration

Chemical Abbreviations

PFBS	Perfluorobutanesulfonic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOA	Perfluorooctanoic acid

Acronyms and Abbreviations

AASF	Army Aviation Support Facility
AOI	Area of Interest
DL	Detection limit
HQ	Hazard Quotient
ID	identification
LCMSMS	liquid chromotagraphy with tandem mass spectometry
LOD	limit of detection
OSD	Office of the Secretary of Defense
PFAS	per- and polyfluoralkyl substances
QSM	Quality Systems Manual
Qual	interpreted qualifier
USEPA	United States Environmental Agency
ng/l	nanograms/liter

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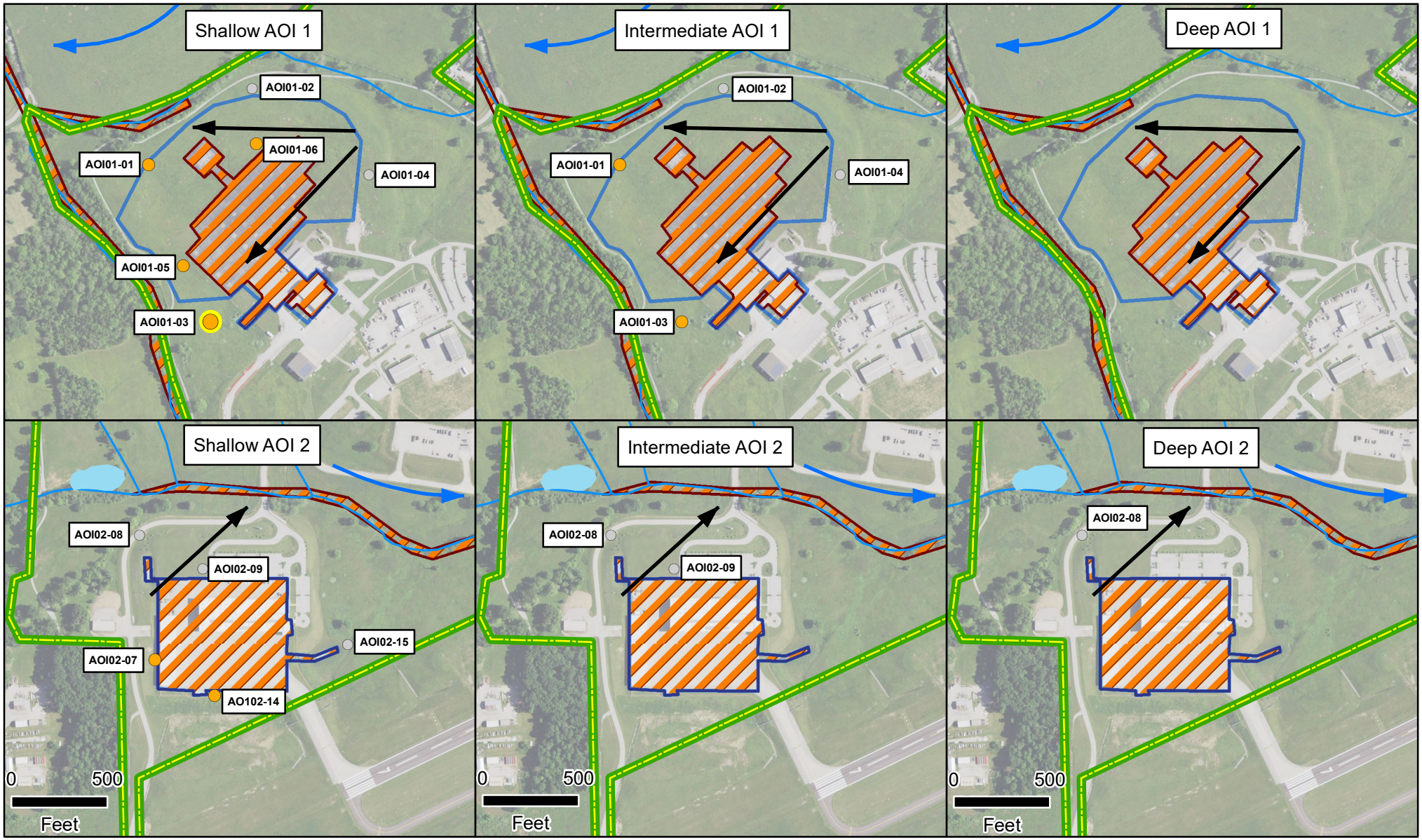
Frankfort, Kentucky

Figure 6-1
PFOS Detections in Soil (AOI 1 and AOI 2)



Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

PFOS Results (µg/kg)
- ND (Non-Detect)
- >ND - 13
- >13 -160
- >160 - 1,600
- >1,600

NOTES:
PFAS = Per- and Polyfluoroalkyl Substances
PFOS = perfluorooctanesulfonic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
Exceedances of The Office of the Secretary of Defense (OSD) Screening Level (SL) are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

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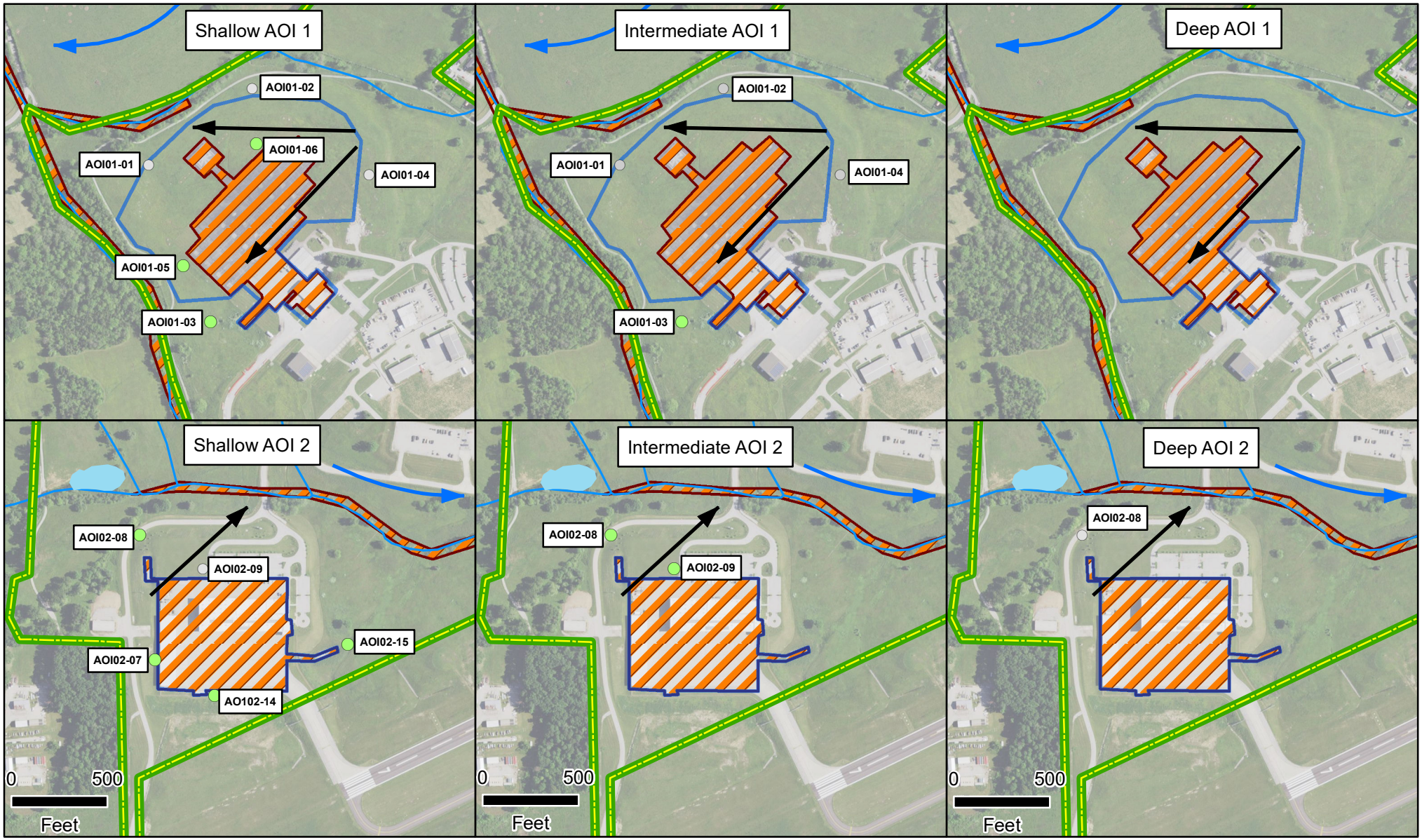
Boone National Guard Center
Frankfort, Kentucky

Figure 6-2
PFOA Detections in Soil (AOI 1 and AOI 2)



Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

PFOA Results (µg/kg)
- ND (Non-Detect)
- >ND - 19
- >19 - 250
- >250 - 2,500
- >2,500

NOTES:
PFAS = Per- and Polyfluoroalkyl Substances
PFOA = perfluorooctanoic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
Exceedances of The Office of the Secretary of Defense (OSD) Screening Level (SL) are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
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Prepared For:.....USACE

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Boone National Guard Center
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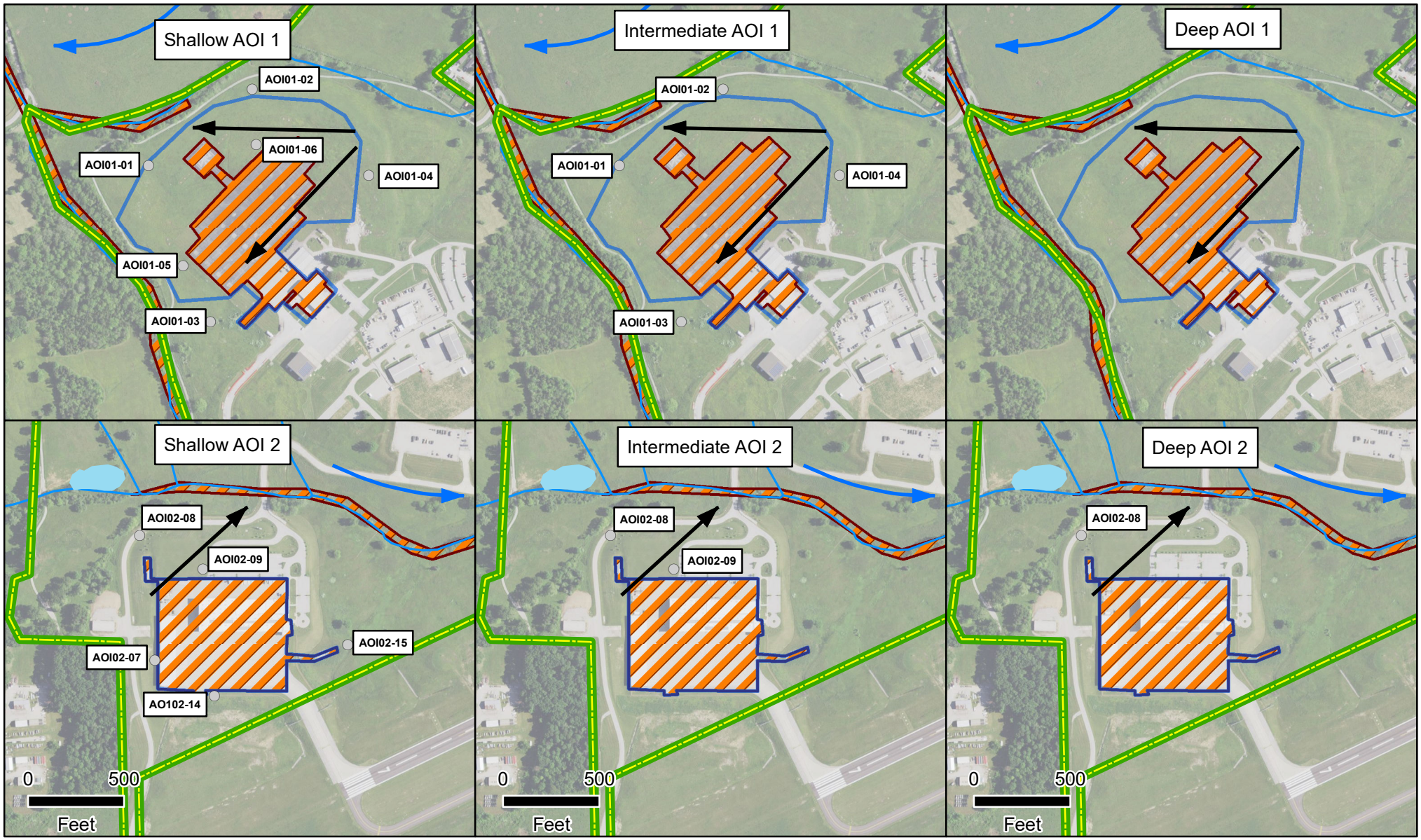
Figure 6-3
PFBS Detections in Soil (AOI 1 and AOI 2)



Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

PFBS Results (µg/kg)
- ND (Non-Detect)
- >ND - 10
- >10 - 1,900
- >1,900 - 25,000
- >25,000

NOTES:
PFAS = Per- and Polyfluoroalkyl Substances
PFBS = perfluorobutanesulfonic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
Exceedances of The Office of the Secretary of Defense (OSD) Screening Level (SL) are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
Prepared By:.....WSP
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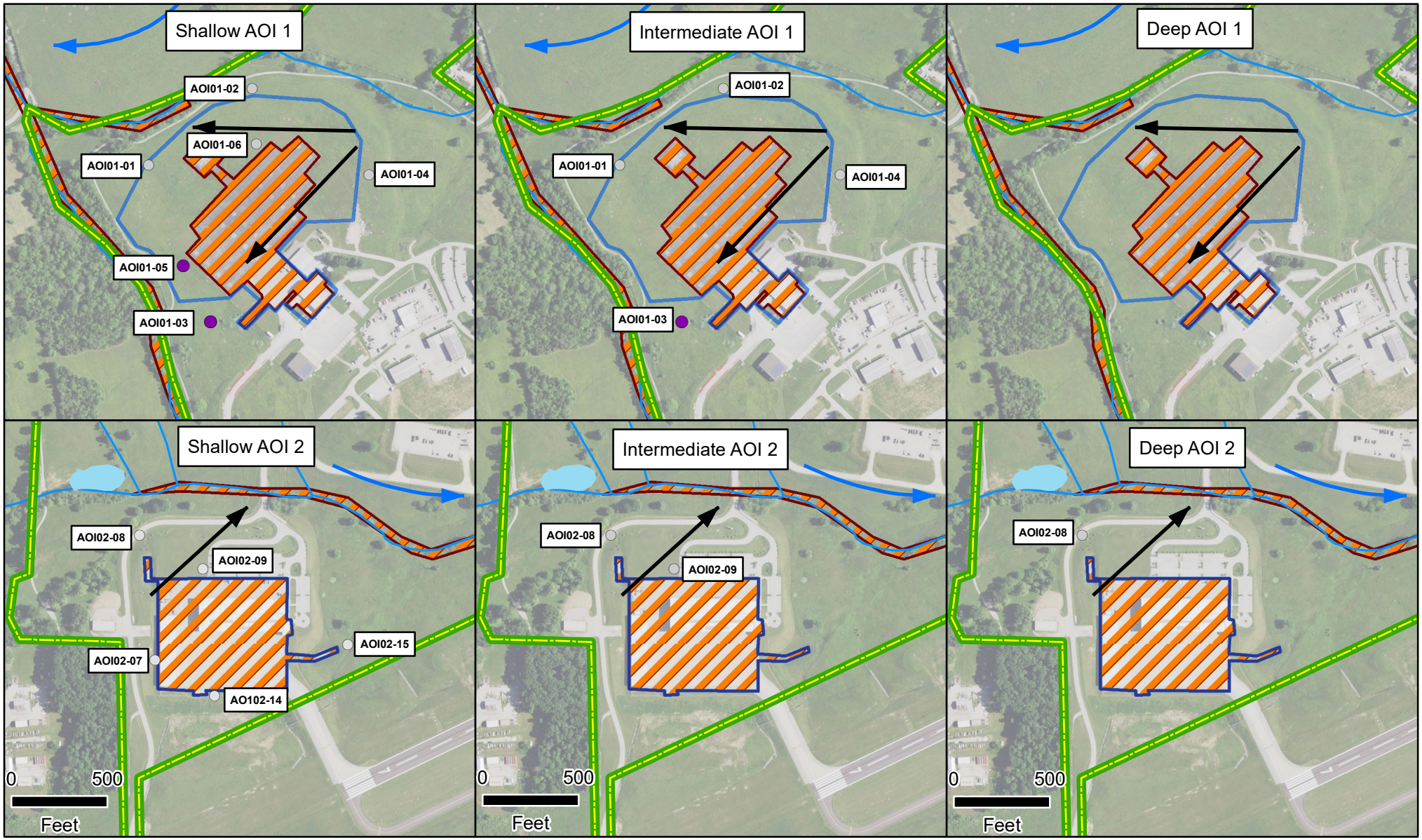
Figure 6-4
PFHxS Detections in Soil (AOI 1 and AOI 2)



N

Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

PFHxS Results (µg/kg)
- ND (Non-Detect)
- >ND - 10
- >10 -130
- >130 - 1,600
- >1,600

NOTES:
PFAS = Per- and Polyfluoroalkyl Substances
PFHxS = perfluorohexanesulfonic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
Exceedances of The Office of the Secretary of Defense (OSD) Screening Level (SL) are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
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Figure 6-5
PFNA Detections in Soil (AOI 1 and AOI 2)

Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

PFNA Results (µg/kg)
- ND (Non-Detect)
- >ND - 19
- >19 - 250
- >250 - 2,500
- >2,500

NOTES:
PFAS = Per- and Polyfluoroalkyl Substances
PFNA = perfluorononanoic acid
ND = Non-Detect
(µg/Kg) = Microgram(s) per Kilogram
Exceedances of The Office of the Secretary of Defense (OSD) Screening Level (SL) are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
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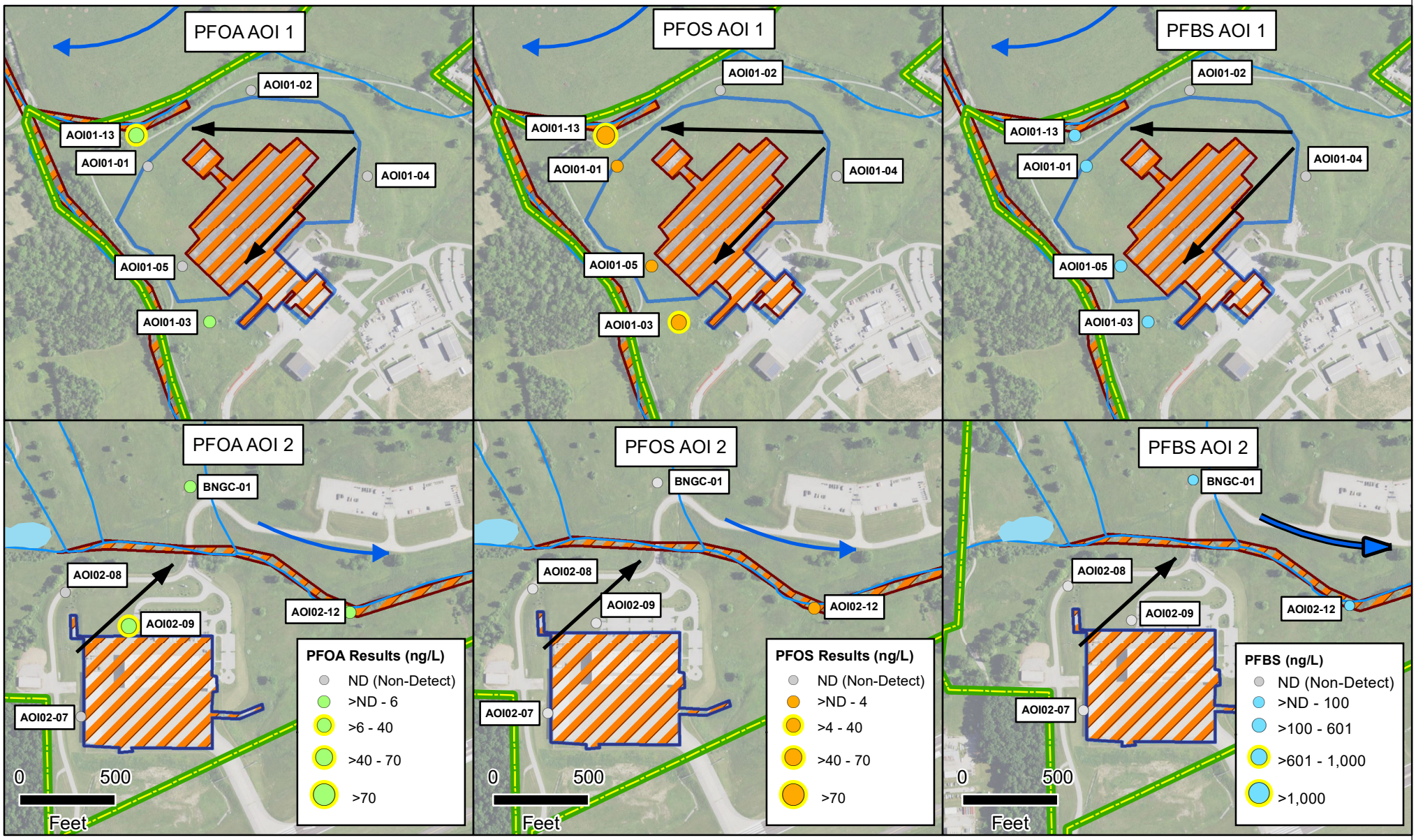
Figure 6-6
PFOA, PFOS, and PFBS Detections in Groundwater (AOI 1 and AOI 2)



Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

NOTES:
PFAS = Per- and Polyfluoroalkyl Substances
PFOS = perfluorooctanesulfonic acid
PFOA = perfluorooctanoic acid
PFBS = perfluorobutanesulfonic acid
ND = Non-Detect
ng/L = nanogram(s) per liter
Exceedances of The Office of the Secretary of Defense (OSD) Screening Level (SL) are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
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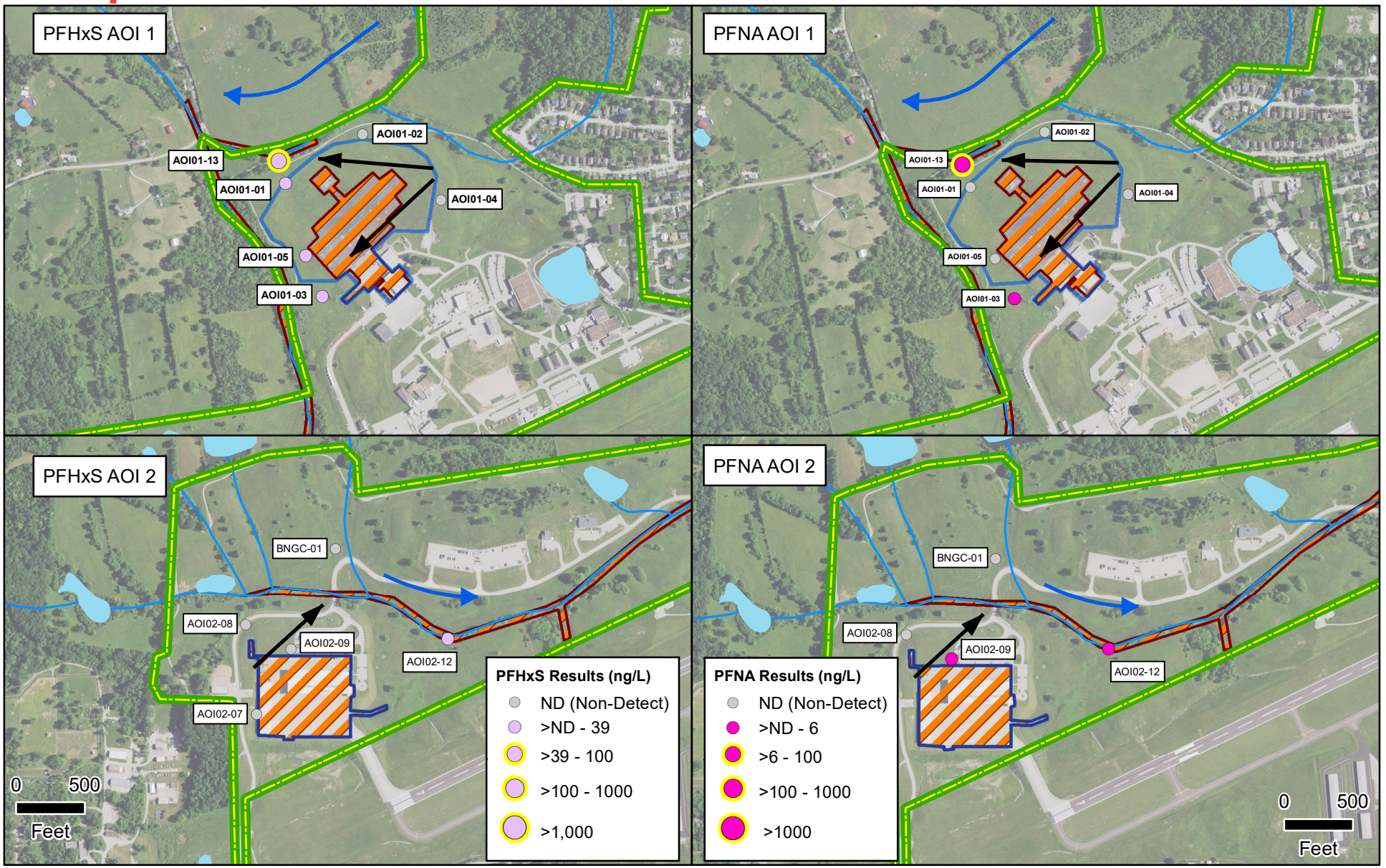
Figure 6-7
PFHxS and PFNA Detections in Groundwater (AOI 1 and AOI 2)



Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

NOTES:
PFAS = Per-and Polyfluoroalkyl Substances
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
ND = Non-Detect
ng/L = nanogram(s) per liter
Exceedances of The Office of the Secretary of Defense (OSD) Screening Level (SL) are depicted with a yellow halo.

Data Sources:
ESRI 2020
AECOM 2020

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Prepared For:.....USACE

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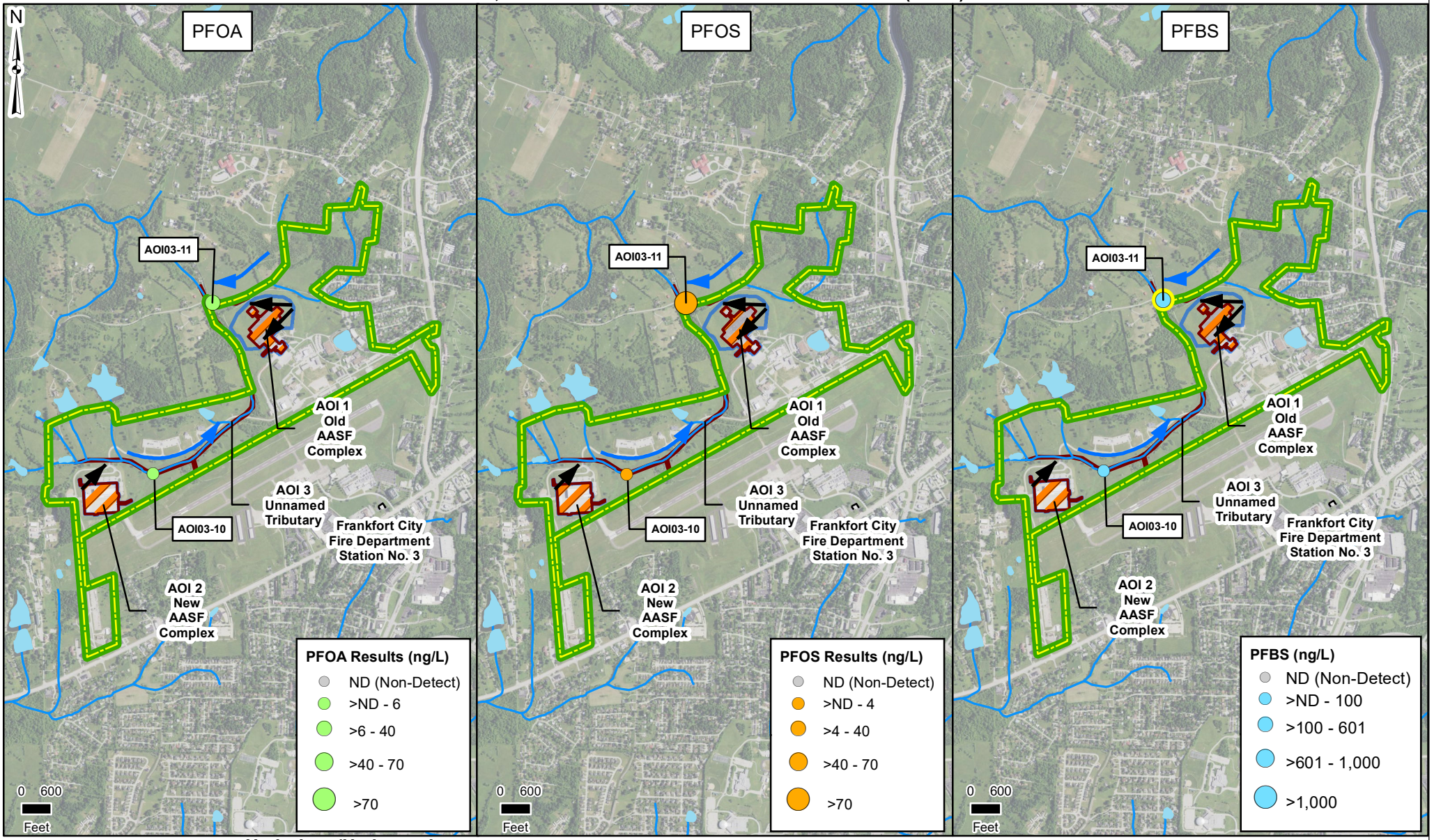
Frankfort, Kentucky

Figure 6-8
PFOS, PFOA and PFBS Detections In Surface Water (AOI 3)



Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

NOTES:
PFAS = Per- and Polyfluoroalkyl Substances
PFOS = perfluorooctanesulfonic acid
PFOA = perfluorooctanoic acid
PFBS = perfluorobutanesulfonic acid
ND = Non-Detect
ng/L = nanogram(s) per liter

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

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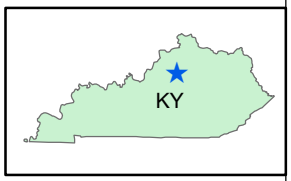
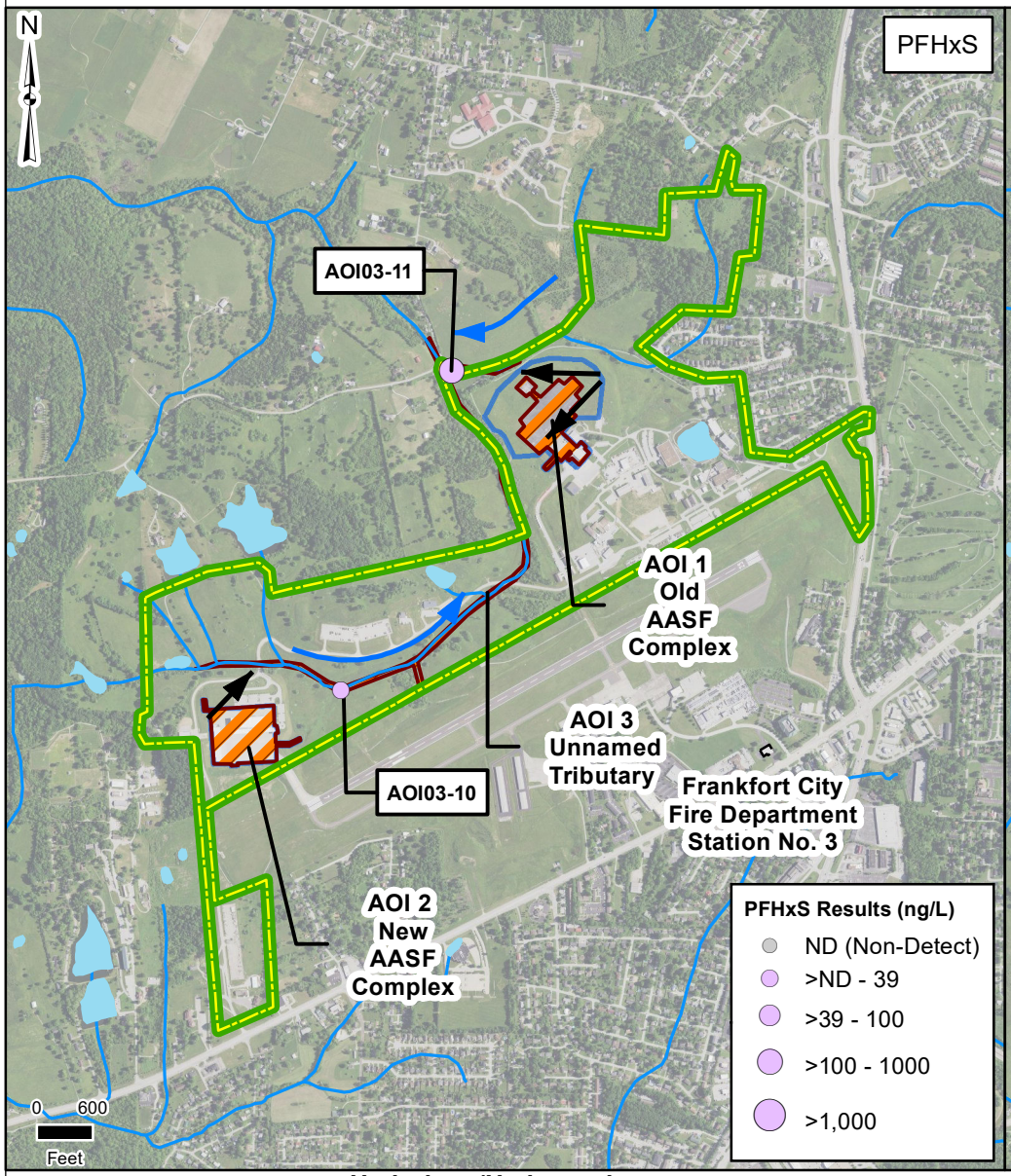
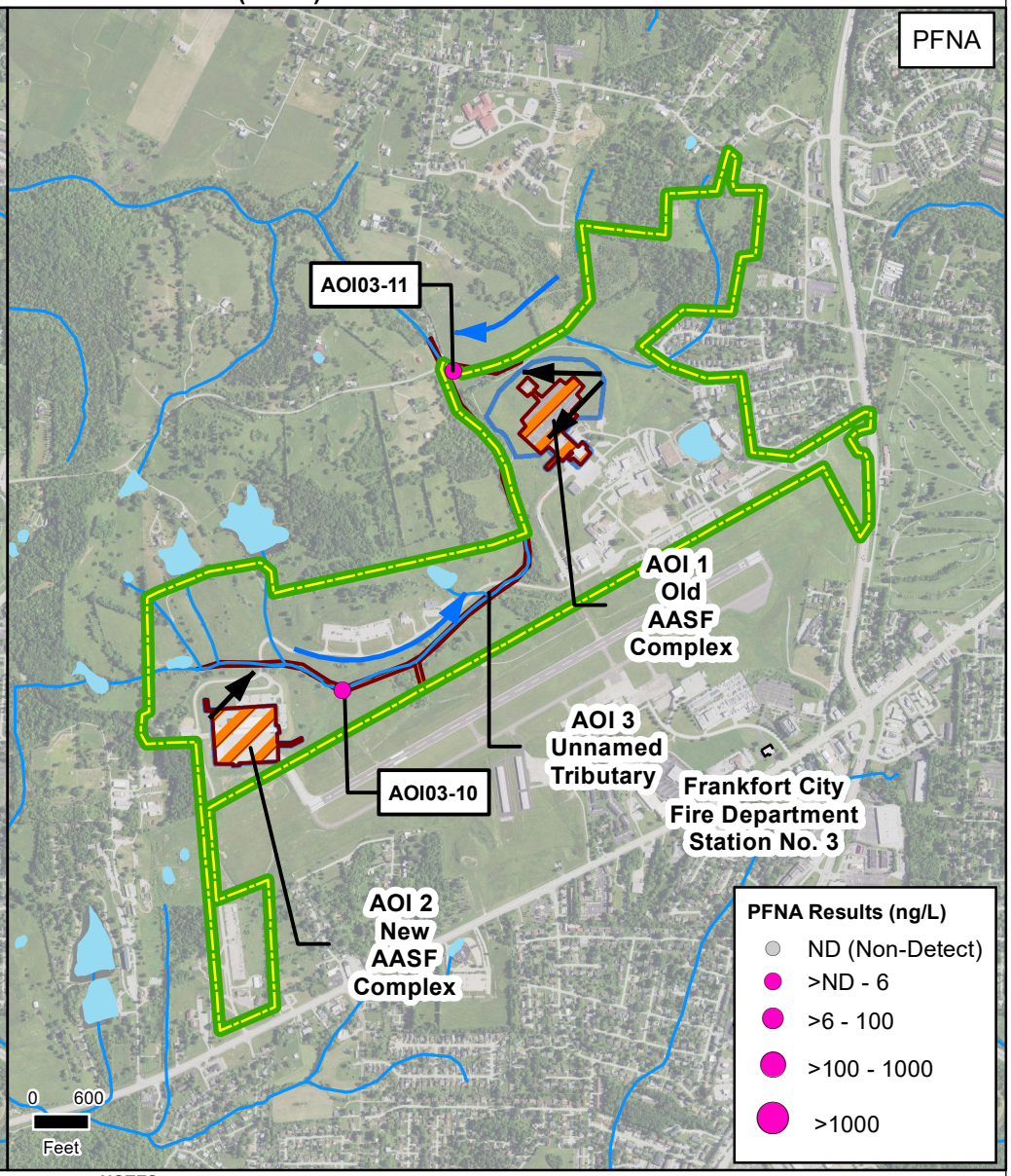
Site Inspection Report
Boone National Guard Center
Frankfort, Kentucky

Figure 6-9
PFHxS and PFNA Detections In Surface Water (AOI 3)







Facility Data
- Facility Boundary
- Area of Interest (AOI)
- Potential PFAS Release

Hydrology/Hydrogeology
- Surface Water Flow Direction
- Groundwater Flow Direction
- Water Body
- River/Stream

NOTES:
PFAS = Per-and Polyfluoroalkyl Substances
PFHxS = Perfluorohexanesulfonic acid
PFNA = Perfluorononanoic acid
ND = Non-Detect
ng/L = nanogram(s) per liter

Data Sources:
ESRI 2020
AECOM 2020

Date:.....October 2022
Prepared By:.....WSP
Prepared For:.....USACE

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7. EXPOSURE PATHWAYS

The CSM for each AOI, revised based on the SI findings, is presented on **Figure 7-1** through **Figure 7-3**. Please note that while the CSM discussion assists in determining if a receptor may be affected, 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 Facility 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 figures use 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 CSMs indicate whether potentially complete exposure pathways may exist, the recommendation for future study in a 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 exposure pathways for 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 EPA guidance for risk screening (EPA, 2001). Receptors at the Facility include site workers (e.g., staff and soldiers), construction workers, recreational users, trespassers and off-facility residents.

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 each AOI based on the aforementioned criteria.

7.1.1 AOI 1

AOI 1 is the Old AASF area that includes a maintenance hangar north of the armory, parking aprons, and a helicopter landing pad. Mobile AFFF-containing fire extinguishers were historically stored at AOI 1 before the completion of the New AASF. Four Amerex Model 630

mobile fire extinguishers transferred from the Old AASF to the New AASF were emptied at an unknown location (suspected to have been the Old AASF).

PFOS, PFOA, PFHxS, and PFNA were detected in surface soil at AOI 1, and PFOS was detected in soil above its respective SL. Site workers, construction workers, and trespassers/visitors could contact constituents in surface soil via incidental ingestion and inhalation of dust. Therefore, the surface soil exposure pathway for site workers, construction workers, and trespassers/visitors is potentially complete. PFOS, PFOA, PFHxS, and PFNA were detected in subsurface soil at AOI 1. Construction workers could contact constituents in subsurface soil via incidental ingestion and inhalation of dust; therefore, the subsurface soil exposure pathway for construction workers is potentially complete. The CSM for AOI 1 is presented in **Figure 7-1.**

7.1.2 AOI 2

AOI 2 is the New AASF. After the New AASF was completed in 2015, mobile fire extinguishers were transferred from the Old AASF to the New AASF. Four AFFF mobile fire extinguishers, emptied in an unknown location as described in **Section 2.3**, are now stored at the New AASF. During the PA, a storage unit on the western edge of the New AASF area contained eleven 5-gallon pails of Amerex Model 534 AFFF concentrate, two 5-gallon pails of Chemguard AFFF concentrate, and one 5-gallon pail of National Foam AFFF concentrate (all of which contain PFAS). One 55-gallon drum of Chemguard AFFF solution, two 55-gallon drums of National Foam AFFF solution and one 55-gallon drum of Monsanto Fire Resistant Foam were also stored in the separate secondary containment storage area.

PFOS, PFOA, and PFNA were detected in surface soil at AOI 2. Site workers, construction workers, and trespassers/visitors could contact constituents in surface soil via incidental ingestion and inhalation of dust. Therefore, the surface soil exposure pathways for site workers, construction workers, and trespassers/visitors are potentially complete. PFOA and PFNA were detected in subsurface soil at AOI 2. Construction workers could contact constituents in subsurface soil via incidental ingestion and inhalation of dust; therefore, the subsurface soil exposure pathway for construction workers is potentially complete. The CSM for AOI 2 is presented in **Figure 7-2**.

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 at each AOI based on the aforementioned criteria.

No potable wells are located within the Facility boundary. The Facility receives potable water from a municipal source, the FPB, with the water intake located approximately 2 miles from the Facility. As further detailed in **Section 5.1.3**, a recent sample from the FPB did not contain PFOA, PFOS, or PFBS that exceeded the SLs. As detailed in **Section 2.2.3,** a desktop survey of potential private and public water supply wells within a 4-mile distance of the BNGC boundary identified 14 domestic wells and four agricultural/irrigation wells as potential receptor locations downstream of where surface water in AOI 3 (unnamed tributary) flows off the Facility, near where surfacing groundwater in AOI 1 was sampled (AOI01-13).

7.2.1 AOI 1

Samples of groundwater were collected from temporary monitoring wells in AOI 1 and a surfacing groundwater (seep) location. PFOS was detected above its SL in groundwater collected from one of the temporary monitoring wells in AOI 1, while PFOA, PFBS, PFHxS, and PFNA were detected in groundwater from temporary monitoring wells at concentrations below the applicable SLs.

In the sample from surfacing groundwater (seep) location AOI01-13, PFBS was detected at a concentration below the SL, while PFOS, PFOA, PFHxS, and PFNA were detected at concentrations that exceeded the SL. The surfacing groundwater from location AOI01-13 discharges into the AOI 3 stream channel. Based on the SI sampling results for AOI 1, contact with surfacing groundwater could result in exposure to site workers, construction workers, trespassers/visitors, and off-Facility residents via ingestion. Contact with subsurface groundwater during ground-disturbing activities could result in exposure to construction workers via incidental ingestion. Therefore, the exposure pathway for ingestion is potentially complete for these receptors. The CSM for AOI 1 is presented in **Figure 7-1**.

7.2.2 AOI 2

Samples of groundwater were collected from temporary monitoring wells in AOI 2 and a surfacing groundwater (seep) location. PFOA was detected above its SL in groundwater collected from one of the temporary monitoring wells at AOI 2. PFOS, PFNA, and PFBS were detected in groundwater at concentrations below the SLs in temporary monitoring wells installed at AOI 2, while PFHxS was not detected in any of the four monitoring wells installed at AOI 2.

PFOA, PFOS, PFBS, PFHxS, and PFNA were detected at concentrations below the SLs in one sample of surfacing groundwater seeping from the ground surface downgradient of AOI 2. Based on the results of the SI in AOI 2, contact with surfacing groundwater (seep) could result in exposure to site workers, construction workers, trespassers/visitors, and off-Facility residents via ingestion. Contact with subsurface groundwater during ground-disturbing activities could result in exposure to construction workers via ingestion. Therefore, the exposure pathway for ingestion is potentially complete for these receptors. The CSM is presented in **Figure 7-2**.

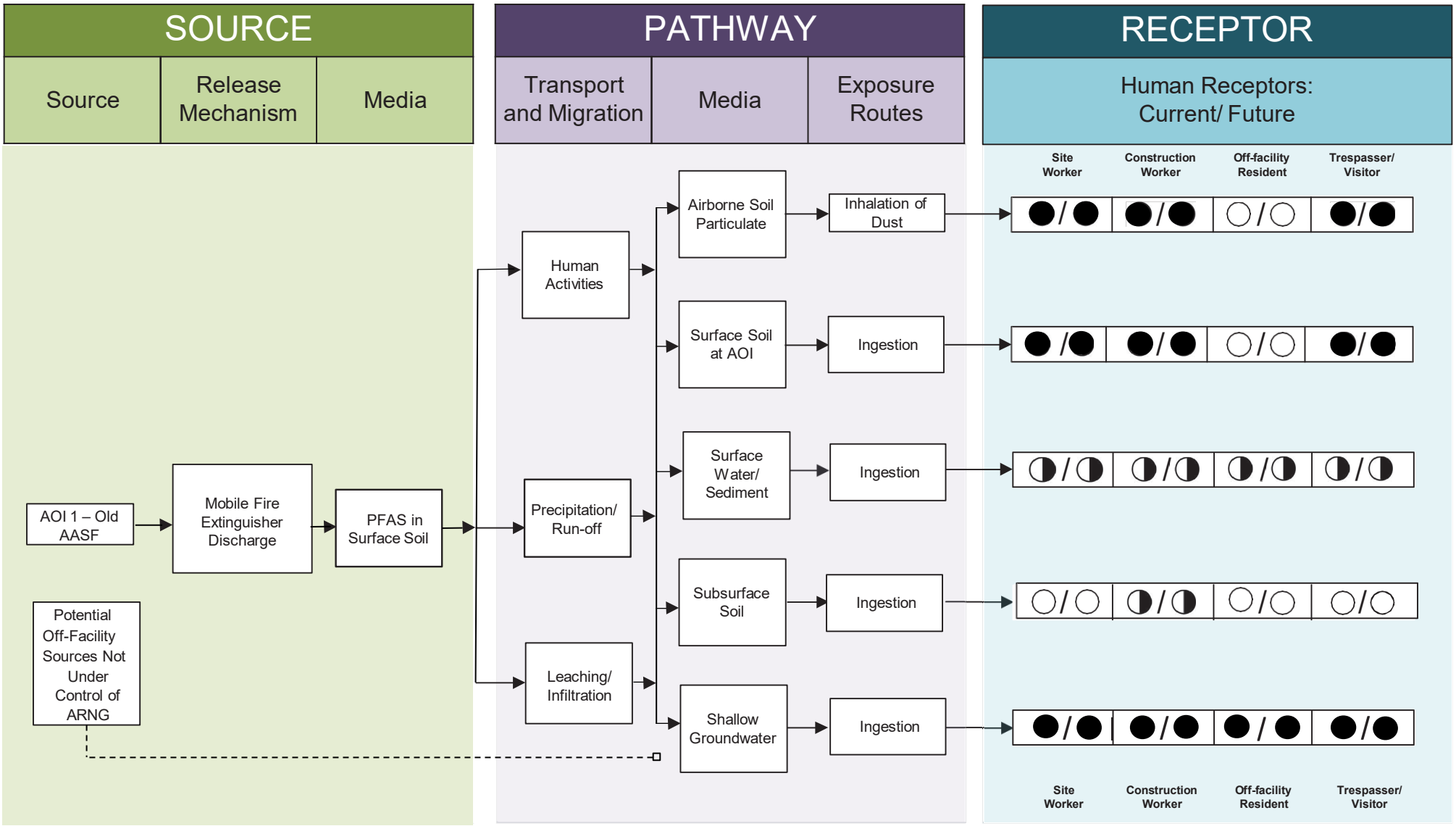
7.3 SURFACE WATER EXPOSURE PATHWAY

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

7.3.1 AOI 3

Samples of surface water were collected from the unnamed tributary at two locations (AOI03-10-SW and AOI03-11-SW) downstream of AOI 1 and AOI 2, respectively. PFOS was detected in AOI03-10-SW and AOI03-11-SW at concentrations of 0.91 J ng/L and 190 ng/L, respectively; PFOA was detected at concentrations of 3.5 and 11 ng/L, respectively; PFBS was detected at concentrations of 0.71 J and 11 ng/L, respectively; PFHxS was detected at concentrations of 0.55 J and 120 ng/L, respectively; and PFNA was detected at concentrations of 0.91 J and 2.5 ng/L, respectively.

Sample AOI03-11-SW was collected from a location that is downstream from where surfacing groundwater (associated with location AOI01-13) enters into the AOI 3 stream channel. Based on the results of the SI, contact with surface water could result in exposure to site workers, construction workers, off-Facility residents, and recreational users/trespassers/visitors via ingestion. The PFAS detections in surface water were not compared to SLs; however, given the detections in surface water the exposure pathway for ingestion is potentially complete for these receptors. The CSM is presented in **Figure 7-3**. Sediment within AOI 3 was not sampled as part of the SI.



LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway with no Exceedances of Screening Levels
- Potentially Complete Pathway with Exceedance of Screening Levels

Figure 7-1
Conceptual Site Model, AOI 1
Boone National Guard Center

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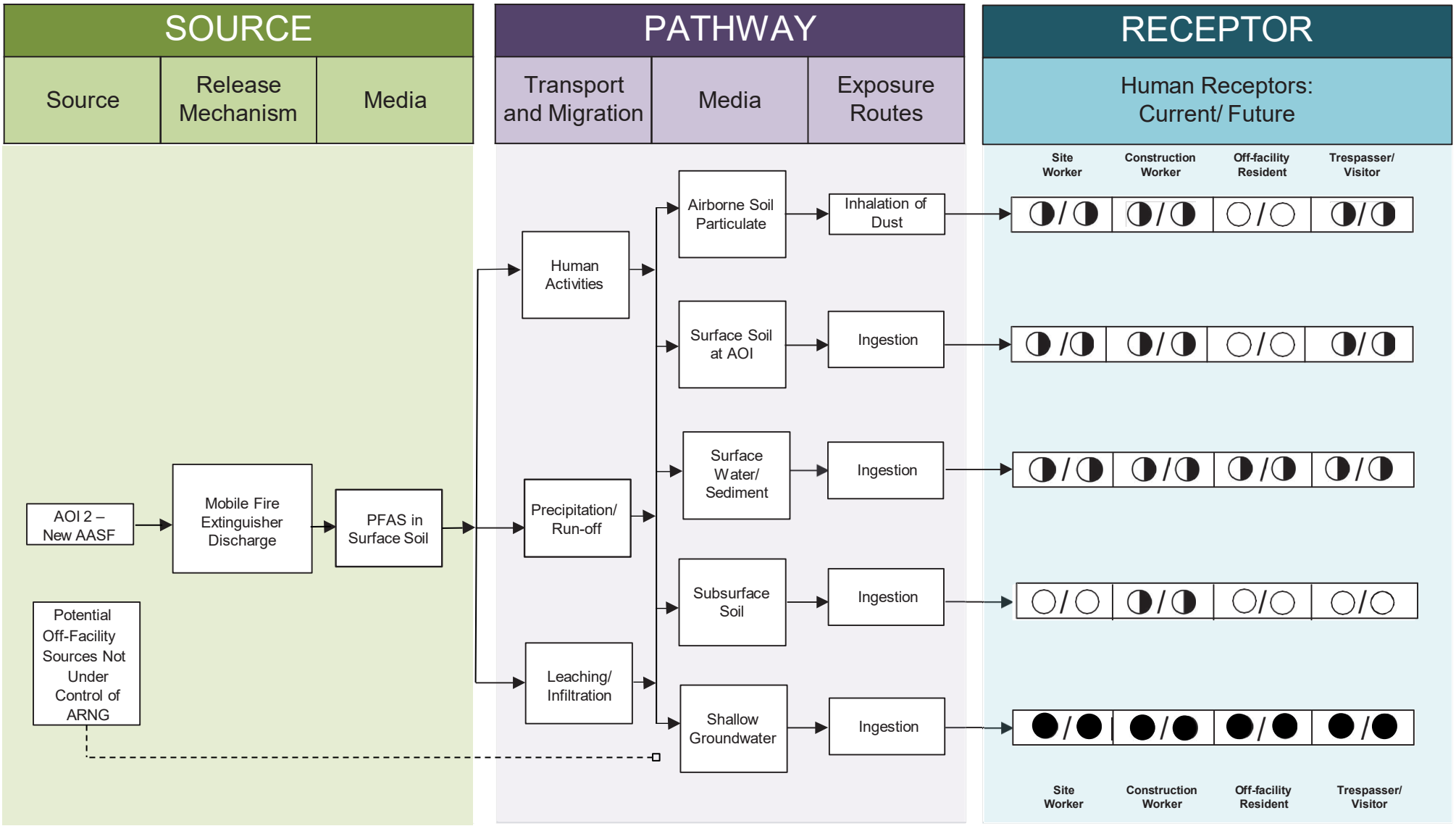

LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway with no Exceedances of Screening Levels
- Potentially Complete Pathway with Exceedance of Screening Levels

Note: The residential receptor refers to an off-facility receptor

Figure 7-2
Conceptual Site Model, AOI 2
Boone National Guard Center

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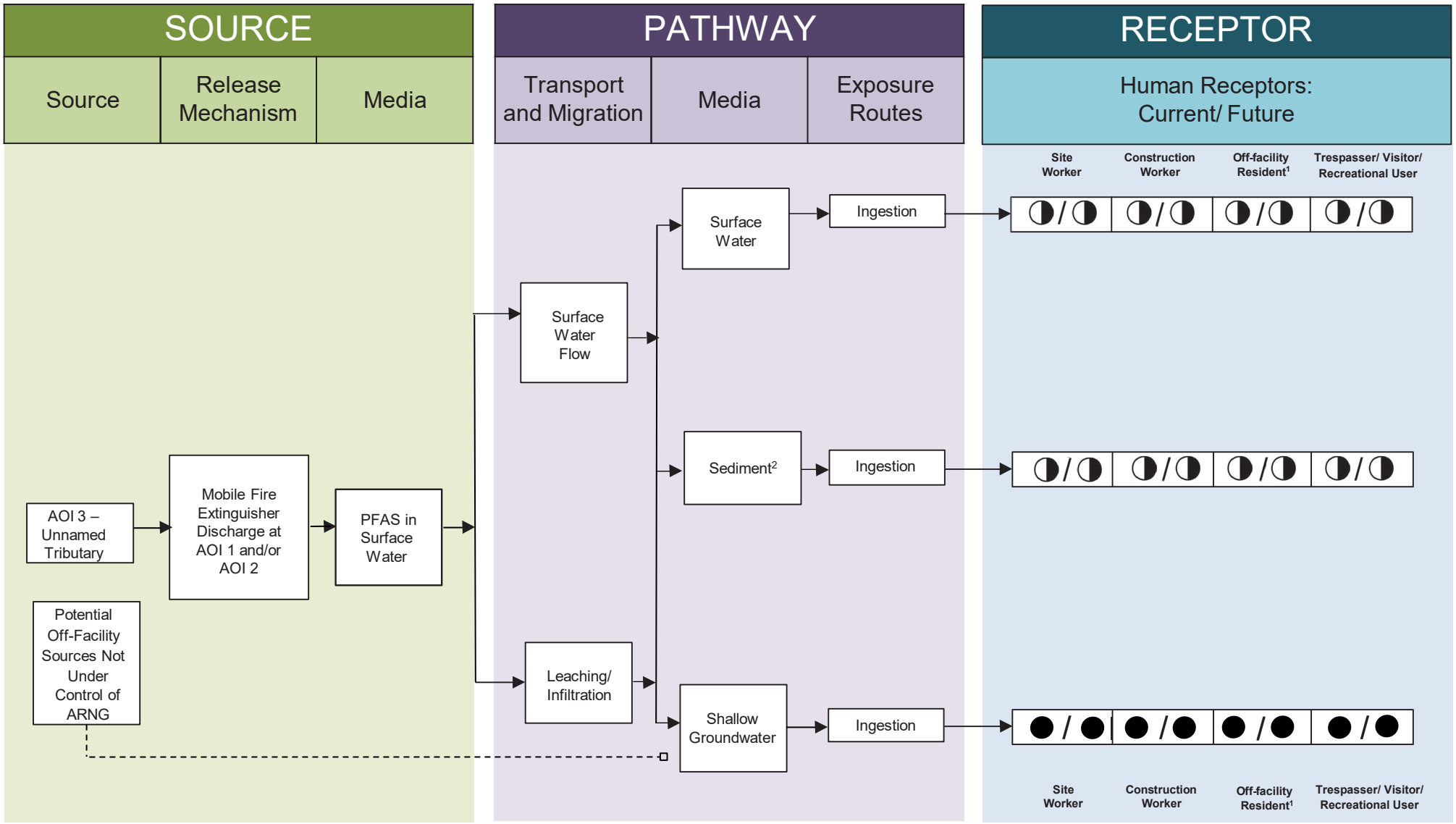

LEGEND

- Flow-Chart Stops
- Flow-Chart Continues
- Partial / Possible Flow
- Incomplete Pathway
- Potentially Complete Pathway with no Exceedances of Screening Levels
- Potentially Complete Pathway with Exceedance of Screening Levels

Note:

1) The residential receptor refers to an off-facility receptor
2) The sediment pathway was not assessed

Figure 7-3
Conceptual Site Model, AOI 3
Boone National Guard Center

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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 at the Facility were conducted from 25 October through 04 November 2021. The SI field activities included soil, groundwater, and surface water sampling. Field activities were conducted in accordance with the UFP-QAPP Addendum (EA/Wood, 2021a), except as previously noted in **Section 5.10**.

To fulfill the project DQOs set forth in the approved SI UFP-QAPP Addendum (EA/Wood, 2021a), samples were collected and analyzed for a subset of 18 compounds by LC/MS/MS compliant with QSM 5.3 Table B-15 (DoD, 2020) as follows.

- 18 soil samples from 11 locations (soil borings locations);
- 11 grab groundwater samples from nine temporary well locations
- Two grab samples from surfacing groundwater (seep) locations;
- Two surface water samples from a Facility stream; and,
- 21 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 AOIs 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 CSMs were refined to assess whether a potentially complete pathway exists between the source and potential receptors for potential exposure at the AOIs, which are described in **Section 7**.

8.2 OUTCOME

Based on the results of this SI, further evaluation under CERCLA in the form of a RI is warranted for AOI 1, AOI 2, and AOI 3. Based on the CSMs developed and revised based on the SI findings, there is potential for exposure to receptors from AOI 1, AOI 2, and AOI 3 from sources on the Facility resulting from historical DoD activities. Sample chemical analytical concentrations collected during the SI were compared against the project SLs in soil and groundwater, as described in **Table 6-1**. The SI results relative to the SLs are summarized below for each AOI.

At AOI 1:

- PFOS was detected in AOI 1 soil at a concentration exceeding the SL. PFOA, PFHxS, and PFNA were detected in AOI 1 soil at concentrations below the SLs. PFBS was not detected in soil at AOI 1.

- PFOA, PFOS, PFBS, PFHx, and PFNA were detected in groundwater. PFOS exceeded the SL in groundwater collected from a temporary monitoring well at AOI 1. PFOA, PFBS, PFHxS, and PFNA did not exceed the SLs in groundwater collected from temporary monitoring wells at AOI 1; however, they were detected at concentrations that exceed their respective SLs in the surfacing groundwater (seep) downgradient of AOI 1 near the Facility boundary and AOI 3. PFBS was detected in the surfacing groundwater at a concentration below the SL.
- Based on the results of the SI, further evaluation of AOI 1 is warranted in the RI.

At AOI 2:

- PFOS, PFOA, and PFNA were detected in soil at concentrations less than the SLs. PFBS was not detected in soil samples at AOI 2.
- PFOS, PFOA, PFBS, PFHxS, and PFNA were detected in groundwater. PFOA exceeded the SL in groundwater collected from a temporary monitoring well at AOI 2. PFHxS was not detected in groundwater collected from any of the four temporary wells sampled, while PFBS, PFNA, and PFOS were detected in temporary wells at concentrations below the SL. PFOS, PFOA, PFBS, PFHxS, and PFNA were detected in surfacing groundwater at concentrations lower than the SLs.
- Based on the results of the SI, further evaluation of AOI 2 is warranted in the RI.

At AOI 3:

- PFOA, PFOS, PFBS, PFHxS, and PFNA were detected in AOI 3 surface water, at maximum concentrations of 11 ng/L, 190 ng/L, 11 ng/L, 120 ng/L, and 2.5 ng/L, respectively. Surfacing groundwater that exceeded the SLs at location AOI01-13 which is upgradient and proximal to AOI03-11 and at the downstream end of AOI 3, enters the streambed of AOI 3. Therefore, the relevant compounds in groundwater from AOI 1 may have affected the surface water in AOI 3 as observed in sample location AOI03-11, which is near the Facility boundary.
- The PFAS detections in surface water were not compared to SLs; however, based on the results of the SI, further evaluation of AOI 3 is warranted.

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. Based on the CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at the facility because HFPO-DA is generally not a component of MIL-SPEC AFFF and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

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	Groundwater – Facility Boundary[1]	Surface Water[2]	Future Action
1	Old AASF	●	●	●	NA	Proceed to RI
2	New AASF	◐	●	◐	NA	Proceed to RI
3	Unnamed Tributary	NA	NA	●	◐	Proceed to RI

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

Notes:
1. Surfacing groundwater associated with AOI 1 was located within the AOI 3 stream channel.
2. There is no screening level for surface water.

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