DOCUMENTATION CONTROL PAGE

Fort A.P. Hill – Environmental Management System

Environmental and Natural Resources Division
Directorate of Public Works
Fort A.P. Hill, VA

<table>
<tr><td colspan="2">Originating Office: DPW-ENRD</td><td>Review Frequency: As required</td></tr>
<tr><td colspan="3">Document Title: Final Fort AP Hill PFAS PA/SI Report

Document No: FW-SEMS-003</td></tr>
<tr><td>Document Organization Owner:

DPW – ENRD</td><td>Prepared By:
Contract-ARCADIS
USACE - Baltimore</td><td>Revision Date: June 2022</td></tr>
<tr><td>Contact Name: Gef Fisher
George.e.fisher24.civ@army.mil</td><td>Distribution: External</td><td>Original Date: June 2022</td></tr>
</table>

FINAL PRELIMINARY ASSESSMENT AND SITE INSPECTION OF PER- AND POLYFLUOROALKYL SUBSTANCES

Fort A.P. Hill, Virginia

Prepared For:
U.S. Army Corps of Engineers, Baltimore District
2 Hopkins Plaza
Baltimore, Maryland 21201

June 2022

Preliminary Assessment and Site Inspection of Per-and Polyfluoroalkyl Substances

Fort A.P. Hill, Virginia

Courtney MS Ingersoll, PMP
Site Inspection Project Manager, Arcadis U.S., Inc

Rhonda Stone, PMP
Project Manager, Arcadis U.S., Inc

Christopher Spooner, PE
Project Engineer/Technical Expert, Arcadis U.S., Inc

Prepared for:

U.S. Army Corps of Engineers

Contract No.: W912DR-18-D-0004

Delivery Order No.: W912DR1818F0685

Prepared by:

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover

Maryland 21076

Our Ref.:

30001992.3DK10

Date:

June 2022

CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

The United States Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations nationwide. The PA identifies areas of potential interest (AOPIs) where PFAS-containing materials were used, stored, and/or disposed, or areas where known or suspected releases to the environment occurred. The SI includes multi-media sampling at AOPIs 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. This Fort A.P. Hill PA/SI was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense policy and guidance.

Fort A.P. Hill is a military training complex located in the eastern portion of Caroline County, Virginia with small portions also extending into Essex County, Virginia. The installation occupies 75,794 acres; the majority of which consists of range areas. Fort A.P. Hill also includes a 1,532-acre cantonment area with office buildings and residential subdivision. The installation is used year-round for military training of both active and reserve troops of the U.S. Army, U.S. Navy, U.S. Marines, and U.S. Air Force, as well as other government agencies.

The Fort A.P. Hill PA identified 18 AOPIs for investigation during the SI phase. SI sampling results from the 18 AOPIs were compared to risk-based screening levels calculated by the Office of the Secretary of Defense (OSD) for PFOS, PFOA, and PFBS. PFOS, PFOA, and/or PFBS were detected in soil, groundwater and/or surface water at 16 out of 18 AOPIs; and seven of the 18 AOPIs had PFOS, PFOA, and/or PFBS present at concentrations greater than the risk-based screening levels. The Fort A.P. Hill PA/SI identified the need for further study in a CERCLA remedial investigation. **Table ES-1** below summarizes the PA/SI sampling results and provides recommendations for further study in a remedial investigation or no action at this time at each AOPI.

Table ES-1. Summary of AOPIs Identified during the PA, PFOS, PFOA and PFBS Sampling at Fort A.P. Hill and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)			Recommendation
	GW	SO	SW	
Fire Station 7	No	No	NS	No action at this time
Fire Station 8	Yes	Yes	NS	Further study in an RI
Fire Station 9	No	No	NS	No action at this time
Fire Training Facility	No	No	NS	No action at this time
Old Headquarters WWTP	Yes	No	NS	Further study in an RI

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS)			Recommendation
	GW	SO	SW	
New Wilcox WWTP	Yes	No	No	Further study in an RI
Vehicle Maintenance Facility	Yes	NS	NS	Further study in an RI
Training Area 17A – Transformer Fire	No	No	NS	No action at this time
Range 24 – Mover 1	No	No	NS	No action at this time
Range 24 – Mover 2	No	No	NS	No action at this time
Range 29 – Plywood Structures	Yes	No	NS	Further study in an RI
Range 29 – Bunker	Yes	No	NS	Further study in an RI
Range 33 – Target Area	No	NS	NS	No action at this time
Range 34 – Lines 15 & 16	No	No	NS	No action at this time
Range 42 – Mover Target Area	No	NS	NS	No action at this time
Range 43 – Plywood Structures Area	No	NS	NS	No action at this time
Taylor's Corner Landfill	Yes	NS	NS	Further study in an RI
Wilcox Landfill	No	NS	NS	No action at this time

Notes:
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
NS – not sampled
RI – remedial investigation
SO – soil
SW – surface water

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS), at Army installations (installations) nationwide. The Army is the lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Executive Order 12580 and is conducting the PA/SI consistent with its authority under CERCLA, 42 United States Code §§ 9600, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq. The PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at Fort A.P. Hill based on the use, storage and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether or not a release occurred, and the PFOS, PFOA, and PFBS results were compared to the Office of the Secretary of Defense (OSD) PFOS, PFOA, and PFBS risk screening levels to determine whether further investigation is warranted. This report provides the PA/SI for Fort A.P. Hill, Virginia and was completed in accordance with CERCLA and The National Oil and Hazardous Substances Pollution Contingency Plan.

1.1 Project Background

PFAS are a class of compounds used in a wide range of industrial applications and commercial products due to their unique surface tension/leveling properties. Due to industry and regulatory concerns about the potential health effects and adverse environmental impacts, there has been a reduction in the manufacture and use of PFAS worldwide. In the U.S., significant reductions in the production, importation, and use of PFOS and PFOA (two individual compounds in the PFAS class) occurred between 2001 and 2015 (Interstate Technology Regulatory Council 2017). PFBS replaced PFOS in some applications and is currently used and manufactured in the U.S.

In 2016, the United States Environmental Protection Agency (USEPA) established a lifetime health advisory of 70 nanograms per liter (ng/L) in drinking water for PFOS or PFOA and for the sum of PFOS and PFOA when both are present (USEPA 2016). On 15 October 2019, the OSD provided guidance on the investigation of PFOS, PFOA, and PFBS at Department of Defense (DoD) restoration sites (OSD 2019). The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in tap water or soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD memo, on 08 April 2021, USEPA published an updated toxicity assessment for PFBS (USEPA 2021). Based on the updated toxicity assessment for PFBS, the OSD issued a memorandum on 15 September 2021 to include updated PFBS risk screening levels. The September 2021 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program is provided for reference as **Appendix A**. The OSD risk screening levels for tap water (and also used to evaluate groundwater or surface water used as drinking water sources) are 40 ng/L for PFOS and PFOA, and 600 ng/L for PFBS. The PFOS and PFOA soil screening levels for the residential and industrial/commercial scenarios are 0.13 milligrams per kilogram (mg/kg) (residential) and 1.6 mg/kg (industrial/commercial). The soil

screening levels for PFBS are 1.9 mg/kg (residential) and 25 mg/kg (industrial/commercial). These screening criteria are discussed further in **Section 6.5**.

1.2 PA/SI Objectives

This PA/SI was conducted consecutively because the results of the PA yielded AOPIs that necessitated continuing onto the SI phase in accordance with CERCLA. Consequently, this report provides the combined objectives of both PA and SI reports.

1.2.1 PA Objectives

During the PA, investigators collect readily available information and conduct site reconnaissance. This PA will evaluate and document areas where PFAS-containing materials were used, stored, and/or disposed, so the Army can distinguish between sites that pose little or no threat to human health and the environment and sites that require further investigation.

1.2.2 SI Objectives

An SI is conducted when the PA determines an AOPI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multi-media sampling at AOPIs 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.

Installation-specific data quality objectives (DQOs) and the sampling design and rationale are summarized in **Sections 6.1** and **6.2**.

1.3 PA/SI Process Description

For Fort A.P. Hill, PA/SI development followed the process described in **Sections 1.3.1** through **1.3.5** below. **Section 3** provides a summary of the PA activities completed, and **Section 6** provides a summary of the SI activities completed for Fort A.P. Hill. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**.

1.3.1 Pre-Site Visit

An installation kickoff teleconference was held between applicable points of contact (POCs) from the Army PA team (United States Army Environmental Command [USAEC], United States Army Corps of Engineers [USACE], Arcadis U.S., Inc. [Arcadis], and Fort A.P. Hill). The kickoff call occurred 20 March 2019 to discuss the goals and scope of the PA, project scheduling, installation access, timeline for the site visit, access to installation-specific databases, and to request available records.

Records review was conducted before the site visit to obtain electronically available documents from the installation and external sources for review. The purpose of the records review was to identify any area on the installation that may have been a location where PFAS-containing materials were used, stored,

and/or disposed of, as well as to gather information on the physical setting and site history at Fort A.P. Hill.

A read-ahead package was prepared and submitted to the appropriate POCs two weeks before the site visit. The read-ahead package contained the following information:

- The Installation Management Command (IMCOM) operation order
- The Army PA Operations Security requirements package, which includes the antiterrorism/ operations security review cover sheet (**Appendix C**)
- The PFAS PA kickoff call minutes
- An information paper on the PA portion of the Army's PFAS PA/SI
- Contact information for key POCs
- A list of the data sources requested and reviewed
- A list of preliminary locations identified during the kickoff call and pre-site visit records review to be evaluated for use, storage, and/or disposal of PFAS-containing materials, where additional information on those areas will be collected through personnel interviews, additional document review, and site reconnaissance.
- A list of roles for the installation POC to consider when recommending potential interviewees.

1.3.2 Preliminary Assessment Site Visit

The site visit was conducted 30 April to 02 May 2019. An in-brief meeting was held to provide installation staff with the objectives of the site visit and team introductions. **Section 3** includes information regarding personnel interviewed.

Personnel interviews were conducted with individuals having significant historical knowledge at Fort A.P. Hill. The interviews focused on confirming information discussed in historical documents, collecting information not in historical documents, and corroborating other interviewees' information.

Site reconnaissance included visual surveys which assessed the points of potential use, storage, and/or disposal of PFAS-containing materials, as well as potential secondary impacts, and the migration potential from each AOPI (e.g., stormwater drains, building drains and sumps, cracks in the floor/pavement). Physical attributes of the preliminary locations were documented, including local slope and ground and floor conditions (i.e., paved, unpaved, visual staining), surface water bodies and surface flow, potential receptors, and the distance to the installation boundary. Access to existing groundwater monitoring wells, if present, were also noted during the site reconnaissance in case the monitoring wells could be proposed for SI sampling. Photo documentation of the preliminary locations was collected, and access limitations or advantages related to potential future sampling activities were noted.

An exit briefing was conducted on 02 May 2019 with the installation to discuss preliminary findings of the PA site visit as well as raise any items identified during the site visit, discuss any follow-up items, and review the schedule for submitting deliverables.

1.3.3 Post-Site Visit

Information collected before, during, and after the site visit was reviewed and corroborated by cross-referencing records and reviewing interview details and observations noted during site visit reconnaissance. A site visit trip report was completed and provided to the installation POC, applicable USAEC POCs, and USACE regional POCs following the site visit. The information collected during the pre-site visit and site visit activities was compiled to develop the installation-specific PA portion of the PA/SI report (**Section 3**). Site data obtained during the PA were used to develop preliminary conceptual site models (CSMs) for each AOPI, which served as the basis for developing the SI scope of work presented in an installation-specific Quality Assurance Project Plan (QAPP) Addendum.

1.3.4 Site Inspection Planning and Field Work

The SI process was initiated at the installation to evaluate PFOS, PFOA, and PFBS presence or absence at each AOPI and determine whether further investigation is warranted. An SI kickoff teleconference was held between the Army PA team and Fort A.P. Hill.

The objectives of the SI kickoff teleconference were to:

- discuss the AOPIs selected for sampling,
- gauge regulatory involvement (Virginia Department of Environmental Quality) requirements or preferences,
- identify overlapping unexploded ordnance or cultural resource areas,
- discuss the plan for investigation derived waste (IDW) handling and disposal,
- identify specific installation access requirements and potential schedule conflicts,
- discuss general SI deliverable and field work schedule information and logistics.

Following development of the SI sampling technical approach, an SI scoping teleconference was held to obtain concurrence on the SI sampling plan from USAEC, USACE, and Fort A.P. Hill. Additional discussion topics included:

- confirmation of the plan for IDW handling and disposal,
- an updated SI deliverable and field work schedule.

A Programmatic Uniform Federal Policy-Quality Assurance Project Plan (PQAPP) was developed and finalized in October 2019 for the USAEC PFAS PA/SI (Arcadis 2019). The PQAPP details general planning processes for collecting data and describes the implementation of quality assurance (QA) and quality control (QC) activities for the SI portion for Army installations nationwide. Additionally, an installation-specific QAPP Addendum was developed to define the DQOs, present the sampling design and rationale, and provide qualifications for project personnel. The SI field work was completed in accordance with the PQAPP (Arcadis 2019) and the approved installation-specific QAPP Addendum. A Site Safety and Health Plan (SSHP) was also developed as an attachment to the QAPP Addendum to identify specific health and safety hazards that may be encountered at the installation during sampling. The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was

developed for Army installations nationwide. The QAPP Addendum and SSHP were submitted to the installation and finalized before commencement of field work.

The DQOs, sampling design and rationale, and field methods employed for the SI are summarized from the QAPP Addendum developed for Fort A.P. Hill (Arcadis 2020a) in **Sections 6.1** through **6.3**.

After finalization of the QAPP Addendum and SSHP, field planning and coordination with the installation and subcontractors was completed. Once the schedule was determined, field teams mobilized to the installation to complete the scope of work defined in the QAPP Addendum.

1.3.5 Data Analysis, Validation, and Reporting

Environmental samples collected during the SI were submitted to a DoD Environmental Laboratory Accreditation Program (ELAP)-accredited for PFOS, PFOA, and PFBS analysis by liquid chromatography with tandem mass spectrometry and compliant with the DoD Quality Systems Manual (QSM) 5.3 (DoD and Department of Energy 2019). Laboratory analytical results were then validated and verified by a project chemist to assess the usability of the data collected. Validated analytical results were summarized in the context of OSD risk screening levels (defined in **Section 6.5**).

2 INSTALLATION OVERVIEW

The following subsections provide general information about Fort A.P. Hill, including the location and layout, the installation mission over time, a brief site history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells, and surface water intakes within a 5-mile radius of the installation, and applicable ecological receptors.

2.1 Site Location

Fort A.P. Hill is an all-purpose, year-round, military training center located predominantly in Caroline County, Virginia, with small portions in neighboring Essex County (**Figure 2-1**). Spanning 75,794 acres, Fort A.P. Hill is the largest range and training center in the National Capital Region, and one of the largest East Coast installations. The installation is 20 miles southeast of Fredericksburg, Virginia and is situated roughly midway between Richmond, Virginia, and the Washington, D.C. metropolitan area. The installation is bisected by U.S. Route 301 (**Figure 2-2**). The installation rests on the upper Atlantic Coastal Plain and in the watersheds of the Rappahannock and Mattaponi Rivers. Fort A.P. Hill's terrain consists of rolling hills with some wetlands throughout the post. Most of the installation is forested. To the south and west, the installation is bordered by forest, farmland, and the town of Bowling Green. Forests, farmland, housing subdivisions, and the town of Port Royal lie to the east and north (Army 2018b).

The northern boundary of Fort A.P. Hill is bordered by the village of Corbin. The eastern boundary is bordered by the village of Port Royal. Adjacent to the southern boundary is the village of Sparta. The western boundary borders the town of Bowling Green. Private residences border portions of the perimeter of Fort A.P. Hill, and additional land use surrounding Fort A.P. Hill consists of agricultural lands, light industry, and commercial businesses (Army 2006).

2.2 Mission and Brief Site History

Officially established on 11 June 1941, the Fort A.P. Hill Military Reservation was created to provide large, unencumbered maneuver areas and artillery ranges in anticipation of the oncoming war. The installation continues to provide valuable field and weapons familiarization training to date (Army 2018b).

In 1963, Fort A.P. Hill became a sub installation of Fort Lee, Virginia. The 1970s were characterized by construction and expansion of facilities including a new ammunition supply point and new barracks. Currently, Fort A.P. Hill is a training and maneuver center focused on providing realistic joint and combined arms training. The installation is used year-round for military training of both active and reserve troops of the U.S. Army, U.S. Navy, U.S. Marines, and U.S. Air Force, as well as other government agencies (EA Engineering, Science, and Technology, Inc. [EA] 2019).

Most of the population on Fort A.P. Hill is transient due to the primary mission of training; however, there is a small development of on-post residential housing located in the cantonment area (**Figure 2-2**). Additionally, Fort A.P. Hill allows permitted recreational hunting and fishing to on-installation and off-installation users.

2.3 Current and Projected Land Use

The Fort A.P. Hill cantonment area consisting of approximately 1,532 acres includes housing, administrative buildings, and operational facilities. Remaining Fort A.P. Hill acreage is the operational range complex. According to Fort A.P. Hill staff, the installation currently utilizes 51 operational ranges, 31 training sites, 35 artillery firing points, 6 helipads, 5 airfields, 7 observation points, and 2 forward armor and refueling points, totaling 74,262 acres (EA 2019).

An easement is located in the center of the installation along U.S. Route 301. Currently, the county owns this land and uses it as a detention facility. This property contains a drinking water supply well, and wastewater lines are connected to the New Wilcox Wastewater Treatment Plant on Fort A.P. Hill.

2.4 Climate

Fort A.P. Hill is located at the northern edge of the Atlantic Coastal Plain Physiographic Province, approximately 4 miles east of the Fall Line, which separates the Piedmont Physiographic Province from the Coastal Plain Physiographic Province. Fort A.P. Hill's location lies within the transition zone between the northern and southern climates of the U.S. Therefore, the Fort A.P. Hill area is characterized by moderate temperature, precipitation, and wind velocities. Summers are warm and humid, and winters are mild (United States Army Toxic and Hazardous Materials Agency [USATHAMA] 1982).

The average annual daily maximum and minimum temperatures in the area are 67 degrees Fahrenheit (ºF) and 45 ºF, respectively. January is the coldest month with an average temperature of 46 ºF while July is the hottest month with an average temperature of 89 ºF. The average annual precipitation is 40 inches with ranges varying from approximately 30 inches to 60 inches. Precipitation is well distributed throughout the year with the average monthly precipitation ranging from 2.5 inches in February to 4.8 inches in August. The mean annual snowfall is 15.3 inches (USATHAMA 1982, Army 2006).

2.5 Topography

Fort A.P. Hill lies within the Atlantic Coastal Plain of northeastern Virginia. The topography ranges from rolling countryside terrain to mostly level plains interrupted by numerous shallow valleys (**Figure 2-3**). The maximum relief at Fort A.P. Hill is approximately 245 feet, varying from 10 feet in the north to 255 feet on hilltops throughout the installation (Army 2006). Hill crest elevations generally decrease from west to east from a maximum of approximately 245 feet above mean sea level in the northeastern periphery to approximately 180 feet above mean sea level on the southeastern boundary (Army 2006). Slopes generally range up to 30 percent (%) with some slopes as great as 50% in steeper stream valleys (USATHAMA 1982).

2.6 Geology

Fort A.P. Hill lies entirely within the Virginia Coastal Plain physiographic province. This portion of the Virginia Coastal Plain (i.e., the northwestern portion) is characterized by rolling terrain and deeply carved stream valleys. The Virginia Coastal Plain is underlain by a wedge of unconsolidated to partly consolidated sediments of the Cretaceous, Tertiary, and Quaternary age (i.e., clay, sand, gravel) which dip and thicken to the east and unconformably overlie a basement of consolidated crystalline bedrock.

The thickness of the sediments wedge in Virginia ranges from 0 feet in the western portion to more than 6,000 feet proximal to the Atlantic Ocean coast in the east. The thickness of the sediments wedge underlying Fort A.P. Hill ranges from 500 to 1,500 feet (United States Geological Survey [USGS] 2006).

2.7 Hydrogeology

Groundwater occurs throughout the sediments of the Coastal Plain although yields vary considerably from formation to formation. There are three major aquifers separated by three confining units in the Fort A.P. Hill area. The three aquifers from shallowest to deepest are: Surficial aquifer, Aquia aquifer, and Potomac aquifer. The confining units are identified as the Calvert confining unit, Nanjemoy-Marlboro confining unit, and the Potomac confining unit (USGS 2006). A description of each aquifer and confining unit is provided below:

- Surficial aquifer: The surficial aquifer is widespread, shallow, and moderately used as a source of groundwater. It consists of sands and interbedded silts and clays and can be up to several tens of feet in thickness. Beneath the surficial aquifer lies the Calvert confining unit (USGS 2006).
- Calvert confining unit: the Calvert confining unit is widespread and deep. It consists of silty and clayey fine-grained sands and can be up to a few hundred feet in thickness (USGS 2006).
- Nanjemoy-Marlboro confining unit: the Nanjemoy-Marlboro confining unit is widespread across the Virginia Coastal Plain. It consists primarily of silty and clayey fine-grained sands and ranges in thickness from several tens to several hundreds of feet. Beneath the Nanjemoy-Marlboro confining unit lies the Aquia aquifer (USGS 2006).
- Aquia aquifer: the Aquia aquifer is widespread across the Virginia Coastal Plain but is sparsely used as a groundwater resource. The Aquia aquifer consists of medium to coarse-grained sands and ranges in thickness from several tens to several hundreds of feet. Beneath the Aquia aquifer lies the Potomac confining unit (USGS 2006).
- Potomac confining unit: the Potomac confining unit is widespread across the Virginia Coastal Plain, and ranges in thickness up to several tens of feet, at depths of up to a few thousand feet. The Potomac confining unit lies above the Potomac aquifer and generally consists of clay that is interbedded with coarse-grained quarts, sands, and gravels. Beneath the Potomac confining unit lies the Potomac aquifer (USGS 2006).
- Potomac aquifer: the Potomac aquifer is the largest, deepest, and more frequently used source of groundwater in the Virginia Coastal Plain and can be as thick as several thousand feet. The Potomac aquifer primarily consists of coarse-grained sands and gravels, and interbedded clays. Beneath the Potomac aquifer lies basement bedrock (USGS 2006).

Within the installation, the surficial aquifer generally occurs at depths of approximately 15 to 25 feet below ground surface (bgs). Because the aquifer is unconfined, groundwater flows under the influence of gravity with flow patterns usually resembling a subdued reflection of local topography (Army 2006).

Recharge to the underlying Aquia aquifer occurs principally in outcrop areas west of the installation, near the fall line (approximately co-incident with Interstate 95). The aquifer is also recharged by infiltration through the overlying confining units. Of the water that infiltrates to the surficial aquifer within the installation, a small percentage recharges the Aquia aquifer. The rate of recharge through the confining

units is not uniform, with flow greater in areas where significant pumping from the Aquia or underlying aquifers occur (induced recharge) or where the confining unit is thinner or paleochannels that intersect the confining unit are present. Variation in confining unit composition and thickness and location of paleochannels in the confining unit is not well documented in the vicinity of the installation. Most of the groundwater recharging the Aquia aquifer flows laterally in a general eastward direction where it eventually discharges to pumping wells or the Chesapeake Bay.

Similar to Aquia aquifer recharge, the Potomac aquifer is recharged in outcrop areas near the fall line west of the installation and infiltration through the confining units. A small percentage of the groundwater reaching the Aquia aquifer subsequently recharges the Potomac aquifer. Also, like the Aquia aquifer, groundwater flow is generally eastward, with a significant portion of the recharged groundwater removed by pumping.

The surficial aquifer is relatively thin and low yielding and is generally only used locally for some domestic potable and non-potable water supply. A majority of the domestic wells and all of the permitted public water supply, irrigation, and commercial and industrial wells in Caroline County withdraw from the confined Potomac aquifer and to a lesser amount the Aquia aquifer. Drinking water supply wells at Fort A.P. Hill draw groundwater from the confined Aquia and Potomac aquifers underlying the installation.

2.8 Surface Water Hydrology

Fort A.P. Hill is located within a portion of the Rappahannock River and the York River drainage basins. Surface water on the installation originates from runoff and as groundwater discharges from shallow aquifers on-installation and flows off-installation via multiple tributaries of the Rappahannock River or the Mattaponi River. The major stream networks on the installation include Ware Creek, Mount Creek, Goldenvale Creek, Mill Creek, Portobago Creek, Meadows Run, Roy's Run, and Smoots Run (EA 2019, Army 2006).

The northeastern 75% of the facility drains to the Rappahannock River, which drains to the Chesapeake Bay. The southwestern 25% of the facility drains to the Mattaponi River, which drains to the York River then to the Chesapeake Bay (EA 2019).

Based on published data, exposures of the contact between the Calvert Formation clays and oxidized sand and silts of the Pliocene Sand and Gravel are present in surface water channels near seeps and springs, indicating the presence of a vertical migration barrier that channels groundwater flow toward streams (Army 2006).

Approximately 20 lakes and ponds (totaling 440 acres in water surface area) and numerous beaver ponds are also located at Fort A.P. Hill. The largest lakes and ponds include Travis Lake, Bowies Pond, Lonesome Gulch Pond, Buzzard Pond, Beaver Pond, Maxey Gregg Pond, Delos Lake, Smoots Pond, and White Lake (Army 2006).

2.9 Relevant Utility Infrastructure

The following subsections provide general information regarding the installation's stormwater and wastewater management systems, as well as information on how the utility infrastructures may influence the fate and transport of PFAS constituents at Fort A.P. Hill.

2.9.1 Stormwater Management System Description

Fort A.P. Hill contains 10 major streams that drain to the Mattaponi/York River watershed and seven major streams that drain to the Rappahanock River watershed. Fort A.P. Hill also contains numerous manmade lakes and ponds with a surface area totaling more than 630 acres. Essentially all the watersheds contain multiple beaver ponds and other natural impoundments. Fort A.P. Hill has 31 Best Management Practices stormwater facilities/structures that have been constructed to manage stormwater runoff from many of the installation facilities. The Best Management Practices include extended detention basins, infiltration basins, bioretention structures (rain gardens), permeable pavers, and other low impact development stormwater practices (EEE Consulting, Inc. 2012).

2.9.2 Sewer System Description

The Wilcox wastewater treatment plant (WWTP) is the active WWTP at Fort A.P. Hill run by American Water. The wastewater system services the main cantonment and several sub-areas. It is comprised of four independent components that include over 33 miles of pipe, 38 lift stations, two treatment plants, and two treatment lagoons (American Water 2020). The Wilcox WWTP also services an easement that is no longer owned by Fort A.P. Hill. Historically, there was a previous WWTP in use, the Old Headquarters WWTP, which operated at Fort A.P. Hill from 1979 to 1993, prior to the New Wilcox WWTP.

2.10 Potable Water Supply and Drinking Water Receptors

Fort A.P. Hill has 31 drinking water supply wells located throughout the main cantonment and northern post areas. These wells supply all drinking water on the installation and are maintained and operated by American Water. On-post drinking water receptors include residents, site workers, and recreational users (hunters and fishers). Drinking water supply wells at the installation draw groundwater from the confined Aquia and Potomac aquifers underlying the installation.

The Rappahannock River and Rappahannock River Basin northeast of the installation contain several surface water intakes for public drinking water consumption (Virginia Department of Environmental Quality 2015). Additionally, the Mattaponi River southwest of the installation contains one surface water intake. These intakes are all either upgradient of the installation or more than 5 miles downstream of any AOPIs on Fort A.P. Hill. However, these rivers and their tributaries are used for recreational purposes.

There are numerous off-post potable supply wells surrounding Fort A.P. Hill which have various uses and owners (e.g., public water supply systems, privately owned water supply wells, irrigation, agriculture, industrial). An Environmental Data Resources, Inc. (EDR) report includes search results from a variety of environmental, state, city, and other publicly available databases for a referenced property. An EDR report was generated for Fort A.P. Hill, which along with the state of Virginia well inventory Freedom of Information Act (FOIA) request data identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-4**). Most of the off-post potable supply wells within a 5-mile radius of Fort A.P. Hill are concentrated along the southwestern installation boundary, northeastern boundary, and scattered north of the installation boundary. The EDR Report for well search results near Fort A.P. Hill and Virginia well inventory from the FOIA is provided as **Appendix E** (provided in Final electronic copy only); designations of the wells' use as drinking water supply or other may not be documented. Other

wells installed in the area with use designations other than water supply (i.e., monitoring, piezometer, observation, geothermal, or exploratory wells) are not shown on the figure.

The town of Bowling Green water system wells are located approximately 1.5 miles from the southwestern installation boundary. Groundwater originating from the western portion of A.P. Hill potentially flows to the west/southwest towards surface water bodies and streams (**Figure 2-2**). The town of Port Royal water system is located approximately 0.5 to 1 mile from the northeastern installation boundary. Groundwater originating from the eastern portion of A.P. Hill potentially flows to the east/northeast towards surface water bodies and streams (**Figure 2-2**). Following records review and research, neither the town of Bowling Green water system nor the town of Port Royal water system have been previously sampled for PFAS constituents. The only off-installation water system within a 5-mile radius of Fort A.P. Hill that was sampled during the third Unregulated Contaminant Monitoring Rule (UCMR3) monitoring, which included the analysis of six PFAS constituents (including PFOS, PFOA, and PFBS), was Spotsylvania County water system northwest of the installation boundary (about 2.0 miles from the installation; however, a small portion lies adjacent to the installation boundary). PFOS, PFOA, and PFBS were not detected in the Spotsylvania County water system (i.e., and therefore were less than the OSD risk screening levels) during the UCMR3 sampling conducted in 2013 and 2014. The limit of detection (LOD) at the time of UCMR3 sampling was 40 ng/L for PFOS, 20 ng/L for PFOA, and 90 ng/L for PFBS.

There is a residential area with known drinking water supply wells about 100 yards north of the northeast installation boundary adjacent to Training Area 17A – Transformer Fire.

Additionally, there is an off-post easement along U.S. Route 301 bisecting the installation, which Caroline County currently owns and uses for a detention center. The detention center has one drinking water supply well located approximately 0.65 miles northeast of the New Wilcox WWTP.

2.11 Ecological Receptors

The PA team collected information regarding ecological receptors available in the installation documents. The following information is provided for future reference should the Army decide to evaluate exposure pathways relevant to the ecological receptors.

Fort A.P. Hill has a large diversity of species, habitats, and harbors 12 species of flora and fauna that are listed as either threatened or endangered.

Endangered flora species on Fort A.P. Hill include:

- Swamp Pink (Helonias bullata), a perennial wetland evergreen
- Small Whorled Pogonia (Isotria medeoloides), an upland forest-dwelling orchid
- New Jersey Rush (Juncus caesariensis), an obligate wetland graminoid
- American Ginseng (Panax quinquefolius), a perennial herb

Endangered fauna species on Fort A.P. Hill include:

- Indiana Bat (myotis sodalist), a small to medium-sized bat with dark brown to black fur

- Northern Long-Eared Bat (myotis septentrionalis), which was historically present in every county in Virginia prior to fungal disease. The last observation of the Northern Long-Eared Bat on Fort A.P. Hill was in 2001.
- Little Brown Bat (myotis lucifugus), a small to medium-sized insectivorous bat with glossy fur
- Tri-colored Bat (perimyotis subflavus), a small forest-dwelling bat and the second smallest bat species in eastern North America
- Kenk's Amphipod (stygobromus kenki), an amphipod currently only known to be in six spring seeps on Fort A.P. Hill
- Bachman's Sparrow (peucaea aestivalis), a ground-nesting bird and fire-dependent species
- Rappahannock Spring Amphipod (sygobromus foliatus), a relatively large mucoid-like amphipod that inhabits shallow groundwater habitats
- Rusty Blackbird (euphagys carolinus), a medium-sized blackbird that prefers wet forested areas

These species are identified to support natural resources and biodiversity management in a manner that meets all statutory and regulatory requirements (Army 2018b).

2.12 Previous PFAS Investigations

Previous (i.e., pre-PA) PFAS investigations relative to Fort A.P. Hill, including both those conducted and not conducted by the Army, are summarized to provide full context of available PFAS constituent data for Fort A.P. Hill. However, only data collected by the Army will be used to make recommendations for further investigation. In response to the IMCOM Operations Order 16-088, nine of the 31 Fort A.P. Hill drinking water wells were sampled for PFOA and PFOS in 2016 as part of the IMCOM PFOA PFOS Water System Testing effort. Results were not detected above the laboratory limit of quantitation (LOQ) of 2 parts per trillion (ppt) for PFOA and 4 ppt for PFOS (IMCOM 2018); and were therefore below OSD risk screening levels.

Additionally, 24 out of the 31 on-post drinking water supply wells, including re-sampling of some previously sampled wells, were sampled in 2019 by American Water. All results of this sampling effort were also not detected above the laboratory LOQ of approximately 4 ppt for both PFOA and PFOS under USEPA Method 537 (Mid-Atlantic Laboratories, Inc. 2019); and were therefore below the OSD risk screening levels.

Expanded results showing the frequency of sampling and results are included in **Table 2-1**.

3 SUMMARY OF PA ACTIVITIES

To document areas where any potential current and/or historical PFAS-containing materials were used, stored and/or disposed at Fort A.P. Hill, data was collected from three principal sources of information and are described in the subsections below:

1. Records review
2. Personnel interviews
3. Site reconnaissance.

Preliminary locations of potential use, storage, and/or disposal of PFAS-containing materials were then evaluated in the PA (during records review, personnel interviews, and/or site reconnaissance) and were categorized as AOPIs or as areas not retained for further investigation at this time based on a combination of information collected (e.g., records reviewed, personnel interviews, internet searches). A summary of the observations made, and data collected through records reviews (**Appendix F**), installation personnel interviews (**Appendix G**), site reconnaissance photos (**Appendix H**), and site reconnaissance logs (**Appendix I**) during the PA process for Fort A.P. Hill is presented in **Section 4**. Further discussion regarding rationale for not retaining areas for further investigation is presented in **Section 5.1**, and further discussion regarding categorizing areas as AOPIs is presented in **Section 5.2**.

3.1 Records Review

The records reviewed for this PA included, but were not limited to, various Installation Restoration Program (IRP) administrative record documents, compliance documents, Fort A.P. Hill fire department documents, Fort A.P. Hill Directorate of Public Works documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. Additionally, an EDR report (**Appendix E**, provided in Final electronic copy only) generated for Fort A.P. Hill was reviewed to obtain off-post water supply well information. A list of the specific documents reviewed for Fort A.P. Hill is provided in **Appendix F**.

3.2 Personnel Interviews

Interviews were conducted during the site visit. If a previously identified interviewee was not available during the site visit, attempts were made to complete the interview via telephone before or following the site visit or by contacting an alternate interviewee identified by the installation POC.

The list of roles for the installation personnel interviewed during the PA process for Fort A.P. Hill is presented below (affiliation is with Fort A.P. Hill unless otherwise noted).

- Environmental Compliance Chief
- Environmental Specialist
- Environmental Specialist, Pest Control Manager, Wastewater/Drinking Water Manager
- Environmental Chief
- Pest Controller

- Private Utilities Coordinator
- Hazardous Waste Manager
- Natural/Cultural Resources Manager
- Fire Chief
- Fire Fighter/Training Coordinator
- Training Aviation Coordinator
- Range Control Coordinator
- Forestry Technician
- Forestry Supervisor
- Communications Personnel
- Maintenance Personnel

The compiled interview logs are provided in **Appendix G**.

3.3 Site Reconnaissance

Site reconnaissance and visual surveys were conducted at preliminary locations identified at Fort A.P. Hill during the records review process, the installation in-brief meeting, and/or during the installation personnel interviews. A photo log from the site reconnaissance is provided in **Appendix H**; photos were used to assist in verification of qualitative data collected in the field. The site reconnaissance logs are provided in **Appendix I**.

Access to existing groundwater monitoring wells, if present, were also noted during the site reconnaissance in case the monitoring wells could be proposed for SI sampling.

4 POTENTIAL PFAS USE, STORAGE, AND/OR DISPOSAL AREAS

Fort A.P. Hill was evaluated for all potential current and historical use, storage, and/or disposal of PFAS-containing materials. There are a variety of PFAS-containing materials used in relation to current and historical Army operations. However, the use, storage, and/or disposal of aqueous film-forming foam (AFFF) is the most prevalent potential source of PFAS chemicals at DoD facilities. As such, this section is organized to summarize the AFFF-related uses first, and all remaining potential PFAS-containing materials in the subsequent section.

4.1 AFFF Use, Storage, and Disposal Areas

AFFF was developed in the mid-1960s in response to a need for firefighting foams better suited to extinguish Class B, fuel-based fires. AFFF formulations consist of water, an organic solvent, up to 5% hydrocarbon surfactants, and 1 to 3% PFAS (Interstate Technology Regulatory Council 2020). AFFF concentrate is designed to be diluted with water to become a 1, 3, or 6% foam. AFFF releases at DoD facilities may have occurred during firefighter training, emergency response actions, equipment testing, or accidental releases. The military still primarily uses AFFF for Class B fires; however, the current formulations of AFFF contain significantly lower amounts of PFOS, PFOA, and their precursors, and significant operational changes have been implemented to restrict uncontrolled releases and non-essential use of PFAS-containing foams. Army installations may still house AFFF, commonly stored in closed containers (e.g., 55-gallon drums, 5-gallon buckets), within designated storage buildings or at firehouses.

Members of the Fort A.P. Hill Fire Department and Directorate of Public Works environmental team were interviewed during the site visit to obtain data back to 2000 on AFFF use and storage. Additionally, data on AFFF storage was collected from historical reports and documents provided by the Army.

There are three active fire stations fire stations at Fort A.P. Hill: Fire Station 7, Fire Station 8, and Fire Station 9. Fire Station 8 is the main fire station located in the Headquarters area of the main cantonment. Fire Station 7 is located on the north portion of the installation, and Fire Station 9 is located south of the U.S. Highway 301 divide near the operational range area of the installation. Fire Station 7 and Fire Station 8 were historically used fire stations on Fort A.P. Hill; there are no additional historical fire stations.

AFFF storage is in a storage locker co-located with Fire Station 9. Additionally, AFFF is kept filled in the reservoirs on fire engines. Each fire station houses fire engines. Fire department personnel stated AFFF is generally transported in closed containers from the Fire Station 9 storage location then transferred into engines; however, occasional filling at Fire Station 9 may occur. Therefore, incidental AFFF spills are a possibility at all the fire stations on Fort A.P. Hill. Fort A.P. Hill personnel noted old AFFF was swapped out from all Fort A.P. Hill fire department vehicles at the MED site behind Wilcox Camp. Following the swap out, each foam tank followed the triple rinse standard operating procedure (SOP) and rinsate was collected and sent off post for disposal. The unused AFFF in storage at Fire Station 9 was also disposed of off post along with the rinsate from the fire truck tank cleaning operations.

According to Fort A.P. Hill fire department personnel, AFFF nozzle testing has not been conducted at Fort A.P. Hill since at least 2000. However, historical information on nozzle testing, spills, or other AFFF use is unknown.

The Fort A.P. Hill Fire Department Chief also indicated a large amount (i.e., more than one gallon) of AFFF concentrate was released during a fire hose nozzle test in 2016 at Fire Station 8. The exact time or amount of AFFF released is unknown. One specific AFFF spill was reported by the fire department during the PA. An approximately 40-gallon AFFF spill occurred on 12 June 2012 due to a fire engine reservoir malfunction. This spill may have impacted the Vehicle Maintenance Facility when the fire engine was sent there for maintenance.

The fire department frequently uses AFFF to extinguish fires on training ranges and to protect expensive targets. Specific incidents were reported by the fire department during the PA interview at Range 24 mover targets, Range 29, Range 33, Range 34, Range 42, Range 43, and Training Area 17A – Transformer Fire. All these ranges were determined to be AOPIs following the PA site visit, and more information on the AFFF releases at each AOPI can be found in the AOPI discussions in **Section 5.2**.

The Fort A.P. Hill fire department utilizes one fire training facility located near Fire Station 9. Only water is used at this facility for training. Despite this, there is a high possibility of release of residual AFFF from nozzles during training at this facility because AFFF is frequently used in the same fire engines to extinguish fires at other areas of the installation.

4.2 Other PFAS Use, Storage, and /or Disposal Areas

Following document research, personnel interviews, and site reconnaissance at Fort A.P. Hill, WWTPs, landfills, pesticide areas, car washes, and maintenance shops were also identified as preliminary locations for use storage, and/or disposal of PFAS-containing materials. A summary of information gathered in the PA for each of these preliminary locations is described below. Specific discussion regarding areas not retained for further investigation and AOPIs are presented in **Section 5.1** and **Section 5.2**, respectively.

WWTPs and Landfills

Several WWTPs and landfills were identified at Fort A.P. Hill as locations where PFAS-containing materials were likely disposed. Both the Old Headquarters WWTP and the New Wilcox WWTP operated during the same timeframe of various fire stations at Fort A.P. Hill, which each had reported or suspected uses/spills of AFFF (**Section 4.1**). Therefore, it is likely both WWTPs received PFAS-containing materials (i.e., AFFF in this instance) via sanitary drains from the fire stations. The Old Headquarters WWTP utilized sludge drying beds (lined with sand) where digested sludges were dried prior to being disposed of in the sanitary landfill on-post. As a result of records review, both the Taylor's Corner Landfill and Wilcox Landfill received sanitary wastes (i.e., potentially sludges from the WWTPs) during the operational periods of the Old Headquarters WWTP. The New Wilcox WWTP sludges are disposed off-post. Additional details regarding the WWTPs and landfills identified at Fort A.P. Hill are included in **Section 5.2**.

Pesticide Areas

During a telephonic interview with the IMCOM Pest Management Consultant, it was noted that products containing Sulfluramid (i.e., associated with insecticides) may have contained PFAS and were phased out in 1996. During the PA records review, the IMCOM Pest Management Consultant provided records of potentially PFAS-containing pesticides and insecticides used and/or stored at Army installations and did not identify Fort A.P. Hill as an installation which used or stored PFAS-containing pesticides or insecticides.

Additionally, the PA team reviewed available pesticide use inventory documentation provided by the installation and did not identify PFAS-containing pesticides use, storage, or disposal.

Car Washes and Maintenance Shops

Several car washes and maintenance shops were evaluated as preliminary locations for use, storage, and disposal of PFAS-containing materials. Following records review, interviews, and site reconnaissance, PFAS-containing materials were not identified at the Central Wash Facility and the Maintenance Shop Storage Shed. Safety data sheets (SDSs) were reviewed for soaps and waxes used at the Morale, Welfare and Recreation (MWR) Car Wash and do not list PFAS-containing materials. Some fire engine maintenance occurs at the Vehicle Maintenance Facility, but most engines are sent to Fort Belvoir for maintenance. As noted in **Section 4.1**, the engine's AFFF reservoir from the spill at Fire Station 8 after draining was sent to the Fort A.P. Hill maintenance facility to be decommissioned. Specific discussion regarding these areas is included in **Section 5.1** and **Section 5.2**.

4.3 Readily Identifiable Off-Post PFAS Sources

An exhaustive search to identify all potential off-post PFAS sources (i.e., not related to operations at Fort A.P. Hill) is not part of the PA/SI. However, potential off-post PFAS sources within a 5-mile radius of the installation identified during the records search and site visit are described below.

There is an off-post easement along U.S. Route 301 bisecting the installation, which Caroline County currently uses for a detention center. The detention center is approximately 0.65-mile northeast of the New Wilcox WWTP. The sewer lines at this facility are connected to and serviced by the New Wilcox WWTP. While no known activities occur that are anticipated to contribute PFAS, specific wastes are unknown.

5 SUMMARY OF AREAS RESEARCHED AND AOPIs

The preliminary locations evaluated for potential use, storage, and/or disposal of PFAS-containing materials at Fort A.P. Hill were further refined during the PA process and identified either as an area not retained for further investigation or as an AOPI. In accordance with the established process for the PA/SI, 18 areas have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

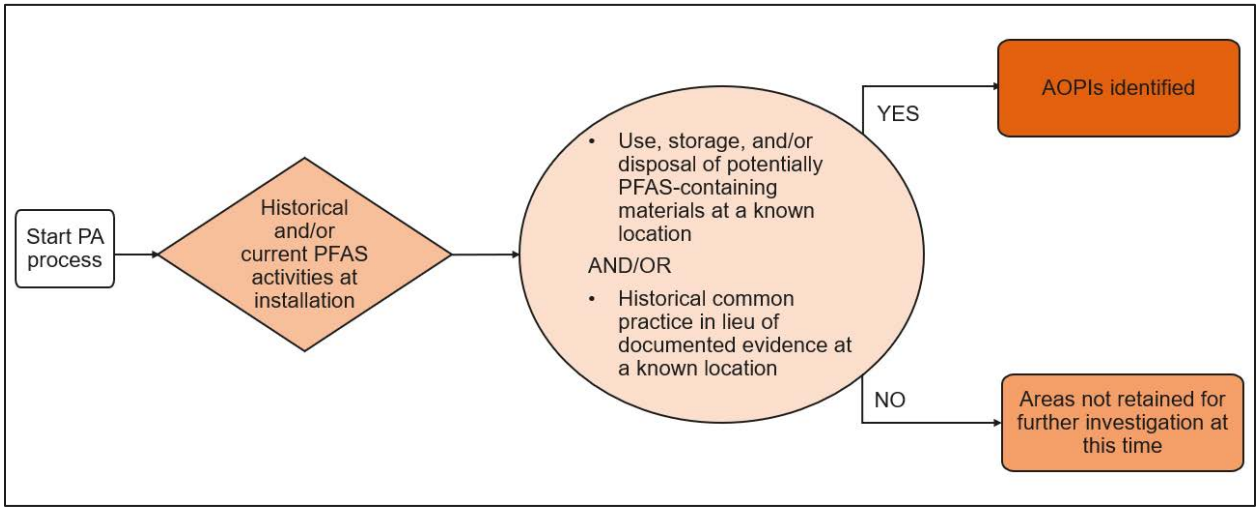


Figure 5-1: AOPI Decision Flowchart

The areas not retained for further investigation are presented in **Section 5.1**. The areas retained as AOPIs are presented in **Section 5.2**.

Data limitations for this PA/SI at Fort A.P. Hill are presented in **Section 8**.

5.1 Areas Not Retained for Further Investigation

Through the evaluation of information obtained during records review, personnel interviews, and/or site reconnaissance, the areas described below were categorized as areas not retained for further investigation at this time.

A brief site history and rationale for areas not retained for further investigation are presented in **Table 5-1**, below.

Table 5-1. Installation Areas Not Retained for Further Investigation

Area Description	Dates of Operation	Relevant Site History	Reason Eliminated
Building 160	April 2019 to Present	Communications building with a newly installed (April 2019) suppression system containing HFC-227. HFC-227 is a gas that is purchased containerized. Records reviewed and interviews with site personnel indicated this system has not been tested (i.e., not released from containerized system) since the installation.	Records reviewed and interviews with site personnel noted system components are containerized and have not been tested to date. There is no information gap in the operational history of the use of this suppression system.
Building 136	At least 1980 to Unknown	Building 136 is the former photography/x-ray lab associated with the medical clinic. The building has been demolished and is now a grassy field adjacent to the MWR Car Wash. No records were available to confirm PFAS-containing materials that were used during operation or to confirm other solvent-related contamination in the area (i.e., to indicate environmental impacts from building operations). Soil study documents related to closure were not available.	No known use, storage, or disposal of PFAS-containing materials.
Building 0940 (Hangar)	Unknown	Building is used by tenant organizations (U.S. Navy and other groups). The building does not contain a fire suppression system but does have one Amerex model 490 portable suppression tank that uses Purple K. The Purple K SDS confirms the product does not contain PFAS.	No use, storage, or disposal of PFAS-containing materials.
Building 1203 (Hangar)	Unknown	Building is used by a tenant organization (Night Vision) a couple times a year. The building has a built-in fire suppression system that only uses water and contains five portable Amerex wheeled extinguishers (three Amerex model 490 and two Amerex model 690). The Amerex SDS confirms the product does not contain PFAS.	No use, storage, or disposal of PFAS-containing materials.
Building 1538 (Hangar)	Unknown	Building is used by tenant organizations. The building does not contain a fire suppression system. No PFAS-containing materials were identified.	No use, storage, or disposal of PFAS-containing materials.

Area Description	Dates of Operation	Relevant Site History	Reason Eliminated
Building 9027 (Hangar)	Unknown	Building is used by a tenant organization. The building does not contain a fire suppression system but does have one Amerex portable model 490 that uses Purple K. The Purple K SDS confirms the product does not contain PFAS.	No use, storage, or disposal of PFAS-containing materials.
Central Vehicle Wash Facility	Unknown to Present	Main motor pool where Army vehicles are washed. There are ten wash points, and the facility is permitted. Wash water goes to an oil-water separator prior to discharge to a nearby creek. No soap or PFAS-containing materials are used here currently or have been used historically.	No use, storage, or disposal of PFAS-containing materials.
MWR Car Wash	Unknown to present	The MWR Car Wash uses soaps, wax, and tire cleaner from Custom Kraft products. This car wash is in the Headquarters area adjacent to a creek. SDSs for all soaps and waxes included proprietary mixtures but were reviewed and do not list PFAS constituents.	No known use, storage, or disposal of PFAS-containing materials.
Anderson Club Building Fire	Early-1990s	Fire incident in early-1990s, where the entire building burned down. The Anderson Club Building Fire was not identified by the Fort A.P. Hill fire department as an area of AFFF use or disposal. Additionally, records reviewed did not indicate AFFF was used to extinguish the fire. The fire occurred between Building 160 and Fire Station 8.	No known use, storage, or disposal of PFAS-containing materials.
Pesticide Mixing Building	Unknown to present	The Pesticide Mixing Building is in current use. Pesticides and herbicides are mixed inside and/or outside the building on concrete pads that do not contain drains. If spills occur, a spill kit is used for clean-up and material is disposed off-post as hazardous waste. The current pesticide database does not list any PFAS-containing products. Specific pesticides used historically are unknown.	No known use, storage, or disposal of PFAS-containing materials.
Old Entomology Building	Unknown to 1980s	The Old Entomology Building closed in late 1980s under the Resource Conservation and Recovery Act after chlordane and dichlorodiphenyltrichloroethane clean up. This was not an IRP site and was closed to industrial use standards. The current pesticide database does not show any PFAS-containing products. Specific pesticides used historically are unknown.	No known use, storage, or disposal of PFAS-containing materials.

Area Description	Dates of Operation	Relevant Site History	Reason Eliminated
Maintenance Shop Storage Shed	Unknown to present	The Maintenance Shop area contains a chemical storage shed. No chemicals containing PFAS were identified.	No use, storage, or disposal of PFAS-containing materials.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. None of the AOPIs overlap with Fort A.P. Hill IRP sites and/or Headquarters Army Environmental System sites. At the time of this PA, none of the Fort A.P. Hill IRP sites have historically been investigated or are currently being investigated for the possible presence of PFAS constituents.

The AOPI locations are shown on **Figure 5-2**. Aerial photographs of each AOPI depicting the approximate extent of PFAS-containing materials (if applicable) are presented on **Figures 5-3** through **5-20** and include active monitoring wells in the vicinity of each AOPI, if applicable.

5.2.1 Fire Station 7

Fire Station 7 (**Figure 5-3**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the possibility of incidental spills or leaks while transferring AFFF, washing fire engines, or additional regular fire department practices. The fire station has been in use since 2008. AFFF is transferred into fire engines regularly; however, no spills or incidents involving AFFF have been recorded. The facility contains a drain that goes to the Central WWTP.

5.2.2 Fire Station 8

Fire Station 8 (**Figure 5-4**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to an AFFF spill and regular AFFF use that may have resulted in other incidental spills. Fire Station 8 has been in use since 1966. AFFF has been transferred into fire engines regularly at this facility since 2000. Activities involving AFFF prior to 2000 are unknown. A large AFFF spill occurred on 12 June 2012 due to an AFFF reservoir malfunction on a fire engine. Residual AFFF was drained from the fire engine prior to maintenance, and the AFFF concentrate was containerized and sent to the on-post hazardous waste facility for disposal off-post. Before maintenance, the engine was stored on a gravel area under an awning adjacent to the paved parking lot. It is believed that AFFF may have leaked in this area.

5.2.3 Fire Station 9

Fire Station 9 (**Figure 5-5**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the possibility of incidental spills or leaks while transferring AFFF, washing fire engines, or additional regular fire department practices. Fire Station 9 has been in use since 2013 and includes a storage warehouse. AFFF is stored in 5-gallon buckets in a storage locker at the site. AFFF is

generally transported in closed containers to other fire stations and then transferred into engines; however, occasional filling at this location may occur.

5.2.4 Fire Training Facility

The Fire Training Facility (**Figure 5-6**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to residual AFFF that may have been released with water used for training. The Fire Training Facility has been in use by the fire department for hazardous material training since the early 2000s. Class A materials, such as wood pallets and bales of straw, are burned in the building and disposed of in a nearby dumpster. A metal aircraft is also on site and used for fire department training. No AFFF has been used in this area; only water is used for training. Despite this, there is a high possibility of release of residual AFFF from nozzles during training at this facility because AFFF is frequently used in the same fire engines to extinguish fires at other areas of the installation.

5.2.5 Old Headquarters WWTP

The Old Headquarters WWTP (**Figure 5-7**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to receipt of waste conveyance from Fire Station 8. The site was in use from 1979 to 1993. Fire Station 8 drains, which were potentially contaminated with AFFF, historically went to this WWTP. Three sludge drying beds (lined with sand) were located on site. The digested sludge from the Old Headquarters WWTP was first dried in the sludge drying beds, then disposed of in the sanitary landfill on-post. Effluent from this plant went to the sewer then to Maracossic Creek.

5.2.6 New Wilcox WWTP

The New Wilcox WWTP (**Figure 5-8**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the drainage effluent from fire stations to the site. The WWTP has been in operation since 1991. Currently, the WWTP is run by American Water. Drains, which are potentially contaminated with AFFF from fire stations, go to this WWTP. The plant includes two lagoons and eight sludge drying beds, which are all lined; solids are disposed of off-post. Outfall is into an unnamed tributary of Mill Creek adjacent to the eastern side of the WWTP. Four associated monitoring wells are located on-site.

5.2.7 Vehicle Maintenance Facility

The Vehicle Maintenance Facility (**Figure 5-9**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to potential drainage of AFFF from the 20 June 2012 spill at Fire Station 8. The facility has been in operation since in 1972. Some fire engine maintenance occurs at the Vehicle Maintenance Facility, but most engines are sent to Fort Belvoir for maintenance. The engine’s AFFF reservoir from the spill at Fire Station 8 after draining was sent to the maintenance facility to be decommissioned. At this point AFFF could have been released at the facility. Additionally, the Vehicle Maintenance Facility is included as an AOPI for other historical leaks, spills, or releases to the drain field.

The sanitary sewer historically connected to a drain field west of the building adjacent to the road; research indicates that floor drains in bays were not part of the sanitary system and would have drained to the Old Headquarters WWTP. The drain field is now abandoned, and all drains currently connect to the Wilcox WWTP. Therefore, the drain field is not evaluated as part of this AOPI.

5.2.8 Training Area 17A – Transformer Fire

Training Area 17A – Transformer Fire (**Figure 5-10**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to extinguish a fire. Training Area 17A – Transformer Fire is a laser range adjacent to the installation's northern boundary. On 14 April 2018, a downed power line caused a transformer fire. About 5 gallons of AFFF was used to spot treat logs over an area measuring about 400 square feet. The use of AFFF was required to keep the fire from migrating off-post to a residential area with known drinking water supply wells about 100 yards north of the installation boundary.

5.2.9 Range 24 – Mover 1

Range 24 – Mover 1 (**Figure 5-11**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to control a fire. Range 24 is utilized for pre-deployment training. Two mover targets (not co-located) consist of an approximately 200-foot long, 8-foot-high concrete wall backed by a soil berm. The walls were previously built from creosote timbers. Around 2005 at least one large fire occurred on the creosote timbers at each mover target. AFFF was used at these mover targets to control a large fire by completely covering the entire wall with AFFF. Incidental AFFF contact with soil would have occurred, as well as, leaching from residual AFFF on the creosote timbers. The creosote timbers were removed and disposed off-post when the concrete walls were built.

5.2.10 Range 24 – Mover 2

Range 24 – Mover 2 (**Figure 5-12**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to control a fire. Range 24 is utilized for pre-deployment training. Two mover targets (not co-located) consist of an approximately 200-foot long, 8-foot-high concrete wall backed by a soil berm. The walls were previously built from creosote timbers. Around 2005 at least one large fire occurred on the creosote timbers at each mover target. AFFF was used at these mover targets to control a large fire by completely covering the entire wall with AFFF. Incidental AFFF contact with soil would have occurred, as well as, leaching from residual AFFF on the creosote timbers. The creosote timbers were removed and disposed off-post when the concrete walls were built.

5.2.11 Range 29 – Plywood Structures

Range 29 – Plywood Structures (**Figure 5-13**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to extinguish a munitions fire. Range 29, the Infantry Platoon Battle Course, is a heavily forested area. AFFF was previously used to extinguish a munitions fire at the large plywood building on this range sometime between 2010 and 2019. At the time of SI field work, the building and associated utilities had been removed.

5.2.12 Range 29 - Bunker

Range 29 – Bunker (**Figure 5-14**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to extinguish a fire. Range 29, the Infantry Platoon Battle Course, is a heavily forested area. AFFF was used to extinguish a fire at a wooden turret sometime between 2010 and 2019. The turret has been removed and is now a large depression in the ground. Soil in place when the turret existed remains on site.

5.2.13 Range 33 – Target Area

Range 33 – Target Area (**Figure 5-15**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to extinguish fires at the site. Range 33 is a small arms shooting range made up of approximately 50 targets. Tracers at this range have previously caught fire and ignited creosote timbers at multiple targets. The targets have one creosote timber each that function as target protection. AFFF has been used to extinguish fires at these creosote timbers several times; however, the fire department was unable pinpoint exact locations or time frames.

A creek is located north and adjacent to the target area.

5.2.14 Range 34 – Lines 15 & 16

Range 34 Lines 15 & 16 (**Figure 5-16**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to extinguish fires at the site. Range 34 is a small arms shooting range with targets in wooded areas. Wildfires have previously occurred at this range, which caused creosote timbers at Lines 15 & 16 to catch fire. AFFF was used to extinguish the fires. Fires may have occurred at additional timbers but were unknown by current fire department personnel at the time of the PA.

A small pond is located adjacent to these targets.

5.2.15 Range 42 – Mover Target Area

Range 42 – Mover Target Area (**Figure 5-17**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the use of AFFF to prevent the destruction of large trees. Range 42 is operated by the Asymmetric Warfare Group and is used for survival, leadership, and medical training. Prescribed burns have previously occurred at this range adjacent to the back road and mover target. AFFF would have been used at the base of larger trees to prevent the trees from falling and causing damage to expensive targets. Fire department personnel with experience assisting with prescribed burns pointed out several trees as examples during the PA site reconnaissance, but exact locations of AFFF use are unknown.

5.2.16 Range 43 – Plywood Structures Area

Range 43 – Plywood Structures Area (**Figure 5-18**) is identified as an AOPI following records review, personnel interviews, and site reconnaissance due to the preventive use of AFFF. Range 43 is also operated by the Asymmetric Warfare Group and contains many plywood structures (e.g., small houses, turrets). AFFF has been sprayed around the base of some of these structures for protection before

training operations; however, the fire department cannot pinpoint exact locations. Smoot's Pond is located southeast of this AOPI.

5.2.17 Taylor's Corner Landfill

Taylor's Corner Landfill (**Figure 5-19**) is identified as an AOPI following records review due to the possible disposal of PFAS-containing materials. Taylor's Corner Landfill was historically used as a sanitary landfill at Fort A.P. Hill and possibly received sludge wastes from the Old Headquarters WWTP. The Old Headquarters WWTP received sanitary wastes from the Fire Station 8 bay drains, where AFFF drained (**Section 5.2.5**).

During a 1982 Installation Assessment (USATHAMA 1982), the Taylor's Corner Landfill was noted as the primary sanitary landfill for Fort A.P. Hill prior to the Wilcox Landfill. Taylor's Corner Landfill began operation in 1968 and ended prior to 1988. Taylor's Corner Landfill is located to the west of Wilcox Drive in the northern/central portion of the installation. Soil, groundwater, surface water, and sediment were investigated throughout 2001 to 2002 and 2006 to 2007 to evaluate constituents in the environment from landfill operations. Based on the investigation results, no further assessment was required, and the landfill utilizes institutional controls (i.e., signs).

5.2.18 Wilcox Landfill

Wilcox Landfill (**Figure 5-20**) is identified as an AOPI following records review due to the possible disposal of PFAS-containing materials. Wilcox Landfill was historically used as a sanitary landfill at Fort A.P. Hill and possibly received sludge wastes from the Old Headquarters WWTP. The Old Headquarters WWTP received sanitary wastes from the Fire Station 8 bay drains, where AFFF drained (**Section 5.2.5**).

The Wilcox Landfill operated as a permitted landfill from 1981 to 1992 and consists of approximately 8 acres in the northern/central portion of the installation. Two of the landfill trenches are covered with a synthetic cap, and six trenches are covered with a soil cap. Post-closure care (after 1992) included groundwater and landfill decomposition gas monitoring. In 2006, the Virginia Department of Environmental Quality required biannual monitored attenuation of groundwater. Long term monitoring and landfill cap integrity inspections will continue as required by the Virginia Department of Environmental Quality permit.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at Fort A.P. Hill, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at Fort A.P. Hill at 18 AOPIs to evaluate presence or absence of PFOS, PFOA, and PFBS in comparison with the OSD risk screening levels. An installation-specific QAPP Addendum (Arcadis 2020a) was developed to supplement the general information provided in the PQAPP (Arcadis 2019) and to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for each of the installation's AOPIs in accordance with the USACE Engineer Manual on Conceptual Site Models, EM 200-1-12 (USACE 2012). The preliminary CSMs identified potential human receptors and chemical exposure pathways based on current and/or reasonably anticipated future land uses. The preliminary CSMs identified all 18 AOPIs as having potentially complete soil, groundwater, surface water, and/or sediment pathways, which guided the SI sampling. The QAPP Addendum details the sampling design and rationale based on each AOPI's preliminary CSM. The SI scope of work was completed in April to May 2020 and April to May 2021 through the collection of field data and analytical samples.

The SI field work was completed in accordance with the SOPs, technical guidance instructions (TGIs), sampling design, and QA/QC requirements as detailed in the QAPP Addendum (Arcadis 2020a) and PQAPP (Arcadis 2019). The subsections below summarize the DQOs, sampling design and rationale, sampling activities and methods, and data analyses procedures for the SI phase at Fort A.P. Hill. Non-conformances to the prescribed procedures in the PQAPP and QAPP Addendum are described in **Section 6.3.3**. Analytical results obtained through SI field activities are summarized in **Section 7**.

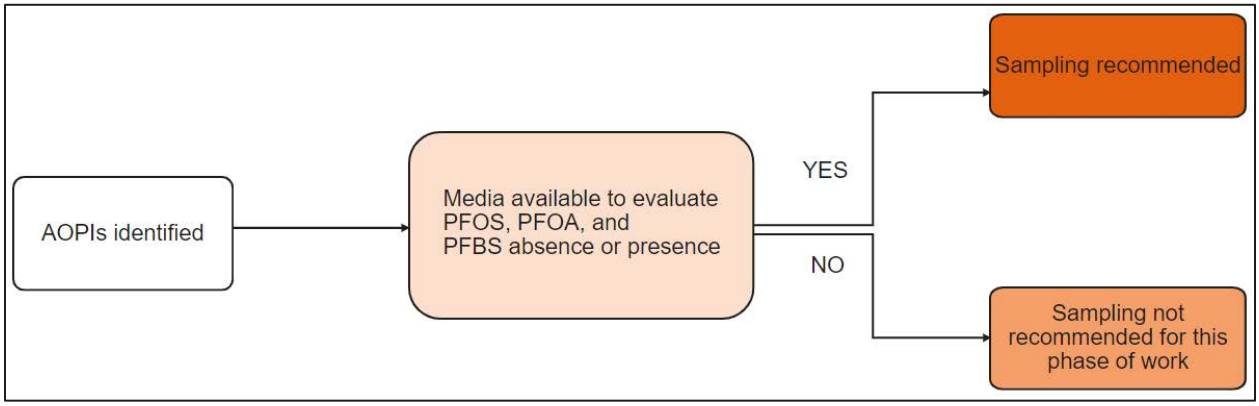
6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 2020a), the objective of the SI is to evaluate absence or presence at individual AOPIs identified in the PA and to determine if further investigation is warranted. This SI at Fort A.P. Hill evaluated groundwater, soil, and/or surface water for PFOS, PFOA, and PFBS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

The rationale for sampling at each AOPI is illustrated on **Figure 6-1** below.

Figure 6-1: AOPI Sampling Decision Tree



The sampling design for SI sampling activities at Fort A.P. Hill is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2020a). The areas of focus for this SI (i.e., sites within the Fort A.P. Hill cantonment area and active range areas) were selected based on a review of historical documents and information obtained by conducting personal interviews during the PA site visit. Soil and/or groundwater samples were collected from all 18 AOPIs. Additionally, a surface water sample was collected at the New Wilcox WWTP AOPI.

Sampling points were positioned at locations of known or suspected AFFF uses, locations of runoff collection, and locations downgradient of known or suspected releases of AFFF and were determined based on specific historical evidence and surface runoff/groundwater flow conditions at each AOPI.

Approximate sampling depths and constituents analyzed for each sampling location and medium are included in **Table 6-1**. Sampling depths noted for existing monitoring wells represent approximately the center of the saturated screened interval. Specific sampling rationale for each AOPI is presented in **Table 6-2** below.

Table 6-2. SI Sampling Rationale at Fort A.P. Hill

AOPI Name	SI Sampling Rationale
Fire Station 7	• Two grab groundwater samples were collected in the inferred downgradient directions (northeast and southeast) of the possible AFFF release area. • One surface soil sample was collected within the top 2 feet of native soil via direct-push technology (DPT). The sample was positioned immediately adjacent to the fire station apron in the most likely location of runoff from incidental AFFF releases.
Fire Station 8	• One grab groundwater sample was collected in the direct surface runoff location from the concrete apron (north). A surface soil sample was co-located with this boring.

AOPI Name	SI Sampling Rationale
	• One surface soil sample was collected within the top 2 feet of native soil via hand auger at the AFFF spill location. The soil sample is located at the source area of the AFFF spill.
Fire Station 9	• Two grab groundwater samples were collected. One sample was positioned in the direct surface runoff location from the concrete apron (east of the building, north of the concrete apron) where AFFF spills or nozzle testing may have occurred; the additional sample was in the inferred downgradient direction from the first sample (northeast). • One surface soil sample was co-located with the groundwater sample in the direct surface runoff location from the concrete apron.
Fire Training Facility	• Two grab groundwater samples were collected. One sample was placed in the inferred downgradient direction (northeast) of the area of possible releases of residual AFFF sprayed with water during training exercises; one sample is in the surface runoff direction from the driveway surrounding the building (northwest). • One surface soil sample was co-located with the groundwater sample within the suspected runoff area.
Vehicle Maintenance Facility	• One grab groundwater sample was collected in the inferred downgradient direction (west-northwest) of the possible AFFF release area in the parking lot of the facility. • Soil was not sampled because specific location(s) of AFFF release at this AOPI are unknown.
Old Headquarters WWTP	• Two grab groundwater samples were collected. One sample was located in the inferred downgradient direction (south-southeast) of the former sludge drying beds location; the additional sample was located directly in the former sludge drying bed location. • One surface soil sample was co-located with the groundwater sample at the former sludge drying beds location.
New Wilcox WWTP	• Three groundwater samples were collected from existing monitoring wells (one sample each at wells MW-2, MW-3, and MW-4). • One surface water sample was collected at the confluence of the two streams adjacent to the WWTP to account for surface water release at the WWTP outfall and groundwater that may be discharging to surface water.

AOPI Name	SI Sampling Rationale
	• No soil samples were collected because there is no suspected mechanism for release to soil at the sludge drying beds or lagoons locations.
Training Area 17A – Transformer Fire	• One grab groundwater sample was collected at the most downgradient point of the AFFF source location. • One surface soil sample was co-located with the groundwater sample.
Range 24 - Mover 1	• One grab groundwater sample was collected in the inferred downgradient direction (northeast) of the mover target; an additional sample was planned directly in the berm where AFFF was sprayed, but groundwater was not located. • One surface soil sample was collected from the AFFF-impacted soil berm.
Range 24 - Mover 2	• Two grab groundwater samples were collected. One sample was located in one possible downgradient direction (northeast of the mover target); the additional sample was located directly in the berm where AFFF was sprayed. An additional groundwater sample was planned in the second possible downgradient direction (southwest), but groundwater was not located. • One surface soil sample was co-located with the groundwater sample at the AFFF-impacted soil berm.
Range 29 - Plywood Structure	• One grab groundwater sample was collected in the inferred downgradient direction (north-northwest) of the plywood structure location. • One surface soil sample was collected from the direct surface runoff location at the ditch east of the structure.
Range 29 – Bunker	• One grab groundwater sample was collected in the inferred downgradient direction (south) of the bunker location. • One surface soil sample was collected directly from the AFFF-impacted soil at the bunker location.
Range 33 - Target Area	• Four grab groundwater samples were collected in the inferred downgradient direction (north-northeast) of the target area. • No soil samples were collected because the specific location(s) of AFFF use is unknown, and the potential use area covers a widespread area.
Range 34 - Lines 15 & 16	• One grab groundwater sample was collected in the inferred downgradient direction (north-northwest) of the target locations.

AOPI Name	SI Sampling Rationale
	• Two surface soil samples were collected from locations immediately adjacent to the creosote timbers onto which AFFF was sprayed.
Range 42 - Mover Target Area	• One grab groundwater sample was collected in the inferred downgradient direction (northeast) of the target area where AFFF was used as fire protection. • No soil samples were collected because the specific location(s) of AFFF release are unknown, and the potential use area covers a widespread area.
Range 43 – Plywood Structures Area	• Three grab groundwater samples were collected in the inferred downgradient direction (east-southeast) of the plywood structures area where AFFF was used as fire protection. • Four surface soil samples were collected (i.e., one at each plywood structure) where AFFF was used as fire protection.
Taylor's Corner Landfill	• Two grab groundwater samples were collected in the inferred downgradient direction (south-southeast) of the landfill where potentially PFAS-containing materials were disposed during landfill operations. • No soil samples were collected because the specific disposal location(s) of potentially PFAS-containing materials are unknown.
Wilcox Landfill	• Four groundwater samples were collected from existing monitoring wells in the inferred downgradient direction (west) of the landfill where potentially PFAS-containing materials were disposed during landfill operations. Additionally, the sampled monitoring wells have historically contained other constituents (i.e., non-PFAS constituents) related to landfill operations. • No soil samples were collected because the specific disposal location(s) of potentially PFAS-containing materials are unknown.

6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019), the SOPs and TGIs included as Appendix A to the PQAPP, the QA/QC requirements identified in Worksheet #20 of the PQAPP, the approved scope and sampling methods outlined in the site-specific QAPP Addendum (Arcadis 2020a), and the safety procedures specified in the Accident Prevention Plan (Arcadis 2018) and SSHP (Arcadis 2020b). The sampling methods described in the SOPs and TGIs establish equipment requirements, procedures for preparing equipment and containers before sampling, sampling procedures under various conditions, and procedures for storing samples to ensure that sample contamination does not occur during collection, and transport. In general, sampling techniques used in the SI were consistent with conventional sampling techniques used in the environmental industry, but

special considerations were made regarding PFAS-containing materials and equipment and cross-contamination potential.

The sampling methods employed during the SI are detailed in the PQAPP (Arcadis 2019) and QAPP Addendum (Arcadis 2020a). The subsections below provide a summary of the field methods and procedures utilized to complete the SI scope of work. Field notes and field forms (i.e., soil boring logs, groundwater purging logs, sample collection logs, equipment calibration forms, and tailgate health and safety forms) documenting the SI sampling activities are included in **Appendices J** and **K**, respectively.

6.3.1 Field Methods

Groundwater samples were collected via DPT from discrete direct-push points at first groundwater; dual tube drill casing was advanced using a top-down sampling method to minimize cross-contamination at depth. Groundwater samples were collected via low-flow purging methods from approximately the center of the saturated screened interval at existing monitoring wells. At sampling locations where only soil was collected, a hand auger was used to collect a grab soil sample. At sampling locations where soil and groundwater were collected, soil samples were collected in PFAS-free acetate liners then boreholes were advanced via DPT to collect groundwater. A peristaltic pump with PFAS-free disposable high-density polyethylene tubing was used to collect groundwater samples through a screen-point sampler. In some cases, where groundwater recharge was low, samples were collected via check valve and parameters were not collected. Field change reports were completed for these samples and are discussed below in **Section 6.3.3**.

Soil lithological descriptions were logged for the entire depth above each soil sample/borehole and were documented on field forms. Where used with DPT samples, cores were collected in a sleeve and logged by a geologist. Soil samples collected via hand auger or DPT methods were collected in accordance with the TGI for PFAS-Specific Drilling and Monitoring Well Installation (P-12 in Appendix A to the PQAPP [Arcadis 2019]). Soil samples were collected from the top 2 feet of native soil. Coordinates for each soil sampling location were recorded using a handheld global positioning system.

Surface water samples were collected using direct-fill methods just below the water surface. Surface water samples were collected from downstream to upstream to reduce siltation in sequential samples. Coordinates for the surface water sampling location were recorded using a handheld global positioning system.

6.3.2 Quality Assurance/Quality Control

Worksheets #20 of the PQAPP and QAPP Addendum provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), source blanks for water used in the initial decontamination step for drill tooling, and field blanks (FBs) for laboratory-supplied water used in the final decontamination step.

QA/QC samples were collected at the frequencies specified in the QAPP Addendum (Arcadis 2020a), typically at a rate of 1 per 20 parent samples. Field duplicates and matrix spike/matrix spike duplicate samples were collected for groundwater and surface water for PFOS, PFOA, and PFBS only. A field duplicate was collected for soil and analyzed for PFOS, PFOA, and PFBS only. EBs were collected for media sampled for PFOS, PFOA, and PFBS at a frequency of one per piece of relevant equipment for

each sampling event, as specified in the QAPP Addendum (Arcadis 2020a). The decontaminated reusable equipment from which EBs were collected include screen-point samplers, drill casing and cutting shoes, hand augers, and water-level meters, as applicable, to the sampled media. Source blanks were collected from the water used to wash drill tooling. Analytical results for blank samples are discussed in **Section 7.19**.

6.3.3 Field Change Reports

No instances of major scope modifications (i.e., those that may have had a significant impact on the project scope and/or data usability/quality, or required stop-work, and warranted discussion with USACE) were encountered during the Fort A.P. Hill SI work.

In some cases, clarifications to the established scope of work may be needed but do not necessarily constitute a non-conformance from the sampling plans described in the QAPP Addendum (Arcadis 2020a). Minor modifications from and clarifications for the procedures and scope of work detailed in the QAPP Addendum and PQAPP and that did not affect DQOs are documented in Field Change Reports (FCRs) included as **Appendix L** and are summarized below:

- At the Range 24 – Mover 1 AOPI, proposed groundwater sample FTAPH-R24M1-1-GW was not collected. Field staff drilled to 25 feet bgs and did not encounter groundwater; therefore, the boring was abandoned. Field staff observed soil at 25 feet bgs was completely dry, and due to topography, groundwater was not expected for at least another 20 feet bgs (for a total of about approximately 45 feet bgs). Groundwater was collected at boring FTAPH-R24M1-2-GW, therefore the DQOs of identifying presence or absence in groundwater were still achieved and attempts to collect additional groundwater samples at the AOPI were not pursued. This field change is detailed in FCR-FAPH-01 in **Appendix L**.
- At the Range 24 – Mover 2 AOPI, proposed groundwater sample FTAPH-R24M2-3-GW was not collected. Field staff drilled to 29.6 feet bgs and hit refusal at that depth. Groundwater samples FTAPH-R24M2-1-GW and FTAPH-R24M2-2-GW were collected. This field change is detailed in FCR-FAPH-02 in **Appendix L**.
- At the Fire Station 8 AOPI, boring location FTAPH-FS8-1-GW was moved, and a new soil sample was added at the newly located boring. The originally scoped boring location south of the building was not permitted by the installation due to utility concentration along the entire side of the building. Another boring location downgradient of the spill location was not possible. Therefore, the boring location was moved to the location of direct surface water runoff from the apron in a ditch north of the concrete. This new boring location is in the permitted stormwater runoff location and provides valuable data as this location is where any incidental AFFF spills or nozzle spraying would run off. This field change is detailed in FCR-FAPH-03 in **Appendix L**.
- At the Range 29 – Bunker AOPI, proposed groundwater sample FTAPH-R29B-1-GW was moved, and proposed groundwater sample FTAPH-R29B-2-GW was not collected. The originally scoped location within the old bunker for sample FTAPH-R29B-1-GW was not accessible by the DPT drill rig. Therefore, the sample was moved to the closest downgradient edge of the bunker. This sample was within approximately 15 feet of the scoped location for sample FTAPH-R29B-2-GW, and sample FTAPH-R29B-2-GW could not be moved further downgradient due to unexploded ordnance safety

concerns. Therefore, only one groundwater sample was collected. This field change is detailed in FCR-FAPH-04 in **Appendix L**.

- At the Range 29 – Plywood Structure AOPI, proposed soil sample FTAPH-R29PS-1-SO was moved, and groundwater sample FTAPH-R29PS-1-GW was not collected. Boring FTAPH-R29PS-2-GW was collected first at the Range 29 Plywood Structure AOPI. At boring FTAPH-R29PS-2-GW, the depth to groundwater was deeper than anticipated. Since groundwater was collected at boring FTAPH-R29PS-2-GW, the DQOs of identifying presence or absence in groundwater were achieved. The soil sample at FTAPH-R29PS-1 was moved because of backfill located at the originally scoped location of the boring (the building was removed between the PA site visit and the SI fieldwork). The soil sample was instead collected from the ditch in the immediate direction of surface runoff from the prior building location providing a representative sample of the AOPI. This field change is detailed in FCR-FAPH-05 in **Appendix L**.
- At the Fire Station 7 AOPI Location, soil sample FTAPH-FS7-1-SO was moved, and a soil sample was added to the new boring location. The soil sample location was moved approximately 50 yards south-southeast based on field observation of the best location of runoff collection from the fire station apron. This field change is detailed in FCR-FAPH-06 in **Appendix L**.
- At the Fire Training Facility AOPI, boring FTAPH-FTA-1-GW/SO was moved. The originally scoped location east of the building was not the best surface runoff location based on field observations. Local runoff for the entire driveway area sloped gradually toward the west side of the building, so the boring was moved to this location. This follows the rationale proposed in the QAPP Addendum prior to fieldwork. This field change is detailed in FCR-FAPH-07 in **Appendix L**.
- Due to low recharge within the DPT screen sampler, samples were collected using a check valve where necessary instead of a peristaltic pump. In this event, parameters were not collected since all recharged water was used to fill sample bottles. Samples collected with a check valve were turbid; however, this was discussed with USACE, and project chemists instructed the lab on the proper procedure to filter turbidity. PFOS, PFOA, and PFBS sample results are not anticipated to be affected. Affected samples include: FTAPH-R29B-1-GW, FTAPH-R29PS-2-GW, FTAPH-R43-1-GW, FTAPH-FS9-1-GW, FTAPH-FS9-2-GW, FTAPH-FTA-1-GW, FTAPH-FS7-1-GW, FTAPH-FS7-2-GW, FTAPH-VMF-1-GW, FTAPH-HQWWTP-1-GW, FTAPH-HQWWTP-2-GW, and FTAPH-17A-1-GW. This field change is detailed in FCR-FAPH-08 in **Appendix L**.
- Additional SI sampling was conducted during a second field mobilization at Fort A.P. Hill in April and May 2021. A combination of groundwater and/or soil samples were collected from two existing AOPIs to supplement previously collected SI data (Range 33 – Target Area and Range 43 – Plywood Structures) and from two AOPIs identified after the initial field mobilization (Taylors Corner Landfill and Wilcox Landfill). The supplemental/additional data was collected to bolster rationale for a remedial investigation (RI) or no further action at this time at select AOPIs. **Section 7** includes analytical data collected during the second field mobilization for these AOPIs. This field change is detailed in FCR-FAPH-09 in **Appendix L**.

6.3.4 Non-Conformance Reports

Following field work, data review concluded that field teams neglected to collect a field duplicate for soil due to miscommunication; therefore, only matrix spike/matrix spike duplicate QC samples were collected for soil. This affects the project DQOs; however, data was still determined to be usable since the objective of the SI is to determine absence or presence of PFOS, PFOA, and PFBS. A Non-Conformance Report was completed for this instance and is included in **Appendix M**.

6.3.5 Decontamination

Non-dedicated reusable sampling equipment (e.g., hand augers, drill cutting shoes and casing, screen-point samplers, and water-level meters) that came into direct contact with sampling media was decontaminated before first use, between sampling locations/intervals, and before demobilization in accordance with P-09, TGI - Groundwater and Soil Sampling Equipment Decontamination (Arcadis 2019; Appendix A).

6.3.6 Investigation-Derived Waste

IDW, including groundwater and decontamination fluids were collected and disposed on the ground at the point of collection. Soil cuttings were placed back into boring locations. Since PFOS, PFOA, and PFBS are currently not categorized as a hazardous waste, this complies with the Virginia Department of Environmental Quality and installation requirements in place at the time of field work during April and May 2020, and April and May 2021. Non-IDW wastes were removed from the site immediately upon completion of each day's field activities. Non-IDW includes personal protective equipment and other disposable materials (e.g., gloves, plastic sheeting, Lexan tubes, and high-density polyethylene and silicon tubing) that came into contact with sampling media.

6.4 Data Analysis

The subsections below summarize the laboratory analytical methods and the methodology used to evaluate data collected during the SI through data verification and usability assessments (as completed by a project chemist, independent of the project team).

6.4.1 Laboratory Analytical Methods

Analytical samples collected during the SI were submitted to Pace Analytical Services, LLC (formerly Shealy Environmental Services, Inc.), an ELAP-accredited laboratory for PFAS analysis, including PFOS, PFOA, and PFBS, by liquid chromatography with tandem mass spectrometry. Laboratory analyses associated with the SI were completed in accordance with Worksheets #12.1 through #12.5 in the PQAPP (Arcadis 2019). Eighteen PFAS-related compounds, including PFOS, PFOA, and PFBS, were analyzed for in groundwater, soil, and surface water samples using an analytical method that is ELAP-accredited and compliant with QSM 5.3, Table B-15 (DoD and Department of Energy 2019).

Additionally, the following general chemistry and physical characteristic analyses were completed for select soil samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 2020a) by the analytical method noted:

- Total organic carbon by Solid Waste Test Method 846 9060A
- Grain size analysis by American Society for Testing and Materials D422-63
- pH by Solid Waste Test Method 846 9045D.

These data are collected as they may be useful in future fate and transport studies.

The laboratory LOD is defined as “the lowest concentration for reliable reporting of a non-detect of a specific analyte in a specific matrix with a specific method at 99 percent confidence” (DoD 2017). The lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias is known as the limit of quantitation (LOQ; DoD 2017). Concentrations detected between the LOD and LOQ, therefore, are considered estimates and are qualified as such on laboratory analytical reports. Instrument-specific detection limits (e.g., the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99 percent confidence; DoD 2017), as provided for each analyte by the laboratory, are reported along with the LODs and LOQs in the laboratory analytical reports included in the Data Usability Summary Report (DUSR) (**Appendix O**).

6.4.2 Data Validation

All analytical data generated during the SI were verified and validated in accordance with the data verification procedures described in Worksheets #34 through #36 of the PQAPP (Arcadis 2019). Each laboratory data package/sample delivery group underwent Stage 3 data validation in accordance with DoD QSM 5.3 (DoD 2019). Additionally, 10% of the data underwent Stage 4 data validation. Copies of the data validation reports for each sample delivery group are included as attachments to the DUSR in **Appendix N**. The Level IV analytical reports are included with **Appendix N** in the final electronic deliverable only.

6.4.3 Data Usability Assessment and Summary

A data usability assessment was completed for all analytical data associated with SI sampling at Fort A.P. Hill. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix N**), was prepared in accordance with the USACE Engineer Manual 200-1-10 (USACE 2005), the Final DoD General Data Validation Guidelines (DoD 2019), and the Final DoD Data Validation Procedure for Per-and Polyfluoroalkyl Substances Analysis by QSM Table B-15 (DoD 2020) that reviewed precision, accuracy, completeness, representativeness, comparability, and sensitivity. A statement of overall data usability is included in the DUSR.

Based on the final data usability assessment, the environmental data collected at Fort A.P. Hill during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUSR and its associated data validation reports (**Appendix N**), and as indicated in the full analytical tables (**Appendix O**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and Fort A.P. Hill QAPP Addendum (Arcadis 2020a). Data qualifiers applied to laboratory analytical results for samples collected during the SI at Fort A.P. Hill are provided in the data tables, data validation reports, and the Data Usability Summary Table located at the end of the DUSR. Qualifiers for data shown on figures are defined in the notes of figures.

6.5 Office of the Secretary of Defense Risk Screening Levels

The OSD risk screening levels for PFOS, PFOA, and PFBS in groundwater (tap water) and soil were calculated using the USEPA's RSL calculator for residential and industrial/commercial worker receptor scenarios and current toxicity values. These risk screening levels are shown in **Table 6-3**.

Table 6-3 OSD Risk Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater and Soil Using USEPA's RSL Calculator

Chemical	Residential Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator		Industrial/Commercial Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator
	Tap Water (ng/L or ppt) [1]	Soil (mg/kg or ppm) [1,2]	Soil (mg/kg or ppm) [1,2]
PFOS	40	0.13	1.6
PFOA	40	0.13	1.6
PFBS	600	1.9	25

Notes:

1. Risk screening levels for tap water and soil provided by the OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September 15 (**Appendix A**).
2. All soil data will be screened against both the Residential Scenario and Industrial/Commercial risk screening levels (if collected from less than 2 feet bgs), regardless of the current and projected land use of the AOPI.

mg/kg = milligram per kilogram
ng/L = nanograms per liter
ppm = parts per million
ppt = parts per trillion

The OSD residential tap water risk screening levels will be used to compare all groundwater data for this Army PFAS PA/SI. While the current and most likely future land uses of the AOPIs at Fort A.P. Hill are industrial/commercial, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, and PFBS will be used to evaluate detected soil concentrations. The data from the SI sampling event are compared to the OSD risk screening levels in **Section 7**. If concentrations of PFOS, PFOA, or PFBS are detected greater than the OSD risk screening levels, further investigation is recommended in **Section 8**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at Fort A.P. Hill (field duplicate results are provided in the associated tables). Sampled media and QA/QC samples were analyzed for the constituents prescribed per Worksheet #18 of the QAPP Addendum (Arcadis 2020a) and as noted in **Table 6-1**. The sample results discussion below focuses on the PFOS, PFOA, and PFBS analytical results because they have OSD risk screening levels. The Army will make subsequent investigation decisions based on these constituents' concentrations relative to the OSD risk screening levels.

Tables 7-1 through **7-3** provide a summary of the groundwater, soil, and surface water analytical results for PFOS, PFOA, and PFBS. **Table 7-4** summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix O** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at Fort A.P. Hill with OSD risk screening level exceedances is depicted on **Figure 7-1. Figures 7-2** through **7-19** show the PFOS, PFOA, and PFBS analytical results for groundwater, soil, and/or surface water at each AOPI. Non-detected results are reported as less than the LOQ. Detections of PFOS, PFOA, and/or PFBS greater than the applicable OSD risk screening levels are highlighted in summary tables and on figures. Groundwater and surface water data collected during the SI are reported in ng/L, or parts per trillion, and soil data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection and for surface water during sample collection are provided on the field forms in **Appendix K**. Soil lithological descriptions are provided on the field forms in **Appendix K**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. Groundwater was generally first encountered at depths of approximately 11 to 50 feet bgs.

Table 7-4 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances?
Fire Station 7	No
Fire Station 8	Yes
Fire Station 9	No
Fire Training Facility	No
Old Headquarters WWTP	Yes
New Wilcox WWTP	Yes
Vehicle Maintenance Facility	Yes
Training Area 17A – Transformer Fire	No
Range 24 – Mover 1	No
Range 24 – Mover 2	No
Range 29 – Plywood Structures	Yes
Range 29 – Bunker	Yes

AOPI Name	OSD Exceedances?
Range 33 – Target Area	No
Range 34 – Lines 15 & 16	No
Range 42 – Mover Target Area	No
Range 43 – Plywood Structures Area	No
Taylor's Corner Landfill	Yes
Wilcox Landfill	No

7.1 Fire Station 7

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Fire Station 7.

7.1.1 Groundwater

Groundwater sampling at Fire Station 7 occurred on 29 to 30 April 2020. Two groundwater samples were collected following DPT drilling, located in the inferred downgradient groundwater flow directions of Fire Station 7. Groundwater sample FTAPH-FS7-1-GW was collected to the northeast of Fire Station 7, and FTAPH-FS7-2-GW was collected to the southeast of Fire Station 7 (**Figure 7-2**).

PFOS, PFOA, and PFBS were detected in both FTAPH-FS7-1-GW and FTAPH-FS7-2-GW groundwater samples at concentrations less than the applicable OSD risk screening levels (**Table 7-1**). The maximum concentrations of PFOS (18 ng/L) and PFOA (22 ng/L) were observed at FTAPH-FS7-1-GW, and the maximum concentration of PFBS (7.1 BJ+ [compound has been found in the sample as well as its associated blank, its presence in the sample may be suspect and reported result may be biased high] ng/L) was observed at FTAPH-FS7-2-GW.

7.1.2 Soil

Soil sampling at Fire Station 7 occurred on 29 April 2020. One surface soil sample, FTAPH-FS7-1-SO, was collected from the 0 to 2 feet bgs interval. FTAPH-FS7-1-SO was collected immediately adjacent to the Fire Station 7 apron where AFFF would have most likely migrated during runoff events (**Figure 7-2**).

PFOS (0.0015 mg/kg) and PFOA (0.00090 J [estimated] mg/kg) were detected in surface soil sample FTAPH-FS7-1-SO, each below the residential and industrial/commercial OSD risk screening levels (**Table 7-2**). PFBS was not detected in FTAPH-FS7-1-SO.

7.2 Fire Station 8

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Fire Station 8.

7.2.1 Groundwater

Groundwater sampling at Fire Station 8 occurred on 29-30 April 2020. One groundwater sample, FTAPH-FS8-1-GW, was collected following DPT drilling, located in the permitted stormwater runoff location at Fire Station 8 (**Figure 7-3**).

PFOS (82 J- [estimated and may be biased low] ng/L) and PFOA (54 J- ng/L) were detected in groundwater sample FTAPH-FS8-1-GW at concentrations greater than their applicable OSD risk screening levels. PFBS was detected in groundwater sample FTAPH-FS8-1-GW at a concentration (47 J- ng/L) less than the applicable OSD risk screening level (**Table 7-1**).

7.2.2 Soil

Soil sampling at Fire Station 8 occurred on 27 April 2020. Two surface soil samples, FTAPH-FS8-1-SO and FTAPH-FS8-2-SO, were collected from the 0 to 2 feet bgs interval. FTAPH-FS8-1-SO was co-located with FTAPH-FS8-1-GW, and FTAPH-FS8-2-SO was collected within the AFFF spill location (**Figure 7-3**).

In surface soil sample FTAPH-FS8-1-SO, PFOS (0.17 mg/kg) was detected above the residential OSD risk screening levels, but below the industrial/commercial risk screening levels. PFOA (0.00096 J mg/kg) was detected below the residential and industrial/commercial OSD risk screening levels. PFBS was not detected in FTAPH-FS8-1-SO. In surface soil sample FTAPH-FS8-2-SO, PFOS (0.0020 mg/kg) was detected below the residential and industrial/commercial OSD risk screening levels. PFOA and PFBS were not detected in FTAPH-FS8-2-SO (**Table 7-2**).

7.3 Fire Station 9

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Fire Station 9.

7.3.1 Groundwater

Groundwater sampling at Fire Station 9 occurred on 29 April 2020. Two groundwater samples were collected following DPT drilling. One was in the permitted stormwater runoff location for Fire Station 9, and one in the inferred downgradient groundwater flow directions of Fire Station 9. Groundwater sample FTAPH-FS9-1-GW was collected to the east of Fire Station 9, and FTAPH-FS9-2-GW was collected to the northeast of Fire Station 7 (**Figure 7-4**).

PFOS (34 J+ [estimated, may be biased high] ng/L) and PFOA (6.4 J- ng/L) were detected in groundwater sample FTAPH-FS9-1-GW at concentrations less than the applicable OSD risk screening levels. PFBS was not detected in FTAPH-FS9-1-GW. PFOS (9.8 ng/L) was detected in groundwater sample FTAPH-FS9-2-GW at a concentration less than the applicable OSD risk screening level. PFOA and PFBS were not detected in FTAPH-FS9-2-GW (**Table 7-1**).

7.3.2 Soil

Soil sampling at Fire Station 9 occurred on 29 April 2020. One surface soil sample, FTAPH-FS9-1-SO, was collected from the 0-2 ft bgs interval and was co-located with FTAPH-FS9-1-GW (**Figure 7-4**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-FS9-1-SO (**Table 7-2**).

7.4 Fire Training Facility

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with AOPI Fire Training Facility.

7.4.1 Groundwater

Groundwater sampling at Fire Training Facility occurred on 29 April 2020. Two groundwater samples were collected following DPT drilling. One groundwater sample, FTAAPH-FTA-1-GW, was collected in the surface runoff direction from the Fire Training Facility. One groundwater sample, FTAAPH-FTA-2-GW, was collected in the inferred downgradient direction of the potential AFFF release area related to training exercises (**Figure 7-5**).

PFOS (19 J- ng/L) and PFOA (4.1 J- ng/L) were detected in groundwater sample FTAPH-FTA-1-GW at concentrations less than the applicable OSD risk screening levels. PFBS was not detected in FTAPH-FTA-1-GW. PFOS and PFOA were not detected in groundwater sample FTAPH-FTA-2-GW. PFBS (4.3 BJ+ ng/L) was detected in groundwater sample FTAPH-FTA-2-GW at a concentration less than the applicable OSD risk screening level (**Table 7-1**).

7.4.2 Soil

Soil sampling at Fire Training Facility occurred on 29 April 2020. One surface soil sample, FTAPH-FTA-1-SO was collected from the 0-2 ft bgs interval and was co-located with FTAPH-FTA-1-GW (**Figure 7-5**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-FTA-1-SO (**Table 7-2**).

7.5 Old Headquarters WWTP

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the Old Headquarters WWTP.

7.5.1 Groundwater

Groundwater sampling at Old Headquarters WWTP occurred on 29 April 2020. Two groundwater samples were collected following DPT drilling. One groundwater sample, FTAPH-HQWWTP-1-GW, was collected within the former sludge drying beds. One groundwater sample, FTAPH-HQWWTP-2-GW, was collected in the inferred downgradient groundwater flow direction of the former sludge drying beds (**Figure 7-6**).

PFOA (430 ng/L) was detected in groundwater sample FTAPH-HQWWTP-1-GW at a concentration greater than the OSD risk screening level. PFOS (11 ng/L) and PFBS (33 ng/L) were detected in groundwater sample FTAPH-HQWWTP-1-GW at concentrations lower than the applicable OSD risk screening levels. PFOA (190 ng/L) was detected in groundwater sample FTAPH-HQWWTP-2-GW at a concentration greater than the OSD risk screening level. PFOS (7.4 ng/L) and PFBS (22 ng/L) were detected in groundwater sample FTAPH-HQWWTP-2-GW at concentrations lower than the applicable OSD risk screening levels (**Table 7-1**).

7.5.2 Soil

Soil sampling at Old Headquarters WWTP occurred on 29 April 2020. One surface soil sample, FTAPH-HQWWTP-1-SO, was collected from the 0-2 ft bgs interval and was co-located with the FTAPH-HQWWTP-1-GW sample within the former sludge drying beds (**Figure 7-6**).

PFOS (0.0027 mg/kg) was detected in surface soil sample FTAPH-HQWWTP-1-SO, below the residential and industrial/commercial OSD risk screening levels. PFOA and PFBS were not detected in surface soil sample FTAPH-HQWWTP-1-SO (**Table 7-2**).

7.6 New Wilcox WWTP

The subsections below summarize the groundwater and surface water PFOS, PFOA, and PFBS analytical results associated with the New Wilcox WWTP.

7.6.1 Groundwater

Groundwater sampling at New Wilcox WWTP occurred on 6 March 2020. Groundwater samples were collected from monitoring wells MW-2, MW-3, and MW-4, for a total of three groundwater samples. FTAPH-MW-2 and FTAPH-MW-3 are located on the northern edge of the New Wilcox WWTP, and FTAPH-MW-4 is located on the northeastern edge of the New Wilcox WWTP (**Figure 7-7**).

PFOS, PFOA, and PFBS were all detected in each of the three groundwater samples (**Table 7-1**). PFOS (10 ng/L), PFOA (9.2 ng/L), and PFBS (2.0 J ng/L) were all detected in FTAPH-MW-2 at concentrations lower than the OSD risk screening levels.

PFOS (150 ng/L) and PFOA (43 ng/L) were detected in FTAPH-MW-3 at concentrations greater than the OSD risk screening levels. PFBS (13 ng/L) was detected at a concentration lower than the OSD risk screening levels.

PFOS (34 ng/L), PFOA (29 ng/L), and PFBS (6.2 ng/L) were all detected in FTAPH-MW-4 at concentrations lower than the OSD risk screening levels.

7.6.2 Soil

No soil samples were collected because there is no suspected mechanism for release to soil at the sludge drying beds or lagoons locations since the lagoons and drying beds are lined.

7.6.3 Surface Water and Sediment

Surface water sampling at New Wilcox WWTP occurred on 29 April 2020. One sample, FTAPH-WILCOX-1-SW, was collected at the confluence of the two streams adjacent to the New Wilcox WWTP to evaluate potential groundwater discharge to surface water (**Figure 7-7**).

PFOS (14 ng/L), PFOA (1.8 J ng/L), and PFBS (8.4 ng/L) were all detected in FTAPH-WILCOX-1-SW at concentrations lower than the OSD risk screening levels (**Table 7-3**).

Sediment was not sampled since it is a potential exposure media that could be impacted via surface water adsorption to sediment. The soil, groundwater, and surface water sample results are used to make inferences about the potential for surface water and sediment impacts.

7.7 Vehicle Maintenance Facility

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with the Vehicle Maintenance Facility.

7.7.1 Groundwater

Groundwater sampling at Vehicle Maintenance Facility occurred on 29 April 2020. One groundwater sample, FTAPH-VMF-1-GW, was collected in the inferred downgradient groundwater flow direction of the possible AFFF spill area (**Figure 7-8)**.

PFOS (320 ng/L) and PFOA (120 ng/L) were detected in groundwater sample FTAPH-VMF-1-GW at concentrations greater than their applicable OSD risk screening levels. PFBS (150 ng/L) was detected at a concentration less than the OSD risk screening level (**Table 7-1**).

7.7.2 Soil

Soil was not sampled because the exact potential release points at this AOPI are unknown.

7.8 Training Area 17A – Transformer Fire

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Training Area 17A – Transformer Fire.

7.8.1 Groundwater

Groundwater sampling at Training Area 17A – Transformer Fire occurred on 30 April 2020. One groundwater sample was collected following DPT drilling at the downgradient edge of AFFF release (**Figure 7-9**).

PFOS (6.3 J- ng/L) and PFOA (4.0 J- ng/L) were detected in FTAPH-17A-1-GW at concentrations lower than the OSD risk screening levels. PFBS was not detected in groundwater sample FTAPH-17A-1-GW (**Table 7-1**).

7.8.2 Soil

Soil sampling at Training Area 17A – Transformer Fire occurred on 30 April 2020. One surface soil sample, FTAPH-17A-1-SO was collected from the 0-2 ft bgs interval and was co-located with groundwater sample FTAPH-17A-1-GW (**Figure 7-9**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-17A-1-SO (**Table 7-2**).

7.9 Range 24 – Mover 1

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Range 24 - Mover 1.

7.9.1 Groundwater

Groundwater sampling at Range 24 - Mover 1 occurred on 27 April 2020. One sample, FTAPH-R24M1-2-GW, was collected following DPT drilling in the inferred downgradient groundwater flow direction from where AFFF was sprayed (**Figure 7-10**).

PFOA (5.1 J- ng/L) was detected in FTAPH-R24M1-2-GW at a concentration lower than the OSD risk screening levels. PFOS and PFBS were not detected in groundwater sample FTAPH-R24M1-2-GW (**Table 7-1**).

7.9.2 Soil

Soil sampling at Range 24 - Mover 1 occurred on 27 April 2020. One surface soil sample, FTAPH-R24M1-1-SO was collected from the 0-2 ft bgs interval and was located at the AFFF-release area soil berm (**Figure 7-10**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-R24M1-1-SO (**Table 7-2**).

7.10 Range 24 - Mover 2

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Range 24 - Mover 2.

7.10.1 Groundwater

Groundwater sampling at Range 24 - Mover 2 occurred on 27 April 2020. Two samples were collected following DPT drilling. One groundwater sample, FTAPH-R24M2-1-GW, was in the inferred downgradient groundwater flow direction (northeast) of the AFFF release area soil berm. One groundwater sample, FTAPH-R24M2-2-GW, was located within the AFFF release area soil berm (**Figure 7-11**).

PFOS (11 ng/L), PFOA (3.9 ng/L), and PFBS (2.4 J ng/L) were all detected in FTAPH-R24M2-1-GW at concentrations lower than the OSD risk screening levels. PFOS (3.0 J ng/L) and PFOA (3.8 ng/L) were detected in FTAPH-R24M2-2-GW at concentrations at concentrations lower than the OSD risk screening levels. PFBS was not detected in FTAPH-R24M2-2-GW (**Table 7-1**).

7.10.2 Soil

Soil sampling at Range 24 - Mover 2 occurred on 27 April 2020. One surface soil sample, FTAPH-R24M2-1-SO was collected from the 0-2 ft bgs interval and was co-located with groundwater sample FTAPH-R24M2-1-GW (**Figure 7-11**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-R24M2-1-SO (**Table 7-2**).

7.11 Range 29 – Plywood Structure

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Range 29 – Plywood Structure.

7.11.1 Groundwater

Groundwater sampling at Range 29 – Plywood Structure occurred on 28 April 2020. One sample, FTAPH-R29PS-2-GW, was collected following DPT drilling in the inferred downgradient groundwater flow direction (north-northwest) of the plywood structure location (**Figure 7-12**).

PFOS (63 ng/L) was detected in FTAPH-R29PS-2-GW at a concentration greater than the OSD risk screening level. PFOA (4.0 J ng/L) was detected in FTAPH-R29PS-2-GW at a concentration lower than the OSD risk screening level. PFBS was not detected in FTAPH-R29PS-2-GW (**Table 7-1**).

7.11.2 Soil

Soil sampling at Range 29 – Plywood Structure occurred on 28 April 2020. One surface soil sample, FTAPH-R29PS-1-SO was collected from the 0 to 2 feet bgs interval to the east of the Range 29- Plywood Structure (**Figure 7-12**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-R29PS-1-SO (**Table 7-2**).

7.12 Range 29 - Bunker

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Range 29 - Bunker.

7.12.1 Groundwater

Groundwater sampling at Range 29 – Bunker occurred on 28 April 2020. One sample, FTAPH-R29B-1-GW, was collected following DPT drilling immediately adjacent the bunker location (**Figure 7-13**).

PFOA (160 J- ng/L) was detected in FTAPH-R29B-1-GW at a concentration greater than the OSD risk screening level. PFOS (15 J- ng/L) was detected in FTAPH-R29B-1-GW at a concentration lower than the OSD risk screening level. PFBS was not detected in FTAPH-R29B-1-GW (**Table 7-1**).

7.12.2 Soil

Soil sampling at Range 29 – Bunker occurred on 28 April 2020. One surface soil sample, FTAPH-R29B-1-SO was collected from the 0 to 2 feet bgs interval and was co-located with FTAPH-R29B-1-GW (**Figure 7-13**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-R29B-1-SO (**Table 7-2**).

7.13 Range 33 - Target Area

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with Range 33 – Target Area.

7.13.1 Groundwater

Groundwater sampling at Range 33 – Target Area occurred on 28 April 2020 and 27 April 2021. A total of four samples, FTAPH-R33-1-GW, FTAPH-R33-2-GW, FTAPH-R33-3-GW, and FTAPH-R33-4-GW were collected following DPT drilling in the inferred downgradient groundwater flow direction (north-northeast) from Range 33 – Target Area (**Figure 7-14**).

PFOS, PFOA, and PFBS were not detected in any of the four groundwater samples collected at Range 33 – Target Area (**Table 7-1**).

7.13.2 Soil

Soil was not sampled because specific location(s) of AFFF release at this AOPI are unknown, and the potential use area covers a widespread area.

7.14 Range 34 – Lines 15 & 16

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Range 34 – Lines 15 & 16.

7.14.1 Groundwater

Groundwater sampling at Range 34 – Lines 15 & 16 occurred on 28 April 2020. One sample, FTAPH-R34-1-GW, was collected following DPT drilling in the inferred downgradient groundwater flow direction (north-northwest) of Range 34- Lines 15 & 16 (**Figure 7-15**).

PFOS, PFOA, and PFBS were not detected in groundwater sample FTAPH-R34-1-GW (**Table 7-1)**.

7.14.2 Soil

Soil sampling at Range 34 – Lines 15 & 16 occurred on 29 April 2020. One sample, FTAPH-R34-1-SO, was collected in the northern portion of the AOPI, and sample FTAPH-R24-2-SO was collected in the southern portion of the AOPI (**Figure 7-15**).

PFOS, PFOA, and PFBS were not detected in surface soil sample FTAPH-R34-1-SO or in surface soil sample FTAPH-R34-2-SO (**Table 7-2**).

7.15 Range 42 – Mover Target Area

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with Range 42 – Mover Target Area.

7.15.1 Groundwater

Groundwater sampling at Range 42 – Mover Target Area occurred on 28 April 2020. One sample, FTAPH-R42-1-GW, was collected following DPT drilling in the inferred downgradient groundwater flow direction (northeast) of the Range 42 – Mover Target Area (**Figure 7-16**).

PFOS (4.8 ng/L) was detected in FTAPH-R42-1-GW at a concentration lower than the OSD risk screening levels. PFOA and PFBS were not detected in groundwater sample FTAPH-R42-1-GW (**Table 7-1**).

7.15.2 Soil

Soil was not sampled because specific location(s) of AFFF release at this AOPI are unknown, and the potential use area covers a widespread area.

7.16 Range 43 – Plywood Structures Area

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with Range 43 – Plywood Structures Area.

7.16.1 Groundwater

Groundwater sampling at Range 43 – Plywood Structures Area occurred on 29 April 2020 and 26 April 2021. A total of three samples, FTAPH-R43-1-GW, FTAPH-R43-2-GW, and FTAPH-R43-3-GW were collected following DPT drilling in the inferred downgradient groundwater flow of where AFFF had been used as fire protection (**Figure 7-17**).

PFOS (30 ng/L) and PFOA (2.2 J ng/L) were detected in FTAPH-R43-1-GW at concentrations lower than the OSD risk screening levels. PFBS was not detected in groundwater sample FTAPH-R43-1-GW (**Table 7-1**).

PFOS (1.8 J ng/L) was detected in FTAPH-R43-2-GW at concentrations lower than the OSD risk screening levels. PFOA and PFBS were not detected in groundwater sample FTAPH-R43-2-GW (**Table 7-1**).

PFOS (4.3 J- ng/L) was detected in FTAPH-R43-3-GW at concentrations lower than the OSD risk screening levels. PFOA and PFBS were not detected in groundwater sample FTAPH-R43-3-GW (**Table 7-1**).

7.16.2 Soil

Soil sampling at Range 43 – Plywood Structures Area occurred on 26 April 2021. A total of four samples, FTAPH-R43-1-SO, FTAPH-R43-2-SO, FTAPH-R43-3-SO and FTAPH-R43-4-SO were collected adjacent to each plywood structure area (i.e., one soil sample per plywood structures area) (**Figure 7-17**).

PFOS, PFOA, and PFBS were not detected in any of the four surface soil samples at Range 43 – Plywood Structures Area (**Table 7-2**).

7.17 Taylor's Corner Landfill

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with Taylor's Corner Landfill.

7.17.1 Groundwater

Groundwater sampling at Taylor's Corner Landfill occurred on 28 April 2021. Two samples, FTAPH-TCL-1-GW and FTAPH-TCL-2-GW, were collected following DPT drilling in the inferred downgradient groundwater flow of where PFAS-containing materials were disposed as part of landfilling operations. FTAPH-TCL-1-GW was collected on the west side of Wilcox Drive and FTAPH-TCL-2-GW was collected on the east side of Wilcox Drive (**Figure 7-17**).

PFOS (6.7 ng/L) was detected in FTAPH-TCL-1-GW at a concentration lower than the OSD risk screening levels. PFOA (59 ng/L) was detected in FTAPH-TCL-1-GW at a concentration greater than the OSD risk screening levels. PFBS was not detected in groundwater sample FTAPH-TCL-1-GW (**Table 7-1**).

PFBS (6.6 ng/L) was detected in FTAPH-TCL-2-GW at a concentration lower than the OSD risk screening levels. PFOA (58 ng/L) was detected in FTAPH-TCL-2-GW at a concentration greater than the OSD risk screening levels. PFOS was not detected in groundwater sample FTAPH-TCL-2-GW (**Table 7-1**).

7.17.2 Soil

Soil was not sampled because the specific disposal location(s) of potentially PFAS-containing materials are unknown.

7.18 Wilcox Landfill

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with Wilcox Landfill.

7.18.1 Groundwater

Groundwater sampling at Wilcox Landfill occurred on 12 May 2021. A total of four groundwater samples were collected from existing downgradient monitoring wells (GW-7, GW-9, GW-12, and GW-16) that are part of ongoing monitoring activities for other constituents associated with landfilling operations at Wilcox Landfill (**Figure 7-17**).

PFOA (12 ng/L) was detected in FTAPH-GW-7 at concentrations lower than the OSD risk screening levels. PFOS and PFBS were not detected in groundwater sample FTAPH-GW-7 (**Table 7-1**).

PFOA (7.6 ng/L) was detected in FTAPH-GW-9 at concentrations lower than the OSD risk screening levels. PFOS and PFBS were not detected in groundwater sample FTAPH-GW-9 (**Table 7-1**).

PFOS, PFOA, and PFBS were not detected in groundwater sample FTAPH-GW-12 (**Table 7-1**).

PFOA (6.1 ng/L) was detected in FTAPH-GW-16 at concentrations lower than the OSD risk screening levels. PFOS and PFBS were not detected in groundwater sample FTAPH-GW-16 (**Table 7-1**).

7.18.2 Soil

Soil was not sampled because the specific disposal location(s) of potentially PFAS-containing materials are unknown.

7.19 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, and PFBS, one soil sample per AOPI was analyzed for TOC, pH, moisture content, and grain size data as they may be useful in future fate and transport studies. The TOC in the soil samples ranged from 1,220 to 5,210 mg/kg. The TOC at the installation was slightly lower than what is typically observed in topsoil (5,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in soils at Fort A.P. Hill ranged from 18.9% to 54.7% with an average of 29%. In general, PFAS constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil (12%) was typical for loam (0 to 12%). The pH of the soil was slightly acidic (4 to 6). Geochemical and physical soil characteristics (i.e., higher percentage of fines and lower TOC) observed underlying the installation are associated with SI soil sample locations. While PFAS constituents are relatively less mobile in soils with high percentages of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

7.20 Blank Samples

A total of three FBs were collected during the SI. PFOS, PFOA, and PFBS were not detected in any of the FBs collected. The FBs were collected using laboratory-supplied deionized water. In the April 2020 event, one source blank was collected from water used during the initial decontamination step by each field team for a total of two source blanks. The April 2020 source blank water came from the installation's potable water supply. In the April 2021 event, one source blank was collected from water used during the initial decontamination step and was collected from the driller water supply (i.e., not supplied by installation's potable water supply). PFOS, PFOA, and PFBS were not detected in any of the source blanks collected.

EBs were collected on the following pieces of non-dedicated equipment utilized during the SI: water level meter, large-diameter high-density polyethylene tubing, hand auger, DPT screen, DPT sampler, and DPT shoe. PFOS, PFOA, and PFBs were not detected in nine out of the ten EBs collected during the SI. PFBS (3.1 J ng/L) was detected in the EB collected from the DPT shoe for one drill team on 30 April 2020. The EB detection was used to adjust and qualify groundwater samples collected by the drill team that sampled at the following AOPIs: Fire Station 7, Fire Station 8, Fire Station 9, Fire Training Facility, Range 24 – Mover 1, Range 42, and Range 43.

Field duplicates and matrix spike/matrix spike duplicate samples collected were all within QC parameters. A field duplicate for soil was not collected during fieldwork due to a team miscommunication. However, data quality was determined to be sufficient by chemists separate from the project team (discussed in **Section 6.4.3**).

The full analytical results for blank samples collected during the SI are included in **Appendix O**.

7.21 Conceptual Site Models

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2020a) were re-evaluated and updated, as necessary, based on the SI sampling results. The CSMs presented on **Figures 7-20** through **7-29** and in this section therefore represent the current understanding of the potential for human exposure. For some AOPIs, the CSM is the same and thus shown on the same figure.

Many of the PFAS constituents found in AFFF are surfactants (which do not volatilize) and are found in a charged or ionic state at environmentally-relevant pH (i.e., pH 5 to 9 standard units). PFOS, PFOA, and PFBS are each negatively charged at environmentally-relevant pH. The media potentially affected by PFOS, PFOA, PFBS releases at Army installations are soil, groundwater, surface water, and sediment. Once released to the environment, a primary factor that inhibits the movement of PFAS constituents is the presence of organic matter and organic co-constituents in soils and sediments. Generally, PFAS constituents are mobile in the potentially affected media, and they are not known to be fully broken down by natural processes.

Based on the historical use or potential use of PFAS-containing materials at the AOPIs, affected media are likely to consist of soil, groundwater, surface water, and sediment. Release and transport mechanisms include dissolution/desorption from soil to groundwater, transport via sediment carried in and dissolution to stormwater and surface water, discharge/recharge between groundwater and surface water, and adsorption/desorption between surface water and sediment. Generic categories of potential human receptors and their associated exposure scenarios that are typically evaluated in a CERCLA human health risk assessment were considered and include on-installation site workers (e.g., industrial/commercial workers, utility workers, or future construction workers who could be exposed to chemicals in soil at an AOPI or to chemicals in tap water in an industrial/commercial building), on-installation residents (e.g., adults and children who could be exposed to chemicals in tap water in a residence), and on-installation recreational users (e.g., hikers or hunters who could be exposed to chemicals in waterways at an installation). Off-installation receptor types could include drinking water receptors (i.e., commercial/industrial workers or residents) and recreational users.

Human exposure pathways are shown as “complete”, “potentially complete”, or “incomplete” on the CSM figures. A complete exposure pathway consists of a constituent source and release mechanism, a transport or retention medium, an exposure point where human contact with the contaminated medium could occur, and an exposure route at the exposure point. If any of these elements is missing, the exposure pathway is incomplete. Pathways are “potentially complete” where data are insufficient to conclude the pathway is either “complete” or “incomplete”. Additionally, the CSMs do not include ecological receptors and exposure pathways. The potential for ecological exposures to PFOS, PFOA, and PFBS may be evaluated at a future date if those pathways warrant further consideration.

Fort A.P. Hill has 31 drinking water supply wells throughout the installation that supply all drinking water on the installation to workers and residents. Wells are downgradient from some AOPIs. The EDR survey report and Commonwealth of Virginia FOIA data have identified off-post drinking water wells sourced from groundwater outside of the installation boundary. Most off-post potable supply wells within a 5-mile radius of Fort A.P. Hill are concentrated along the southwestern installation boundary, northeastern boundary, and scattered north of the installation boundary. To evaluate potential migration of PFOS,

PFOA, and PFBS from the AOPIs towards drinking water supply wells, it is assumed that shallow groundwater mimics surface water flow direction.

The Rappahannock River and Rappahannock River Basin northeast of the installation contain several surface water intakes for public drinking water consumption (Virginia Department of Environmental Quality 2015). Additionally, the Mattaponi River southwest of the installation contains one surface water intake. These intakes are all either upgradient of the installation or more than 5 miles downstream of any AOPIs on Fort A.P. Hill. However, these rivers and their tributaries are used for recreational purposes.

CSMs have been developed for each individual AOPI and were combined where source media and exposure pathways are congruent. The following exposure pathway determinations apply to all CSMs:

- The AOPIs are not likely to be regularly accessed by on-installation residents or recreational users or by off-installation receptors. Therefore, the soil exposure pathways for these receptors are incomplete.
- On-installation recreational users are not likely to contact groundwater during outdoor recreational activities; therefore, the groundwater exposure pathway for on-installation recreational users is incomplete.
- Surface water bodies on-post are not used for drinking water. On-installation site workers and residents are not likely to otherwise have direct contact with surface water and sediment through incidental ingestion and dermal contact. Therefore, the surface water and sediment exposure pathways for on-installation site workers and residents are incomplete.

Figure 7-20 shows the CSM for the Fire Station 7 and Fire Station 8 AOPIs. Incidental AFFF spills during fire engine filling and one known AFFF spill event occurred on paved surfaces and areas surrounding the paved surfaces. Additionally, each of these AOPIs is near surface water bodies, so there is the potential for surface runoff or groundwater discharge to downgradient surface water bodies in the area.

Figure 7-21 shows the CSM for the Old Headquarters WWTP, which potentially received wastewater containing AFFF from fire stations and the Vehicle Maintenance Facility. Former sand-lined sludge beds were utilized at this facility. Since sand is permeable, there was a direct pathway to soil and desorption to groundwater. Soil from the time of the WWTP plant use remains on-site. The outfall from the WWTP went into the sewer system then to Maracossic Creek.

Figures 7-20 and **7-21** have differing source media and release mechanisms as described above but the following exposure pathway determinations apply to both CSMs:

- PFOS, PFOA, and/or PFBS were detected in soil at these AOPIs, and site workers (i.e., installation personnel) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-installation site workers is complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and the AOPIs are upgradient of drinking water wells used to supply potable water at Fort A.P. Hill. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and groundwater originating at the AOPIs flows off-post through the installation's southwest boundary. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater

exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- Groundwater at these AOPIs discharges to tributaries of the Rappahannock or Mattaponi Rivers on the installation. Recreational users could contact constituents through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through tributaries of the Rappahannock and Mattaponi Rivers. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-22 shows the CSM for the Fire Station 9, Fire Training Facility, and Range 43 Plywood Structures Area AOPIs. Incidental AFFF spills during fire engine filling and fire department training events occurred on paved surfaces and areas surrounding the paved surfaces and/or AFFF was sprayed on the soil to act as fire protection. Additionally, these AOPIs are near surface water bodies, so there is the potential for surface runoff or groundwater discharge to downgradient surface water bodies in the area.

- PFOS, PFOA, and/or PFBS were not detected in soil at these AOPIs, therefore the soil exposure pathways are incomplete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and the AOPIs are upgradient of drinking water wells used to supply potable water at Fort A.P. Hill. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and groundwater originating at the AOPIs flows off-post through the central boundary splitting the installation. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- Groundwater at these AOPIs discharges to tributaries of the Rappahannock or Mattaponi Rivers on the installation. Recreational users could contact constituents through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through tributaries of the Rappahannock and Mattaponi Rivers. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-23 shows the CSM for the Vehicle Maintenance Facility AOPI. One known AFFF spill and other potential incidental releases during maintenance of fire engines may have impacted soil or paved surfaces at this location. There are no nearby surface water bodies, so there is no potential for surface runoff to impact surface water at this location. However, surface water and sediment may still be impacted via shallow groundwater discharge.

- Soil was not sampled for PFOS, PFOA, and/or PFBS at this AOPI due to uncertainty as to the exact release location; therefore, the soil exposure pathway for on-installation site workers is potentially complete.

- PFOS, PFOA, and/or PFBS were detected in groundwater at this AOPI, and the AOPI is upgradient of drinking water wells used to supply potable water at Fort A.P. Hill. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at this AOPI, and groundwater originating at the AOPI flows off-post through the central boundary splitting the installation and the southwest boundary. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- Groundwater at this AOPI discharges to tributaries of the Rappahannock or Mattaponi Rivers on the installation. Recreational users could contact constituents through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through tributaries of the Rappahannock and Mattaponi Rivers. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-24 shows the CSM for the New Wilcox WWTP AOPI. This WWTP potentially receives wastewater containing AFFF from fire stations and the Vehicle Maintenance Facility. The WWTP contains lined lagoons and lined sludge drying beds; therefore, there is no direct release mechanism to soil or groundwater. However, one of the lagoons or drying beds could be a source to subsurface soil and groundwater if the liner were compromised. Effluent from the New Wilcox WWTP discharges to an unnamed tributary of Mill Creek immediately adjacent to the site; therefore, there is the potential for groundwater recharge from surface water.

- PFOS, PFOA, and/or PFBS were detected in groundwater at this AOPI, and the AOPI is upgradient of drinking water wells used to supply potable water at Fort A.P. Hill. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at this AOPI, and groundwater originating at the AOPI flows off-post through the central boundary splitting the installation toward an easement immediately northeast of the AOPI. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- Groundwater at this AOPI discharges to the unnamed tributary of Mill Creek on the installation. Recreational users could contact constituents through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through Mill Creek and other tributaries of the Rappahannock River. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-25 shows the CSM for the Training Area 17A – Transformer Fire, Range 24 Mover 1, Range 24 Mover 2, Range 29 Bunker, and Range 29 Plywood Structure AOPIs. AFFF was sprayed on the soil to extinguish fires or act as fire protection at these AOPIs. Additionally, each of these AOPIs is near surface water bodies, so there is potential for surface runoff or groundwater discharge to downgradient surface water bodies in the area.

- PFOS, PFOA, and/or PFBS were not detected in soil at these AOPIs, therefore the soil exposure pathways are incomplete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, however the AOPIs are not upgradient of drinking water wells used to supply potable water at Fort A.P. Hill. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are incomplete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and groundwater originating at the AOPIs flows off-post through the installation's northeast or southwest boundary. Due to the absence of land use controls preventing potable use of groundwater in these areas, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- Groundwater at these AOPIs discharges to tributaries of the Rappahannock or Mattaponi Rivers on the installation. Recreational users could contact constituents through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through tributaries of the Rappahannock and Mattaponi Rivers. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-26 shows the CSM for the Range 33 Target Area AOPI. AFFF was sprayed at multiple targets on this range to extinguish fires on creosote timbers, which potentially contacted soil. Additionally, this AOPI is near a surface water body, so there is potential for surface runoff or groundwater discharge to the surface water body.

- Soil was not sampled for PFOS, PFOA, and/or PFBS at this AOPI due to uncertainty as to the exact release location; therefore, the soil exposure pathway for on-installation site workers is potentially complete.
- PFOS, PFOA, and/or PFBS were not detected in groundwater at this AOPI, therefore the groundwater exposure pathways are incomplete.
- Recreational users could contact constituents in the surface water body or others downgradient through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through tributaries of the Mattaponi River. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-27 shows the CSM for the Range 34 Lines 15 & 16 AOPI. AFFF was sprayed at each of the targets on Lines 15 & 16 to extinguish fires on creosote timbers, which potentially contacted soil.

Additionally, this AOPI is near a surface water body, so there was potential for surface runoff or groundwater discharge to the surface water body.

- PFOS, PFOA, and/or PFBS were not detected in soil at this AOPI, therefore the soil exposure pathways are incomplete.
- PFOS, PFOA, and/or PFBS were not detected in groundwater at this AOPI, therefore the groundwater exposure pathways are incomplete.
- As PFOS, PFOA, and/or PFBS were not detected in soil and groundwater, which are the source media by which surface water and sediment could be impacted, the surface water and sediment exposure pathways are also considered to be incomplete.

Figure 7-28 shows the CSM for the Range 42 Mover Target Area AOPI. AFFF was sprayed on the soil to act as fire protection at these AOPIs. Additionally, each of these AOPIs is near surface water bodies, so there is potential for surface runoff or groundwater discharge to downgradient surface water bodies in the area

- Soil was not sampled for PFOS, PFOA, and/or PFBS at these AOPIs due to uncertainty as to the exact release location; therefore, the soil exposure pathway for on-installation site workers is potentially complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and the AOPIs are upgradient of drinking water wells used to supply potable water at Fort A.P. Hill. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and groundwater originating at the AOPIs flows off-post through the southwest installation boundary. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- Groundwater at this AOPI discharges to tributaries of the Mattaponi River on the installation. Recreational users could contact constituents through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through tributaries of the Mattaponi River. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Figure 7-29 shows the CSM for the Taylor's Corner Landfill and Wilcox Landfill AOPIs. Disposal of potentially PFAS-containing materials as part of landfilling activities may have impacted subsurface soil and subsequently groundwater. Surface water and sediment may be impacted via shallow groundwater discharge.

- Soil was not sampled for PFOS, PFOA, and/or PFBS at these AOPIs due to uncertainty as to the exact release location; therefore, the soil exposure pathway for on-installation site workers is potentially complete.

- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and the AOPIs are potentially upgradient of drinking water wells used to supply potable water at Fort A.P. Hill. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-installation site workers and residents are potentially complete.
- PFOS, PFOA, and/or PFBS were detected in groundwater at these AOPIs, and groundwater originating at the AOPI flows off-post through the central boundary and/or southeast boundary. Due to the absence of land use controls preventing potable use of groundwater in this area, the groundwater exposure pathway (via drinking water ingestion and dermal contact) for off-installation receptors is potentially complete.
- Groundwater at this AOPI discharges to tributaries of the Mill Creek and Rappahannock Rivers on the installation. Recreational users could contact constituents through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for on-installation recreational users are potentially complete.
- Surface water bodies flow off-post through tributaries of the Mill Creek and Rappahannock Rivers. Recreational users off-post could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-installation recreational users are potentially complete.

Following the SI sampling, 17 out of the 18 AOPIs were considered to have complete or potentially complete exposure pathways. Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for remedial investigation is based on the comparison of analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-3**).

8 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at Fort A.P. Hill based on the use, storage, and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether or not a release of PFOS, PFOA, and PFBS to the environment occurred.

OSD provided residential risk screening levels based on the USEPA oral reference dose for PFOS, PFOA, and PFBS in soil and groundwater (tap water) and industrial/commercial risk screening levels for PFOS, PFOA, and PFBS in soil (**Appendix A**). A combination of document review, internet searches, interviews with installation personnel, and an installation site visit were used to identify specific areas of suspected PFOS, PFOA, and PFBS use, storage, and/or disposal at Fort A.P. Hill. Following the evaluation, 18 AOPIs were identified.

Fort A.P. Hill has 31 drinking water supply wells located throughout the main cantonment and northern post areas (**Figure 2-2**). Drinking water supply wells are screened in deeper aquifers at depths ranging 182 to 580 feet bgs. Drinking water supply wells were sampled for PFOS/PFOA in 2016 and 2019. PFOS and PFOA were not detected in the samples and were therefore less than the OSD risk screening levels.

All AOPIs were sampled during the SI at Fort A.P. Hill to identify presence or absence of PFOS, PFOA, and PFBS at each AOPI. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019), the Fort A.P. Hill QAPP Addendum (Arcadis 2020a), and the subsequent remobilization FCR (**Appendix L**).

Analytical results indicate PFOS, PFOA, and/or PFBS are present in 16 out of 18 AOPIs. PFOS and/or PFOA were detected above the OSD risk screening levels in nine of the groundwater samples collected. PFOS was detected above the residential OSD risk screening level but below the industrial/commercial OSD risk screening level in one of the soil samples collected. A total of seven AOPIs had at least one sample with detections above the OSD risk screening levels. The maximum PFOS, PFOA, or PFBS concentration in groundwater was 430 ng/L (PFOA) at the Old Headquarters WWTP. The maximum PFOS, PFOA, or PFBS concentration in soil was 0.17 mg/kg (PFOS) at Fire Station 8. Surface water was collected at one location, New Wilcox WWTP, with a maximum detection of 14 ng/L (PFOS). Sediment was not sampled during the SI.

Following the SI sampling, 17 out of the 18 AOPIs with confirmed PFOS, PFOA, and/or PFBS presence were considered to have complete or potentially complete exposure pathways.

- The soil exposure pathways for on-installation site workers are complete for three AOPIs where PFOS, PFOA, and/or PFBS were detected in soil samples: Fire Station 7, Fire Station 8, and Old Headquarters WWTP. The soil exposure pathways for on-installation site workers are potentially complete for five AOPIs where soil was not sampled due to uncertainty of release points: Vehicle Maintenance Facility, Range 33 Target Area, Range 42 Mover Target Area, Taylor's Corner Landfill (subsurface soil), and Wilcox Landfill (subsurface soil).
- The drinking water exposure pathways via groundwater for on-installation site workers and residents are potentially complete for 11 AOPIs where PFOS, PFOA, and/or PFBS were detected in groundwater samples and the AOPI is located potentially upgradient of on-post potable wells:

Fire Station 7, Fire Station 8, Fire Station 9, Fire Training Facility, Old Headquarters WWTP, Vehicle Maintenance Area, New Wilcox WWTP, Range 42-Mover Target Area, Range 43-Plywood Structures Area, Taylor's Corner Landfill, and Wilcox Landfill.

- The drinking water exposure pathways via groundwater for off-installation receptors are potentially complete for 16 AOPIs where PFOS, PFOA, and/or PFBS compounds were detected in groundwater samples and the groundwater may migrate off-installation: Fire Station 7, Fire Station 8, Fire Station 9, Fire Training Facility, Old Headquarters WWTP, Vehicle Maintenance Area, New Wilcox WWTP, Training Area 17A – Transformer Fire, Range 24 – Mover 1, Range 24 – Mover 2, Range 29 – Bunker, Range 29 – Plywood Structure, Range 42-Mover Target Area, and Range 43-Plywood Structures Area, Taylor's Corner Landfill, and Wilcox Landfill.
- The surface water and sediment exposure pathways for on-installation and off-installation recreational users are potentially complete for all AOPIs, except the Range 34 Lines 15 & 16 AOPI where PFOS, PFOA, and/or PFBS was not detected in both soil and groundwater samples.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for future study in a remedial investigation or no action at this time is based on the comparison of the SI analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-3**). **Table 8-1** below summarizes the AOPIs identified at Fort A.P. Hill, SI (PFOS, PFOA, and PFBS) sampling, and recommendations for each AOPI. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

Table 8-1. Summary of AOPIs Identified during the PA, PFOS, PFOA, and PFBS Sampling at Fort A.P. Hill, and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? Yes/No/ND/NS			Recommendation
	GW	SO	SW	
Fire Station 7	No	No	NS	No action at this time
Fire Station 8	Yes	Yes	NS	Further study in an RI
Fire Station 9	No	No	NS	No action at this time
Fire Training Facility	No	No	NS	No action at this time
Old Headquarters WWTP	Yes	No	NS	Further study in an RI
New Wilcox WWTP	Yes	No	No	Further study in an RI
Vehicle Maintenance Facility	Yes	NS	NS	Further study in an RI
Training Area 17A – Transformer Fire	No	No	NS	No action at this time
Range 24 – Mover 1	No	No	NS	No action at this time
Range 24 – Mover 2	No	No	NS	No action at this time
Range 29 – Plywood Structures	Yes	No	NS	Further study in an RI
Range 29 – Bunker	Yes	No	NS	Further study in an RI

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels? Yes/No/ND/NS			Recommendation
	GW	SO	SW	
Range 33 – Target Area	No	NS	NS	No action at this time
Range 34 – Lines 15 & 16	No	No	NS	No action at this time
Range 42 – Mover Target Area	No	NS	NS	No action at this time
Range 43 – Plywood Structures Area	No	NS	NS	No action at this time
Taylor's Corner Landfill	Yes	NS	NS	Further study in an RI
Wilcox Landfill	No	NS	NS	No action at this time

Notes:
GW – groundwater
NS – not sampled
RI - remedial investigation
SO – soil
SW – surface water

Data collected during the PA (**Section 3**, **Section 4**, **Section 5**) and SI (**Section 6 and Section 7**) were sufficient to draw the conclusions summarized in **Section 9**. The data limitations relevant to the development of this PA for PFOS, PFOA, and PFBS at Fort A.P. Hill are discussed below.

Records gathered for the use, storage and/or disposal of PFAS-containing materials were reviewed during the PA process. Documentation specific to AFFF may have been limited (e.g., each AFFF use; procurement records, documentation of AFFF used during crash responses or fire training activities) due to lack of recordkeeping requirements for the full timeline of common AFFF practices. Anecdotal accounts of AFFF use (and therefore likely PFOS, PFOA, and PFBS use) were limited to available installation personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS-containing material) use. As indicated in site visit interviews with Fort A.P. Hill Fire Department staff, AFFF was used sporadically on railroad ties that caught on fire during firing activities (i.e., the railroad ties were used as backstops for firing targets and occasionally caught on fire during operations). The Fort A.P. Hill Fire Department identified the locations of fires and general AFFF use, however, there could be additional locations or locations with larger AFFF extents. Specific locations of AFFF use on multiple operational range areas could not be determined during the PA due to lack of documentation. AFFF use was confirmed during interviews with fire department personnel (**Appendix G**); however, personnel could not pinpoint exact locations where AFFF was sprayed or the frequency of use. This applies to Range 29 Plywood Structures, Range 33 Target Area, Range 42 Mover Target Area, and Range 43 – Plywood Structures Area AOPIs.

A comprehensive well survey was not completed as part of the PA/SI; therefore, the information reviewed regarding off-post wells is limited to what is contained in the EDR well search results and a Commonwealth of Virginia drinking water well FOIA request. The EDR well search report (**Appendix E**)

was referenced when identifying potential off-post drinking water receptors. The FOIA data was also referenced, but existence of wells was not verified by contacting private well owners or other methods.

The searches for ecological receptors and off-post PFOS, PFOA, and PFBS sources were not exhaustive and were limited to easily identifiable and readily available information evaluated during the relevant documents research, installation personnel interviews, and site reconnaissance.

Finally, the available PFOS, PFOA, and PFBS analytical data consists of on-post shallow groundwater samples from borings at 18 AOPIs, shallow soil samples from 11 AOPIs, and a surface water sample near one AOPI. No residential wells or private wells were sampled in the SI. SI groundwater results do not include aquifers where drinking water wells are screened; however, these wells were sampled prior to this PA/SI (**Section 2.12**). Available data, including PFOS, PFOA, and PFBS, is listed in **Appendix O**, which were analyzed per the selected analytical method.

Results from this PA/SI indicate further study in a remedial investigation is warranted at Fort A.P. Hill in accordance with the guidance provided by the OSD.

9 REFERENCES

American Water. 2020. Fort A.P. Hill, Port Royal, Virginia. Available online at: https://www.amwater.com/corp/products-services/military-services/fort-ap-hill

Arcadis. 2018. Accident Prevention Plan: A-E Services, PFASs Contamination in the Cleanup/Restoration Programs at Active Army Installations – Nationwide. Prepared for USACE, Baltimore District. March.

Arcadis. 2019. Final Programmatic Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP), USAEC PFAS PA/SI, Active Army Installations, Nationwide, USA. October.

Arcadis. 2020a. Final UFP QAPP Addendum, Revision 0, USAEC PFAS PA/SI, Fort A.P. Hill, Virginia. April.

Arcadis. 2020b. Final Site Safety and Health Plan, Revision 0, Fort A.P. Hill, Bowling Green, Virginia, April.

Army. 2006. Draft Final Operational Range Assessment Program Phase I Qualitative Assessment Report Fort A.P. Hill Bowling Green, Virginia. December

Army. 2018a. Army Guidance for Addressing Releases of Per- and Polyfluoroalkyl Substances. September 4. Available online at: https://www.fedcenter.gov/admin/itemattachment.cfm?attachmentid=1150.

Army. 2018b. Integrated Cultural Resources Management Plan, United States Army Garrison, Fort A.P. Hill, Virginia. August.

DoD. 2017. Fact Sheet: Detection and Quantitation – What Project Managers and Data Users Need to Know. October.

DoD and Department of Energy. 2019. Consolidated Quality Systems Manual for Environmental Laboratories, Version 5.3. May.

DoD. 2019. Environmental Data Quality Working Group: Final General Data Validation Guidelines. November 4.

DoD. 2020. Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15. May 1.

EA Engineering, Science, and Technology, Inc. (EA) 2019. Final Advanced Assessment Report for FY18-Fy22 Operational Range Assessments, Fort A.P. Hill, Virginia. February.

EEE Consulting, Inc. 2012. Watershed Management Plan, Fort A.P. Hill, Virginia. February.

Fort A.P. Hill. 2012. Watershed Management Plan, Fort A.P. Hill, Virginia. February.

IMCOM. 2018. IMCOM – PFOA PFOS Water System Testing. August.

Interstate Technology Regulatory Council. 2017. History and Use of Per-and Polyfluoroalkyl Substances (PFAS). November. Available online at: https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf.

Interstate Technology Regulatory Council. 2020. Section 3.1 Firefighting Foams. Updated April 14.

Available online at: https://pfas-1.itrcweb.org/3-firefighting-foams/#3_1

Mid-Atlantic Laboratories, Inc. 2019. Certificate of Analysis. August.

Office of the Secretary of Defense (OSD). 2019. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. October.

OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.

USACE. 2005. Environmental Quality: Guidance for Evaluating Performance-Based Chemical Data, Engineer Manual 200-1-10, CEMP-RA/CECW-E, June 30.

USACE. 2012. Environmental Quality: Conceptual Site Models, Engineer Manual 200-1-12, CEMP-CE, December 28.

US Army Toxic and Hazardous Materials Agency. 1982. Installation Assessment of the U.S. Army Garrison, Fort A.P. Hill, Bowling Green, VA. Report No. 316C. April.

USEPA. 1991. Guidance for Performing Preliminary Assessments Under CERCLA. EPA/540/G-91/013. September. Available online at: https://semspub.epa.gov/work/11/157081.pdf.

USEPA. 2016. Lifetime Health Advisories and Health Effects Support Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate. EPA-HQ-OW-2014-0138; FRL-9946-91-OW. Federal Register/ Vol. 81. No. 101. May 25. Available online at: https://www.govinfo.gov/content/pkg/FR-2016-05-25/pdf/2016-12361.pdf.

USEPA. 2021. Human Health Toxicity Values for Perfluorobutane Sulfonic Acid (CASRN 375-73-5) and Related Compound Potassium Perfluorobutane Sulfonate (CASRN 29420-49-3). EPA/600/R-20/345F. Center for Public Health and Environmental Assessment, Office of Research and Development, Washington DC. April.

USGS. 2006. The Virginia Coastal Plain Hydrogeologic Framework.

Virginia Department of Environmental Quality. 2015. Commonwealth of Virginia State Water Resources Plan. October.

ACRONYMS

°F	degrees Fahrenheit
%	percent
AFFF	aqueous film-forming foam
amsl	above mean sea level
AOPI	area of potential interest
Arcadis	Arcadis U.S., Inc.
Army	United States Army
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
DPT	direct-push technology
DQO	data quality objective
DUSR	Data Usability Summary Report
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
FB	field blank
FCR	Field Change Report
FOIA	Freedom of Information Act
GIS	geographic information system
GW	groundwater
IDW	investigation-derived waste
IMCOM	Installation Management Command
installation	United States Army or Reserve installation
IRP	Installation Restoration Program
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligrams per kilogram (parts per million)

MWR	Morale, Welfare, and Recreation
ng/L	nanogram per liter (parts per trillion)
NS	not sampled
OSD	Office of the Secretary of Defense
PA	preliminary assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POC	point of contact
ppm	parts per million
ppt	parts per trillion
PQAPP	Programmatic Uniform Federal Policy-Quality Assurance Project Plan
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RI	remedial investigation
RSL	Regional Screening Level
SDS	safety data sheet
SI	site inspection
SO	soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
SW	surface water
TGI	technical guidance instruction
UCMR3	third Unregulated Contaminant Monitoring Rule
U.S.	United States
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USATHAMA	United States Army Toxic and Hazardous Materials Agency

USEPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant

TABLES

Table 2-1 Historical Groundwater PFOS, PFOA, and PFBS Analytical Results
PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

Sample Location		Headquarters 1		Headquarters 2		HQ STP	Archer	800/1200 Meter Range	EOD		Cooke 1	Wilcox 1	Wilcox 2	Wilcox 3
Sample Date		7/12/2016	7/24/2019	7/12/2016	7/24/2019	7/24/2019	7/24/2019	7/24/2019	7/12/2016	7/24/2019	7/24/2019	7/24/2019	7/24/2019	8/14/2019
Units	OSD risk screening level (ng/L)*	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Perfluorooctanoic acid (PFOA)	40	20 U	4.24 U	20 U	4.39 U	4.39 U	4.39 U	4.31 U	20 U	4.39 U	4.31 U	4.46 U	4.39 U	4.39 U
Perfluorobutanesulfonic acid (PFBS)	600	-	4.24 U	-	4.39 U	4.39 U	4.39 U	4.31 U	-	4.39 U	4.31 U	4.46 U	4.39 U	4.39 U
Perfluorooctane sulfonate (PFOS)	40	40 U	4.24 U	40 U	4.39 U	4.39 U	4.39 U	4.31 U	40 U	4.39 U	4.31 U	4.46 U	4.39 U	4.39 U

Table 2-1 Historical Groundwater PFOS, PFOA, and PFBS Analytical Results
PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

Sample Location		Rodes 1	Longstreet	Arena 1		Arena 2		Wilcox STP	Laser Range	Rappa-hannock	Lodge	
Sample Date		7/24/2019	7/24/2019	7/12/2016	7/24/2019	7/11/2016	7/24/2019	7/30/2019	7/30/2019	7/30/2019	7/12/2016	7/30/2019
Units	OSD risk screening level (ng/L)*	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Perfluorooctanoic acid (PFOA)	40	4.39 U	4.39 U	20 U	4.31 U	20 U	4.46 U	4.31 U	4.24 U	4.31 U	20 U	4.31 U
Perfluorobutanesulfonic acid (PFBS)	600	4.39 U	4.39 U	-	4.31 U	-	4.46 U	4.31 U	4.24 U	4.31 U	-	4.31 U
Perfluorooctane sulfonate (PFOS)	40	4.39 U	4.39 U	40 U	4.31 U	40 U	4.46 U	4.31 U	4.24 U	4.31 U	40 U	4.31 U

Table 2-1 Historical Groundwater PFOS, PFOA, and PFBS Analytical Results
PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

Sample Location		Drop Zone 1		Drop Zone 2		Heth	Davis 1	Davis 2	Davis 3	
Sample Date		7/12/2016	7/30/2019	7/12/2016	7/30/2019	7/30/2019	7/30/2019	7/30/2019	7/12/2016	7/30/2019
Units	OSD risk screening level (ng/L)*	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Perfluorooctanoic acid (PFOA)	40	20 U	4.31 U	20 U	4.31 U	4.24 U	4.31 U	4.31 U	20 U	4.24 U
Perfluorobutanesulfonic acid (PFBS)	600	-	4.31 U	-	4.31 U	4.24 U	4.31 U	4.31 U	-	4.24 U
Perfluorooctane sulfonate (PFOS)	40	40 U	4.31 U	40 U	4.31 U	4.24 U	4.31 U	4.31 U	40 U	4.24 U

Notes and Acronyms:

* OSD risk screening level for tap water.

Public System Name: American Water- Fort A.P. Hill Location

Sources: IMCOM sampling data provided by the Army (PFOS and PFOA results provided) and Mid-Atlantic Laboratories, Inc. analytical reports

EOD - explosive ordnance disposal

HQ - headquarters

NA - not available

ng/L - nanograms per liter

OSD - Office of the Secretary of Defense

STP - sanitary treatment plant

U - not detected at or above the corresponding quantitation limit

Table 6-1 - Site Inspection Sampling Location Details
USAEC PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

AOPI	Matrix	Sample ID	Depth Interval	Sample Method	Analytes
Fire Station 7	Groundwater	FTAPH-FS7-1-GW-043020	26.5-30 ft bgs	DPT Grab	PFAS
		FTAPH-FS7-2-GW-042920	31.5-35 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-FS7-1-SO-042920	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
Fire Station 8	Groundwater	FTAPH-FS8-1-GW-042720	31.5- 35 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-FS8-1-SO-042720	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
		FTAPH-FS8-2-SO-042720	0-2 ft bgs	Hand Auger	PFAS
Fire Station 9	Groundwater	FTAPH-FS9-1-GW-042920	21.5-25 ft bgs	DPT Grab	PFAS
		FTAPH-FS9-2-GW-042920	21.5-25 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-FS9-1-SO-042920	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
Fire Training Facility	Groundwater	FTAPH-FTA-1-GW-042920	16.5-20 ft bgs	DPT Grab	PFAS
		FTAPH-FTA-2-GW-042920	26.5-30 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-FTA-1-SO-042920	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
Vehicle Maintenance Facility	Groundwater	FTAPH-VMF-1-GW-042920	46-50 ft bgs	DPT Grab	PFAS
Old Headquarters WWTP	Groundwater	FTAPH-HQWWTP-1-GW-042920	28-32 ft bgs	DPT Grab	PFAS
		FTAPH-HQWWTP-2-GW-042920	30-34 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-HQWWTP-1-SO-042920	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
New Wilcox WWTP	Groundwater	FTAPH-MW-2-050620	20 ft bgs	Low flow	PFAS
		FTAPH-MW-3-050620	20 ft bgs	Low flow	PFAS
		FTAPH-MW-4-050620	20 ft bgs	Low flow	PFAS
	Surface Water	FTAPH-WILCOX-1-SW-042920	Mid-Stream	Grab	PFAS
Fire Training Area 17A	Groundwater	FTAPH-17A-1-GW-043020	26-30 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-17A-1-SO-043020	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
Range 24 - Mover 1	Groundwater	FTAPH-R24M1-2-GW-042720	11.5- 15 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-R24M1-1-SO-042720	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size

AOPI	Matrix	Sample ID	Depth Interval	Sample Method	Analytes
Range 24 - Mover 2	Groundwater	FTAPH-R24M2-1-GW-042720	23-27 ft bgs	DPT Grab	PFAS
		FTAPH-R24M2-2-GW-042720	20-24 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-R24M2-1-SO-042720	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
Range 29 - Plywood Structure	Groundwater	FTAPH-R29PS-2-GW-042820	46.5- 50 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-R29PS-1-SO-042820	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
Range 29 - Bunker	Groundwater	FTAPH-R29B-1-GW-042820	46-50 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-R29B-1-SO-042820	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
Range 33 - Target Area	Groundwater	FTAPH-R33-1-GW-042820	21-25 ft bgs	DPT Grab	PFAS
		FTAPH-R33-2-GW-042721	4.8- 9.8 ft bgs	DPT Grab	PFAS
		FTAPH-R33-3-GW-042721	5.64- 10.64 ft bgs	DPT Grab	PFAS
		FTAPH-R33-4-GW-042721	4.3- 9.3 ft bgs	DPT Grab	PFAS
Range 34 - Lines 15 & 16	Groundwater	FTAPH-R34-1-GW-042920	18-22 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-R34-1-SO-042920	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
		FTAPH-R34-2-SO-042920	0-2 ft bgs	Hand Auger	PFAS
Range 42 - Mover Target Area	Groundwater	FTAPH-R42-1-GW-042820	26.5-30 ft bgs	DPT Grab	PFAS
Range 43 - Plywood Structure Area	Groundwater	FTAPH-R43-1-GW-042920	26.5-30 ft bgs	DPT Grab	PFAS
		FTAPH-R43-2-GW-042621	21- 25 ft bgs	DPT Grab	PFAS
		FTAPH-R43-3-GW-042621	21- 25 ft bgs	DPT Grab	PFAS
	Soil	FTAPH-R43-1-SO-042621	0-2 ft bgs	Hand Auger	PFAS
		FTAPH-R43-2-SO-042621	0-2 ft bgs	Hand Auger	PFAS, TOC, pH, grain size
		FTAPH-R43-3-SO-042621	0-2 ft bgs	Hand Auger	PFAS
		FTAPH-R43-4-SO-042621	0-2 ft bgs	DPT Grab	PFAS
Taylor's Corner Landfill	Groundwater	FTAPH-TCL-1-GW-042821	21- 24 ft bgs	DPT Grab	PFAS
		FTAPH-TCL-2-GW-042821	11- 15 ft bgs	DPT Grab	PFAS
Wilcox Landfill	Groundwater	FTAPH-GW-7-051221	14.5- 24.5 ft bgs	Low flow	PFAS
		FTAPH-GW-9-051221	21- 31 ft bgs	Low flow	PFAS
		FTAPH-GW-12-051221	17- 32 ft bgs	Low flow	PFAS
		FTAPH-GW-16-051221	Unknown	Low flow	PFAS

Notes:

1. Depth units are reported in feet below ground surface (ft bgs) unless otherwise noted. Sampling depth noted for existing monitoring wells indicates the depth at approximately the center of the saturated screened interval.

2. In addition to laboratory analytes, field parameters were measured for groundwater samples and include temperature, pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential. Lithologic descriptions were logged continuously at soil boring locations, and for sediment sampling locations. Field parameters and lithological descriptions are shown on field sampling forms included in **Appendix K**.

3. The PFAS analyte group includes PFOS, PFOA, PFBS and 15 other PFAS constituents.

AOPI = Area of Potential Interest

DPT = Direct Push Technology

GW = groundwater

ID = identification

PFAS = per- and polyfluoroalkyl substances

PFBS = perfluorobutanesulfonic acid

PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil
SW = surface water
TOC = total organic carbon
WWTP = wastewater treatment plant

Table 7-1 - Groundwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

AOPI	Sample/ Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			OSD Risk Screening Level for Tap Water	40		40		600	
			Sample Type	Result	Qual	Result	Qual	Result	Qual
Fire Station 7	FTAPH-FS7-1-GW-043020	04/30/2020	N	**18**		**22**		4.1	UB
	FTAPH-FS7-2-GW-042920	04/29/2020	N	**6.8**		**13**		**7.1**	BJ+
Fire Station 8	FTAPH-FD-1-042720 / FTAPH-FS8-1-GW-042720	04/27/2020	FD	**62**		**46**		**41**	
	FTAPH-FS8-1-GW-042720	04/27/2020	N	**82**	J-	**54**	J-	**47**	J-
Fire Station 9	FTAPH-FS9-1-GW-042920	04/29/2020	N	**34**	J+	**6.4**	J-	7.8	UJ-
	FTAPH-FS9-2-GW-042920	04/29/2020	N	**9.8**		4.3	U	4.3	U
Fire Training Facility	FTAPH-FTA-1-GW-042920	04/29/2020	N	**19**	J-	**4.1**	J-	6.1	UJ-
	FTAPH-FTA-2-GW-042920	04/29/2020	N	3.9	U	3.9	U	**4.3**	BJ+
Old Headquarters WWTP	FTAPH-HQWWTP-1-GW-042920	04/29/2020	N	**11**		**430**		**33**	
	FTAPH-HQWWTP-2-GW-042920	04/29/2020	N	**7.4**		**190**		**22**	
New Wilcox WWTP	FTAPH-MW-2-050620	05/06/2020	N	**10**		**9.2**		**2.0**	J
	FTAPH-MW-3-050620	05/06/2020	N	**150**		**43**		**13**	
	FTAPH-MW-4-050620	05/06/2020	N	**34**		**29**		**6.2**	
Vehicle Maintenance Facility	FTAPH-VMF-1-GW-042920	04/29/2020	N	**320**		**120**		**150**	
Training Area 17A- Transformer Fire	FTAPH-17A-1-GW-043020	04/30/2020	N	**6.3**	J-	**4.0**	J-	4.2	UJ-
Range 24 - Mover 1	FTAPH-R24M1-2-GW-042720	04/27/2020	N	6.2	UJ-	**5.1**	J-	6.2	UJ-
Range 24 - Mover 2	FTAPH-R24M2-1-GW-042720	04/27/2020	N	**11**		**3.9**		**2.4**	J
	FTAPH-R24M2-2-GW-042720	04/27/2020	N	**3.0**	J	**3.8**		3.6	U
Range 29 - Plywood Structure	FTAPH-R29PS-2-GW-042820	04/28/2020	N	**63**		**4.0**	J	4.1	U
Range 29 - Bunker	FTAPH-R29B-1-GW-042820	04/28/2020	N	**15**	J-	**160**	J-	7.6	UJ-
Range 33- Target Area	FTAPH-R33-1-GW-042820	04/28/2020	N	3.8	U	3.8	U	3.8	U
	FTAPH-R33-2-GW-042721	04/27/2021	N	4.9	UJ-	4.9	UJ-	4.9	UJ-
	FTAPH-R33-3-GW-042721	04/27/2021	N	3.6	U	3.6	U	3.6	U
	FTAPH-R33-4-GW-042721	04/27/2021	N	3.5	U	3.5	U	3.5	U
Range 34 - Lines 15 & 16	FTAPH-FD-2-042820 / FTAPH-R34-1-GW-042920	04/28/2020	FD	3.6	U	3.6	U	3.6	U
	FTAPH-R34-1-GW-042920	04/29/2020	N	3.5	U	3.5	U	3.5	U
Range 42 - Mover Target Area	FTAPH-R42-1-GW-042820	04/28/2020	N	**4.8**		3.8	U	3.8	U

Table 7-1 - Groundwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

AOPI	Sample/ Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			OSD Risk Screening Level for Tap Water	40		40		600	
			Sample Type	Result	Qual	Result	Qual	Result	Qual
Range 43 - Plywood Structures Area	FTAPH-R43-1-GW-042920	04/29/2020	N	**30**		**2.2**	J	4.0	U
	FTAPH-R43-2-GW-042621	04/26/2021	N	**1.8**	J	3.5	U	3.5	U
	FTAPH-R43-3-GW-042621	04/26/2021	N	**4.3**	J-	3.9	UJ-	3.9	UJ-
Taylor's Corner Landfill	FTAPH-TCL-1-GW-042721	04/28/2021	N	**6.7**		**59**		3.5	U
	FTAPH-TCL-2-GW-042721	04/28/2021	N	3.9	U	**58**		**6.6**	
	FTAPH-FD-3-GW-042821 / FTAPH-TCL-2-GW-042821	04/28/2021	FD	3.9	U	**56**		**6.9**	
Wilcox Landfill	FTAPH-GW-7	05/12/2021	N	4.0	U	**12**		4.0	U
	FTAPH-GW-9	05/12/2021	N	3.9	U	**7.6**		3.9	U
	FTAPH-GW-12	05/12/2021	N	3.8	U	3.8	U	3.8	U
	FTAPH-GW-16	05/12/2021	N	3.8	U	**6.1**		3.8	U

Notes:

1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Grey shaded values indicate the result was detected greater than the Office of the Secretary of Defense (OSD) risk screening levels (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.).

Acronyms/Abbreviations:

AOPI = area of potential interest
FD = field duplicate sample
GW = groundwater
ID = identification
MW = monitoring well
N = primary sample
ng/L = nanograms per liter (parts per trillion)
OSD = Office of the Secretary of Defense
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
WWTP = wastwater treatment plant

Qual = qualifier

BJ + = The compound has been found in the sample as well as its associated blank, its presence in the sample may be suspect and reported result may be biased high.
J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
J - = The analyte was positively identified; however the associated numerical value is an estimated concentration only and may be biased low
J + = The analyte was positively identified; however the associated numerical value is an estimated concentration only and may be biased high
U = The analyte was analyzed for but the result was not detected above the limit of quantitation.
UB = Compound considered non-detect at the listed value due to associated blank contamination.
UJ = The analyte was analyzed for but was not detected. The limit of quantitation is approximate and may be inaccurate or imprecise.
UJ - = The analyte was analyzed for but was not detected. The limit of quantitation is approximate and may be inaccurate or imprecise, and may be biased low

Table 7-2 - Soil PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

AOPI	Sample/Parent ID	Sample Date	Analyte	PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Risk Screening Level Industrial/Commercial Scenario	1.6		1.6		25	
			OSD Risk Screening Level Residential Scenario	0.13		0.13		1.9	
			Sample Type	Result	Qual	Result	Qual	Result	Qual
Fire Station 7	FTAPH-FS7-1-SO-042920	04/29/2020	N	**0.0015**		**0.0009**	J	0.0012	U
Fire Station 8	FTAPH-FS8-1-SO-042720	04/27/2020	N	**0.17**		**0.00096**	J	0.0011	U
	FTAPH-FS8-2-SO-042720	04/27/2020	N	**0.002**		0.00098	U	0.00098	U
Fire Station 9	FTAPH-FS9-1-SO-042920	04/29/2020	N	0.001	U	0.001	U	0.001	U
Fire Training Facility	FTAPH-FTA-1-SO-042920	04/29/2020	N	0.0011	U	0.0011	U	0.0011	U
Old Headquarters WWTP	FTAPH-HQWWTP-1-SO-042920	04/29/2020	N	**0.0027**		0.0011	U	0.0011	U
Training Area 17A - Transformer Fire	FTAPH-17A-1-SO-043020	04/30/2020	N	0.0012	U	0.0012	U	0.0012	U
Range 24 - Mover 1	FTAPH-R24M1-1-SO-042720	04/27/2020	N	0.00096	U	0.00096	U	0.00096	U
Range 24 - Mover 2	FTAPH-R24M2-1-SO-042720	04/27/2020	N	0.0011	U	0.0011	U	0.0011	U
Range 29 - Plywood Structure	FTAPH-R29PS-1-SO-042820	04/28/2020	N	0.0011	U	0.0011	U	0.0011	U
Range 29 - Bunker	FTAPH-R29B-1-SO-042820	04/28/2020	N	0.0011	U	0.0011	U	0.0011	U
Range 34 - Lines 15 & 16	FTAPH-R34-2-SO-042920	04/29/2020	N	0.001	U	0.001	U	0.001	U
	FTAPH-R34-1-SO-042920	04/29/2020	N	0.0012	U	0.0012	U	0.0012	U
Range 43 - Plywood Structures Area	FTAPH-R43-1-SO-042621	04/26/2021	N	0.0011	U	0.0011	U	0.0011	U
	FTAPH-R43-2-SO-042621	04/26/2021	N	0.001	UJ	0.001	U	0.001	U
	FTAPH-FD-2-SO-042621 / FTAPH-R43-2-SO-042621	04/26/2021	FD	0.0011	U	0.0011	U	0.0011	U
	FTAPH-R43-3-SO-042621	04/26/2021	N	0.001	U	0.001	U	0.001	U
	FTAPH-R43-4-SO-042621	04/26/2021	N	0.001	U	0.001	U	0.001	U

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Grey shaded values indicate the result was detected greater than the residential and/or the industrial/commercial scenarios (OSD. 2021. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. September.).

Acronyms/Abbreviations:
AOPI = area of potential interest
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
OSD = Office of the Secretary of Defense
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
SO = soil
WWTP = wastwater treatment plant

Qual = qualifier
J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for but the result was not detected above the limit of quantitation.
UJ = The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

Table 7-3 - Surface Water PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Fort A.P. Hill, Virginia

AOPI	Sample/Parent ID	Sample Date	Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			Sample Type	Result	Qual	Result	Qual	Result	Qual
New Wilcox WWTP	FTAPH-WILCOX-1-SW-042920	04/29/2020	N	**14**		**1.8**	J	**8.4**	
	FTAPH-FD-1-SW-042920 / FTAPH-WILCOX-1-SW-042920	04/29/2020	FD	**12**		**2.0**	J	**7.7**	

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.

Acronyms/Abbreviations:
AOPI = area of potential interest
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFBS = perfluorobutane sulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonic acid
SW = surface water
WWTP = wasterwater treatment plant

Qual = qualifier
J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.

FIGURES

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

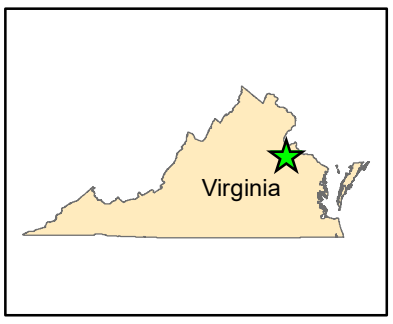
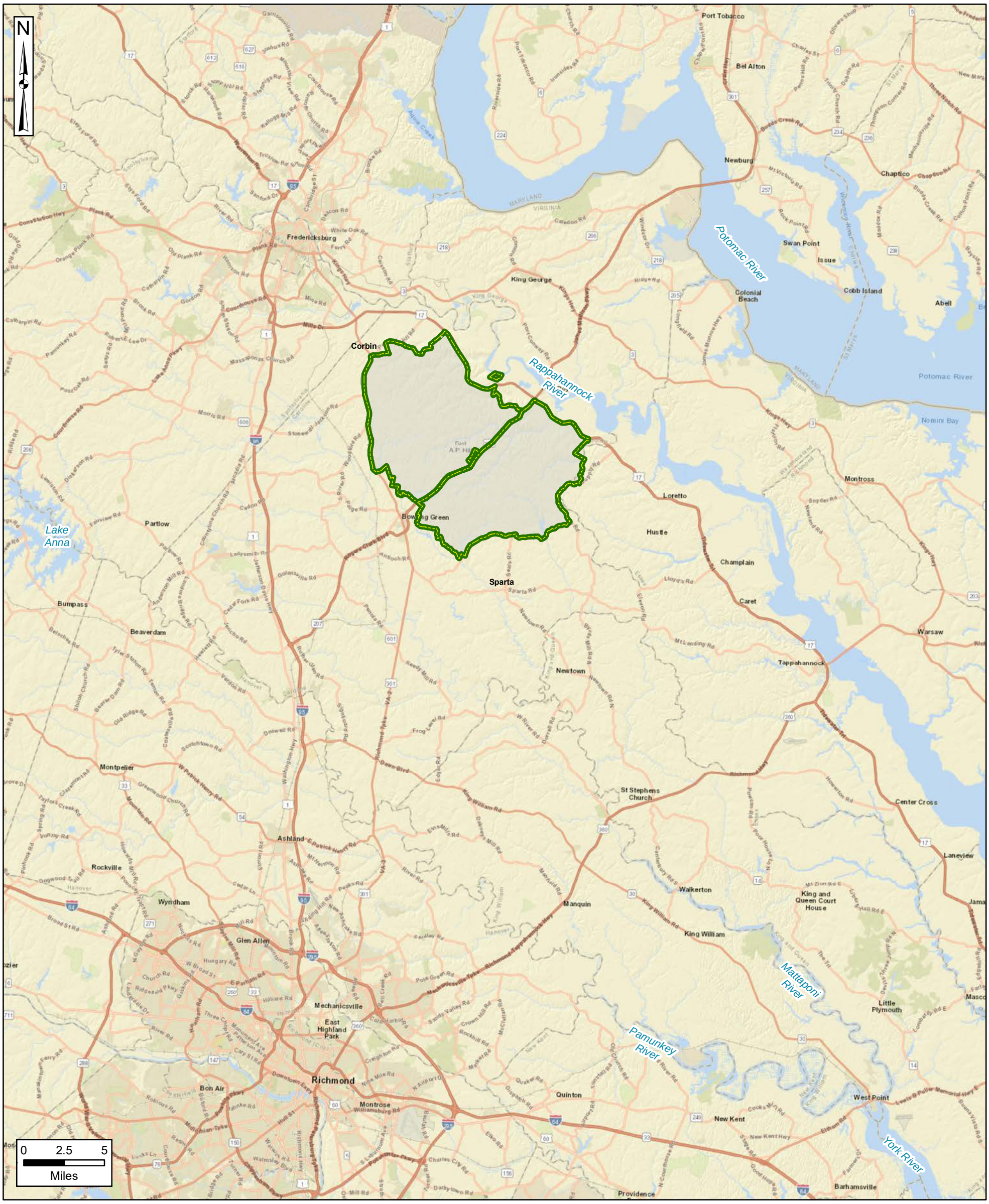


Figure 2-1
Site Location



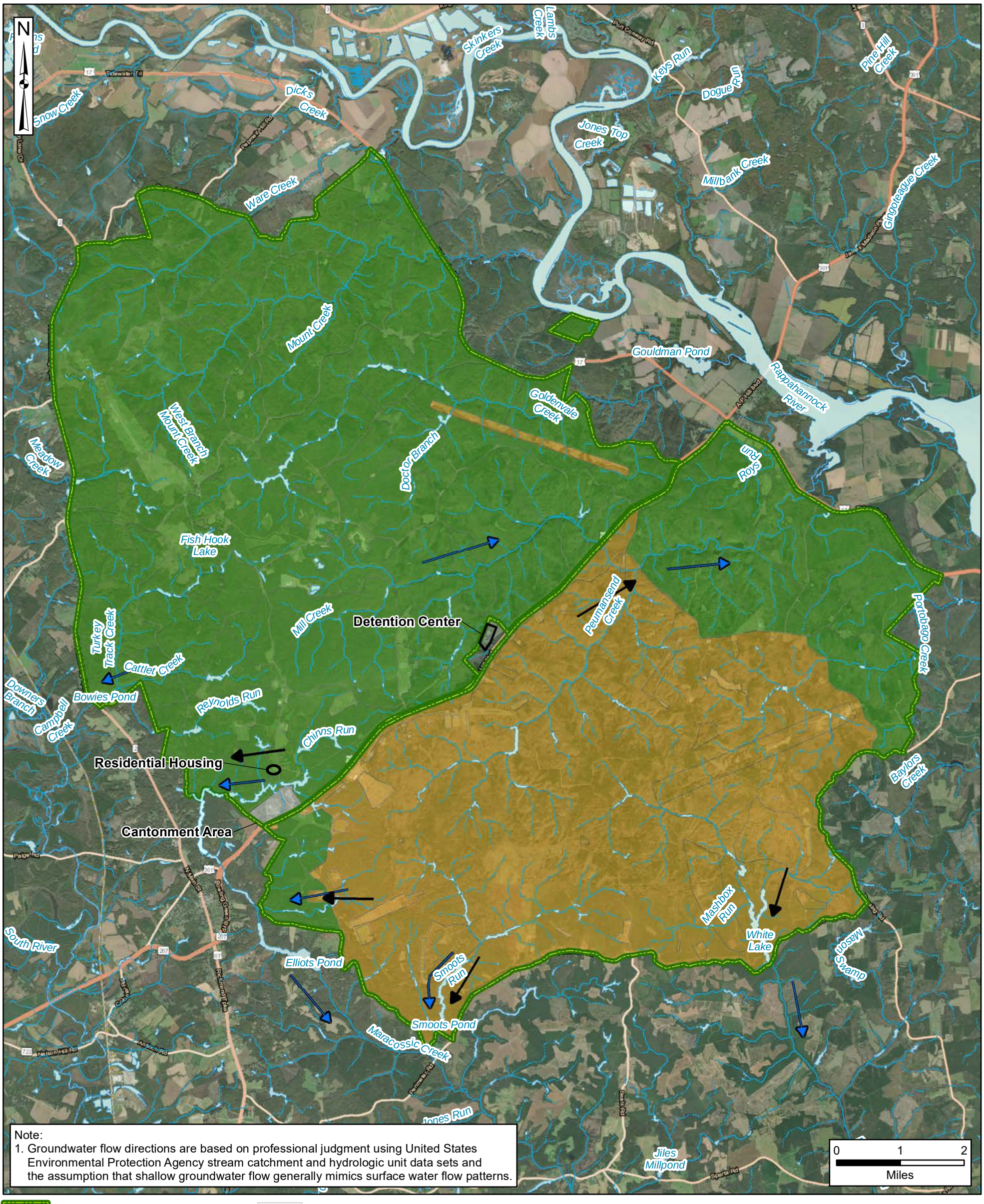
Installation Boundary

Data Sources:
ESRI ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

Figure 2-2
Site Layout



Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

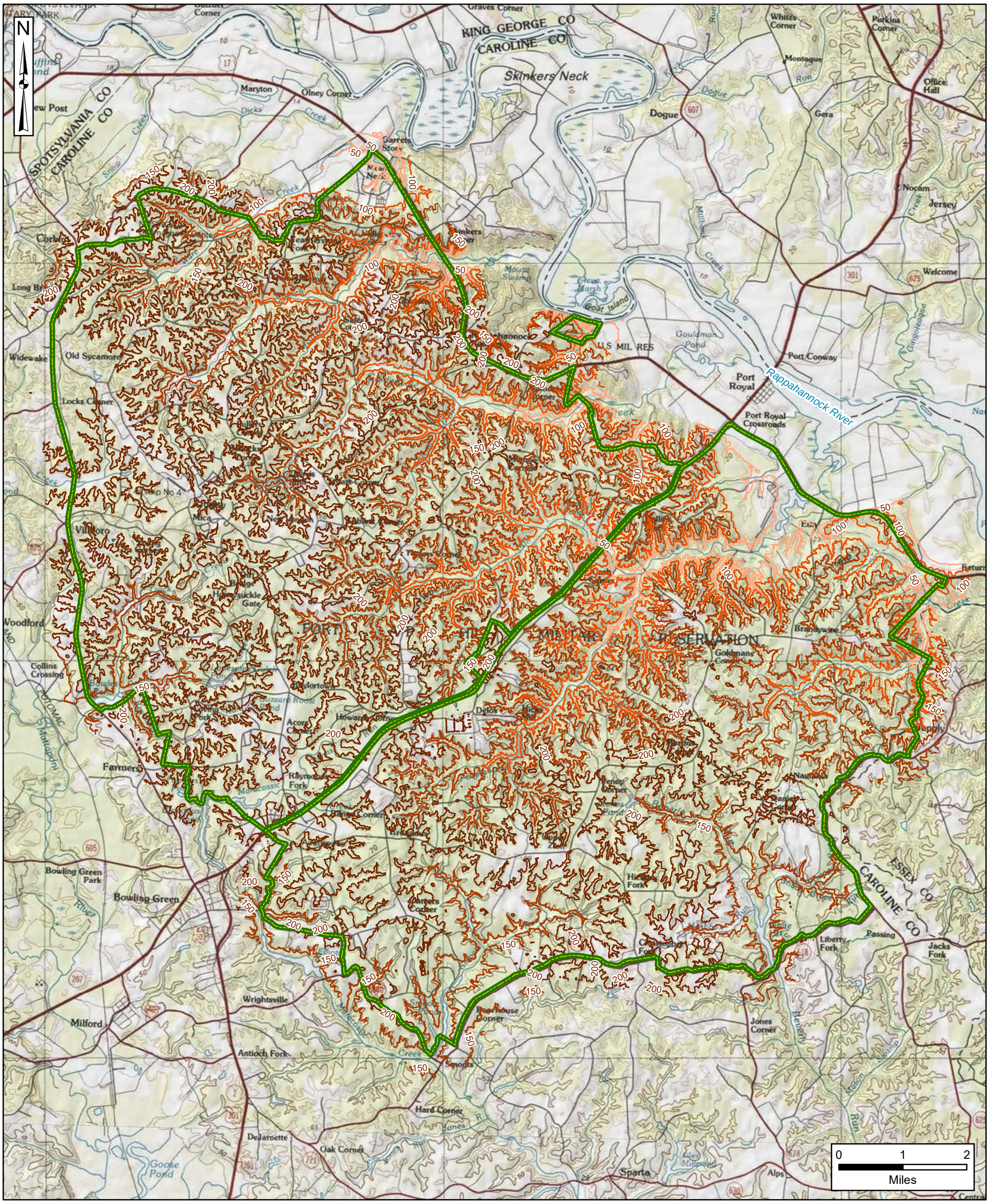
- Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Groundwater Flow Direction
- Cantonment Area
- Maneuver Area
- Operational Range Area

Data Sources:
Fort A.P. Hill, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

Figure 2-3
Topographic Map



Installation Boundary

Elevation Contours

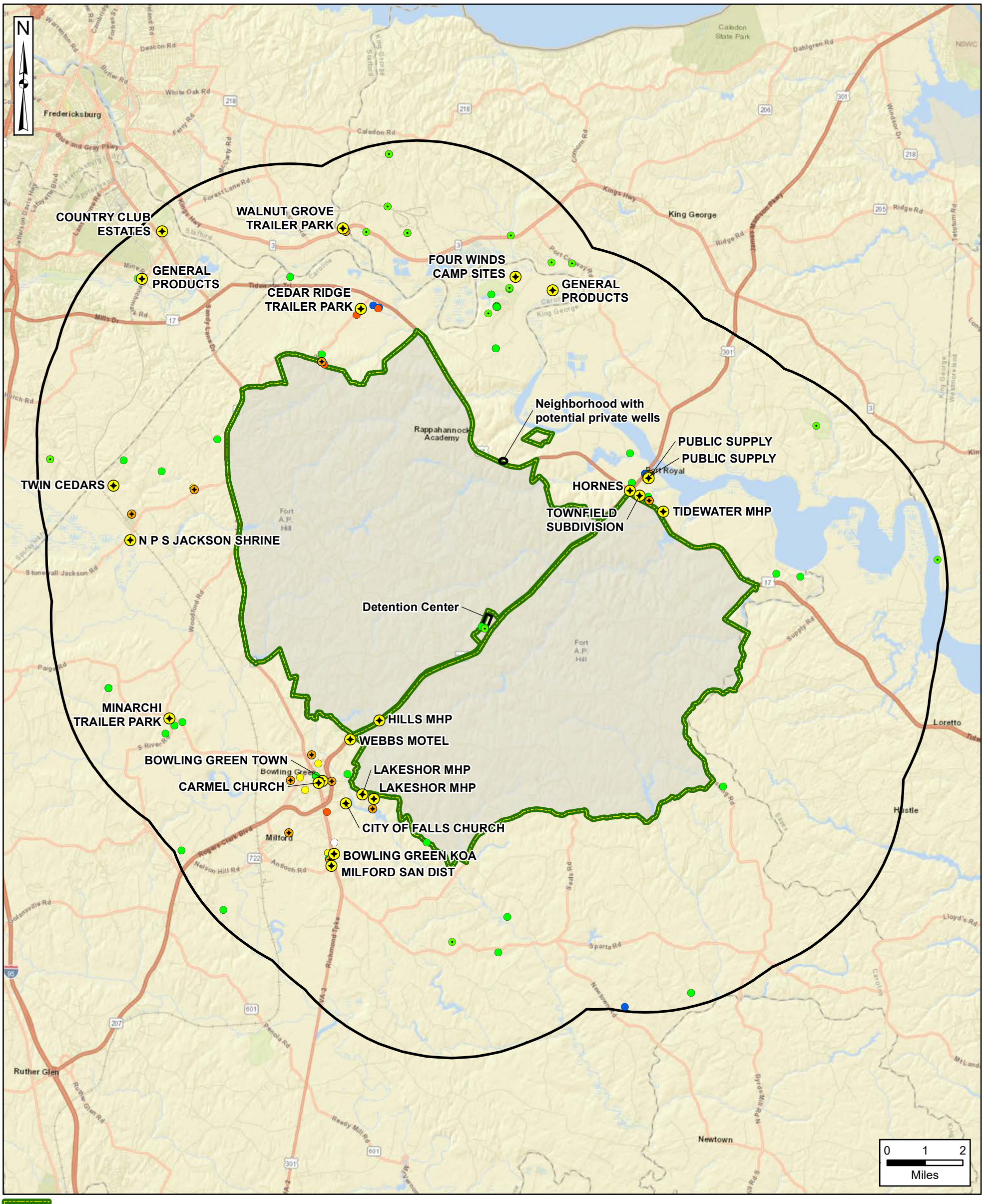
- 50 feet
- 100 feet
- 150 feet
- 200 feet

Data Sources:
ESRI ArcGIS Online, USGS Topo

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

Figure 2-4
Off-Post Potable Supply Wells



Installation Boundary

5-Mile Radius

EDR Wells

- Public Water Supply System Well
- Community Supply Well
- Non-Community Supply Well

Well Inventory (FOIA Request)

- Public Supply Well
- Domestic Use Well
- Agricultural/Irrigation Use Well
- Industrial, Remedial, and Other Well
- Well - Unspecified Use Type

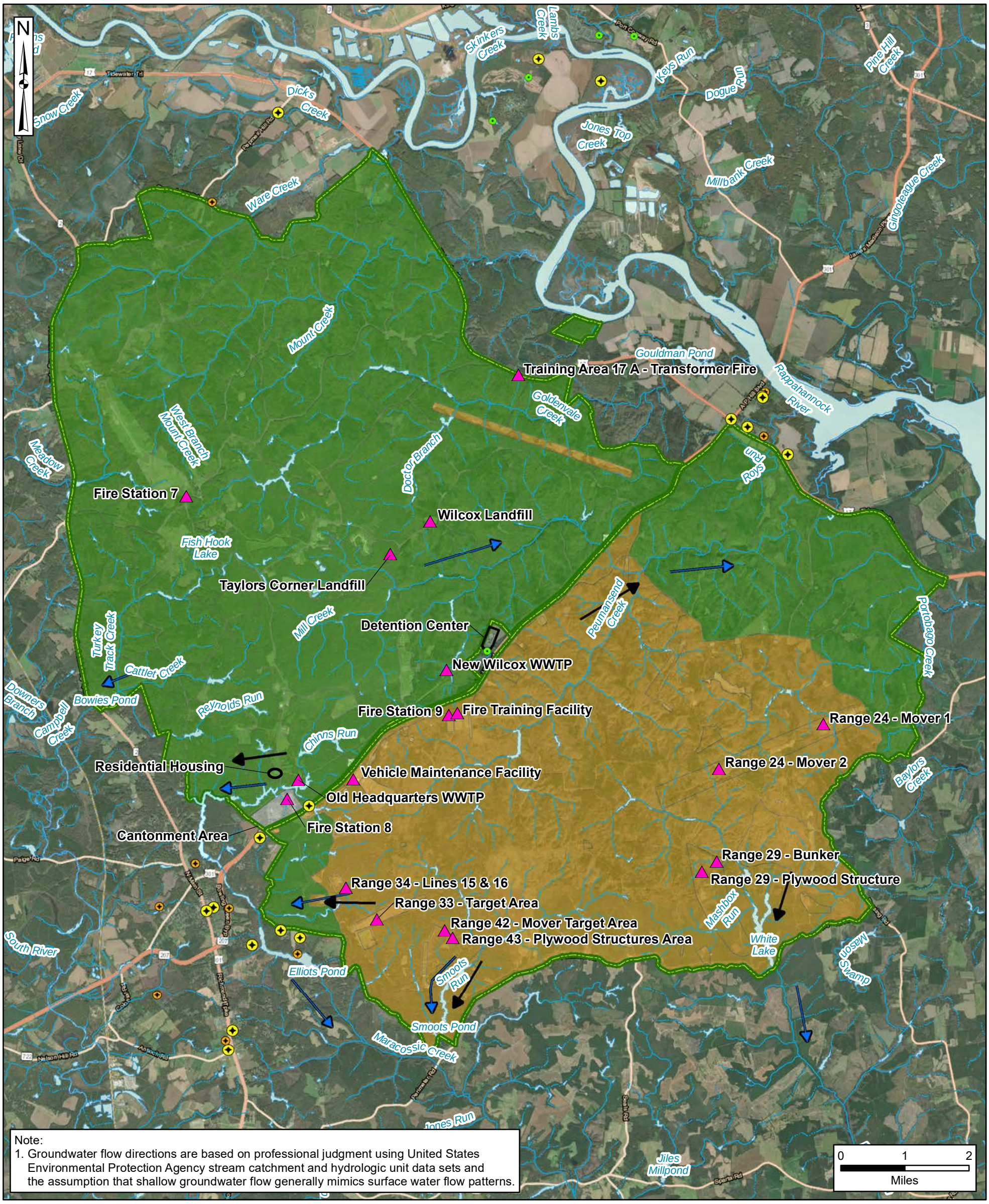
EDR = Environmental Data Resources, Inc.
FOIA = Freedom of Information Act

Data Sources:
EDR, Well Data, 2018
ESRI ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

Figure 5-2
AOPI Overview



Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

- Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Groundwater Flow Direction
- Cantonment Area
- Maneuver Area
- Operational Range Area
- AOPI
- Public Water Supply System Well
- Community Supply Well
- Non-Community Supply Well

AOPI = area of potential interest
WWTP = wastewater treatment plant

Data Sources:
Fort A.P. Hill, Well Data, 2019
EDR, Well Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

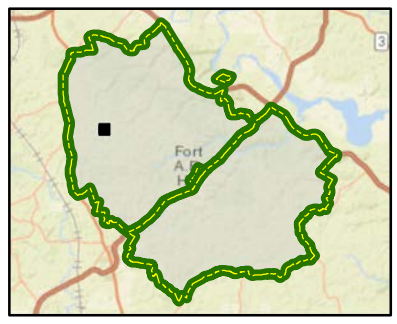


Figure 5-3
Aerial Photo of
Fire Station 7 AOPI

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary

AOPI

Groundwater Flow Direction

Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

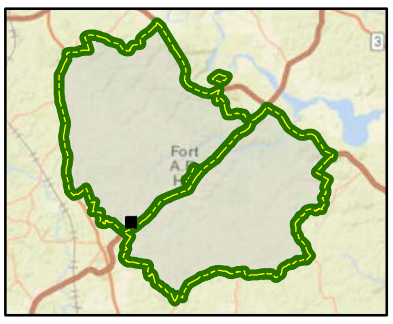


Figure 5-4
Aerial Photo of
Fire Station 8 AOPI

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
Spill Location
Stream (Intermittent)
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
Fort A.P. Hill, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

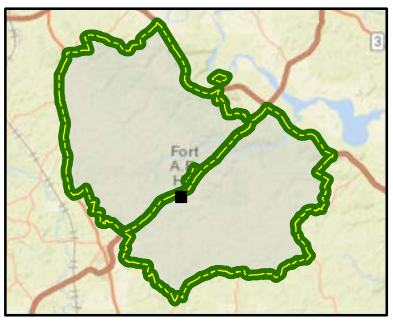


Figure 5-5
Aerial Photo of
Fire Station 9 AOPI

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary

AOPI

Groundwater Flow Direction

Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

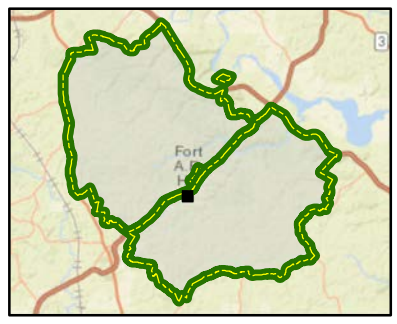
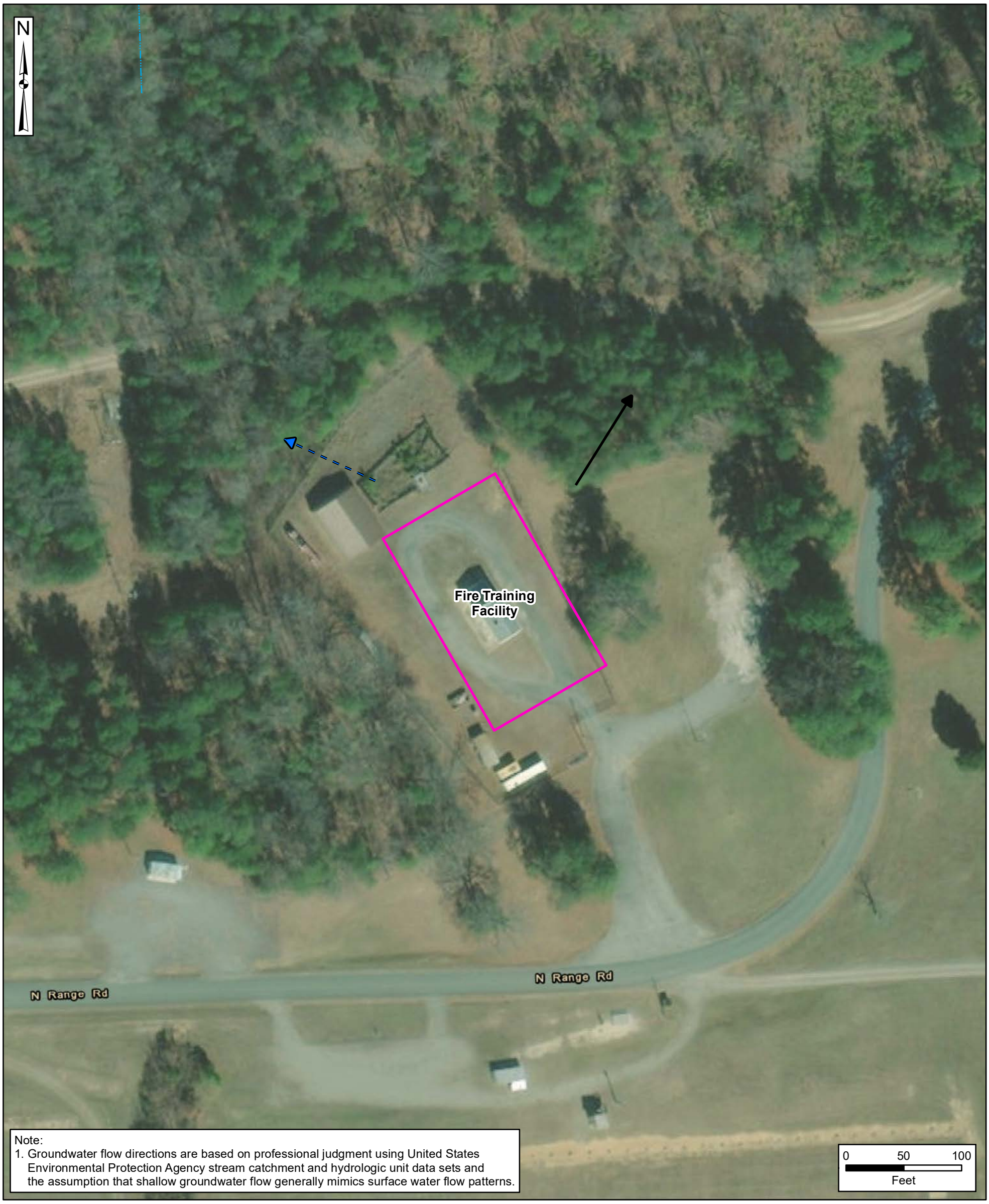


Figure 5-6
Aerial Photo of
Fire Training Facility AOPI



Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
Stream (Intermittent)
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

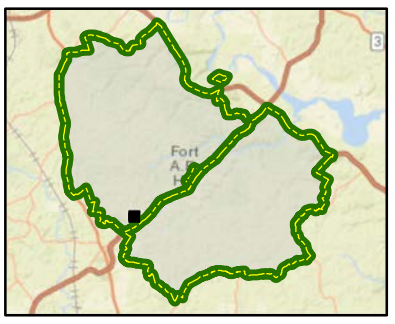


Figure 5-7
Aerial Photo of
Old Headquarters WWTP AOPI

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
Former Sludge Drying Beds
Water Body
Surface Runoff Flow Direction
Groundwater Flow Direction

AOPI = area of potential interest
HQ = Headquarters
STP = sewage treatment plant
WWTP = wastewater treatment plant

Data Sources:
Fort A.P. Hill, Well Data, 2019
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

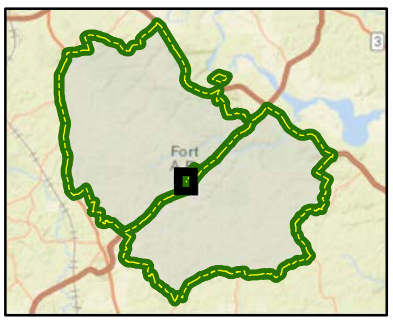


Figure 5-8
Aerial Photo of
New Wilcox WWTP AOPI

N

Detention Center

Peumansend Creek Regional Jail Well

New Wilcox WWTP

Unnamed Tributary of Mill Creek

Perrin Rd

A P Hill Blvd

N Range Rd

301

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

0 250 500
Feet

- Installation Boundary
- AOPI
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Monitoring Well
- Non-Community Supply Well
- Outfall

AOPI = area of potential interest
STP = sewage treatment plant
WWTP = wastewater treatment plant

Data Sources:
Fort A.P. Hill, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

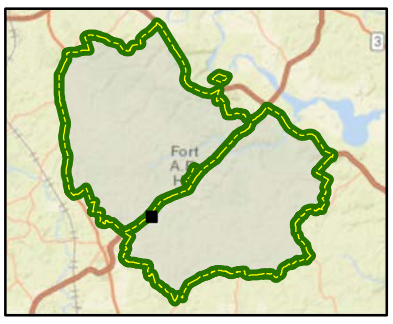


Figure 5-9
Aerial Photo of
Vehicle Maintenance Facility AOPI

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary

AOPI

Groundwater Flow Direction

Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

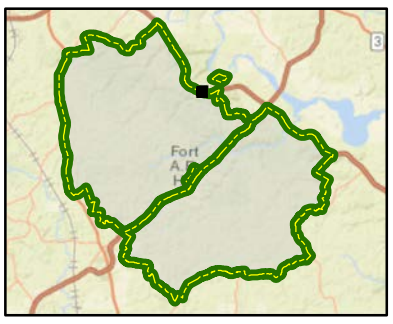


Figure 5-10
Aerial Photo of
Training Area 17A - Transformer Fire AOPI

Installation Boundary

AOPI

Groundwater Flow Direction

Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

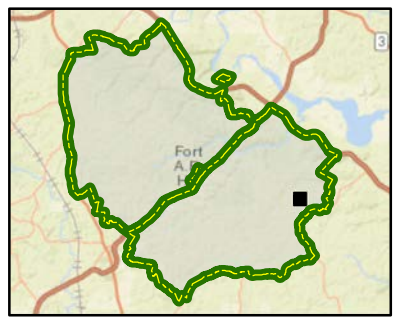


Figure 5-11
Aerial Photo of
Range 24 - Mover 1 AOPI

Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

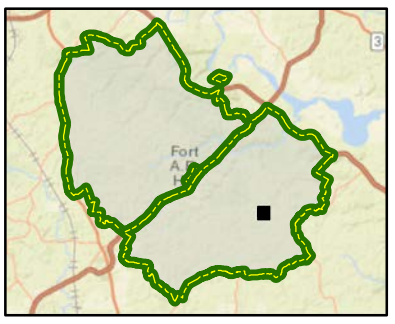


Figure 5-12
Aerial Photo of
Range 24 - Mover 2 AOPI

Installation Boundary

AOPI

Groundwater Flow Direction

Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

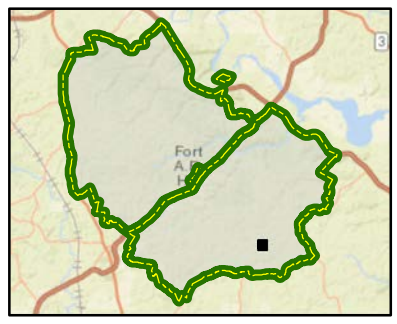


Figure 5-13
Aerial Photo of
Range 29 - Plywood Structure AOPI

Installation Boundary

AOPI

Groundwater Flow Direction

Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

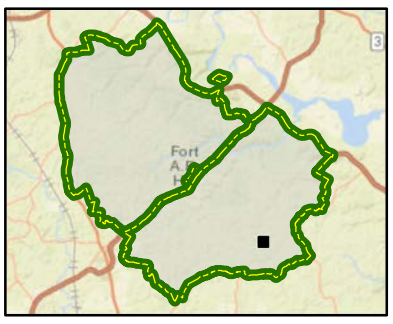
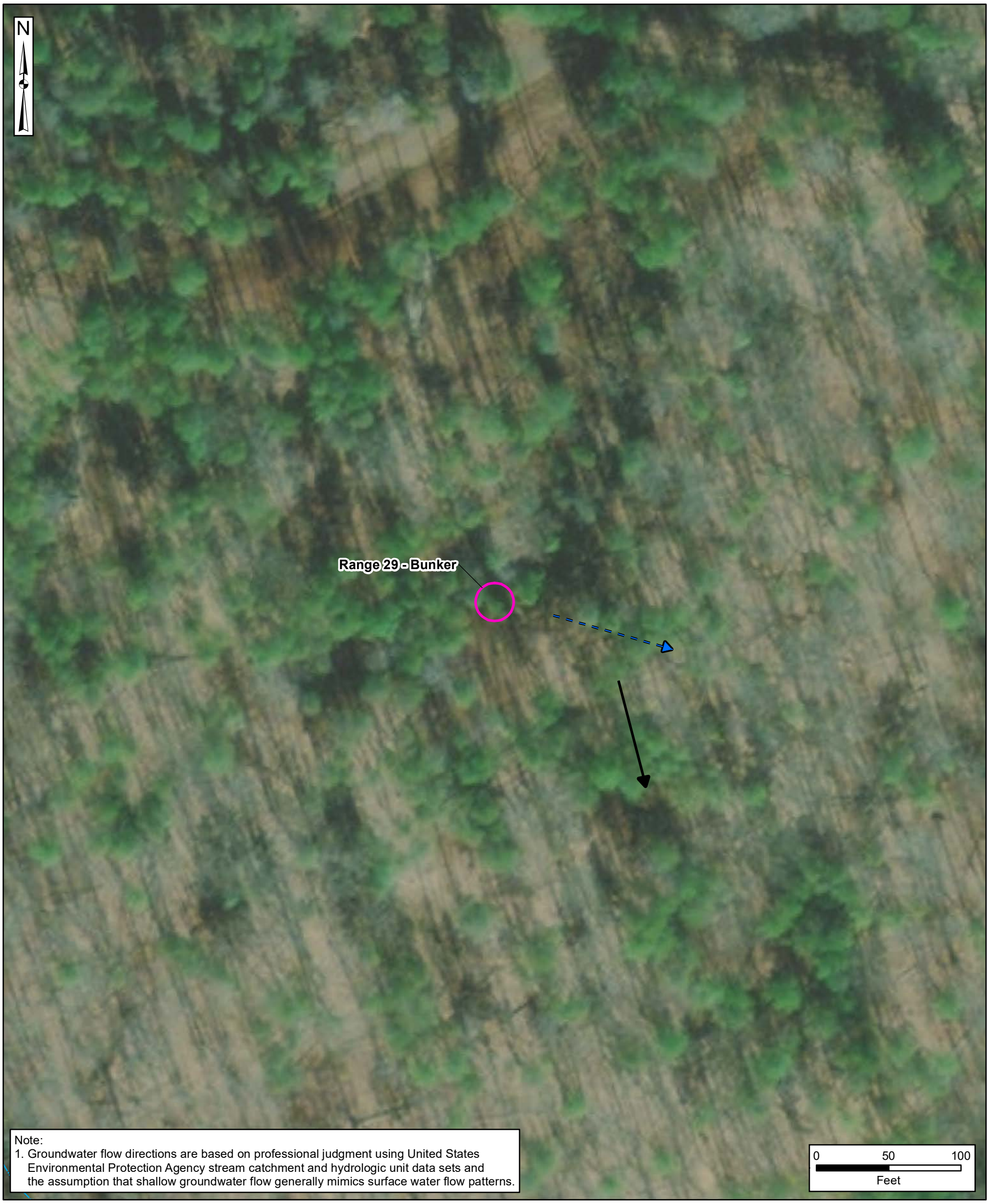


Figure 5-14
Aerial Photo of
Range 29 - Bunker AOPI



Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

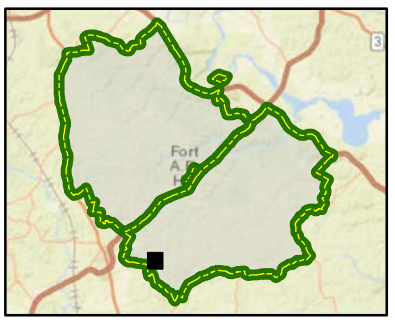


Figure 5-15
Aerial Photo of
Range 33 - Target Area AOPI

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

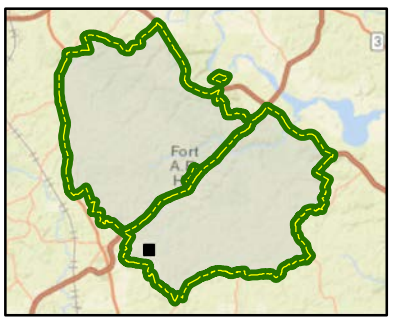
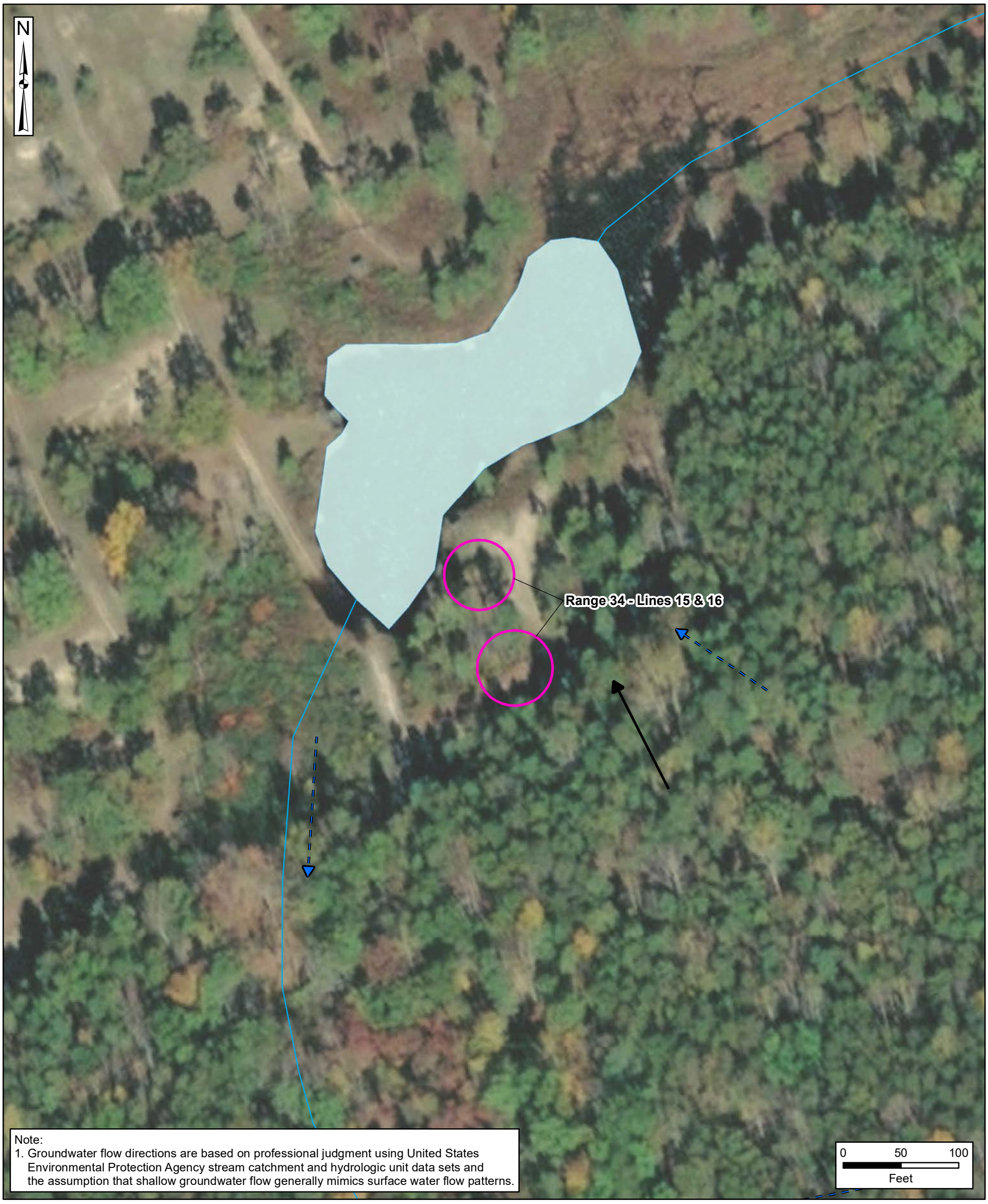


Figure 5-16
Aerial Photo of
Range 34 - Lines 15 & 16 AOPI



Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

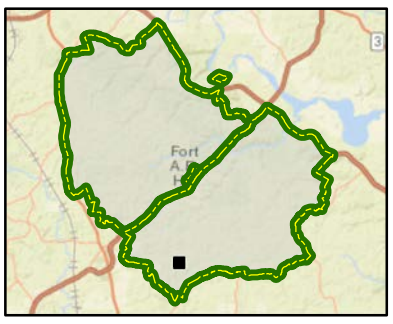
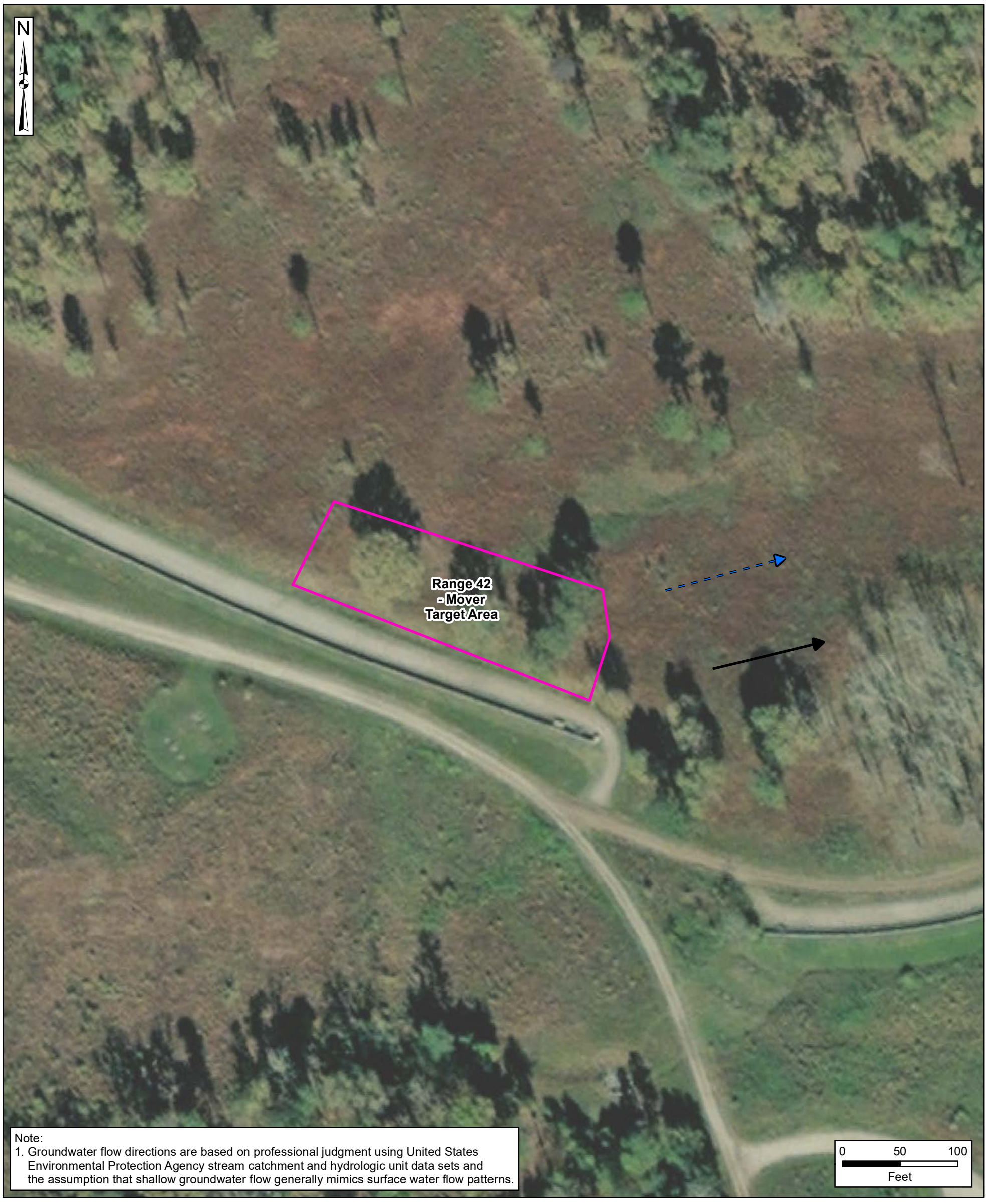


Figure 5-17
Aerial Photo of
Range 42 - Mover Target Area AOPI



Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

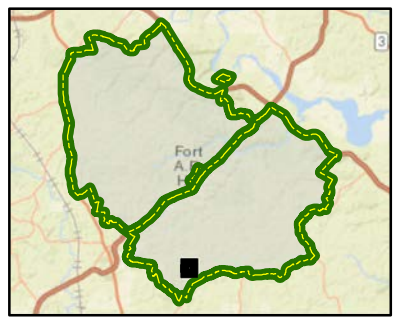


Figure 5-18
Aerial Photo of
Range 43 - Plywood Structures Area AOPI

Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

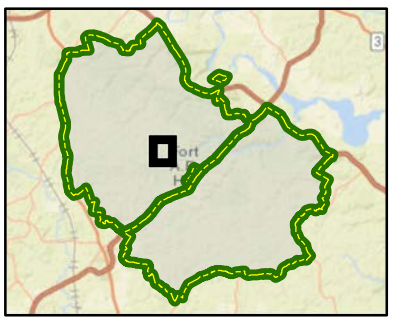


Figure 5-19
Aerial Photo of
Taylors Corner Landfill AOPI

Installation Boundary
AOPI
River/Stream (Perennial)
Stream (Intermittent)
Water Body
Surface Water Flow Direction
Inferred Groundwater Flow Direction

AOPI = area of potential interest

Data Sources:
EDR Well Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

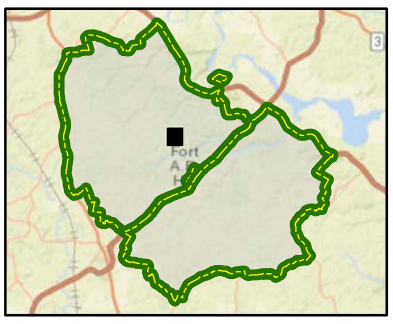


Figure 5-20
Aerial Photo of
Wilcox Landfill AOPI

Installation Boundary
AOPI
Stream (Intermittent)
Surface Water Flow Direction
Groundwater Flow Direction
Monitoring Well

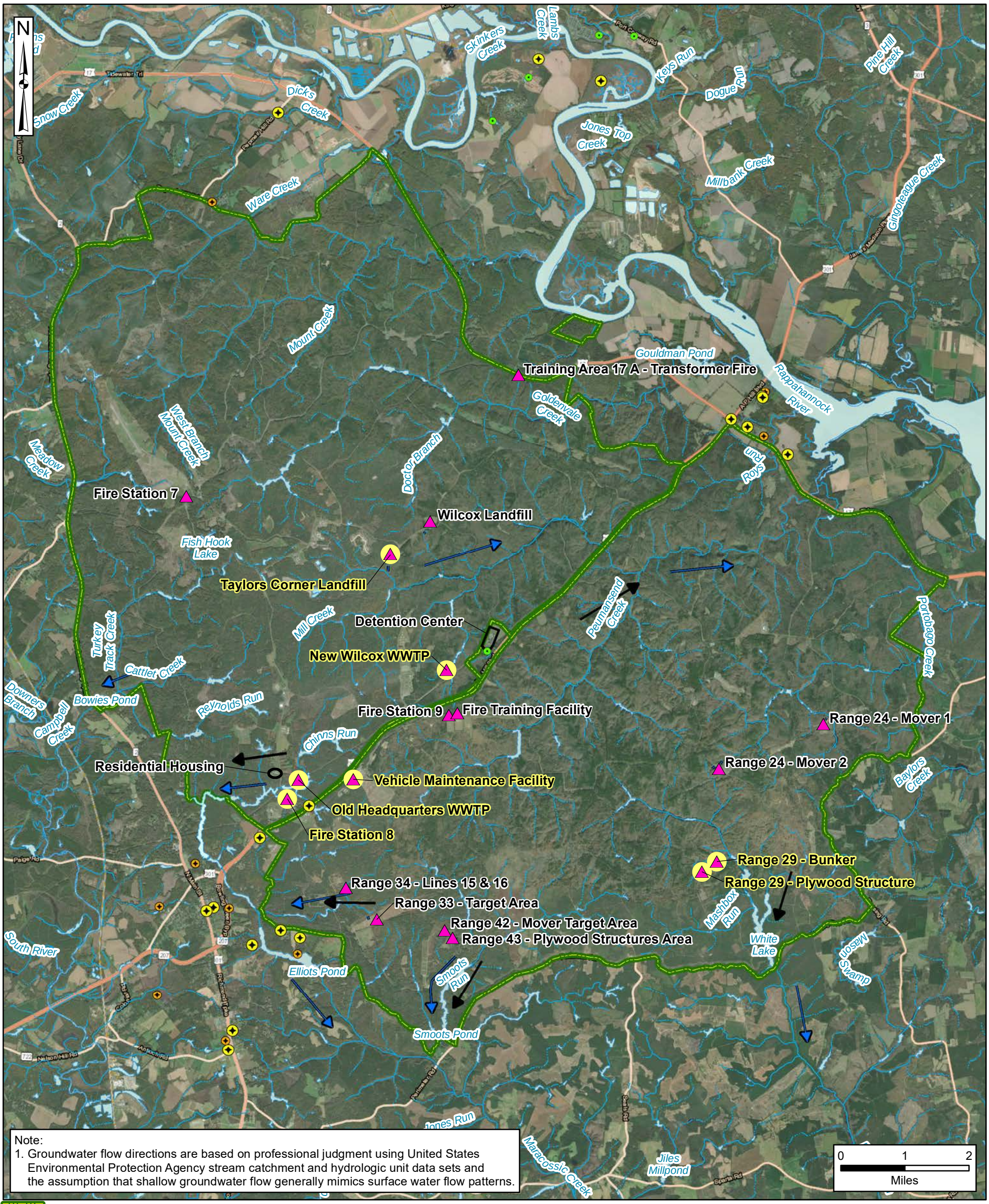
AOPI = area of potential interest

Data Sources:
EDR Well Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

Figure 7-1
AOPI Results Overview



Note:
1. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

- Installation Boundary
- AOPI
- AOPI with OSD Risk Screening Level Exceedance
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Groundwater Flow Direction
- Public Water Supply System Well
- Community Supply Well
- Non-Community Supply Well

AOPI = area of potential interest
OSD = Office of the Secretary of Defense
WWTP = wastewater treatment plant

Data Sources:
Fort A.P. Hill, Well Data, 2019
EDR, Well Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

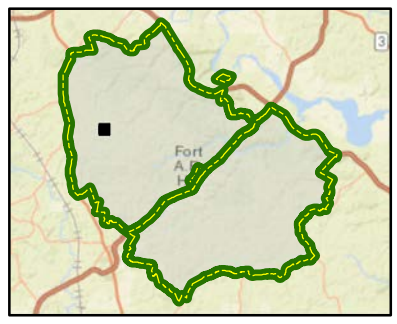


Figure 7-2
Fire Station 7 AOPI
PFOS, PFOA, and PFBS Analytical Results

N

Fire Station 7

A P Hill Dr

FTAPH-FS7-1-GW	
Depth	26.5-30 ft bgs
PFOS	**18**
PFOA	**22**
PFBS	4.1 UB

FTAPH-FS7-1-SO	
PFOS	**0.0015**
PFOA	**0.00090 J**
PFBS	0.0012 U

FTAPH-FS7-2-GW	
Depth	31.5-35 ft bgs
PFOS	**6.8**
PFOA	**13**
PFBS	**7.1 BJ+**

0 50 100
Feet

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
BJ+ = The compound has been found in the sample as well as its associated blank, its presence in the sample may be suspect and reported result may be biased high.
J = The result is an estimated quantity.
U = The analyte was analyzed for but was not detected above the limit of quantitation.
UB = The analyte is considered non-detect at the listed value due to associated blank contamination.

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Surface Soil Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

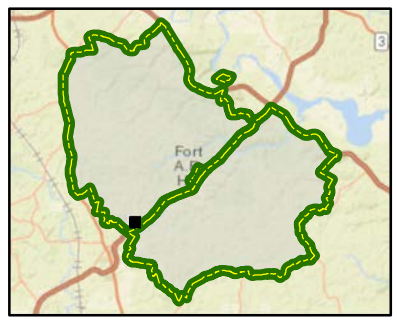


Figure 7-3
Fire Station 8 AOPI
PFOS, PFOA, and PFBS Analytical Results

N

A P Hill Dr

FTAPH-FS8-1-SO	
PFOS	**0.17**
PFOA	**0.00096 J**
PFBS	0.0011 U

FTAPH-FS8-1-GW	
Depth	31.5-35 ft bgs
PFOS	**82 J- [62]**
PFOA	**54 J- [46]**
PFBS	**47 J- [41]**

Fire Station 8

FTAPH-FS8-2-SO	
PFOS	**0.0020**
PFOA	0.00098 U
PFBS	0.00098 U

A P Hill Dr

0 50 100
Feet

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. Soil samples were collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Duplicate sample results are shown in brackets.
6. Bolded values indicate detections.
7. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L or soil risk screening level of 13 mg/kg (OSD 2021) are highlighted gray.
8. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J = The result is an estimated quantity.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.

- Installation Boundary
- AOPI
- Spill Location
- Stream (Intermittent)
- Groundwater Flow Direction
- Surface Runoff Flow Direction
- Surface Soil Sampling Location
- Soil Boring to Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
Fort A.P. Hill, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

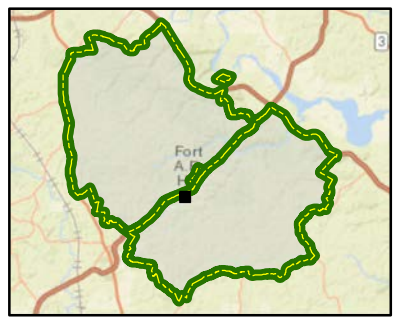


Figure 7-4
Fire Station 9 AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-FS9-2-GW	
Depth	21.5-25 ft bgs
PFOS	**9.8**
PFOA	4.3 U
PFBS	4.3 U

FTAPH-FS9-1-SO	
PFOS	0.0010 U
PFOA	0.0010 U
PFBS	0.0010 U

FTAPH-FS9-1-GW	
Depth	21.5-25 ft bgs
PFOS	**34 J+**
PFOA	**6.4 J-**
PFBS	7.8 UJ-

Fire Station 9

21499 Rd

N Range Rd

N Range Rd

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J+ = The result is an estimated quantity; the result may be biased high.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation is approximate and may be inaccurate or imprecise.

0 50 100
Feet

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Soil Boring to Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

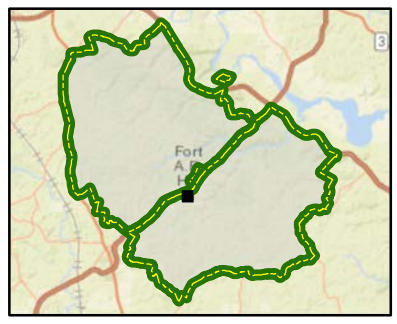


Figure 7-5
Fire Training Facility AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-FTA-1-SO	
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

FTAPH-FTA-1-GW	
Depth	16.5-20 ft bgs
PFOS	**19 J-**
PFOA	**4.1 J-**
PFBS	6.1 UJ-

FTAPH-FTA-2-GW	
Depth	21.5-25 ft bgs
PFOS	3.9 U
PFOA	3.9 U
PFBS	**4.3 BJ+**

Fire Training Facility

N Range Rd

0 50 100
Feet

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
BJ+ = The compound has been found in the sample as well as its associated blank, its presence in the sample may be suspect and reported result may be biased high.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation is approximate and may be inaccurate or imprecise.

Installation Boundary
AOPI
Stream (Intermittent)
Groundwater Flow Direction
Surface Runoff Flow Direction
Soil Boring to Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

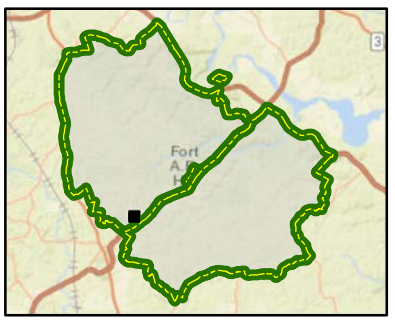


Figure 7-6
Old Headquarters WWTP AOPI
PFOS, PFOA, and PFBS Analytical Results

N

Old Headquarters WWTP

FTAPH-HQWWTP-1-SO	
PFOS	**0.0027**
PFOA	0.0011 U
PFBS	0.0011 U

FTAPH-HQWWTP-1-GW	
Depth	28-32 ft bgs
PFOS	**11**
PFOA	**430**
PFBS	**33**

FTAPH-HQWWTP-2-GW	
Depth	30-34 ft bgs
PFOS	**7.4**
PFOA	**190**
PFBS	**22**

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
7. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
U = The analyte was analyzed for but was not detected above the limit of quantitation.

0 50 100
Feet

Installation Boundary
AOPI
Former Sludge Drying Beds
Water Body
Surface Runoff Flow Direction
Groundwater Flow Direction
Soil Boring to Groundwater Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
HQ = Headquarters
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
STP = sewage treatment plant
WWTP = wastewater treatment plant

Data Sources:
Fort A.P. Hill, Well Data, 2019
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

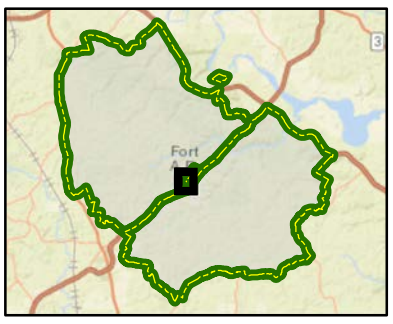


Figure 7-7
New Wilcox WWTP AOPI
PFOS, PFOA, and PFBS Analytical Results

N

Detention Center

Peumansend Creek Regional Jail Well

FTAPH-MW-2	
Depth	16-22 ft bgs
PFOS	**10**
PFOA	**9.2**
PFBS	**2.0 J**

FTAPH-MW-3	
Depth	19-21 ft bgs
PFOS	**150**
PFOA	**43**
PFBS	**13**

FTAPH-WILCOX-1-SW	
PFOS	**14**
PFOA	**1.8 J**
PFBS	**8.4**

FTAPH-MW-4	
Depth	8-20 ft bgs
PFOS	**34**
PFOA	**29**
PFBS	**6.2**

New Wilcox WWTP

Unnamed Tributary of Mill Creek

Perrin Rd

A P Hill Blvd

N Range Rd

301

Notes:
1. Blue data boxes show groundwater sampling results. Yellow data boxes show surface water sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion.
3. Samples were collected 29 April and 6 May 2020.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J = The result is an estimated quantity.

0 250 500
Feet

- Installation Boundary
- AOPI
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Monitoring Well
- Non-Community Supply Well
- Outfall
- Surface Water Sampling Location
- Well Sampling Location

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
STP = sewage treatment plant
WWTP = wastewater treatment plant

Data Sources:
Fort A.P. Hill, Well Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

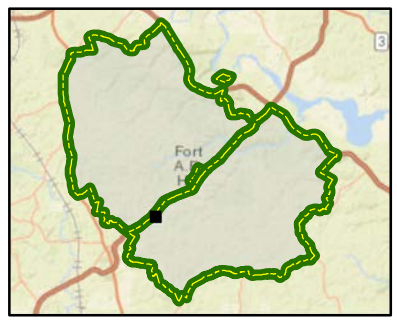


Figure 7-8
Vehicle Maintenance Facility AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-VMF-1-GW	
Depth	46-50 ft bgs
PFOS	**320**
PFOA	**120**
PFBS	**150**

Vehicle Maintenance Facility

N Range Rd

Range Rd

0 50 100
Feet

Notes:
1. Blue data boxes show groundwater sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion.
3. Samples were collected 27-30 April 2020.
4. Bolded values indicate detections.
5. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Groundwater Sampling Location

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

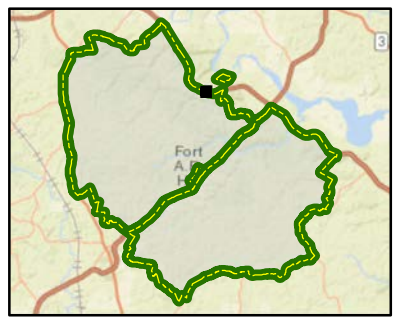


Figure 7-9
Training Area 17A - Transformer Fire AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-17A-1-SO	
PFOS	0.0012 U
PFOA	0.0012 U
PFBS	0.0012 U
FTAPH-17A-1-GW	
Depth	26-30 ft bgs
PFOS	**6.3 J-**
PFOA	**4.0 J-**
PFBS	4.2 UJ-

Training Area 17A
- Transformer Fire

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation is approximate and may be inaccurate or imprecise.

0 50 100
Feet

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Soil Boring to Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

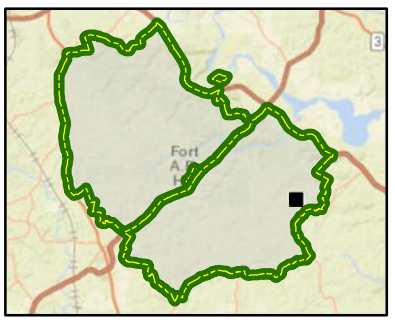


Figure 7-10
Range 24 - Mover 1 AOPI
PFOS, PFOA, and PFBS Analytical Results

N

FTAPH-R24M1-2-GW	
Depth	11.5-15 ft bgs
PFOS	6.2 UJ-
PFOA	**5.1 J-**
PFBS	6.2 UJ-

Range 24 - Mover 1

FTAPH-R24M1-1-SO	
PFOS	0.00096 U
PFOA	0.00096 U
PFBS	0.00096 U

FTAPH-R24M1-1-GW not collected

0 50 100
Feet

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation is approximate and may be inaccurate or imprecise.

Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction
Soil Boring to Groundwater Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

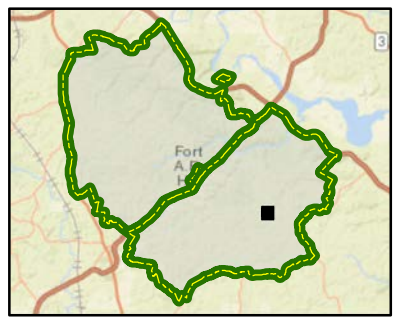


Figure 7-11
Range 24 - Mover 2 AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-R24M2-1-GW	
Depth	23-27 ft bgs
PFOS	**11**
PFOA	**3.9**
PFBS	**2.4 J**

FTAPH-R24M2-1-SO	
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

FTAPH-R24M2-2-GW	
Depth	20-24 ft bgs
PFOS	**3.0 J**
PFOA	**3.8**
PFBS	3.6 U

Range 24 - Mover 2

FTAPH-R24M2-3-GW
not collected

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J = The result is an estimated quantity.
U = The analyte was analyzed for but was not detected above the limit of quantitation.

0 50 100
Feet

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Soil Boring to Groundwater Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

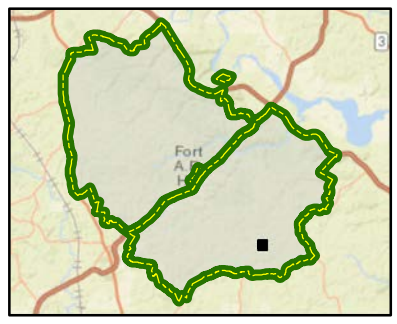


Figure 7-12
Range 29 - Plywood Structure AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-R29PS-2-GW	
Depth	46.5-50 ft bgs
PFOS	**63**
PFOA	**4.0 J**
PFBS	4.1 U

Range 29 - Plywood Structure

FTAPH-R29PS-1-SO	
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

FTAPH-R29PS-1-GW not collected

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
7. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J = The result is an estimated quantity.
U = The analyte was analyzed for but was not detected above the limit of quantitation.

0 50 100
Feet

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Soil Boring to Groundwater Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

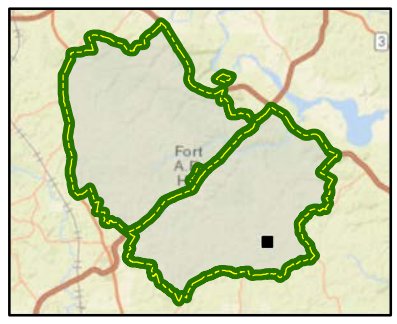


Figure 7-13
Range 29 - Bunker AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-R29B-1-SO	
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U
FTAPH-R29B-1-GW	
Depth	46-50 ft bgs
PFOS	**15 J-**
PFOA	**160 J-**
PFBS	7.6 UJ-

Range 29 - Bunker

FTAPH-R29B-GW-2
not collected

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. The soil sample was collected from 0-2 feet below ground surface (ft bgs).
4. Samples were collected 27-30 April 2020.
5. Bolded values indicate detections.
6. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
7. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation is approximate and may be inaccurate or imprecise

0 50 100
Feet

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Soil Boring to Groundwater Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

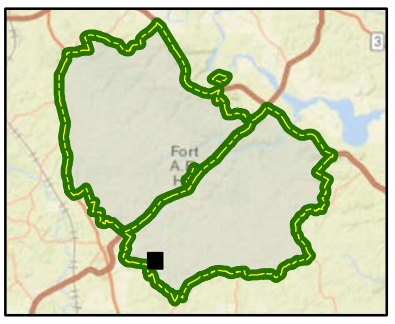


Figure 7-14
Range 33 - Target Area AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-R33-4-GW	
Depth	~7 ft bgs
PFOS	3.5 U
PFOA	3.5 U
PFBS	3.5 U

FTAPH-R33-3-GW	
Depth	~9 ft bgs
PFOS	3.6 U
PFOA	3.6 U
PFBS	3.6 U

FTAPH-R33-1-GW	
Depth	21-25 ft bgs
PFOS	3.8 U
PFOA	3.8 U
PFBS	3.8 U

FTAPH-R33-2-GW	
Depth	~8 ft bgs
PFOS	4.9 UJ-
PFOA	4.9 UJ-
PFBS	4.9 UJ-

Range 33 - Target Area

Reservation Rd 637

Notes:
1. Blue data boxes show groundwater sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion.
3. Samples were collected 27-30 April 2020.
4. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.

0 100 200
Feet

Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction
Groundwater Sampling Location

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

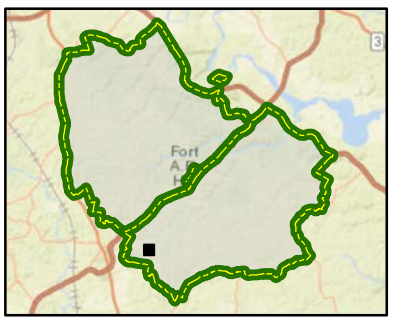


Figure 7-15
Range 34 - Lines 15 & 16 AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-R34-1-GW	
Depth	18-22 ft bgs
PFOS	3.5 U [3.6 U]
PFOA	3.5 U [3.6 U]
PFBS	3.5 U [3.6 U]

FTAPH-R34-1-SO	
PFOS	0.0012 U
PFOA	0.0012 U
PFBS	0.0012 U

FTAPH-R34-2-SO	
PFOS	0.0010 U
PFOA	0.0010 U
PFBS	0.0010 U

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. Soil samples were collected from 0-2 feet below ground surface (ft bgs).
4. Duplicate sample results are shown in brackets.
5. Samples were collected 27-30 April 2020.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
U = The analyte was analyzed for but was not detected above the limit of quantitation.

0 50 100
Feet

Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction
Surface Soil Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

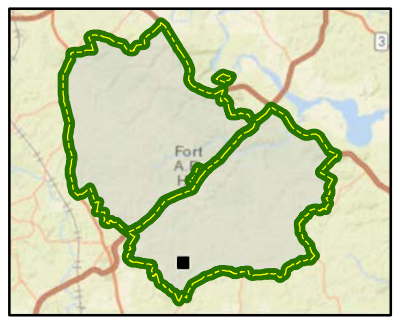
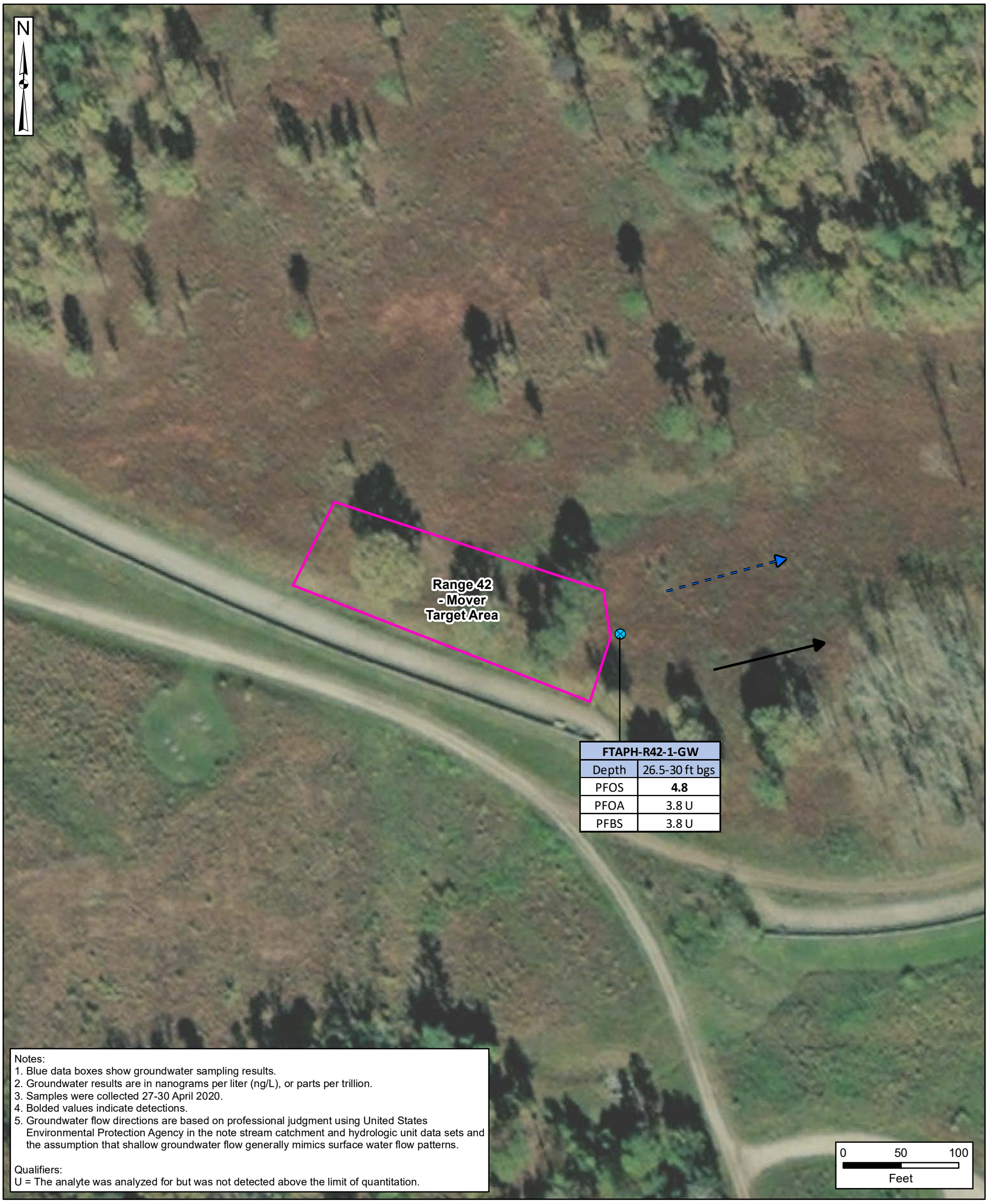


Figure 7-16
Range 42 - Mover Target Area AOPI
PFOS, PFOA, and PFBS Analytical Results



Notes:
1. Blue data boxes show groundwater sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion.
3. Samples were collected 27-30 April 2020.
4. Bolded values indicate detections.
5. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
U = The analyte was analyzed for but was not detected above the limit of quantitation.

Installation Boundary
AOPI
Groundwater Flow Direction
Surface Runoff Flow Direction
Groundwater Sampling Location

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

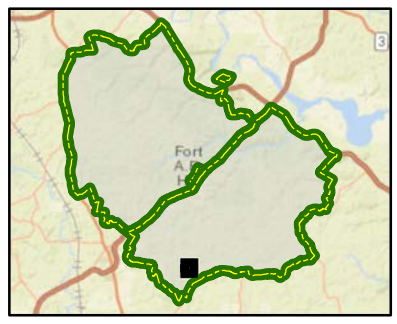


Figure 7-17
Range 43 - Plywood Structures Area AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-R43-4-SO	
PFOS	0.0010 U
PFOA	0.0010 U
PFBS	0.0010 U

FTAPH-R43-3-GW	
Depth	~23 ft bgs
PFOS	**4.3 J-**
PFOA	3.9 UJ-
PFBS	3.9 UJ-

FTAPH-R43-3-SO	
PFOS	0.0010 U
PFOA	0.0010 U
PFBS	0.0010 U

FTAPH-R43-1-SO	
PFOS	0.0011 U
PFOA	0.0011 U
PFBS	0.0011 U

Range 43 - Plywood Structures Area

FTAPH-R43-1-GW	
Depth	26.5-30 ft bgs
PFOS	**30**
PFOA	**2.2 J**
PFBS	4.0 U

FTAPH-R43-2-GW	
Depth	~24 ft bgs
PFOS	**1.8 J**
PFOA	3.5 U
PFBS	3.5 U

FTAPH-R43-2-SO	
PFOS	0.0010 UJ [0.0011 U]
PFOA	0.0010 U [0.0011 U]
PFBS	0.0010 U [0.0011 U]

N

0 150 300
Feet

Notes:
1. Blue data boxes show groundwater sampling results. Green data boxes show soil sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion. Soil results are in milligrams per kilogram (mg/kg), or parts per million.
3. Duplicate sample results are shown in brackets.
4. Soil samples were collected from 0-2 feet below ground surface (ft bgs).
5. Samples were collected on 29 April 2020 and 26 April 2021.
6. Bolded values indicate detections.
7. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit data sets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
J = The result is an estimated quantity.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for but was not detected above the limit of quantitation.

Smoot's Run
Smoot's Pond

Installation Boundary
AOPI
River/Stream (Perennial)
Water Body
Groundwater Flow Direction
Surface Runoff Flow Direction
Surface Soil Sampling Location
Groundwater Sampling Location

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

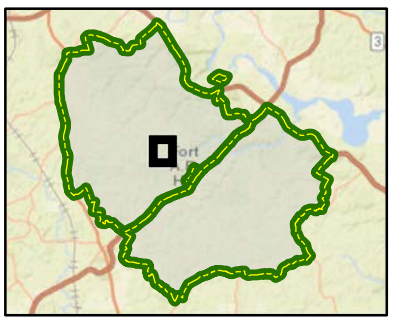
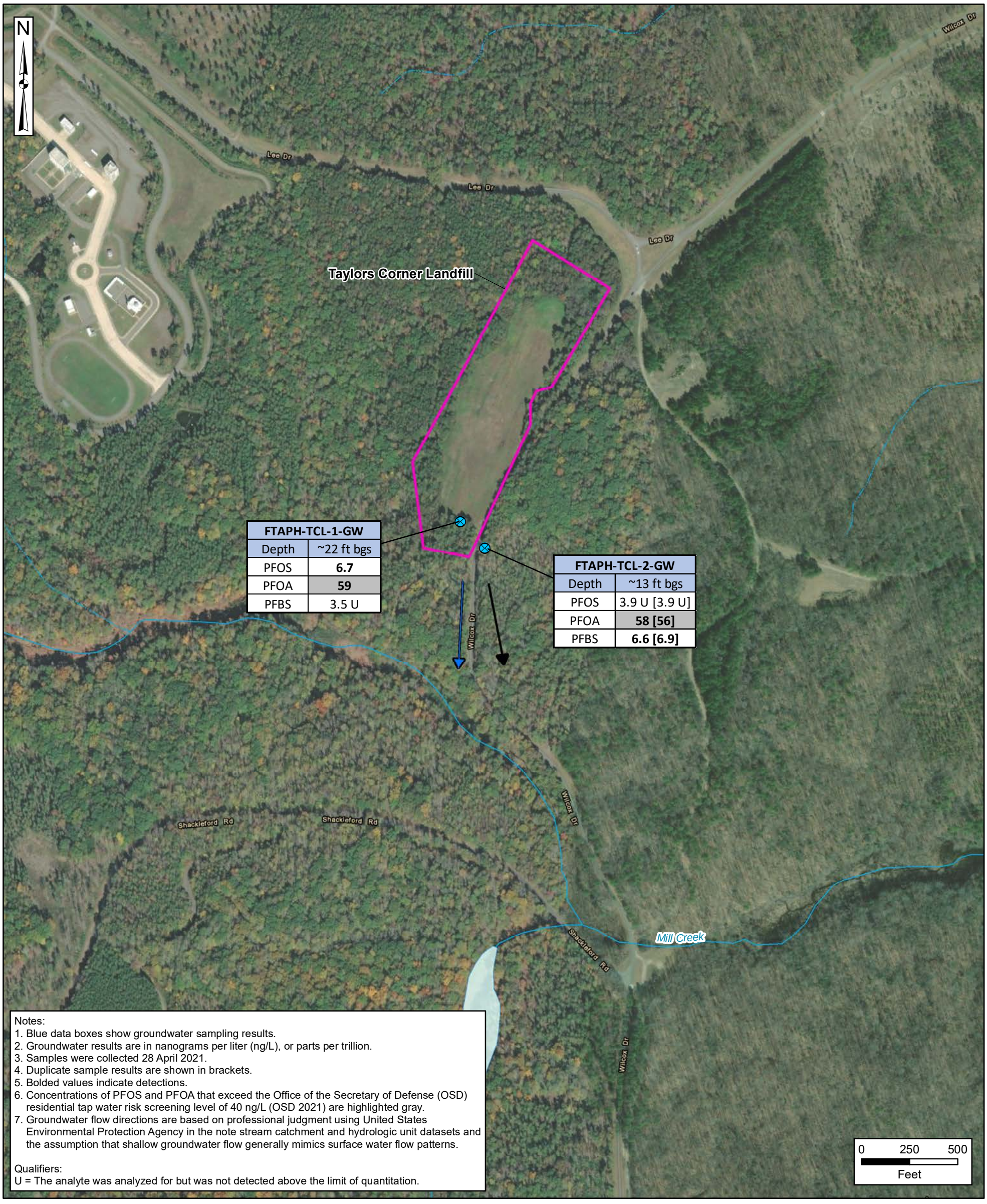


Figure 7-18
Taylors Corner Landfill AOPI
PFOS, PFOA, and PFBS Analytical Results



Notes:
1. Blue data boxes show groundwater sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion.
3. Samples were collected 28 April 2021.
4. Duplicate sample results are shown in brackets.
5. Bolded values indicate detections.
6. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2021) are highlighted gray.
7. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit datasets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
U = The analyte was analyzed for but was not detected above the limit of quantitation.

- Installation Boundary
- AOPI
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Inferred Groundwater Flow Direction
- Groundwater Sampling Location

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
EDR Well Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

USAEC PFAS Preliminary Assessment / Site Inspection
Fort A.P. Hill, VA

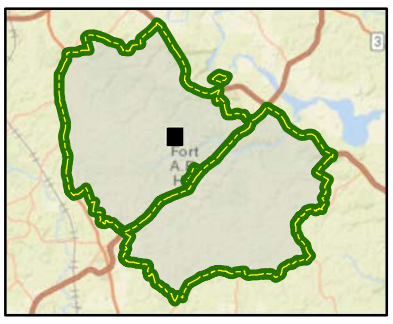


Figure 7-19
Wilcox Landfill AOPI
PFOS, PFOA, and PFBS Analytical Results

FTAPH-GW-7	
Depth	~20 ft bgs
PFOS	4.0 U
PFOA	**12**
PFBS	4.0 U

FTAPH-GW-16	
Depth	Unknown
PFOS	3.8 U
PFOA	**6.1**
PFBS	3.8 U

FTAPH-GW-12	
Depth	~24 ft bgs
PFOS	3.8 U
PFOA	3.8 U
PFBS	3.8 U

FTAPH-GW-9	
Depth	~25 ft bgs
PFOS	3.9 U
PFOA	**7.6**
PFBS	3.9 U

Wilcox Landfill

Wilcox Dr

Notes:
1. Blue data boxes show groundwater sampling results.
2. Groundwater results are in nanograms per liter (ng/L), or parts per trillion.
3. Samples were collected 12 May 2021.
4. Duplicate sample results are shown in brackets.
5. Bolded values indicate detections.
6. Groundwater flow directions are based on professional judgment using United States Environmental Protection Agency in the note stream catchment and hydrologic unit datasets and the assumption that shallow groundwater flow generally mimics surface water flow patterns.

Qualifiers:
U = The analyte was analyzed for but was not detected above the limit of quantitation.

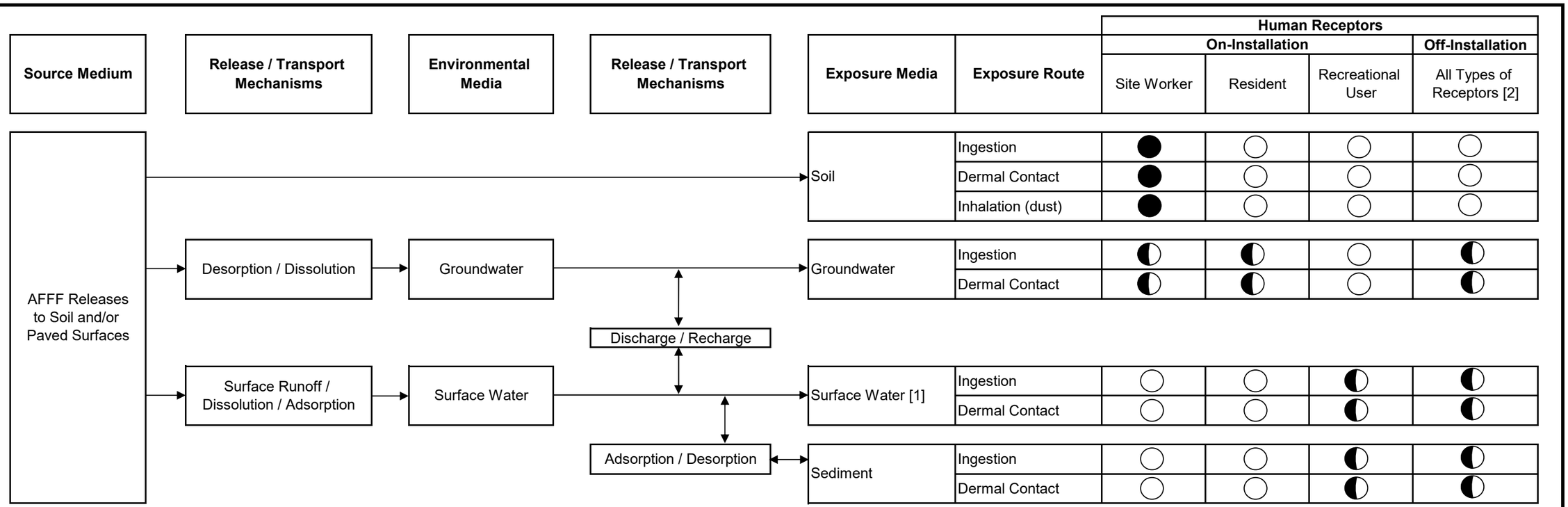
0 150 300
Feet

Installation Boundary
AOPI
Stream (Intermittent)
Surface Water Flow Direction
Groundwater Flow Direction
Monitoring Well
Groundwater Sampling Location - Existing Well

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
EDR Well Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Legend:

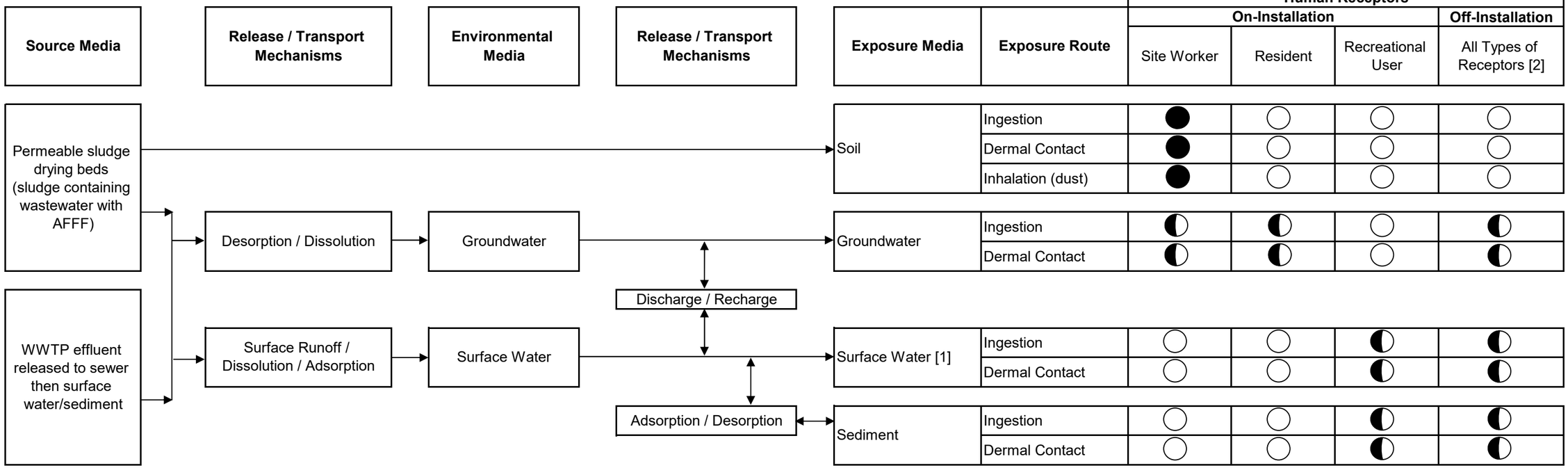
- = Complete Exposure Pathway
- = Potentially Complete Exposure Pathway
- = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest

ARCADIS

Conceptual Site Model - Fire Station 7 and Fire Station 8 AOPIs
United States Army Environmental Command Per- and Polyfluoroalkyl Substances
Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-20



Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

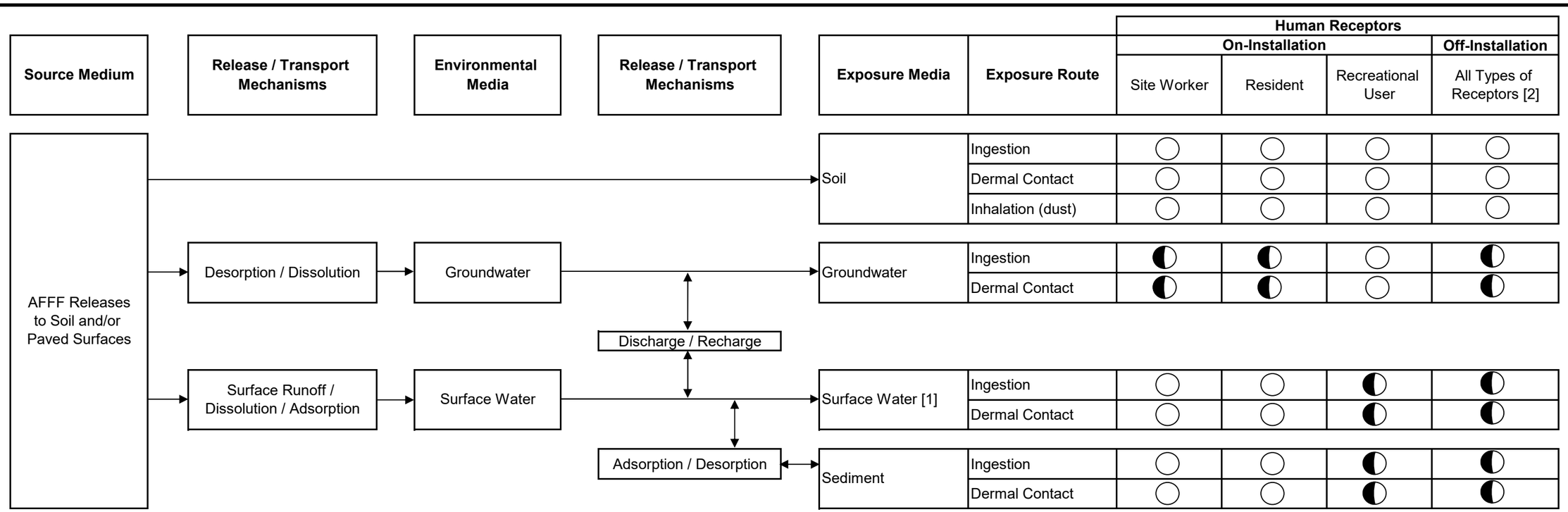
○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest
WWTP = wastewater treatment plant

ARCADIS

Conceptual Site Model - Old Headquarters WWTP AOPI
United States Army Environmental Command Per- and Polyfluoroalkyl Substances
Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-21



Legend:

◐ = Potentially Complete Exposure Pathway

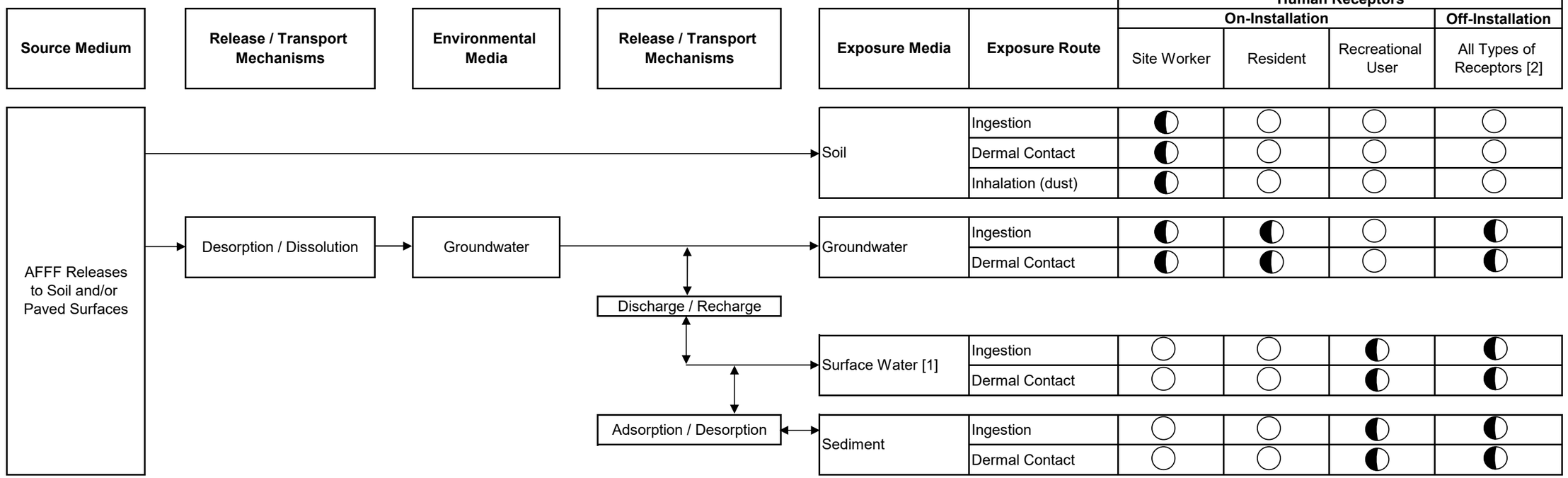
◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest

ARCADIS

Conceptual Site Model - Fire Station 9, Fire Training Facility, and Range 43 Plywood Structures Area AOPIs
United States Army Environmental Command Per- and Polyfluoroalkyl Substances Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-22



Legend:

◐ = Potentially Complete Exposure Pathway

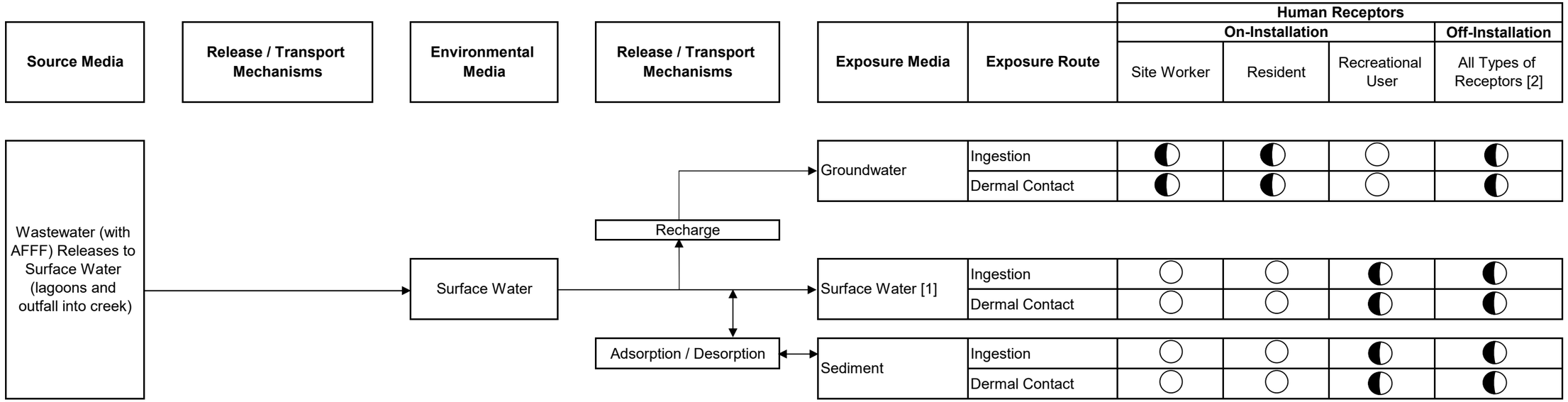
◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest

ARCADIS

Conceptual Site Model - Vehicle Maintenance Facility AOPI
United States Army Environmental Command Per- and Polyfluoroalkyl Substances Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-23



Legend:

◐ = Potentially Complete Exposure Pathway

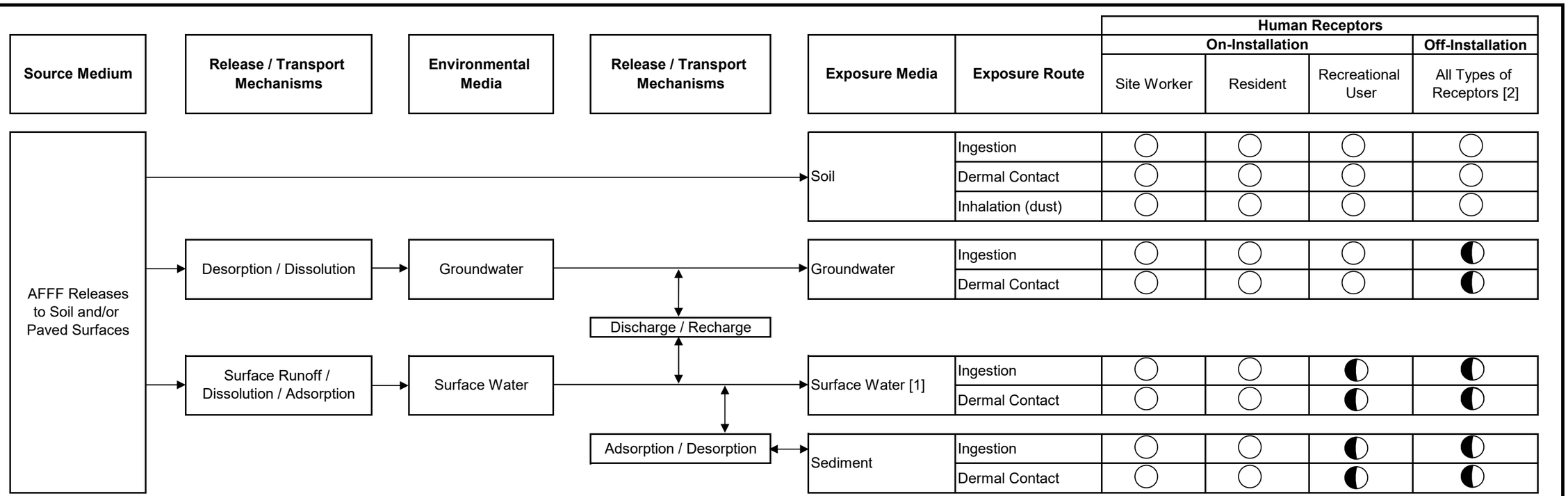
◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest
WWTP = wastewater treatment plant

ARCADIS

Conceptual Site Model - New Wilcox WWTP AOPI
United States Army Environmental Command Per- and Polyfluoroalkyl Substances Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-24



Legend:

◐ = Potentially Complete Exposure Pathway

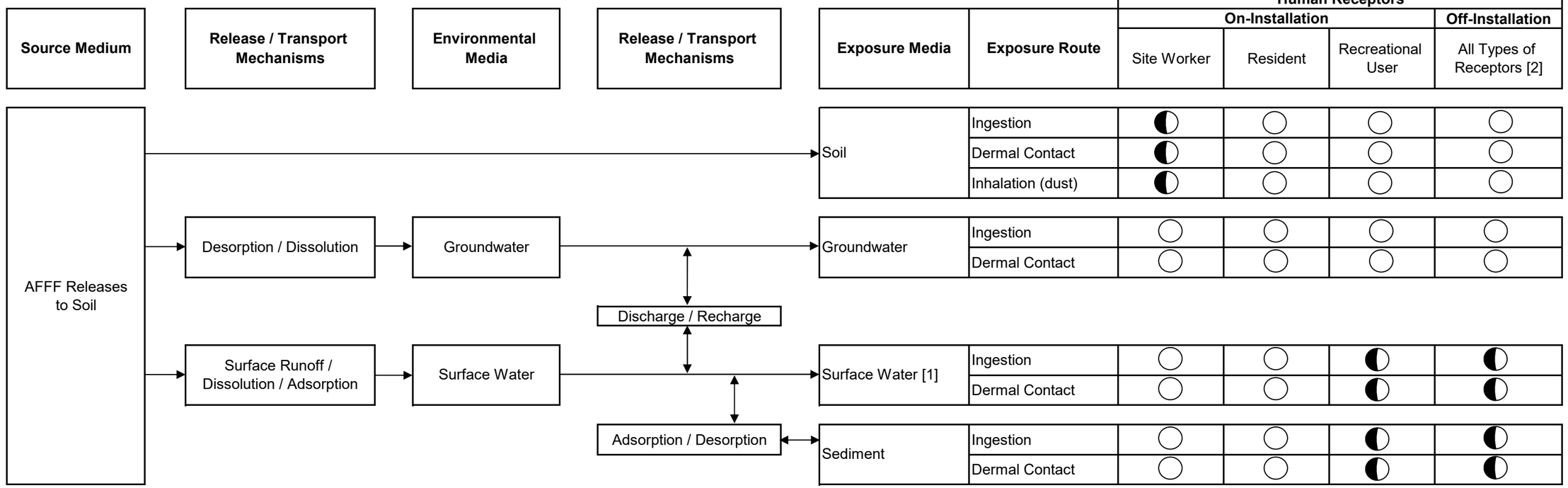
◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest

ARCADIS

Conceptual Site Model - Training Area 17A - Transformer Fire, Range 24 Mover 1, Range 24 Mover 2, Range 29 Bunker, and Range 29 Plywood Structure AOPIs
United States Army Environmental Command Per- and Polyfluoroalkyl Substances Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-25



Legend:

◐ = Potentially Complete Exposure Pathway

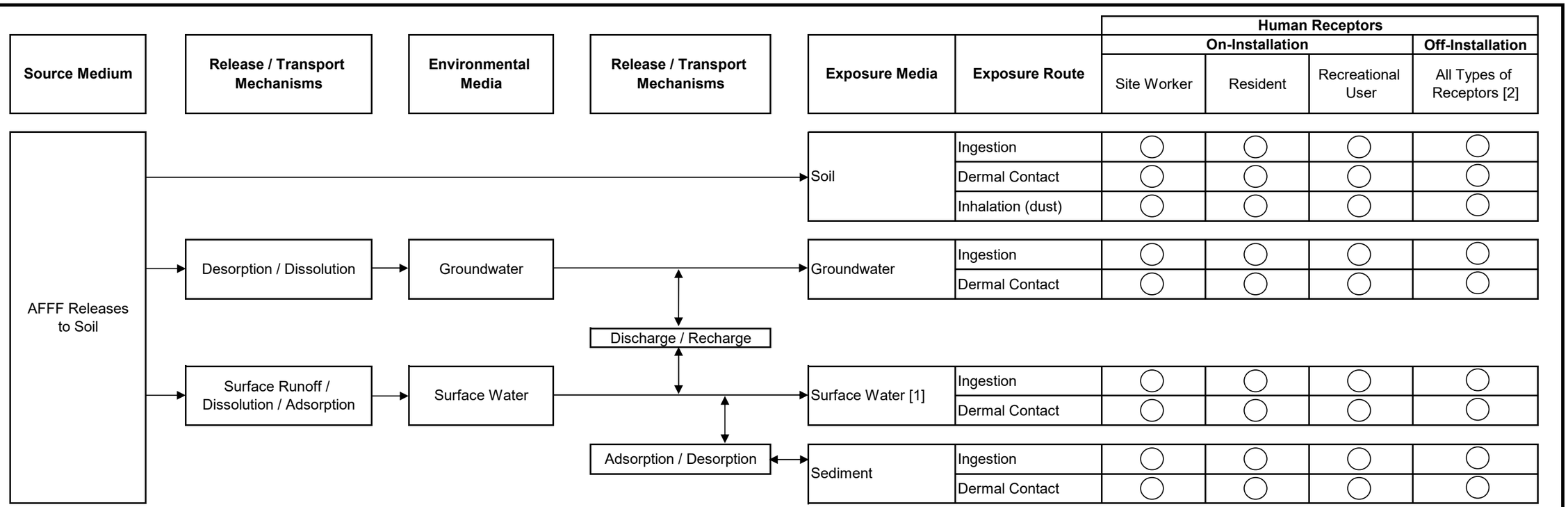
◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest

ARCADIS

Conceptual Site Model - Range 33 Target Area AOPI
United States Army Environmental Command Per- and Polyfluoroalkyl Substances Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-26



Legend:

◐ = Potentially Complete Exposure Pathway

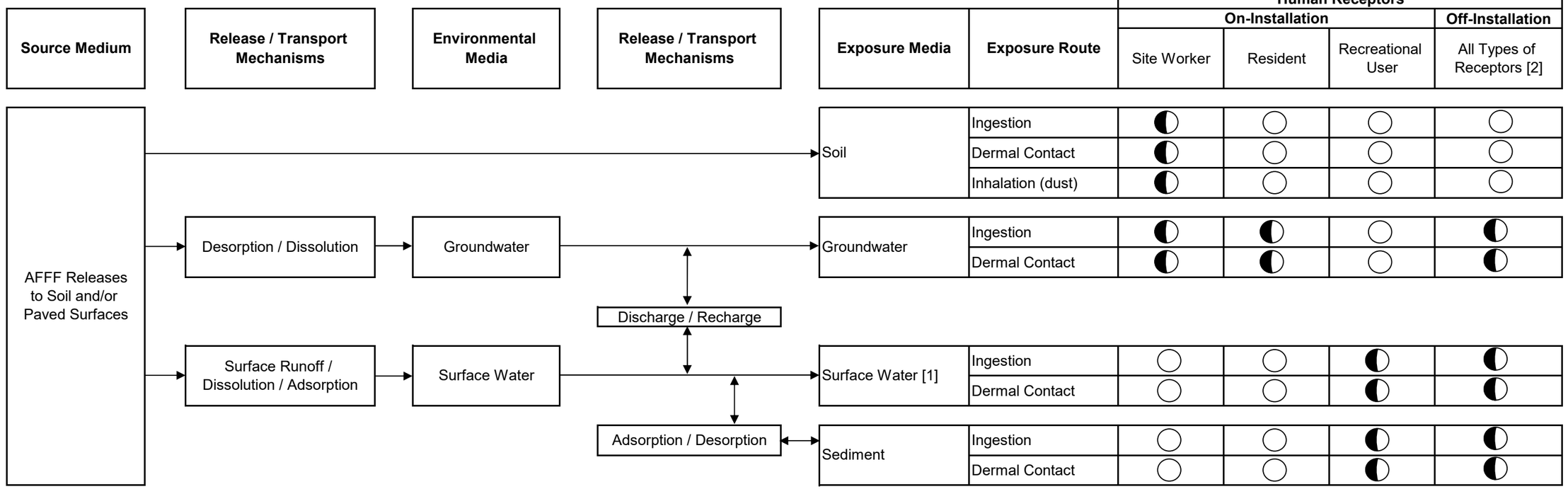
◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest

ARCADIS

Conceptual Site Model - Range 34 Lines 15 & 16 AOPI
United States Army Environmental Command Per- and Polyfluoroalkyl Substances Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-27



Legend:

◐ = Potentially Complete Exposure Pathway

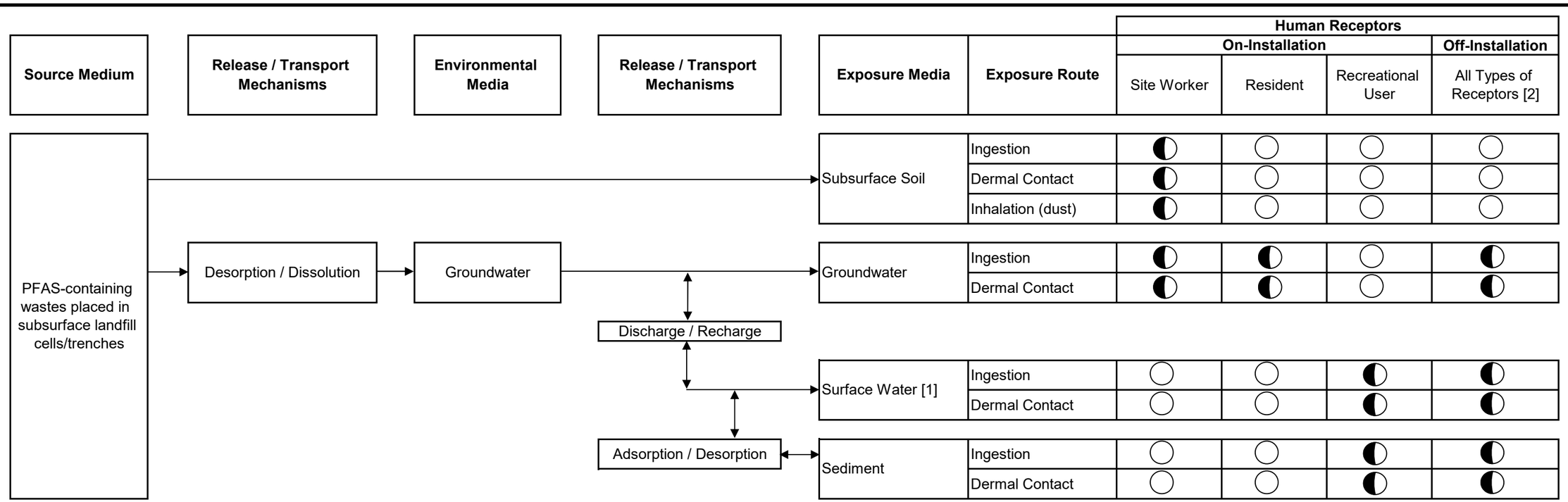
◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AFFF = aqueous film-forming foam
AOPI = area of potential interest

ARCADIS

Conceptual Site Model - Range 42 Mover Target Area
United States Army Environmental Command Per- and Polyfluoroalkyl Substances
Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-28



Legend:

◐ = Potentially Complete Exposure Pathway

◯ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.
AOPI = area of potential interest
PFAS = per- and polyfluoroalkyl substances

ARCADIS

Conceptual Site Model - Taylor's Corner Landfill and Wilcox Landfill
United States Army Environmental Command Per- and Polyfluoroalkyl Substances Preliminary Assessment / Site Inspection
Fort A.P. Hill, Virginia

Figure 7-29

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover, Maryland 21076

Tel 410 987 0032

Fax 410 987 4392

www.arcadis.com

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
US ARMY ENVIRONMENTAL COMMAND
2455 REYNOLDS ROAD
JOINT BASE SAN ANTONIO FORT SAM HOUSTON, TX 78234-7588

AMIM-AEC-N (200-1a2)

MEMORANDUM FOR RECORD

SUBJECT: Additional Per- and Poly-fluoroalkyl Substances (PFAS) Sites Requiring Further Evaluation in a Remedial Investigation at Fort A.P. Hill, Virginia.

1. A PFAS Site Inspection (SI) has been completed at Fort A.P. Hill, Virginia. In the SI, 18 Areas of Potential Interest (AOPIs) were screened against the Regional Screening Levels (RSLs) provided in the September 2021 Office of the Assistant Secretary of Defense (OASD) memo, Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. This screening effort determined that 7 of the 18 AOPIs required additional investigation in the Remedial Investigation (RI) phase.

2. On July 6, 2022, OASD published a revised memorandum (Enclosure) that provided RSLs for six PFAS compounds including Perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA), Perfluorononanoic acid (PFNA), Perfluorohexanesulfonic acid (PFHxS), Hexafluoropropylene oxide dimer acid (HFPO- DA) and Perfluorobutane Sulfonate (PFBS) based on the latest (May 2022) U.S. Environmental Protection Agency screening levels.

3. The environmental sampling data from the Fort A.P. Hill SI effort were rescreened against the levels identified in the July 2022 OASD memo. It was determined that 15 of the 18 AOPIs now warrant further evaluation in the Remedial Investigation. The 15 AOPIs that will be included in the Fort A.P. Hill PFAS RI are:

- **Fire Station 7**
- Fire Station 8
- **Fire Station 9**
- **Fire Training Facility**
- New Wilcox WWTP
- Old Headquarters WWTP
- **Range 24 – Mover 2**
- Range 29 – Bunker
- Range 29 – Plywood Structures
- **Range 42 – Mover Target Area**
- **Range 43 – Plywood Structures Area**
- Taylor's Corner Landfill
- **Training Area 17A – Transformer Fire**

- Vehicle Maintenance Facility
- **Wilcox Landfill**

* Bolded text indicates additional AOPIs moving to RI based on July 2022 screening levels

4. The point of contact for this memorandum is the undersigned at 210-793-6898.

Encl
Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program

LAURIE HAINES-EKLUND
Team Lead, PFAS Program Team
USAEC Northeast Division

ENCLOSURE

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3400 DEFENSE PENTAGON
WASHINGTON, DC 20301-3400

ENERGY, INSTALLATIONS,
AND ENVIRONMENT

July 6, 2022

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS, ENERGY AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE NAVY (ENERGY, INSTALLATIONS AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (INSTALLATIONS, ENVIRONMENT AND ENERGY)
DIRECTOR, NATIONAL GUARD BUREAU (JOINT STAFF, J8)
DIRECTOR, DEFENSE LOGISTICS AGENCY (INSTALLATION MANAGEMENT)

SUBJECT: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program

The Department of Defense (DoD) conducts cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Defense Environmental Restoration Program (DERP). Our goal is protection of human health and the environment in a risk-based, fiscally-sound manner. This memorandum provides clarifying technical guidance on the investigation of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA, or GenX), based on recent U.S. Environmental Protection Agency (EPA) information. This guidance is applicable to investigating these chemicals at Environmental Restoration Account-funded, Base Realignment and Closure Account-funded, and federal Air and Army Guard Operation and Maintenance account-funded sites.

This revised memorandum accounts for the May 2022 EPA screening levels for PFOS, PFOA, PFNA, PFHxS and HFPO-DA. PFBS remains unchanged since the May 2021 update. EPA has provided screening levels for these PFAS compounds using, updated, final, peer-reviewed information from the Agency for Toxic Substances and Disease Registry[1] and the EPA Office of Water.[2]

PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA are part of a larger class of chemicals known as per- and polyfluoroalkyl substances (PFAS). PFAS shall be addressed in the same manner as other contaminants of concern within the DERP. HFPO-DA has primarily

[1] Agency for Toxic Substances and Disease Registry (ATSDR), May 2021. *Toxicological Profile for Perfluoroalkyls*.

[2] U.S. Environmental Protection Agency (EPA), *Provisional Peer-Reviewed Toxicity Values for Perfluorobutane Sulfonic Acid (CASRN 375-73-5)* and October 2021. *Human Health Toxicity Values for Hexafluoropropylene Oxide (HFPO) Dimer Acid and Its Ammonium Salt (CASRN 13252-13-6 and CASRN 62037-80-3), Also Known as "GenX Chemicals."* Office of Water.

been used as a replacement for PFOA in the manufacture of fluoropolymers, so it is not likely to have been released at the vast majority of DoD properties. As with other chemicals, the conceptual site model should be used to determine the necessity for addressing HFPO-DA.

Under CERCLA, site-specific regional screening levels[3] (RSLs) for these chemicals are shown in the EPA RSL Tables or may be calculated using the EPA online calculator. The values are provided in the attachment. When multiple PFAS are encountered at a site, RSLs set at a hazard quotient of 0.1 are used for screening purposes. These RSLs should be used to determine if further investigation in the remedial investigation (RI) phase is warranted or if no further action is required. Consistent with the CERCLA process, DoD Components will incorporate these screening values into ongoing and future preliminary assessment/site inspections (PA/SI) and will reevaluate completed PA/SIs with a determination of "no further action," to assess if an RI is now necessary.

During the RI phase, the RfDs for PFOS, PFOA, PFBS, PFNA, PFHxS, and HPFO-DA and the oral cancer slope factor (CSF) for PFOA of 0.07 $(mg/kg\text{-}day)^{-1}$ will be used to conduct site specific risk assessments in accordance with Risk Assessment Guidance for Superfund Volume I, Part A (EPA/540/1-89/002, December 1989).[4] Site-specific risk assessment results will depend on the levels of PFAS found at each site, and will be used to determine if any necessary remedial actions are required in accordance with CERCLA, DERP, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This memorandum is effective immediately and supersedes and cancels the Assistant Secretary of Defense for Sustainment memorandum, "Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program," September 15, 2021. The point of contact for this matter is Ms. Alexandria Long, at 703-571-9061 or alexandria.d.long.civ@mail.mil.

MCANDREW.MICHAEL.1043243000
Digitally signed by MCANDREW.MICHAEL.1043243000
Date: 2022.07.06 13:39:15 -04'00'

Michael McAndrew
Deputy Assistant Secretary of Defense for Construction
Performing the Duties of Principal Deputy Assistant Secretary of Defense for Energy, Installations, and Environment

Attachment:
As stated

[3] For sites on the National Priorities List, the DoD Components will use the EPA site specific screening levels, if provided.
[4] Currently there are six PFAS – PFOS, PFOA, PFBS, PFNA, PFHxS, HPFO-DA (GenX) – with established toxicity values that DoD can use to perform a baseline risk assessment to determine whether remedial action is needed under CERCLA.

Attachment: Risk Screening Levels Calculated for PFOS, PFOA, PFBS, PFNA, PFHxA, HFPO-DA in Groundwater or Soil Using EPA's RSL Calculator

Chemical	Carcinogenic Slope Factor - Oral (SF) (mg/kg-day)-1	Non-Carcinogenic Reference Dose (RfD) (mg/kg-day)	Residential Scenario Screening Levels Calculated Using EPA RSL Calculator								Industrial/Commercial Composite Worker Screening Levels Calculated Using EPA RSL Calculator			
			Tap Water (ng/L or pptr)				Soil (mg/kg or ppm)				Soil (mg/kg or ppm)			
			HQ = 0.1	HQ = 1.0	ILCR = 1E-06	ILCR = 1E-04	HQ = 0.1	HQ = 1.0	ILCR = 1E-06	ILCR = 1E-04	HQ = 0.1	HQ = 1.0	ILCR = 1E-06	ILCR = 1E-04
PFOS	NA	2.00E-06	4	40	NA	NA	0.013	0.13	NA	NA	0.16	1.6	NA	NA
PFOA	7.00E-02	3.00E-06	6	60	1,100	111,000	0.019	0.19	7.8	775	0.25	2.5	33	3,280
PFBS	NA	3.00E-04	601	6010	NA	NA	1.9	19	NA	NA	25	250	NA	NA
PFNA	NA	3.00E-06	6	59	NA	NA	0.019	0.19	NA	NA	0.25	2.5	NA	NA
PFHxS	NA	2.00E-05	39	394	NA	NA	0.13	1.30	NA	NA	1.6	16	NA	NA
HFPO-DA	NA	3.00E-06	6	60	NA	NA	0.023	0.23	NA	NA	0.35	3.5	NA	NA

HQ=Hazard Quotient
ILCR=Incremental Lifetime Cancer Risk
NA=Not available/applicable

NOTES:

- Apply the Tap Water RSLs to groundwater used as drinking water.
- The table represents screening levels based on residential and industrial/commercial worker receptor scenarios for either direct ingestion of groundwater (residential scenario only) or incidental ingestion of soil (both residential and composite worker scenarios).
- Default exposure assumptions for each potential receptor scenario, contained in EPA's RSL Calculator on May 2022.
- Final peer reviewed toxicity values considered valid for risk assessment, and the screening levels may be found in EPA's RSL table or EPA's RSL calculator used to develop them.
- Other potential receptor scenarios (e.g., recreational user, site trespasser, construction worker) are not included in the above table, but could be relevant receptors at a site potentially containing PFAS. These receptors, and their associated exposure scenarios, should be further considered in the scoping phase and completion of the Baseline Human Health Risk Assessment typically completed during an RI.
- The shaded values represent conservative screening levels in groundwater or soil that when exceeded should be considered a contaminant of potential concern in the risk assessment process and calculations of site-specific risk posed.