SITE INSPECTION REPORT FOR PER- AND POLYFLUOROALKYL SUBSTANCES AT RED RIVER ARMY DEPOT, TEXAS

Prepared for:

U.S. ARMY

ODCS, G-9, ISE BRAC

Final

December 2023

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Prepared for:
ODCS, G-9, ISE BRAC
600 Army Pentagon
Washington, DC 20310

Prepared by:
ARS Aleut Remediation
663 Emory Valley Rd
Oak Ridge, TN 37830

Kaleb Brumbaugh
AAR – Assistant Project Manager

Don Welch
AAR – Corporate Quality Manager

Mark Fletcher
AAR – Director of Environmental Services

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ACRONYMS AND ABBREVIATIONS

%	percent
%R	percent recovery
°C	degrees Celsius
AFFF	aqueous film-forming foam
amsl	above mean sea level
AOPI	Area of Potential Interest
APAR	Affected Property Assessment Report
Army	U.S. Army
bgs	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	centimeters per second
CoC	chain-of-custody
CSM	conceptual site model
DCE	dicholoroethylene
DERP	Defense Environmental Restoration Program
DoD	U.S. Department of Defense
DPT	Direct Push Technology
DQO	Data Quality Objective
DUA	data usability assessment
ELAP	Environmental Laboratory Accreditation Program
EIS	extracted internal standard
FD	field duplicate
GPS	global positioning system
GW	groundwater
HFPO-DA	Hexafluoropropylene Oxide Dimer Acid (GenX)
HDPE	high-density polyethylene
HQ	hazard quotient
HQDA	Headquarters Department of the Army
ID	identification
IDW	investigation-derived waste
IWTP	Industrial Wastewater Treatment Plant
LC/MS/MS	liquid chromatography with tandem mass spectrometry
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
LSAAP	Lone Star Army Ammunition Plant
LUC	land use control
LUCIP	LUC Implementation Plan
mg/kg	milligrams per kilogram
MIL-SPEC	Military Specification
MS	matrix spike
MSD	matrix spike duplicate
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ng/L	nanograms per liter

NPL	National Priorities List
OTC	Ordnance Training Center
OSD	Office of the Secretary of Defense
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCL	protective contamination levels
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutane sulfonate
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexane sulfonate
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PMZ	plume management zone
PRB	permeable reactive barrier
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RACR	Response Action Complete Report
RAP	Remediation Action Plan
RRAD	Red River Army Depot
RRAD-WEP	RRAD Western Excess Parcel
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPD	relative percent difference
RWRD	Riverbend Water Resources District
RSL	regional screening level
SDG	sample delivery group
SGS	SGS North America, Inc.
SI	Site Inspection
SL	screening level
SO	soil
SOP	standard operating procedure
SVOC	semivolatile organic compound
TAC	TexAmericas Center
TCA	tricholoroethane
TCE	trichloroethylene
TCEQ	Texas Commission on Environmental Quality
TCLP	toxicity characteristic leaching procedure
TDLR	Texas Department of Licensing and Regulation
TGI	technical guidance instruction
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
U.S.	United States

USACE	U.S. Army Corps of Engineers
USDOT	U. S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

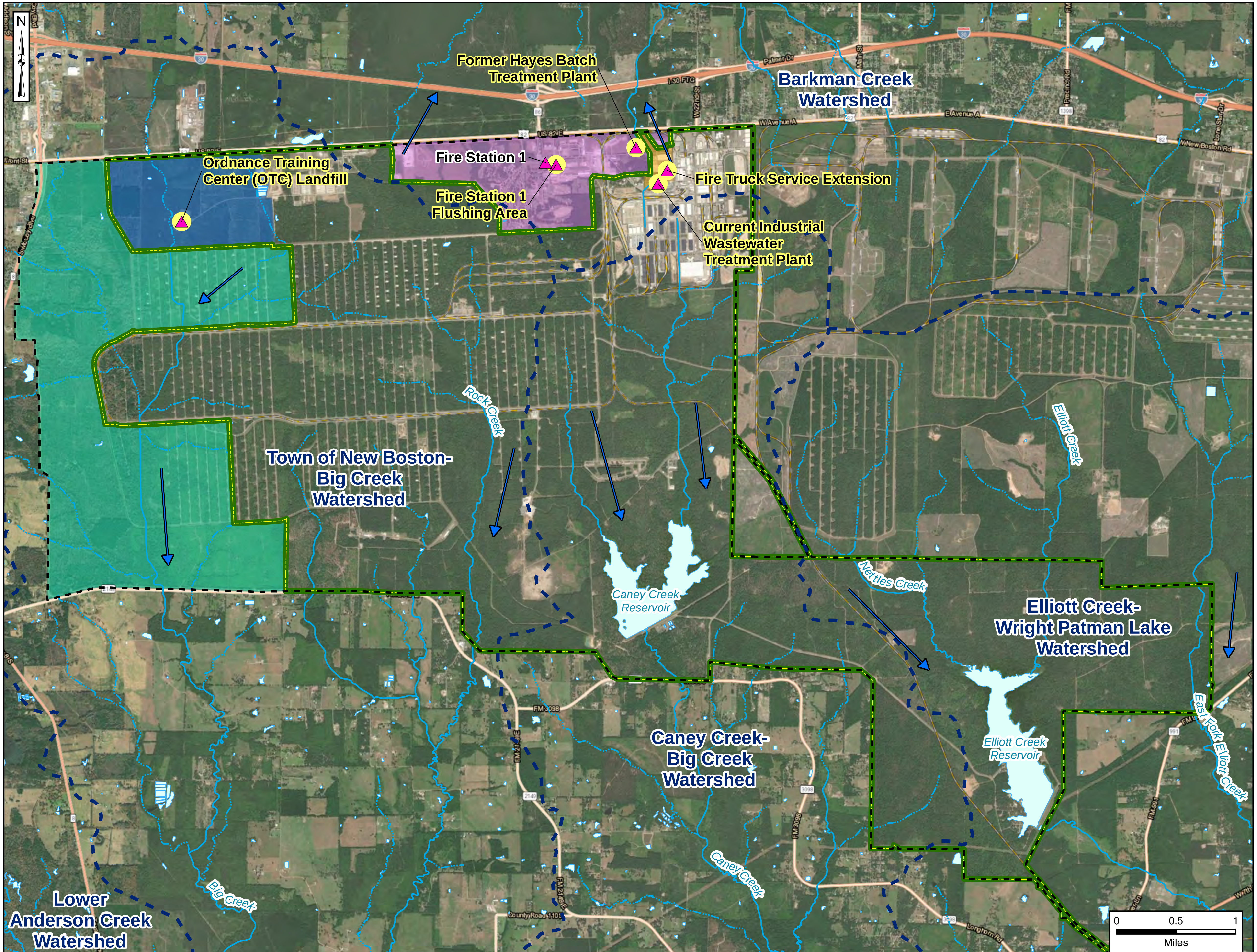
The United States (U.S.) Army (Army) is conducting Preliminary Assessments (PAs) and Site Inspections (SIs) to determine the use, storage, disposal, or release of per- and polyfluoroalkyl substances (PFAS) at Base Realignment and Closure (BRAC) installations, nationwide. This report documents SI activities conducted for six areas of potential interest (AOPIs) at the Red River Army Depot (RRAD) in Bowie County, Texas. AOPIs were identified during the PA phase for investigation through multimedia sampling in an SI phase to determine whether a PFAS release occurred. Activities were completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 U.S.C. §9601, et. seq.), the Defense Environmental Restoration Program (DERP, 10 U.S.C. §2700, et. seq.) the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300), and Army and U.S. Department of Defense (DoD) policy and guidance, and U.S. Environmental Protection Agency (USEPA) guidance.

The PA identified areas where PFAS-containing materials were used, stored, and/or disposed of, or areas where known or suspected releases to the environment occurred. Based on recommendations from the PA, soil and/or groundwater samples were collected from the six AOPIs. The field investigation at RRAD was conducted in accordance with the Uniform federal Policy-Quality Assurance Project Plan (UFP-QAPP) (AAR 2023a). Samples collected during this SI were analyzed for PFAS using procedures compliant with the DoD Quality Systems Manual (QSM) Version 5.3, Table B-15 (DoD 2019) and the laboratory standard operating procedure (SOP).

To determine if further investigation is warranted at each AOPI, this SI followed established USEPA guidance as well as DoD policy and guidance for investigating perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutane sulfonate (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), perfluorohexanoic acid (PFHxA), perfluorobutanoic acid (PFBA), and hexafluoropropylene oxide dimer acid (HFPO-DA) (also known as GenX) (DoD 2023). Analytical results for samples collected during this SI were compared to residential scenario screening levels (SLs) calculated using the USEPA's regional screening level calculator for soil and the tap water criteria for groundwater, as published in the 2023 Office of the Secretary of Defense (OSD) Memorandum (DoD 2023). Of the six PFAS compounds presented in the 24 August 2023 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte in the Final UFP-QAPP for this SI (Aleut 2023a). Based on the conceptual site model (CSM) developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at RRAD because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF). Also, based on GenX's history, including distribution limitations that restricted its use, GenX is generally not a component of other products the military used. Since PFAS is a large grouping consisting of thousands of individual chemicals, PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, and PFBA altogether will be referred to in this report as "Target PFAS."

CSMs were developed during the PA, and then updated for each AOPI where Target PFAS were detected (at concentrations above the level of detection [LOD]). The updated CSMs detail site geological conditions; determine primary and secondary release mechanisms; identify potential human receptors; and detail complete, potentially complete, and incomplete exposure pathways for current and reasonably anticipated future exposure scenarios. Target PFAS were detected in at least one medium at all six AOPIs. PFOS and PFOA concentrations exceeded SLs for groundwater at four of the AOPIs and PFOS equaled the SL at an estimated concentration (J flagged) in a groundwater sample at a fifth AOPI. Figure ES-1 depicts the facility-wide map of AOPIs and the distribution of SL exceedances and proximity to facility boundaries.

Table ES-1 summarizes the AOPIs investigated during the SI and recommendations for further investigation.



BRAC Site Inspection
Red River Army Depot, TX

Figure ES-1
Summary of AOPI
OSD Risk Screening
Level Exceedances

Legend
- Installation Boundary
- Historical RRAD Installation Boundary
- AOPI Location
- AOPI with OSD Risk Screening Level Exceedance
- BRAC 1995 – To Be Transferred (Army Retained, BRAC Control)
- BRAC 1995 – Transfer Complete
- BRAC 2005 – To Be Transferred (Army Retained, BRAC Control)
- BRAC 2005 – Transfer Complete
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Watershed
- Surface Water Flow Direction

AOPI = area of potential interest
BRAC = Base Realignment and Closure
OSD = Office of the Secretary of Defense

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

Table ES-1. Summary of AOPIs and Recommendations for Further Investigation

AOPI Name	Exceedance of SLs		Recommendation
	Groundwater	Soil	
Fire Station 1	No	No	Further investigation not recommended
Fire Station 1 Flushing Area	Yes[1]	No	Further investigation recommended
Fire Truck Service Extension	Yes	No	Further investigation recommended
Ordnance Training Center Landfill	Yes	NS	Further investigation recommended
Former Hayes Batch Treatment Plant	Yes	ND	Further investigation recommended
Current Industrial Wastewater Treatment Plant	Yes	NS	Further investigation recommended

Notes:

Highlighted values indicate AOPIs with a recommendation for further investigation.

AOPI – area of potential interest

No – PFOS, PFOA, PFBS, PFNA, PFHxS, PFHxA, and/or PFBA detected at a concentration below the SL

ND – non-detect

NS – not sampled

SL – screening level

Yes – PFOS, PFOA, PFBS, PFNA, PFHxS, PFHxA, and/or PFBA detected at a concentration above the SL

[1] Recommendation made based on J-flagged groundwater results equal to the SL for PFOS. A J flag qualifier indicates that the analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.

1. INTRODUCTION

The U.S. Army (Army) is conducting Preliminary Assessments (PAs, 40 CFR 300.420(b)) and Site Inspections (SIs, 40 CFR 300.420(c)) to investigate the potential presence or release of Per-and Polyfluoroalkyl Substances (PFAS), by investigating the use, storage, or disposal of per- and polyfluoroalkyl substances (PFAS) at multiple Base Realignment and Closure (BRAC) installations, nationwide. This SI is focused on the 4,632 acres of Red River Army Depot (RRAD) property which were declared excess by the 1995 and 2005 BRAC commissions. This SI was conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 United States Code [U.S.C.] §9601 et seq.); the Defense Environmental Restoration Program (DERP, 10 U.S.C. §2700 et seq.); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 Code of Federal Regulations [CFR] Part 300); and guidance documents developed by the U.S. Environmental Protection Agency (USEPA), the Department of Defense (DoD) and the Army. RRAD is not on the National Priorities List (NPL), and the Army is responsible for compliance with CERCLA in accordance with Executive Order 12580, as amended.

Based on results of the RRAD PFAS PA (AAR 2023b), six areas of potential interest (AOPIs) were identified for investigation through multimedia sampling in an SI to determine whether a PFAS release occurred. RRAD is located in Bowie County, Texas. The installation is approximately 18 miles west of Texarkana, Texas. The installation is adjacent to and south of Hooks, Texas, as well as adjacent to and east of New Boston, Texas (AMC 2017). The location of the installation, including its historical boundary, is depicted on Figure 1-1. Much of the installation is still operational and the site remains active. Further, some transferred property is currently leased back to the Army for RRAD operations. Therefore, this report only discusses the DoD/Active Army operation of excess areas prior to their transfer and not the 14,481 acres within RRAD that will be retained by RRAD as a U.S. Army Reserve enclave. The 4,632 acres of RRAD property which were declared excess by previous BRAC commissions are referred to as the "site" throughout the document. Any references to "off-site" refers to areas that are outside the boundary of these properties. The entire historical extent of RRAD is referred to as the "installation" throughout this document for the purposes of describing operational history and environmental setting.

1.1 SCOPE AND OBJECTIVES

The overall objective of the SI is to determine the presence or absence of PFAS at each AOPI. The SI Report will use the findings from the PA in conjunction with soil and groundwater sampling data to determine whether PFAS have been released to the environment and whether a release has affected or may affect specific human health targets. Furthermore, the SI will evaluate and summarize the need for additional investigation (40 CFR 300.420(c)(1)).

The SI scope included preparation of project planning documents; field investigation; validation and management of analytical data; comparison of analytical data to OSD screening levels (SLs); and documentation of the investigation results. This SI was conducted in accordance with the Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) (AAR 2023a). The field activities followed site-specific sampling and health and safety protocols, as identified in the Accident Prevention Plan and the Site Safety and Health Plan (Appendix E of the UFP-QAPP Addendum).

1.2 RRAD DESCRIPTION

RRAD is an Army facility located in east Texas, in Bowie County. Several rounds of BRAC have impacted RRAD (1988, 1995, and 2005), including transfer of missions into and out of the installation, as well as property conveyances. Across these events, total of 4,632 acres have been declared excess. Some transferred property is currently leased back to the Army for RRAD operations.

The excessed property has been transferred primarily to the Red River Redevelopment Authority, which would later become TexAmericas Center (TAC) in May 2011. Excessed property was also transferred to Riverbend Water Resources District (RWRD), Texas Department of Transportation, and a private landowner as recently as 2016. Excess land which has not yet been transferred may transfer to TAC after the Army has completed environmental response actions. Land which has been transferred is leased back to the Army and/or has been redeveloped into an office and industrial park that is home to multiple businesses (TAC 2021).

During the development of the PA, historical records, interviews, site reconnaissance, available documentation and physical evidence were reviewed to determine where PFAS-containing materials may have previously been stored, used, or disposed (40 CFR 300.420(b)(5)). The evaluated areas include fire stations; pesticide storage facilities; photochemical processing facilities; chemical storage areas; and munitions disposal sites. The RRAD PFAS PA recommended six AOPIs for further investigation in an SI due to known or potential historical PFAS-containing material use, storage, or disposal. The AOPIs, as well as the dates of operation and sizes of each area, are presented in Table 1-1 and illustrated in Figure 1-2.

Table 1-1. List of AOPIs at RRAD

AOPI Name	Dates of Operation	Approximate Size (acres)
Fire Station 1	1942 to present	1
Fire Station 1 Flushing Area	Estimated 1942 to present	1
Fire Truck Service Extension	1983 to present	5
Ordnance Training Center Landfill	1942 to 1985	9
Former Hayes Batch Treatment Plant	1961 to 1978	2
Current Industrial Wastewater Treatment Plant	1978 to present	12

1.3 REPORT ORGANIZATION

The contents of the remaining sections of this SI Report are summarized below:

- ***Section 2. Environmental Setting***—This section discusses the environmental setting at RRAD. Demographics, land use, geology, hydrogeology, hydrology, soil, and climate are described.
- ***Section 3. Field Investigation Activities***—This section provides field procedures followed during the implementation of the SI.
- ***Section 4. Data Analysis and Quality Assurance Summary***—This section describes the laboratory chemical analysis program for the investigation. Sample handling procedures, laboratory equipment calibration, laboratory analytical methods, data reporting and validation, and sample data quality assurance (QA)/quality control (QC) are discussed.
- ***Section 5. Screening Levels***—This section presents the PFAS with SLs outlined in the 2023 Office of the Secretary of Defense (OSD) Memorandum (DoD 2023) and the SLs to which SI results are compared.
- ***Section 6. SI Results***—This section presents the data gathered during the SI activities and updated conceptual site models (CSMs).
- ***Section 7. Conclusions and Recommendations***—This section summarizes the SI conclusions and presents recommendations for the RRAD AOPIs.
- ***Section 8. References***—This section lists the references that were used in the preparation of this report.

- ***Appendices***—Appendices A through I include data from field activities or related assessments:
  - Appendix A. Daily Quality Control Reports
  - Appendix B. Photograph Log
  - Appendix C. Boring Logs and Well Construction Logs
  - Appendix D. Sampling and Calibration Logs
  - Appendix E. Investigation-Derived Waste (IDW) Documents
  - Appendix F. Data Usability Assessment and Laboratory Reports
  - Appendix G. Data Presentation Tables.

2. ENVIRONMENTAL SETTING

This section provides general information about RRAD, including the site location, operational history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 5-mile radius of the installation, and applicable ecological receptors.

2.1 SITE LOCATION

RRAD, including its previous iterations (e.g., Red River Ordnance Depot and Red River Arsenal), was established in 1941 as an ammunition storage facility and since has also been used for major operational missions including maintenance and rebuilding of light tracked vehicles; demilitarization of out-of-specification ordnance; ammunition renovation; maintenance, modification, and recertification of the various weapon systems; and track and road wheel rebuild. RRAD is located in Bowie County, Texas. The installation is approximately 18 miles west of Texarkana, Texas. The installation is adjacent to and south of Hooks, Texas, as well as adjacent to and east of New Boston, Texas (AMC 2017). Land surrounding the installation is sparsely populated; primarily consisting of agricultural land and mixed soft and hardwood forest. There is no land use zoning within Bowie County (U.S. Army Corps of Engineers [USACE] Mobile District 2008). The majority of surface water drainage of RRAD is to the south by way of Big, Rock, Caney, Nettles, Elliott, and East Fork Creeks. The remaining surface water drainage is to the north by Panther Creek and Jones Creek tributaries (which eventually terminates in the Red River). Jones Creek tributaries exist in the most northeastern portion of the installation (Woodward-Clyde Federal Services 1996). Figure 2-1 depicts the RRAD site features, including the site boundary, roads, buildings, topography, and surface water bodies.

2.2 SITE OPERATIONAL HISTORY

The mission of RRAD was originally only to function as an ammunition storage facility. However, in the 1940s, its mission expanded to include general supply storage; tank repair and modification; and tank, artillery, and small firearms shipping. From 1943 to 1944, the Lone Star Ordnance Plant (later named Lone Star Army Ammunition Plant [LSAAP]) was associated with RRAD as the Texarkana Ordnance Center. In 1945, the Texarkana Ordnance Center was abolished and LSAAP was then incorporated with Red River Ordnance Depot (and later named RRAD). These merged installations were referred to Red River Arsenal and conducted primarily demilitarization and renovation work under the jurisdiction of Red River Arsenal until 1951.

From 1945 to 1950, RRAD conducted demilitarization activities that included munitions destruction and equipment renovation. In 1950, RRAD was utilized as the designated assembly site for the Hawk missile system, servicing 25 percent (%) of the Army's needs. In the 1970s, RRAD began conversation of 5,000 M113 vehicles from gasoline to diesel power; conducted in their industrial complex which had the capacity and capability to overhaul and remanufacture tactical vehicles as well as combat systems (ELM Consulting, LLC 2008; ALL Consulting, LLC 2016; HQDA 2020). By 1978, the installation had a general mission to operate a supply depot providing for the receipt, storage, issue, maintenance, and disposal of assigned commodities. The most significant activities included recovery and maintenance of Army motorized vehicles; storage, surveillance, maintenance, and demilitarization of ammunition; and provision of utilities and support services to LSAAP and various branches of the U.S. Military (Headquarters Department of the Army [HQDA] 2019, Department of the Army, Office of the Project Manager for Chemical Demilitarization, and Installation Restoration 1978). In the 1980s, facilities began modernizing, and RRAD was established as the only depot to have major missions in supply, ammunition, and maintenance.

2.3 DEMOGRAPHICS, PROPERTY TRANSFER, AND LAND USE

The installation is primarily surrounded by parks/preserves to the south, agricultural cropland, woodlands, and pastures to the north, the Texarkana metropolitan area to the east, and agricultural cropland, pastures, and the city of New Boston to the west (RRAD 2021). In the city of New Boston is the New Boston Industrial Park. There are no zoning regulations in effect for the area surrounding RRAD, in the non-incorporated area of Bowie County. Land use in Bowie County is heavily agricultural, with approximately 300,000 acres or approximately 52% of the total land area of the county in farm production (United States Department of Agriculture 2017). The population of Bowie County in 2020 was 92,983 according to U.S. Census survey data (U.S. Census Bureau 2020).

2.3.1 BRAC Events

Several rounds of BRAC have impacted RRAD (1988, 1995, and 2005), including transfer of missions into and out of the installation, as well as property conveyances. Across these events, total of 4,632 acres have been declared as Federal Surplus.

2.3.1.1 BRAC 1995 – Transfer Complete

In 1995, the Commission directed the realignment of RRAD to include moving all maintenance missions, except for those related to the Bradley Fighting Vehicle Series, from RRAD to other depot maintenance activities, including into the private sector. RRAD retained the conventional ammunition storage mission, the Intern Training Center, the Rubber Production Facility, and civilian training education missions. The 797 acres of property which was not required to support these missions was excessed as part of the BRAC event, although 60 acres have yet to be transferred (see Section 2.3.1.2). A total of 737 acres were transferred through the Red River Redevelopment Authority, which would later become TAC in May 2011. TAC was founded with the express purpose of acquiring surplus military property and developing it into a dynamic industrial park. Land transfers began in 1999 (Headquarters Department of the Army [HQDA] 2020).

The 737 acres of land which have been transferred are used for residential, commercial, and industrial purposes. Although TAC has redeveloped and sold much of BRAC 1995 - Transfer Complete property, two of the AOPIs evaluated during the SI (Fire Station 1 and Fire Station 1 Flushing Area) are located in areas still owned by TAC. TAC leases some buildings in this area back to the Army, including Fire Station 1. One AOPI is currently owned by RWRD (Former Hayes Batch Treatment Plant).

2.3.1.2 BRAC 1995 – To Be Transferred

There are approximately 60 acres associated with the 797 acres determined to be excess under BRAC 1995 which are known as the “Western Industrial Area” and has not yet been transferred due to ongoing environmental cleanup by BRAC. Two of the AOPIs evaluated during the SI (the Current Industrial Wastewater Treatment Plant and the Fire Truck Service Extension) are within the BRAC 1995 – To Be Transferred property. This area remains owned by the Army and remains under BRAC control until cleanup can be achieved, although several buildings and operations have been transferred to TAC and RWRD for use (HQDA 2019). Although the Current Industrial Wastewater Treatment Plant (IWTP) facility has not been transferred by the Army and is under BRAC control, the Current IWTP property is leased by TAC in furtherance of conveyance and the facility is operated by RWRD under their own permit (Lawson 2021; RRAD 2021).

2.3.1.3 BRAC 2005 – Transfer Complete

The 2005 BRAC Commission recommended the realignment of RRAD, including the relocation of the storage and demilitarization functions of the Munitions Center to the McAlester Army Ammunition Depot, Oklahoma and Blue Grass Army Depot, Kentucky. The BRAC Commission also recommended the relocation of the depot maintenance of tactical missiles to Letterkenny Army Depot, Pennsylvania, and the disestablishment of the supply, storage, and distribution function for tires, packaged petroleum, oil, lubricants, and compressed gases. Open burning/open demolition, missile recertification, and ammunition storage was discontinued at the RRAD after this land transfer.

Approximately 3,835 acres were determined to be excess in 2005. As of 2020, the Army has transferred 3,189 of the 3,865 excess acres of the BRAC 2005 property. These transfers include the RRAD Western Excess Parcel or “RRAD-WEP”) to TAC (2,851 acres), the Texas Department of Transportation (28 acres), and a private owner (311 acres). There are no AOPIs within the BRAC 2005 – Transfer Complete area. The land consists of residential developments, undeveloped land, timber lands, and ranch land.

2.3.1.4 BRAC 2005 – To Be Transferred

There are 646 acres which have yet to be transferred. These are maintained by the Army and will be disposed of through public or negotiated sale, anticipated in the future (HQDA 2020). The Ordnance Training Center (OTC) Landfill is the only AOPI which is located within the BRAC 2005 – To Be Transferred area. The Army is working with the Texas Commission on Environmental Quality (TCEQ) and the USEPA on the ongoing operation of groundwater monitoring at the OTC to receive a remediation complete statement under the Resource Conservation and Recovery Act Permit so that the land may be disposed of via planned public sale.

2.4 TOPOGRAPHY

RRAD is situated within the west Gulf Coastal Plain physiographic province. The area can be described as flat to slightly rolling with extensive flats present in the north. The installation generally slopes gently to the southeast. The overall elevation relief on post is approximately 180 feet.

An estimated 75% of the installation has a slope between 1% and 6%. Occasionally slopes near streams range up to 12%, but these steep slopes are rare. Slopes greater than 12% are not present (Woodward-Clyde Federal Services 1996; Department of the Army, Office of the Project Manager for Chemical Demilitarization, and Installation Restoration 1978).

2.5 GEOLOGY

The Mesozoic-Cenozoic coastal geosyncline that forms the Gulf Coastal Plains physiographic province in the region of RRAD contains formations of limestone and sandstone deposited along margins of the ancient receding coastline. The geologic strata forming Bowie County were deposited during the upper Cretaceous and lower Tertiary periods. The most extensively exposed units in the vicinity are the Wilcox Formation (Paleocene-Eocene Series) and Midway Group (Paleocene Series) of the Tertiary System. The Pleistocene-age (Tertiary) deposits are terraces of the Red River, located north of RRAD. Recent alluvium is present along the floodplain of the Red River and its tributaries, and to a lesser extent, along the narrower floodplains of Caney, Big, and Rock Creeks within RRAD. Descriptions of the geological units found in the vicinity of RRAD are provided below.

The Paleocene-age (Tertiary) Midway Group is mostly clay, locally lignitic, some calcareous siltstone concretions, thin bedded to locally massive, and of various gray shades with some silt in the upper part. The Midway Formation (part of the Midway Group) has been described as a finely laminated marine clay deposited in a slowly subsiding restricted (euxinic) basin, which contains large quantities of pyrite and other iron sulfide minerals. Marine fossils occur throughout its thickness, estimated to be up to 900 feet. This formation is not considered transmissive. The Midway Group is found at RRAD below soil horizons in the northern portion of the facility. To the south and east at LSAAP, the Midway Group lies below the lower portion of the Wilcox Formation (Kemron Environmental Services 2006).

The Paleocene-Eocene Series (Tertiary) Wilcox Group consists primarily of cross-bedded fine- to medium-grained sand, clay, and lignite. The upper and lower portions of the formation have a larger percentage of sand than the middle. However, massive beds 100 feet or more in thickness made entirely of medium sand may occur. Individual sand beds are lenticular and may grade laterally into clay, lignite, or silt in short distances. The clays are generally light to dark gray, whereas the sands tend to be reddish-brown to light gray. The total thickness of the Wilcox Group ranges up to 800 feet. Locally at RRAD, the Wilcox Group was deposited in a fluvial channel/floodplain environment, but farther south it was deposited in a combination fluvial and deltaic environment.

The Eocene-age (Tertiary) Carrizo Sand, which overlies the Wilcox Formation, consists of very fine- to medium-grained quartz sand and an interbedded sequence of fine sand, silt, and clay, generally present near the top of the formation. The highly variable thickness of the Carrizo Sand ranges from 0 to more than 100 feet. The Carrizo Sand has not been reported at RRAD but does outcrop several miles south.

Quaternary alluvium, present along streams and creek beds in the Red River drainage basin, consists primarily of unconsolidated very fine- to very coarse-grained sand interbedded with dark-colored clay silt and gravel. The deposits are highly irregular in areal extent and thickness, which range from 0 to 340 feet in portions of northeast Bowie County (Kemron Environmental Services 2006).

2.6 HYDROGEOLOGY

Groundwater flow is generally in the same direction as surface water flow at areas underlain by the Midway or Wilcox Groups; groundwater and surface water across most of the installation flow to the south. Due to an east-west trending drainage divide in the northern part of the installation, a small portion of groundwater and surface water flow is to the north (Figure 2-1). The clay shales in the northern portion of RRAD yield small quantities of groundwater and are typically hydrostratigraphic. Depth to groundwater is usually shallow, ranging from near ground surface along creek bottoms to approximately 25 to 40 feet along ridge lines. Vertical permeabilities of the soil are low and vary with location and depth. The permeability of the Midway Group has been calculated to be between 8.2 × 10-7 and 1.08 × 10-8 centimeters per second (cm/sec). The permeability of the Wilcox Group is estimated to range from 4.0 × 10-5 to 3.4 × 10-6 cm/sec. These permeabilities correlate well with the recorded geology; the Midway Group is mostly clay, and the Wilcox Group has a mix of sand, silt, and clay.

Groundwater flow through the Quaternary terrace deposits toward areas of discharge, such as excavations or streams. Hydraulic conductivities within these coarse-grained terrace deposit soils range from 4 × 10-4 and 6 × 10-5 cm/sec, which is much higher than those found in the Midway Group and similar to those for the Wilcox Group. The principal source of recharge to the area groundwater system is from rainfall infiltration through sandy/silty portions of the outcrop. There are few such outcrops at RRAD (Kemron Environmental Services 2006).

Aquifers in the vicinity of RRAD include the Carrizo-Wilcox Aquifer (a major aquifer within the Tertiary Wilcox Group) and the Nacatoch Aquifer (a minor aquifer within the Cretaceous sands). Locally, the formations forming the aquifers generally strike east and dip to the south.

The uppermost water bearing unit underlying the northern portion of RRAD consists of the overburden unit and the weathered clay shale unit, which operate together as a single aquifer. In the northern portion of the installation, the bottom of this shallow groundwater bearing unit is approximately 30 feet below ground surface (bgs). The weathered clay shale operates as an aquiclude (it is incapable of transmitting significant quantities of water under ordinary hydraulic gradients) to the Nacatoch Aquifer. Water movement is restricted within the weathered portion of the shale to fractures and the interface along Midway and Wilcox formations. Permeability of the Midway and Wilcox formations is low, varying with location and depth (Kemron Environmental Services 2006; USACE, Mobile District 2008). Perched groundwater present in the upper weathered portion of the Midway Group is influenced primarily by topographic features such as swales and creeks.

Irrigation and municipal water supplies in the immediate vicinity of RRAD account for 51% and 35%, respectively, of total pumping from the Carrizo-Wilcox Aquifer. In the northeast part of the state, near RRAD, water levels in the Carrizo-Wilcox aquifer have been declining. Depth to groundwater at the installation from near surface to 25 to 40 feet bgs at RRAD, although depth to water in some areas can be as deep as 455 feet bgs. Shallow groundwater at RRAD is categorized as Class III. Class III groundwater is generally not considered suitable for consumption by humans (USACE, Mobile District 2008).

Water from the Nacatoch Aquifer is generally alkaline and soft. Groundwater levels in the Nacatoch Aquifer were declining because of over-pumping but have begun to stabilize because of increased use and reliance on surface water for water supplies (Department of the Army, Office of the Project Manager for Chemical Demilitarization, and Installation Restoration 1978; USACE, Mobile District 2008).

2.7 SURFACE WATER HYDROLOGY

Surface drainage primarily flows off post to the south, with a small portion of runoff flowing off post to the north. The drainage divide is formed by a slightly east-west topographic high that crosses the installation from the north and extends eastward through the industrial area (Department of the Army, Office of the Project Manager for Chemical Demilitarization, and Installation Restoration 1978). Due to the divide of the two watersheds, flooding is not a significant concern (Woodward-Clyde Federal Services 1996).

The majority of surface water drainage of RRAD is to the south by way of Big, Rock, Caney, Nettles, Elliott, and East Fork Creeks (which eventually terminates in Wright Patman Lake and the Sulphur River). Surface water discharges eventually to Wright Patman Lake (located within 5 miles downgradient of installation boundary), which is the drinking water source for RRAD and the surrounding communities (USACE, Mobile District 2008).

The remaining surface water drainage is to the north by Panther Creek and Jones Creek tributaries (which eventually terminates in the Red River). Jones Creek tributaries exist in the most northeastern portion of the installation (Woodward-Clyde Federal Services 1996).

Several ponds and lakes on LSAAP and RRAD serve as important game-watering holes and provide some recreational fishing. There is no direct use of groundwater underlying the installation (USACE, Mobile District 2008).

2.8 WATER USAGE

Currently, there are no potable water wells located at RRAD. RRAD purchases their drinking water from a public utility (RWRD; Tetrahedron, Inc. 2017). Surface water has regionally been the main source of potable water since the early 1940s.

Since its construction in the early 1940s until the early 2000s, Caney Creek Reservoir served as the primary source of potable water for RRAD. Caney Creek Reservoir is a 202-acre impounded water body, which has a total capacity of 1,340 acre-feet or approximately 440 million gallons. Elliot Creek Reservoir was also constructed in the early 1940s and used primarily for recreational purposes. Elliot Creek Reservoir is a 183-

acre dammed lake on RRAD, which has a total capacity of 1,930 acre-feet or approximately 630 million gallons (USACE, Mobile District 2008). These reservoirs serve currently as the back-up raw water supply the installation in the case of utility outages.

RRAD transitioned from using these two reservoirs for water supply to purchasing potable water from RWRD in the early 1990s. RRAD utilities became privatized under BRAC 1995 and were then managed by the RWRD. RWRD began providing potable water services, wastewater services, and industrial wastewater services for the installation in 2002 (URS 2006). As of 2016, RWRD receives drinking water from Wright Patman Lake and Milwood Lake (Gschwind 2019). Wright Patman Lake is within 5 miles downgradient of the southern installation boundary. The majority of surface water drainage of RRAD is to the south by way of Big, Rock, Caney, Nettles, Elliott, and East Fork Creeks (which eventually terminate in Wright Patman Lake and the Sulphur River). The remaining surface water drainage is to the north by Panther Creek and Jones Creek tributaries (which eventually terminate in the Red River). The creeks within the installation, Red River, and Sulphur River are not used as drinking water sources (RRAD 2003).

Groundwater is not currently used, and historically has never been used, as a drinking water source for the installation. Shallow groundwater at RRAD is classified as Class III. Class III groundwater is generally not considered suitable for human consumption (USACE, Mobile District 2008). Permeability of the Midway and Wilcox formations is low, varying with location and depth. They function as an aquiclude to the Nacatoch Aquifer (Kemron Environmental Services 2006).

Water from the Carrizo-Wilcox Aquifer is extracted for irrigation and municipal water supplies in the immediate vicinity of RRAD off post. Irrigation and municipal water supplies account for 51% and 35%, respectively, of total pumping from the Carrizo-Wilcox Aquifer (Kemron Environmental Services 2006).

2.9 ECOLOGICAL PROFILE

Mammals found to be common to abundant at RRAD include white-tailed deer, gray squirrel, fox squirrel, raccoon, bobcat, skunk, and armadillo. More than 400 species of birds potentially use natural habitat at RRAD. This includes, but is not limited to, migratory waterfowl, mourning dove, wild turkey, bobwhite quail, American kestrel, red-tailed hawk, red-shouldered hawk, eastern bluebird, and green heron. Caney and Elliott Creek Reservoirs located within RRAD provide habitat for a variety of fish species. This includes spotted gar, largemouth bass, black crappie, red-eared sunfish, blue gill, and spotted sucker. Common reptiles located at the installation include cottonmouth snake, copperhead snake, timber or canebrake rattlesnake, diamondback rattlesnake, kingsnake, northern fence lizard, green anole, box turtle, common snapping turtle, and red-eared slider. Common amphibians include central newt, smallmouth salamander, marbled salamander, spadefoot, narrow-mouth toad, green treefrog, south leopard frog, and bullfrog (USACE, Mobile District 2008).

The alligator snapping turtle, a state-listed threatened species, has been observed at RRAD. It occupies perennial water bodies; deep water of rivers, canals, lakes, and oxbows; and swamps, bayous, and ponds near deep running water. At RRAD it can be found at the Elliot Creek Reservoir. Additionally, the American alligator has also been observed at RRAD in the past. It is listed as threatened by similarity of appearance with the endangered American crocodile (USACE, Mobile District 2008).

The only other federally listed species that may occupy the area are the threatened bald eagle, endangered interior least tern, red-cockaded woodpecker, and threatened Louisiana black bear. Other state-listed bird species that may migrate through the area include the endangered American peregrine falcon and the threated article peregrine falcon (ELM Consulting, LLC 2008).

2.10 CLIMATE

RRAD is in a transitional zone between the subtropical humid climate prevalent further south and the continental climate of the Great Plains and Midwest. Winters are normally mild with freezing temperatures occurring on an average of 35 days per year, while summers are hot and humid with temperatures exceeding 90 degrees Fahrenheit on an average of 89 days per year. Humidity ranges from 50% in the pre-dawn hours to 60% in the afternoon. The average precipitation at RRAD is approximately 51 inches per year. Precipitation occurs mainly during the fall and winter months with rainfall less frequent in the spring and summer. Rainfall during the spring and summer often results in intense thunderstorms that can cause flash floods. However, RRAD is geographically on a divide of two different watersheds; therefore, flooding is not a significant concern.

Snowfall is rare at RRAD, with an average of one to two inches per year. Prevailing winds are out of the south during all months except September, when they are predominantly from the east. Severe local storms, including hailstorms and tornadoes, are most frequent in the spring, with a secondary peak from late November through early January. Hurricanes usually dissipate before they reach the area, with the greatest damage caused by the associated heavy rainfall rather than winds (Woodward-Clyde Federal Services 1996; USACE, Mobile District 2008).

3. FIELD INVESTIGATION ACTIVITIES

This section provides field procedures followed during the implementation of the SI (40 CFR 300.420(c)(4)(i)). The principal guidance document for the field investigation activities and procedures used for the RRAD SI were consistent with the requirements presented in the Army Guidance for Addressing Releases of PFAS (U.S. Army 2018).

3.1 SITE INSPECTION DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) were developed to define the problem at the AOPIs, identify the necessary decisions, specify decision-making rules and the level of confidence necessary to resolve the problem, identify the number of samples necessary to support the decision, and obtain agreement from the decision makers before the sampling program was initiated. The RRAD sample locations were determined based on current site conditions (i.e., groundwater flow direction), historical data (e.g., suspected location of PFAS release), and historical activities (e.g., remedial activities, disposal of potentially contaminated materials). The project stakeholders concurred that selected sampling schemes would be representative of site conditions prior to initiation of field investigation activities. The field investigation at RRAD was conducted in accordance with the UFP-QAPP (AAR 2023a). The field activities employed to execute the UFP-QAPP are described below and include any variances or deviations.

3.2 SAMPLE DESIGN AND RATIONALE

Six AOPIs were investigated during the RRAD SI to determine the presence or absence of PFAS in the environment. Information inputs from the preliminary CSMs presented on Worksheet #10 of the UFP-QAPP (AAR 2023a) are the basis for sample design at each AOPI. All samples were analyzed for the Target PFAS list of PFOA, PFOS, PFBS, PFNA, PFHxS, PFHxA, and PFBA.

The general approach for determining the presence or absence of PFAS at an AOPI consisted of collecting groundwater samples within and/or downgradient from the AOPI and at least two soil samples. Soil samples were not proposed within the Current IWTP and the OTC Landfill because the presence of native soils was not known.

All sample identifications were assigned in the following format:

- Parent soil samples: RRAD-[AOPI]-SO-[Boring No.]-[MMDDYY];
- Parent grab groundwater samples: RRAD-[AOPI]-GW-[Boring No.]-[MMDDYY];
- Parent groundwater samples from existing monitoring wells: RRAD-[existing mw nomenclature]-GW-[Sample No.]-[MMDDYY]
- FD: RRAD-FD-[Duplicate No.]-[Medium Type]-[MMDDYY];
- Blank QC samples: RRAD-[QC sample type]-[QC sample type number]-[MMDDYY].
    - Note: [MMDDYY] = Month Day Year
    - Example Sample Nomenclature: RRAD-FS1-GW-01-022123

3.3 FIELD INVESTIGATION ACTIVITIES

SI field activities were conducted from 31 May to 02 July 2023. The locations and methods of sample collection under the SI are described in the following sections. Sampling procedures adhered to the UFP-QAPP (AAR 2023a), with relevant information summarized below.

Sampling activities at RRAD included collecting surface soil samples from soil borings, sampling existing monitoring wells, as well as installing temporary groundwater monitoring wells and direct push technology (DPT) screen point samplers. One round of groundwater sampling was conducted. Samples were analyzed for 26 PFAS to determine the presence or absence of PFAS. A total of 42 samples were planned among the six AOPIs, including 19 existing monitoring well groundwater samples, two DPT screen point groundwater samples, seven temporary monitoring well groundwater samples, and 14 surface soil samples. A breakdown of samples collected at each AOPI is provided in Table 3-1. Prior to beginning sampling, site reconnaissance and utility clearance were performed. Sampling was completed at one AOPI before moving to the next AOPI when feasible. Any variances in sampling procedure, such as moving a location or sample point elimination, were discussed with the project team, and communicated in the Daily Quality Control Reports submitted via email (Appendix A). Field procedures and any variances are discussed in the following sections. Photographs of SI field activities are provided in Appendix B.

Table 3-1. RRAD AOPI SI Sample Collection

AOPI Name	Soil Samples	Groundwater Samples
Fire Station 1	3	2
Fire Station 1 Flushing Area	5	2
Fire Truck Service Extension	3	5
Ordnance Training Center Landfill	0	7
Former Hayes Batch Treatment Plant	3	5
Current Industrial Wastewater Treatment Plant	0	7
Total	**14**	**28**

3.4 FIELD PROCEDURES

The following sections describe utilities clearance, temporary well installation and development procedures, field procedures for sampling each medium, borehole abandonment, and location survey.

Because many materials routinely used during environmental investigation can potentially contain PFAS, the field crew conducted SI activities in accordance with the PFAS sampling SOPs/Technical Guidance Instructions (TGIs) presented in Appendix B of the UFP-QAPP (AAR 2023a). Procedures include requirements for equipment, containers, handling, and sampling, including PFAS-specific requirements, to ensure that sample contamination does not occur during collection and transport.

3.4.1 Utility Clearance

Prior to initiating intrusive activities, the field manager coordinated underground utility clearances for the six AOPIs through Texas811 "Call Before You Dig." RRAD utility clearance was included as part of the Texas811. As part of the utility clearance process, individual utility companies were consulted (as needed), each area was visually inspected to verify that utilities had been marked, and the field manager looked for signs of unidentified utilities (including overhead utilities) prior to initiating drilling operations. In addition to field manager, the rig geologist and drillers would also check for marked utilities and signs of unidentified utilities prior to initiating drilling operations. As part of field activities hand clearance was conducted at each boring location prior to conducting powered drilling within of known or suspected subsurface utilities, the boreholes were excavated using a low-impact technique (hand auger) to a minimum of 5 feet bgs. If power drilling operations were required within the first 5 feet bgs it was first discussed between the rig geologist, field manager, driller, and any utility company (if needed).

3.4.2 Bulk Source Water Sampling

Prior to beginning work, a bulk source water sample was collected on 31 May 2023 (RRAD-SB-01). The sample was collected from the point of exit from the water tanks used by the drilling subcontractors (Cascade Environmental). The sample cooler used to transport the source blank sample to the lab was lost in transit as discussed in Section 3.4.7. As a result, the sample was recollected on 08 June 2023. It underwent PFAS analysis as a QA/QC measure. Source water was used for decontamination of equipment, including drill tooling, and for abandonment of boreholes. Source water was purged for a minimum of 1 minute prior to filling high-density polyethylene (HDPE) bottles. Concentrations of PFAS were not detected in the source water blank above laboratory reporting limits.

3.4.3 Soil Sampling

All soil samples were collected in accordance with the procedures outlined in the UFP-QAPP (AAR 2023a). QC samples, including duplicates, equipment rinsate blanks, and matrix spike/matrix spike duplicates (MS/MSDs), were also collected.

Soil samples were collected using a stainless-steel hand auger bucket. Each soil core was logged for lithology in accordance with USACE guidance and recorded on a drilling log (drilling logs are provided in Appendix C). Sample bottles were labeled and sealed in Ziploc® bags and placed on wet ice for cooling to ≤6 degrees Celsius (°C). Additional details on protocols for obtaining soil samples are outlined on Worksheet #18 and the Arcadis P-08 TGI PFAS Field Sampling Guide provided in the UFP-QAPP (AAR 2023a). Surface soil samples were collected from the 0- to 2-foot bgs interval.

Soil borings were abandoned following sample collection by backfilling the borehole with bentonite chips. Bentonite chips were hydrated using the bulk source water. Surface restoration matched the surrounding surface (e.g., concrete, asphalt, grass).

3.4.4 Groundwater Sampling

All groundwater samples were collected in accordance with the procedures outlined in the UFP-QAPP (AAR 2023a). QC samples, including duplicates, equipment blanks, and MS/MSDs were also collected.

Groundwater was sampled from permanent monitoring wells, temporary monitoring wells, and from DPT groundwater sampling assemblies (e.g., Geoprobe® SP16 screen point samplers or like tooling). Groundwater was collected using the low-flow purge method via peristaltic pump whenever conditions allowed. Otherwise, groundwater would be collected using grab methods via installed DPT groundwater sampling assemblies, peristaltic pump, or bailers.

Prior to sampling, static water level measurements were collected to the nearest 0.01 foot. Following completion of monitoring well purging and stabilization, samples were collected in laboratory-supplied HDPE plastic containers. All samples were collected and handled while wearing clean non-powdered, disposable nitrile gloves. Sample bottles were labeled and sealed in Ziploc® bags and placed on wet ice for cooling to ≤6°C. New, clean nitrile gloves were donned prior to each new sample collection. Sampling containers were labeled with the following information: site name, sample identification, date and time of sample collection, and type of analysis.

3.4.4.1 Temporary Monitoring Well Sampling

Temporary monitoring wells were installed at Fire Station 1, Fire Station 1 Flushing Area, and the Former Hayes Batch Treatment Plant AOPIs using a Geoprobe® DPT drill rig and constructed using new 3/4-inch 5-foot prepacked 0.010-inch slot schedule 40 polyvinyl chloride (PVC) 65mesh stainless steel wire wrapped screen and 3/4-inch 5-foot schedule 40 PVC risers. All temporary wells were developed or dried multiple times and considered developed after all criteria were achieved excluding stability parameters. Well development forms are provided in Appendix D.

Two temporary wells (RRAD-FHBTP-GW-01, and RRAD-FHBTP-GW-05) were not capable of sustaining adequate purging and experienced continuous drawdown at the lowest pump settings. These wells were purged dry and allowed to recharge. The field team returned to the wells when a sufficient volume of water had entered the wells, not to exceed 24 hours unless recharge was not adequate for sample collection, and grab samples were collected using a peristaltic pump and new HDPE tubing. One temporary well (RRAD-FS1FA-GW-01) ran dry during low flow sample collection, the well was allowed to recover and the second sample bottle was filled.

Once groundwater sampling was complete, all temporary monitoring wells were abandoned in accordance with the Texas Department of Licensing and Regulation (TDLR) *Rules for the Plugging and Abandonment of Drilled Wells* in Chapter 76.104 (TDLR 2018) and as outlined in the RRAD Well Installation Plan (AAR 2023c). Temporary monitoring wells were abandoned by removing all PVC casing and screen and backfilling the borehole from the bottom to the surface with bentonite chips. The chips were then hydrated with bulk source water. Surface completion matched the surrounding surface (i.e., concrete, asphalt, grass).

3.4.4.2 DPT Screen Point Sampling

Groundwater samples were collected from two DPT groundwater sample locations (RRAD-FS1-GW-02 and RRAD-FHBTP-GW-02) using HDPE bailers. Collection methods for DPT groundwater samples are outlined in the RRAD Well Installation Plan (AAR 2023c) and the Arcadis P-08 TGI PFAS Field Sampling Guide provided in the UFP-QAPP (AAR 2023a). Following completion of drilling each borehole for soil lithology and sample collection, the inner drill rods were removed and a decontaminated SP16 DPT groundwater sampling assembly, which included a 3-foot slotted stainless screen attached to the inner drill rods, was installed in the borehole. The outer drilling rods were then retracted, allowing formation water to enter the screened interval.. Groundwater samples were grab collected using a peristaltic pump with new HDPE tubing inserted through the drilling rods or a HDPE bailer.

If groundwater volume allowed for the collection of water quality measurements, they were recorded after the collection of the groundwater sample. Once sampling was complete, all tooling and materials were removed and the borehole abandoned. The borehole was sealed with bentonite chips to approximately 1-foot bgs and the chips were hydrated with bulk source water obtained onsite. Surface restoration matched the surrounding surface (e.g., concrete, asphalt, grass).

3.4.4.3 Monitoring Well Sampling

Existing permanent monitoring wells were sampled at the Fire Turck Service Extension, Current IWTP, and OTC Landfill AOPIs using a peristaltic pump. All monitoring wells were stabilized before sampling.

3.4.5 Equipment Calibration

Equipment including a handheld gas monitor (RKI GX-6000) and a water quality instrument (YSI Professional Plus and In-Situ Aquatroll 600) were calibrated daily per Worksheet #24 of the UFP-QAPP (AAR 2023a) against known standards in accordance with the manufacturer's instructions and documented on the calibration forms provided in Appendix D.

3.4.6 Location Survey

Environmental sample locations and notable site features were located and mapped using a portable Trimble global positioning system (GPS) unit capable of achieving ± 3 feet accurate results. GPS data was transferred for use in ArcGIS mapping applications during data evaluation and reporting.

3.4.7 Deviations and Field Change Requests

No instances of field modification impacting project scope and/or data usability/quality were encountered during the SI fieldwork. Activities were completed per the UFP-QAPP (AAR 2023a).

The following field hardships occurred at RRAD. A cooler was lost in transit and samples had to be recollected, one QC sample (RRAD-01-SO-060323) that was placed in a different cooler arrived at the laboratory and was analyzed without an associated parent sample. The lost cooler was reported and detailed in Daily Quality Control Report Dated 7 Jun 2023. The samples that were lost in transit were recollected. Replacement soil samples were offset to the west by approximately one foot. Replacement groundwater samples were needed only for permanent monitoring well locations and were thus recollected from the same monitoring well. Samples that were recollected as identified in the field due to lost cooler are as follows:

- RRAD-FB-01-060223; the replacement sample was labelled in the field as RRAD-FB-03-060823.
- RRAD-SB-01-053123; the replacement sample was labelled in the field as RRAD-SB-02-060823.
- RRAD-FS1-SO-03-060423; the replacement sample was labelled in the field as RRAD-FS1-SO-03-060823.
- RRAD-FS1FA-SO-02-053123; the replacement sample was labelled in the field as RRAD-FS1FA-SO-02-060823.
- RRAD-FS1FA-SO-03-053123; the replacement sample was labelled in the field as RRAD-FS1FA-SO-03-060823.
- RRAD-FS1FA-SO-04-053123; the replacement sample was labelled in the field as RRAD-FS1FA-SO-04-060823.
- RRAD-FS1FA-SO-05-053123; the replacement sample was labelled in the field as RRAD-FS1FA-SO-05-060823.
- RRAD-345MW57A-GW-01-060123; the replacement sample was labelled in the field as RRAD-345MW57A-GW-02-060823.
- RRAD-WIAMW59-GW-01-060123; the replacement sample was labelled in the field as RRAD-WIAMW59-GW-02-060723.
- RRAD-SFA2A-GW-01-060123; the replacement sample was labelled in the field as RRAD-SFA2A-GW-02-060723.
- RRAD-FS1-SO-01-060323; the replacement sample was labelled in the field as RRAD-FS1-SO-01-060823. However, the field duplicate sample for the original sample (RRAD-FD-SO-01-060323) did arrive to the lab in a separate cooler and was analyzed. The original field duplicate

and the replacement sample were later renamed to more clearly indicate that the samples were not a parent/field duplicate sample set and were collected from the same area, but not borehole. The former Field Duplicate (RRAD-FD-SO-01-060323) is identified in this report as RRAD-FS1-SO-01A-060323 and the recollected parent sample (RRAD-FS1-SO-01-060823) is identified in this report as RRAD-FS1-SO-01B-060823.

- RRAD-FS1FA-SO-01-060123; this sample was identified as having been lost, so a replacement sample was collected and labelled in the field as RRAD-FS1FA-SO-01-060823. However, it was later determined that the laboratory did receive the original sample and that there were now two soil parent samples from the area. The original and replacement samples were later renamed to more clearly indicate that the samples were not a parent/field duplicate sample set and were collected from the same area, but not borehole. The original sample (RRAD-FS1FA-SO-01-060123) is identified in this report as RRAD-FS1FA-SO-01A-060123 and the recollected parent sample (RRAD-FS1FA-SO-01-060823) is identified in this report as RRAD-FS1FA-SO-01B-060823.

The following deviations from the UFP-QAPP are noted below that were indicated during validation:

- Groundwater samples hold time was listed as 14 days from sample collection to sample preparation in the UFP-QAPP.

- Laboratory SOP for groundwater sample hold time was listed as 28 days from sample collection to sample preparation in the UFP-QAPP, resulting in a "J" flag on all groundwater samples, indicating that they are estimated concentrations.

3.5 DECONTAMINATION PROCEDURES

To ensure that chemical analysis results reflect the actual concentrations at sample locations, the non-dedicated, reusable equipment used in sampling activities was rigorously cleaned and decontaminated between sample locations in accordance with the UFP-QAPP (AAR 2023a). The non-disposable sampling equipment used to conduct sampling activities (e.g., drilling rods, screen point samplers, water level meters) was decontaminated before sampling activities began, between locations, between sampling events, and after sampling activities were completed. Decontamination guidelines followed the direction provided in the Arcadis P-07 TGI for Groundwater and Soil Sampling Equipment Decontamination provided in the UFP-QAPP (AAR 2023a). Wastewater generated from decontamination activities was handled as IDW. Decontamination water was combined with well development and sampling purge water and managed as one medium.

The decontamination process included an initial scrub with a laboratory-grade, phosphate-free, biodegradable detergent (e.g., Liquinox® or Alconox®) to remove particulate matter and surface film. Following this scrub, the equipment was then rinsed twice in separate bins containing bulk source water and laboratory-certified PFAS-free water. Decontaminated sampling equipment was wrapped in thin sheets of HDPE to prevent subsequent contamination if being stored and not used immediately.

Decontamination of downhole drill rig equipment was completed prior to use, between locations, and after final use before departing the site. Tooling such as hollow stem augers, DPT rods, and hand augers were decontaminated in a mobile decontamination trailer by using a steam cleaner/power washer followed by a PFAS Free Water rinse. Non-dedicated tools, such as hand augers, water level meters, and taglines were bucket washed in an HPDE bucket with bulk source water/biodegradable detergent (e.g., Liquinox® or Alconox®) and rinsed with bulk source, followed by a final rinse of PFAS-Free water at the drilling site. Equipment was scrubbed using polyethylene or PVC brushes to remove particulates if required.

3.6 DISPOSITION OF FIELD INVESTIGATION-DERIVED WASTE

The IDW generated during the SI at RRAD included solids (e.g., soil, well construction materials, acetate liners) and liquids (e.g., development and purge water, decontamination rinse water). These materials were managed in accordance with the Arcadis P-12 TGI Investigation-Derived Waste Handling and Storage provided in the UFP-QAPP (AAR 2023a).

All IDW generated at RRAD was placed in U.S. Department of Transportation (USDOT)-approved, 55-gallon drums for storage, transport, and disposal. Permanent labels for the drums included a unique container number, a description of the contents (i.e., soil or wastewater), the fill date, the source location, the generator's name (i.e., RRAD), and a telephone number for the generator's point of contact (e.g., AAR Project Manager or Field Manager. Each bucket or carboy used to temporarily store liquid IDW before it was transferred to a 55-gallon drum was marked "Nonpotable Water" or "Decontamination Waste" to comply with requirements of the P-12 TGI provided in the UFP-QAPP (AAR 2023a).

The contents of the IDW drums were sampled for characterization and profiling. A solid waste sample was composited by collecting aliquots from the solid waste drums using a decontaminated stainless-steel spoon. The solids were homogenized in a stainless-steel bowl and then placed into laboratory-supplied sample containers. For drums containing liquid IDW (i.e., wastewater), a composite sample was collected using a peristaltic pump and new HDPE tubing and pumping directly into sample bottles. It was determined that volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, pesticides and herbicides had the potential to be present in the in soil and groundwater samples collected. Therefore, both solid and liquid IDW were analyzed for Toxicity Characteristic Leaching Procedure (TCLP) VOCs, TCLP SVOCs, TCLP metals, TCLP pesticides, and TCLP herbicides. In addition, the certified waste hauler required the analysis of polychlorinated biphenyls (PCBs), BN-embedded polycyclic aromatic hydrocarbons (BN-PAHs), pH, flashpoint, and percent solids (solid IDW only).

No IDW from RRAD was characterized as hazardous. The signed waste manifests and certificates of disposal will be provided in Appendix E prior to the finalization of this report, if available. Containerized waste will be disposed of in accordance with applicable state and Federal Resource Conservation and Recovery Act (RCRA) regulations. Upon the completion of waste disposal, the SI report will be updated, or a letter report will be drafted, describing the licensed and certified waste hauler, the date that IDW drums were picked up by the hauler, and the disposal location for these drums. Soiled personal protective equipment (PPE) that came into contact with sample media was contained in USDOT-approved 55-gallon drums.

4. DATA ANALYSIS AND QUALITY ASSURANCE SUMMARY

This section summarizes the QA/QC program and laboratory chemical analysis program implemented as part of the RRAD SI field activities (40 CFR 300.420(c)(4)). Additional information on these procedures is presented in the UFP-QAPP (AAR 2023a).

SGS North America, Inc. (SGS), located in Orlando, Florida, was selected as the DoD Environmental Laboratory Accreditation Program (ELAP)-accredited analytical laboratory for the analysis of PFAS during the RRAD SI field activities. Sections 4.1 through 4.4 summarize sample handling procedures, laboratory analytical methods, data QA/QC, data reporting and validation, and sample QA/QC. A QA summary of the analytical data is presented in Section 4.5. Appendix F provides the data usability assessment that details the quality and usability of the SI analytical data and the process performed to evaluate the data for compliance with established QC criteria.

4.1 SAMPLE HANDLING PROCEDURES

A critical aspect of sample collection and analysis protocols is the maintenance of strict chain-of-custody (CoC) procedures, which include tracking and documentation during sample collection, shipment, and laboratory processing. The Sample Manager was responsible for sample custody until the samples were properly packaged, documented, and released to FedEx. The laboratory was responsible for sample custody thereafter in accordance with approved procedures.

4.1.1 Chain-of-Custody Record

CoC forms were used to document the traceability and integrity of all samples from the point of collection to the laboratory by maintaining a record of sample collection, shipment, and receipt by the laboratory. A CoC form was filled out and was signed and dated by each sample custodian.

Shipping containers were sealed with custody tape. Sealed coolers were transported to FedEx for priority overnight delivery to the laboratory. The FedEx tracking number associated with each cooler acted as the custody documentation while the sealed coolers were in the possession of FedEx. The CoC form was placed in a resealable plastic bag and taped to the inside lid of the cooler.

When the possession of samples was transferred, the individual relinquishing the samples and the individual receiving the samples signed, dated, and noted the time of transferal on the CoC. This record represents the official documentation for all transferal of sample custody until the samples arrived at the laboratory.

4.1.2 Laboratory Sample Receipt

All samples received by the Laboratory Sample Custodian or designee were checked for proper preservation (e.g., pH, temperature of coolant blank above 2°C or below 6°C); integrity (e.g., leaking, broken bottles); and proper, complete, and accurate documentation and identification (ID) of the samples. The temperature of the coolant blank was noted. No insufficiencies and/or discrepancies were noted.

Samples received at the laboratory were logged into the laboratory computer database. Initial entries included field sample number, date of receipt, and analyses required. As samples were received, they were assigned a laboratory sample ID number. The sample custodian labeled each container with its sample ID number, and the samples then were transferred to their designated storage areas.

Samples received by the laboratory were considered to be physical evidence and were handled according to USEPA procedural safeguards. In addition, all data generated from the sample analyses, including all associated calibrations, method blanks, and other supporting QC analyses, were identified with the project name, project number, and sample delivery group (SDG) designation. All data were maintained under the proper custody. The laboratory provided complete security for samples, analyses, and data.

4.2 LABORATORY ANALYTICAL METHODS

The chemical analysis program for the RRAD SI conforms to the analytical requirements presented in the UFP-QAPP (AAR 2023a) for the chemical analysis of field investigation samples. All samples were analyzed for PFAS using liquid chromatography with tandem mass spectrometry (LC/MS/MS) procedures compliant with U.S. Department of defense (DoD) Quality Systems Manual (QSM) Version 5.3, Table B-15 (DoD 2019) and the laboratory SOP.

4.3 DATA QUALITY ASSURANCE/QUALITY CONTROL

This section presents the QA/QC procedures applied during sampling and laboratory analysis. This discussion includes laboratory QA/QC (Section 4.3.1) and field QA/QC (Section 4.3.2) procedures. Details on the results of the QC samples (field and laboratory) are presented in the data usability assessment (DUA) included in Appendix F.

4.3.1 Laboratory Quality Assurance/Quality Control

Samples were analyzed for PFAS using LC/MS/MS in compliance with DoD QSM Version 5.3, Table B-15 (DoD 2019). QC checks included holding times, method blanks, calibration standards, extracted internal standards (EISs), laboratory control samples (LCSs), MS/MSDs, and detection limits. The acceptance criteria and laboratory SOP are provided in the UFP-QAPP (AAR 2023a).

Method Blanks—Method blanks were used to monitor the possibility of laboratory-induced contamination by running a volume of approved reagent water through the entire analytical scheme (i.e., extraction, concentration, analysis). Blank requirements are specified in the DoD QSM Version 5.3, Table B-15 (DoD 2019) and the laboratory SOP. It should be noted that PFOS was detected in the method blank in batch OP97526 associated with the project at an estimated concentration greater than the detection limit (DL) and less than the limit of quantitation (LOQ). Therefore, the environmental samples associated with this blank with estimated concentrations greater than or equal to the DL and less than or equal to the LOD (i.e., J qualified samples) were additionally qualified as not detected (U qualified) at the LOD. Additionally, the estimated concentrations greater than the LOD and less than or equal to the LOQ were qualified as not being detected (U qualified) at the LOQ. This is described in additional detail in the DUA included as Appendix F.

Matrix Spike/Matrix Spike Duplicates— Additional sample volume was collected from select field sample locations to evaluate accuracy and precision using MS/MSD analyses. MS/MSDs are aliquots of environmental samples to which known concentrations of certain target analytes have been added before sample preparation, cleanup, and determinative procedures have been implemented (SW846 Chapter One). Accuracy was expressed as the percent recovery (%R) of each added compound. Precision was expressed as the relative percent difference (RPD) between the MS and the MSD results. MS/MSD samples were collected and analyzed at a frequency of one for every 20 samples of similar matrix received at the laboratory.

Laboratory Control Samples—LCSs were analyzed to evaluate the accuracy of the analysis in the absence of sample matrix impacts. A known concentration of select compounds were added to the LCS. The spiked samples were analyzed in the same manner as the environmental samples. Accuracy was expressed as the %R of each added compound. An LCS was analyzed with each SDG.

4.3.2 Field Quality Assurance/Quality Control

Table 4-1 summarizes the frequency of field QC samples that were collected during the RRAD field investigation. The requirements for field QC were established on Worksheet #20 of the UFP-QAPP (AAR 2023a).

Table 4-1. Frequency of Field QC Samples for RRAD Field Investigation

QC Sample	Frequency
Field Blank	1 for every 20 or fewer investigative groundwater samples
Source Water Blank	1 per bulk rinse water source that is not laboratory-certified PFAS free water
Matrix Spike	1 for every 20 or fewer investigative samples, per media
Matrix Spike Duplicate	1 for every 20 or fewer investigative samples, per media
Equipment Blank	1 for every 20 or fewer investigative samples
Field Duplicate	1 for every 10 or fewer investigative samples, per media

4.4 DATA REPORTING AND VALIDATION

The AAR QA Manager or designee (Geosyntec) initiated a validation of the analytical data packages. One hundred percent of the data were validated using objective criteria taken from the requirements of the UFP-QAPP (AAR 2023a) and DoD QSM Version 5.3 (DoD 2019) and qualified in accordance with DoD Data Validation Guidelines Module 3 (DoD 2020) and the revised table for sample qualification in the presence of blank contamination (DoD 2023).

Reported laboratory data were reviewed in accordance with DoD QSM Stage 2B validation guidelines to ensure that the QC results fell within appropriate QC limits for holding times, blank contamination, EISs, calibrations, MS/MSDs, LCSs, and ion ratios. Any data validation qualifiers resulting from outlier QC results were applied and a data validation report, as previously described, was prepared. In addition, 10% of the data were validated in accordance with DoD QSM Stage 4 guidelines, and analytical results were checked and recalculated from raw data.

Equipment blanks and field blanks were associated with the corresponding environmental samples. These blanks were evaluated following the same criteria as method blanks, and the associated environmental samples were appropriately qualified as needed. After the data validation for the project was completed, a project DUA (Appendix F) was prepared.

Results from the data validation process that potentially impact the SI findings includes the following:

- In the groundwater sample collected from Fire Station 1 (RRAD-FS1-GW-02), PFOS was originally detected at an estimated concentration of 2.7 J ng/L. However, due to the method blank contamination, the data was qualified as non-detect at the LOD with a U validation qualifier. Therefore, the final result for PFOS is 4.5 UJ ng/L, which is above the PFOS SL of 4 ng/L (described in Section 5). As the concentration was originally reported to be less than the SL, using professional judgment, the sample was determined to not contain PFOS at concentrations above the SL.

- In the groundwater sample collected from the Fire Station 1 Flushing Area (RRAD-FS1FA-GW-02), PFOS was reported at a concentration of 4.0 J ng/L, which is equal to the SL of 4 ng/L. The LOD for this sample is 4.2 ng/L and so the result of 4.0 was qualified as estimated by the laboratory.

As the result indicates an estimated concentration of PFOS equal to SL, the result is treated as an exceedance of the SL.

- The UFP-QAPP for the project indicated that holding time between sample collection and sample preparation was 14 days for aqueous samples. However, the quality manual for laboratory used for the project indicates a holding time between sample collection and sample preparation of 28 days for aqueous samples. Due to this discrepancy, the data validation flagged 37 aqueous samples as being out of hold time for sample preparation. The affected samples were subsequently qualified as follows:
  - Non-detect samples were UJ qualified as estimated less than the LOD.
  - Samples with detections were qualified as estimated (J).

4.5 QUALITY ASSURANCE SUMMARY

A comprehensive QA/QC program was implemented during the sampling event in May 2023 at RRAD. Samples and associated QC samples (e.g., field duplicates, field blanks, equipment blanks, source water blanks, MSs, MSDs) were collected and analyzed for PFAS using methods specified in the UFP-QAPP (AAR 2023a). Consistent with the data quality requirements established in the UFP-QAPP (AAR 2023a) and DQOs, all sample data and associated QC data were evaluated during the review and validation process. Individual sample results were qualified, as necessary, to designate usability of the data toward meeting project objectives. Data qualifiers were applied based on deviations from the measurement performance criteria in the UFP-QAPP (AAR 2023a). Results of the validation are found in the DUA (Appendix F). The analyses associated with each data quality indicator are summarized below, with details of the results of the QC checks provided in the DUA.

4.5.1 Precision

Precision was evaluated by the analysis of MS/MSDs and field duplicate samples and the RPD between the duplicate spike results.

4.5.2 Accuracy

Bias introduced due to blank contamination (in method, instrument, or field blanks) and any impact on accuracy were evaluated during validation. Analytical accuracy was measured through the use of LCSs, MS/MSDs, isotope dilution standards, initial and continuing calibration, and target compound quantitation requirements.

4.5.3 Sensitivity

Sensitivity requirements were evaluated against minimum required LOQs and LODs in the UFP-QAPP (AAR 2023a).

4.5.4 Representativeness

Representativeness was satisfied by ensuring that the UFP-QAPP (AAR 2023a) protocols were followed, appropriate sampling techniques were used, established analytical procedures were implemented, and analytical holding times of the samples were not exceeded.

4.5.5 Comparability

Comparability was achieved by using consistent, documented and UFP-QAPP-approved methods and meeting project accuracy and precision objectives.

4.5.6 Completeness

Completeness measures the amount of valid data obtained from the sampling and analysis effort. For analytical data to be usable, each data point must be validated and meet criteria without significant non-conformance.

4.5.7 Data Usability

Data that have been qualified as estimated (i.e., J and UJ) during validation indicate accuracy, precision, or sensitivity QC measurements may have exceeded criteria, but the results are considered valid. Results that have been qualified as estimated by the laboratory or during the data validation process are done relative to the LOD. J-flagged results were detected above the DL but are less than the LOD and UJ-flagged results are qualified as being less than the LOD.

Data that were recommended for exclusion during validation (qualified X) and subsequently rejected (qualified R) by the project decision team were not used during the evaluation of project objectives.

5. SI SCREENING LEVELS

Detected concentrations of the Target PFAS in samples collected during this SI are compared to residential scenario SLs calculated using the USEPA regional screening level (RSL) calculator for soil and the tap water criteria for groundwater, as published in the 2023 OSD Memorandum (DoD 2023). This SI uses the SLs and a target hazard quotient (HQ) of 0.1 to evaluate the Target PFAS concentrations. These SLs (Table 5-1) are used to evaluate the data and determine if further investigation is warranted at each AOPI.

Table 5-1. Screening Levels from the 2023 OSD Memorandum

Chemical	Residential Tap Water HQ = 0.1 (ng/L or ppt)	Residential Soil HQ = 0.1 (mg/kg or ppm)
PFOS	4	0.013
PFOA	6	0.019
PFBS	600	1.9
PFNA	5.9	0.019
PFHxS	39	0.13
PFHxA	990	3.2
PFBA	1,800	7.8

Note: The residential tap water SLs are used to evaluate groundwater data. The residential soil SLs are used to evaluate soil data.

6. SI RESULTS

This section presents the background, summary of analytical results, and the CSM for each AOPI at RRAD. Sampled media and QA/QC samples were analyzed for the list of 25 PFAS specified in the Performance Work Statement (AAR 2022). The sample results discussed below focus on five Target PFAS outlined in the 2023 OSD Memorandum and sampled as part of this SI (DoD 2023): PFOS, PFOA, PFBS, PFNA, PFHxS, PFHxA, and PFBA. Analytical data tables for all PFAS analyzed using approved methods are provided in Appendix G.

6.1 CONCEPTUAL SITE MODELS

The preliminary CSMs developed for each AOPI during the PA were further refined where Target PFAS were detected above the LOD in soil or groundwater. Based on the SI sample results, CSMs presented for each AOPI represent the current understanding of site conditions with respect to known or suspected sources of PFAS-containing materials, potential transport mechanisms and migration pathways, and potentially exposed human receptors.

The CSMs were prepared in accordance with the Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A) (USEPA 1989) and the *USACE Engineer Manual on Conceptual Site Models*, EM 200-1-12 (USACE 2023). The CSMs evaluated ingestion, dermal contact, and inhalation exposure routes for human receptors. The exposure pathways are evaluated as complete, potentially complete, or incomplete in the CSMs presented in figures in each AOPI-specific CSM section. 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 (USEPA 1989). If any of these elements is missing, the exposure pathway is incomplete. For example, if PFAS are not detected in soil, then there is no source at the AOPI, and the soil exposure pathway is incomplete. Pathways are "potentially complete" where data or information are insufficient to conclude the pathway is either "complete" or "incomplete." Exposure pathways are also potentially complete for media where Target PFAS are detected but existing LUCs are in place for non-PFAS constituents, because the LUCs are not Target PFAS specific. Where PFAS are detected in groundwater, however the hydrogeologic connection between groundwater at the AOPI and a drinking water well is not documented, the groundwater exposure pathway is potentially complete.

Land use controls (LUCs) preventing the residential use of all AOPIs, except for Fire Station 1, are described in the LUC Implementation Plan (LUCIP; Fire Truck Service Extension, Current IWTP, and OTC Landfill), deed without warranty (Fire Station 1 Flushing Area), and Industrial Solid Waste Certification of Closure (Former Hayes Batch Treatment Plant; Dawson Technical LLC 2017, Bowie County Deed Book 1999, Bowie County Deed Book 2005). LUCs restricting access to groundwater are in place at three AOPIs: the Fire Truck Service Extension, Current IWTP, and Former Hayes Batch Treatment Plant. LUCs preventing access to nearby surface water are in place at two AOPIs: Current IWTP and Fire Truck Service Extension. These LUCs are discussed in greater detail in the individual AOPI sections below.

6.2 FIRE STATION 1 AOPI

6.2.1 AOPI Background

The Fire Station 1 is identified as an AOPI following records research, personnel interviews, and site reconnaissance. This building was established in 1942 as a fire station. It was transferred to TAC after BRAC 1995 and is now leased back to the ~~Army~~ Active Army. Fire Station 1 serves to store, wash, and maintain firefighting fleet vehicles. Additionally, small volumes of AFFF were reportedly stored here. The RRAD Fire Department formerly used AFFF for their operations so the firefighting fleet vehicles had the potential to hold AFFF. Therefore, during washing and maintenance practices, there was the potential for AFFF residual to leak or wash off the fleet vehicles and enter the stormwater or sanitary sewers. During interviews, the firefighters stated that routine nozzle testing was not a practice for them. However, the firefighters would flush out their systems when AFFF buckets became empty or if a valve was stuck. The RRAD Fire Department no longer uses AFFF but continued pressure testing of hoses and tank cleanouts does occur.

6.2.2 SI Sampling and Results

Four soil samples and one QC duplicate were collected from four soil borings (RRAD-FS1-SO-01A, RRAD-FS1-SO-01B, RRAD-FD-04-SO, RRAD-FS1-SO-02, and RRAD-FS1-SO-03). Soil samples were collected from areas where runoff from vehicle washing or other maintenance activities may have accumulated. RRAD-FS1-SO-01A, RRAD-FS1-SO-01B and RRAD-FS1-SO-03 were collected from the vegetated area across the street and south of the garage. RRAD-FS1-SO-02 was collected from the vegetated area just west of the garage. Two groundwater samples were collected from two temporary monitoring wells located in downgradient positions to the AOPI. One temporary monitoring well (RRAD-FS1-GW-01) was installed and co-located with RRAD-FS1-SO-01A as shown on Figure 6-1. It was sampled using low-flow methods. Another groundwater sample (RRAD-FS1-GW-02) was collected downgradient of and north of the Fire Station using a SP-16 sampler via grab methods. The Target PFAS analytical results for soil and groundwater samples collected are provided in Table 6-1 and Figure 6-2 and summarized below.

6.2.2.1 Soil

PFOS, PFOA, PFBA, PFNA, PFHxA, and PFHxS were detected in soil at concentrations below their respective SLs. PFBS was not detected above the LODs in any of the soil samples collected at the Fire Station 1 AOPI.

Detections of PFOS, PFOA, and PFBA were highest at RRAD-FS1-SO-02 (0.0068 mg/kg, 0.002 mg/kg, and 0.0017 mg/kg, respectively). PFHxA and PFNA were detected at estimated concentrations (J-flagged) that were highest at RRAD-FS1-SO-02 (0.00082 J mg/kg and 0.00056 J mg/kg). PFHxS were detected at estimated concentrations that were highest at RRAD-FS1-SO-01A (0.00048 J mg/kg). PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected above the LODs in RRAD-FS1-SO-01B.

6.2.2.2 Groundwater

PFOA, PFBA, and PFHxA were detected in groundwater samples at estimated concentrations (J flagged) below the respective SLs. Concentrations of all three analytes were highest at RRAD-FS1-GW-02 (2.6 J ng/L, 16.6 J ng/L, and 4.5 J ng/L, respectively). PFOS, PFBS, PFNA, and PFHxS were not detected above the LODs in any of the groundwater samples collected at Fire Station 1 AOPI.

PFOS was originally detected at an estimated concentration of 2.7 J ng/L at RRAD-FS1-GW-02. However, due to the method blank contamination described in Section 4.3.1, the data was qualified as non-detect at the LOD with a U validation qualifier. Therefore, the final result for PFOS is 4.5 UJ ng/L, which is above the PFOS SL of 4 ng/L. As the concentration was originally reported to be less than the SL, using professional judgment, the sample was determined to not contain PFOS at concentrations above the SL.

6.2.3 CSM

The Fire Station 1 AOPI is approximately 1 acre in size. The area was declared excess under BRAC 1995 and has been transferred to TAC. The fire station consists of a primary building connected to a three-vehicle garage. The ground surface elevation of the Fire Training Pit is approximately 380 feet above mean sea level (amsl). Stormwater runoff from the area likely flows west and east towards the stormwater drains running along the streets and continues to flow south. Surface water and sediment are not present at this AOPI. The closest surface water features to Fire Station 1 are manmade ponds at the Oak Grove Golf Club, located approximately 0.2 miles to the southwest.

Shallow subsurface geology in the northern/central portion of RRAD is generally composed of clays and silty clay shales of the Midway Group. The Midway Group is a marine clay-shale with millimeter scale clay and silty clay horizontal stratification. Vertical migration is limited to occasional small vertical fractures and joints in the weathered portions of the unit. The unit is classified as an aquiclude and has a thickness of approximately 600 feet. Shallow groundwater is approximately between 6 and 13 feet bgs at this AOPI and is reported to flow regionally to the north.

Although the area surrounding this AOPI has been redeveloped into a mixed-use commercial/industrial park, this building continues to be used as a RRAD fire station. There are no land use restrictions at this AOPI. It is owned by TAC and leased back to the Active Army. The installation obtains its drinking water via a public utility, supplied from Wright Patman Lake and Milwood Lake. Wright Patman Lake is within 5 miles downgradient of the southern installation boundary. Groundwater is not currently used, and historically has never been used, as a drinking water source for the installation. Shallow groundwater at RRAD is classified as Class III.

The primary release mechanism is the potential release of PFAS-containing materials to surface soils and/or paved surfaces related to historical operations at Fire Station 1. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from surface soil to deeper subsurface soil and groundwater through infiltration, leaching, and percolation.

There are no current residents at RRAD. However, all exposure pathways for future onsite residents are potentially complete because there are no Target PFAS-specific land use restrictions precluding residential development. The soil exposure pathway is complete for site workers because workers may access the AOPI and Target PFAS were detected in soil samples at Fire Station 1.

Target PFAS were detected in groundwater samples at the AOP. There are no potable water wells located at RRAD and groundwater is not and has never been used for drinking water. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) for future onsite residents and site workers is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use. Groundwater originating in the AOPI could flow offsite and in the absence of LUCs preventing potable use of groundwater offsite, a potentially complete groundwater exposure pathway exists for offsite residents. Figure 6-3 presents the CSM for Fire Station 1.

6.2.4 Recommendation

Although human exposure pathways are complete or potentially complete, detected concentrations of Target PFAS in groundwater and soil at Fire Station 1 AOPI were below the SLs. Therefore, further investigation is not recommended.

Table 6-1. Target PFAS Analytical Results at the Fire Station 1 AOPI

Location ID	Sample ID	Sample Type	Depth (feet)	Sample Date	PFBS	PFHxS	PFNA	PFOA	PFOS	PFBA	PFHxA
Soil				**Units**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
				Screening Levels	**1.9**	**0.13**	**0.019**	**0.019**	**0.013**	**7.8**	**3.2**
RRAD-FS1-SO-01A	RRAD-FS1-SO-01-060323[a]	HA	0-2	06/03/23	No analytical data – cooler lost in transit						
	RRAD- FS1-SO-01A-060323[a,b]	HA	0-2	06/03/23	0.00055 U	**0.00048 J**	**0.00037 J**	**0.0018**	0.00055 U	**0.0011**	**0.0008 J**
RRAD-FS1-SO-01B	RRAD-FS1-SO-01B-060823	HA	0-2	06/08/2023	0.00056 U	0.00056 U	0.00056 U	0.00056 U	0.00056 U	0.00056 U	0.00056 U
	RRAD-FD-04-SO-060823	HA	0-2	06/08/2023	0.00056 U	0.00056 U	0.00056 U	0.00056 U	0.00056 U	0.00056 U	0.00056 U
RRAD-FS1-SO-02	RRAD-FS1-SO-02-053123	HA	0-2	05/31/2023	0.0006 U	0.0006 U	**0.00056 J**	**0.002**	**0.0068**	**0.0017**	**0.00082 J**
RRAD-FS1-SO-03	RRAD-FS1-SO-03-060423[a]	HA	0-2	06/04/23	No analytical data – cooler lost in transit						
	RRAD-FS1-SO-03-060823	HA	0-2	06/08/2023	0.00057 U	0.00057 U	0.00057 U	**0.00036 J**	0.00057 U	00057 U	00057 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**600**	**39**	**5.9**	**6**	**4**	**1,800**	**990**
RRAD-FS1- GW-01	RRAD-FS1-GW-01-061423	TMW	37	06/14/2023	4.0 UJ	4.0 UJ	4.0 UJ	**2 J**	4.0 UJ	8.0 UJ	4.0 UJ
RRAD-FS1- GW-02	RRAD-FS1-GW-02-060623	DPT SP	34	06/14/2023	4.5 UJ	4.5 UJ	4.5 UJ	**2.6 J**	4.5 UJ	**16.6 J**	**4.5 J**

[a] The cooler containing these samples was lost. These samples were recollected.
[b] Sample RRAD-FD-01-SO-060323 was collected as a field duplicate of RRAD-FS1-SO-01-060323. These two samples were packed in separate coolers. The cooler containing RRAD-FS1-SO-01-060323 was lost in transit. As described in Section 3.4.7, RRAD-FD-01-SO-060323 was subsequently renamed RRAD-FS1-SO-01A-060323 as it is no longer a field duplicate and RRAD-FS1-SO-01-060823 was renamed RRAD-FS1-SO-01B-060823 to indicate that the samples were collected from the same area, but not borehole.
Bolded values denote detected concentrations
DPT SP = direct push technology screen point
HA = hand auger
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
mg/kg = milligram per kilogram
ng/L = nanogram per liter
The Screening Levels are the Residential Scenario Screening Levels calculated using EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
TMW = temporary monitoring well
U = The analyte was analyzed for, but not detected above the reported limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was analyzed for but was not detected. The reported limit of detection (LOD) is approximate and may be inaccurate or imprecise.

6.3 FIRE STATION 1 FLUSHING AREA AOPI

6.3.1 AOPI Background

The Fire Station 1 Flushing Area was identified as an AOPI following records research and site reconnaissance. The Fire Station 1 Flushing Area is located east of Fire Station 1 and is owned by TAC. The Flushing Area was used by firefighting fleet vehicles to conduct routine (weekly and/or monthly) hose flushing. Because firefighting fleet vehicles historically carried AFFF, there was the potential for AFFF residual to enter the stormwater system. The volume of AFFF potentially released is unknown. It is unknown when the area began use as a flushing area but may have been used as early as Fire Station 1 was constructed, in 1942. It is still used presently as a fire station by the Active Army.

6.3.2 SI Sampling and Results

Six soil samples were collected from six soil borings (RRAD-FS1FA-SO-01A, RRAD-FS1FA-SO-01B, RRAD-FS1FA-SO-02, RRAD-FS1FA-SO-03, RRAD-FS1FA-SO-04, and RRAD-FS1FA-SO-05), along the vegetated area by the fire hydrant. Two groundwater samples were collected from two temporary monitoring wells installed within the source area; one of the temporary monitoring wells was co-located with RRAD-FS1FA-SO-01A (RRAD-FS1FA-GW-01), and the other RRAD-FS1FA-SO-02 (RRAD-FS1FA-GW-02). These samples were sampled using grab and low-flow methods, respectively. Figure 6-1 depicts sampling locations at the Fire Station 1 Flushing Area AOPI, in conjunction with Fire Station 1. The Target PFAS analytical results for soil and groundwater samples collected are provided in Table 6-2 and Figure 6-2 and summarized below.

6.3.2.1 Soil

PFOS and PFOA were detected at estimated concentrations (J flagged) below their respective SLs in the soil within the central portion of the hose flushing area at RRAD-FS1-SO-01A. Detections of PFOS and PFOA were 0.00028 J ng/L and 0.00036 J ng/L, respectively. PFBA, PFBS, PFNA, PFHxA, and PFHxS were not detected above the LODs in the soil samples collected at the Fire Station 1 Flushing Area AOPI.

6.3.2.2 Groundwater

PFOS was detected at an estimated concentration (J flagged) equal to the SL (4 ng/L) in the eastern sample (RRAD-FS1FA-GW-02). PFOA, PFBA, PFBS, PFHxA, PFHxS, and PFNA were not detected above the LODs in any of the groundwater samples collected at the Fire Station 1 Flushing Area AOPI.

6.3.3 CSM

The Fire Station 1 Flushing Area is approximately 1 acre in size. The area is an open area located approximately 350 feet east of Fire Station 1. Half of the area consists of the paved vehicle staging area and a maintained vegetated field adjacent to a track field. There are two fire hydrants and two stormwater entryways located along the edge of the paved area. Any flushing would enter directly into the stormwater drain. Stormwater runoff from the area likely flows west and east towards the stormwater drains running along the streets and continues to flow south. Surface water and sediment are not present at this AOPI. The closest surface water features to Fire Station 1 Flushing Area are manmade ponds at the Oak Grove Golf Club, located approximately 0.3 miles to the southwest.

Shallow subsurface geology in the northern portion of RRAD is generally composed of clays and silty clay shales of the Midway Group. The Midway Group is a marine clay-shale with millimeter scale clay and silty clay horizontal stratification. Vertical migration is limited to occasional small vertical fractures and joints in the weathered portions of the unit. The unit is classified as an aquiclude and has a thickness of approximately 600 feet. Shallow groundwater is approximately between 6 and 13 feet bgs at this AOPI and is reported to flow regionally to the north.

The area surrounding this AOPI has been redeveloped into a mixed-use commercial/industrial park and the Army still uses this area. There is a land use restriction in the form of a deed notice which prevents residential use of this area (Bowie County Deed Book 1999). It is owned by TAC and leased back to the Army. The installation obtains its drinking water via a public utility, supplied from Wright Patman Lake and Milwood Lake. Wright Patman Lake is within 5 miles downgradient of the southern installation boundary. Groundwater is not currently used, and historically has never been used, as a drinking water source for the installation. Shallow groundwater at RRAD is classified as Class III.

The primary release mechanism is the potential release of AFFF to surface soils and/or paved surfaces related to historical routine hose flushing operations. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from surface soil to groundwater through infiltration, leaching, and percolation, and to surface water and sediment via runoff of precipitation.

Currently, there are no residents at RRAD and a LUC (i.e., deed notice) currently prevents residential use of this AOPI. However, this LUC is not PFAS-specific. Therefore, all exposure pathways for future onsite residents are potentially complete because there are no PFAS-specific land use restrictions precluding residential development. The surface soil exposure pathway at the Fire Station 1 Flushing Area AOPI is complete for site workers because workers may access the AOPI and Target PFAS were detected in surface soil at the AOPI.

Target PFAS compounds were detected in groundwater samples at the AOPI, however there are no potable water wells at RRAD and groundwater is not and has never been used for drinking water. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) for future onsite residents and site workers is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use. Groundwater originating in the AOPI could flow offsite and in the absence of LUCs preventing potable use of groundwater offsite, the groundwater exposure pathway for offsite residents is potentially complete. Figure 6-4 presents the CSM for Fire Station 1 Flushing Area.

6.3.4 Recommendation

Human exposure pathways are complete or potentially complete and detected concentrations of Target PFAS in groundwater at the Fire Station 1 Flushing Area equal the SLs; therefore, further investigation is recommended.

Table 6-2. Target PFAS Analytical Results at the Fire Station 1 Flushing Area

Location ID	Sample ID	Sample Type	Depth (feet)	Sample Date	PFBS	PFHxS	PFNA	PFOA	PFOS	PFBA	PFHxA
Soil				**Units**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
				Screening Levels	**1.9**	**0.13**	**0.019**	**0.019**	**0.013**	**7.8**	**3.2**
RRAD-FS1FA-SO/GW-01A	RRAD-FS1FA-SO-01A-060123 [a]	HA	0-2	06/01/2023	0.00055 U	0.00055 U	0.00055 U	**0.00036 J**	**0.00028 J**	0.00055 U	0.00055 U
RRAD-FS1FA-SO-01B	RRAD-FS1FA-SO-01B-060823[a]	HA	0-2	06/08/2023	0.00066 U	0.00066 U	0.00066 U	0.00066 U	0.00066 U	0.00066 U	0.00066 U
RRAD-FS1FA-SO/GW-02	RRAD-FS1FA-SO-02-053123 [b]	HA	0-2	05/31/2023	No analytical data – cooler lost in transit						
	RRAD-FS1FA-SO-02-060823	HA	0-2	06/08/2023	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U
RRAD-FS1FA-SO-03	RRAD-FS1FA-SO-03-053123 [b]	HA	0-2	05/31/2023	No analytical data – cooler lost in transit						
	RRAD-FS1FA-SO-03-060823	HA	0-2	06/08/2023	0.00055 U	0.00055 U	0.00055 U	0.00055 U	0.00055 U	0.00055 U	0.00055 U
RRAD-FS1FA-SO-04	RRAD-FS1FA-SO-04-053123	HA	0-2	05/31/2023	No analytical data – cooler lost in transit						
	RRAD-FS1FA-SO-04-060823	HA	0-2	06/08/2023	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U
RRAD-FS1FA-SO-05	RRAD-FS1FA-SO-05-053123	HA	0-2	05/31/2023	No analytical data – cooler lost in transit						
	RRAD-FS1FA-SO-05-060823	HA	0-2	06/08/2023	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**600**	**39**	**5.9**	**6**	**4**	**1,800**	**990**
RRAD-FS1FA-SO/GW-01A	RRAD-FS1FA-GW-01-060523	DPT SP	28.5	6/5/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.0 UJ	4.0 UJ
RRAD-FS1FA-SO/GW-02	RRAD-FS1FA-GW-02-060323	TMW	27.5	6/3/2023	4.2 UJ	4.2 UJ	4.2 UJ	4.2 UJ	**4.0 J**	8.3 UJ	4.2 UJ

[a] Sample RRAD-FS1FA-SO-01-060123 was originally identified as a lost sample as described in Section 3.4.7 and therefore a replacement sample was collected. The original sample was later found at the laboratory and thus two parent soil samples were collected from this location. Therefore, RRAD-FS1FA-SO-01-060123 was renamed RRAD-FS1FA-SO-01A-060123 and RRAD-FS1FA-SO-01-060823 was renamed RRAD-FS1FA-SO-01B-060823 to more clearly indicate that the samples were collected from the same area, but not borehole.
[b]The cooler containing these samples was lost. These samples were recollected.
Bolded values denote detected concentrations
DPT SP = direct push technology screen point
HA = hand auger
Highlighted values indicate an exceedance of the Screening Level
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
mg/kg = milligram per kilogram
ng/L = nanogram per liter
The SLs are the Residential Scenario Screening Levels calculated using EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
TMW = temporary monitoring well
U = The analyte was analyzed for, but not detected above the reported limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was analyzed for but was not detected. The reported limit of detection (LOD) is approximate and may be inaccurate or imprecise.

6.4 FIRE TRUCK SERVICE EXTENSION AOPI

6.4.1 AOPI Background

The Fire Truck Service Extension is identified as an AOPI following records research, personnel interviews, and site reconnaissance. The building is owned by TAC and is being leased back to the Active Army for maintenance operations. The Fire Truck Service Extension operations serviced and reconditioned fire trucks brought from other installations as part of the Shelf-Life Maintenance Program. Fire trucks sent to the building to be serviced had the potential to arrive with residual foam on board. Operations were later moved to another building, but the year of operational change is unknown. The Fire Truck Service Extension featured two hull paint booths, parts booths, and a vapor degreaser. Activities included the disassembly of light tracked vehicles for rebuild, cleaning of hulls and component parts, and the machine and welding of component parts. It was constructed between 1983 and 1985 and is currently still in operation.

Historical constituents of concern at this AOPI are volatile organic compounds (VOCs) in groundwater and soil. In 1995, a RCRA Facility Investigation (RFI) was completed on this AOPI as part of the Western Industrial Area. The RFI identified chlorinated solvents in groundwater and soil. The source of the groundwater contamination was attributed to trichloroethylene (TCE) contamination in the former stormwater ditches and the selected remedy included the establishment of a plume management zone (PMZ) around the Western Industrial Area, monitored natural attenuation, and permeable reactive barrier (PRB) walls. The Affected Property Assessment Report (APAR) and Remediation Action Plan (RAP) for the Western Industrial Area were approved by TCEQ in 2008. Long-Term Management including groundwater monitoring, effectiveness reviews of the monitoring, and Five-Year Reviews are performed. AFFF may have been released to site media (soil and groundwater) during fire truck servicing activities.

6.4.2 SI Sampling and Results

Three surface soil samples were collected from three soil borings (RRAD-FTSE-SO-01, RRAD-FTSE-SO-02, and RRAD-FTSE-SO-03) outside the building footprint and the potential release area at the Fire Truck Service Extension AOPI. In addition, three groundwater samples and one QC duplicate were collected from existing permanent monitoring wells. These samples were collected downgradient from the building (RRAD-WIAMW13A-GW-01) and within the AOPI footprint (RRAD-WIAMW14-GW-01, RRAD-FD-01-GW, and RRAD-345MW57A-GW-01). All monitoring wells were sampled using low-flow methods. Panther Creek is west of the AOPI. Sediment and surface water were not sampled at any AOPI as part of this SI. Figure 6-5 depicts sampling locations at the Fire Truck Service Extension AOPI in conjunction with the Current IWTP. The Target PFAS analytical results for soil and groundwater samples collected are provided in Table 6-3 and Figure 6-6 and summarized below.

6.4.2.1 Soil

PFOS and PFOA were detected in soil at concentrations below their respective SLs. PFOS was detected at estimated concentrations (J flagged) below the SL (0.013 mg/kg) in all three sample locations. Estimated concentrations of PFOS were highest at RRAD-FS1-SO-02 (0.00096 J mg/kg). PFOA was detected at an estimated concentration below the SL (0.019 mg/kg) at RRAD-FTSE-SO-02 (0.0005 J mg/kg), located on the southwestern boundary of the AOPI.

PFBA, PFBS, PFNA, PFHxA, and PFHxS were not detected at concentrations above the LODs in the soil samples collected at the Fire Truck Service Extension AOPI.

6.4.2.2 Groundwater

PFOS was detected in groundwater at concentrations above the SL (4 ng/L). PFOS was detected at estimated concentrations (J flagged) above the SL at two locations west of the AOPI and within the AOPI footprint (7.7 J ng/L at RRAD-WIAMW13A-GW-01 and 5.2 J ng/L at RRAD-WIAMW14-GW-01).

PFOA, PFBA, PFHxA, and PFBS were detected at estimated concentrations below their respective SLs and were highest at RRAD-WIAMW13A-GW-01, located west of the AOPI. PFNA and PFHxS were not detected at concentrations above the LODs in the groundwater samples collected at the Fire Truck Service Extension AOPI.

6.4.3 CSM

The Fire Truck Service Extension building covers an area approximately 200,000 square feet in size within the Western Industrial Area. It is surrounded by other buildings and paved roads. The ground surface elevation of Building 255A is approximately 370 feet amsl. Panther Creek is located approximately 600 feet west of the AOPI. The building is surrounded by stormwater drains, which likely conveys stormwater to Panther Creek.

Similar to other AOPIs in the northern portion of the installation, shallow subsurface geology is generally composed of clays and silty clay shales of the Midway Group. The Midway Group is a marine clay-shale with millimeter scale clay and silty clay horizontal stratification. Vertical migration is limited to occasional small vertical fractures and joints in the weathered portions of the unit. The unit is classified as an aquiclude and has a thickness of approximately 600 feet. Shallow groundwater is approximately between 5 and 13 feet bgs at this AOPI and flows to the north.

This AOPI has not yet been transferred but will continue to be deed restricted for commercial and industrial activities. A commercial/industrial LUC and a groundwater use restriction are recorded in the deed for this site (Dawson Technical LLC 2017). There is also fencing preventing access to Panther Creek. The current LUCs are unrelated to PFAS. The installation obtains its drinking water via a public utility, supplied from Wright Patman Lake and Milwood Lake. Wright Patman Lake is within 5 miles downgradient of the southern installation boundary. Groundwater is not currently used, and historically has never been used, as a drinking water source for the installation. Shallow groundwater at RRAD is classified as Class III.

The primary release mechanism is the potential release of AFFF to surface soils and/or paved surfaces related to historical operations. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from surface soil to deeper subsurface soil and groundwater through infiltration, leaching, and percolation and to surface water and sediment via runoff of precipitation or discharge of groundwater to surface water. Surface water and sediment are not present at the Fire Truck Service Extension AOPI, however as stated previously, stormwater drains likely convey stormwater to Panther Creek nearby.

Currently, there are no residents at RRAD and a LUC is in place which prevents residential use of this AOPI. However, this LUC is not PFAS-specific. Therefore, all exposure pathways for future onsite residents are potentially complete because there are no PFAS-specific land use restrictions precluding residential development. The surface soil exposure pathway at the Fire Truck Service Extension AOPI is complete because Target PFAS were detected in surface soil and site workers may access the AOPI.

Target PFAS were detected in groundwater samples at the AOPI, however there are no potable water wells located at RRAD and groundwater is not and has never been used for drinking water. Additionally, LUCs restricting access to groundwater are currently in place at the AOPI. However, the onsite groundwater exposure pathway for future onsite residents and site workers is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use. Groundwater originating in the AOPI could flow offsite and in the absence of LUCs preventing potable use of groundwater offsite, a potentially complete groundwater exposure pathway exists for offsite residents.

Target PFAS in soil or groundwater at the AOPI could migrate and discharge to Panther Creek surface water or sediment. Surface water downgradient of the AOPI is not used for drinking water. Surface water and sediment are not potential exposure media applicable to the off-site residential exposure scenario for this AOPI. Although fencing is in place to prevent on-site access to Panther Creek onsite, surface water and sediment exposure pathways for onsite workers and offsite recreational users are conservatively identified as potentially complete for incidental ingestion and dermal contact. Figure 6-7 presents the CSM for the Fire Truck Service Extension.

6.4.4 Recommendation

Human exposure pathways are complete or potentially complete and detected concentrations of Target PFAS in groundwater at the Fire Truck Service Extension exceed the SLs; therefore, further investigation is recommended.

Table 6-3. Target PFAS Analytical Results at the Fire Truck Service Extension

Location ID	Sample ID	Sample Type	Depth (feet)	Sample Date	PFBS	PFHxS	PFNA	PFOA	PFOS	PFBA	PFHxA
Soil				**Units**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
				Screening Levels	**1.9**	**0.13**	**0.019**	**0.019**	**0.013**	**7.8**	**3.2**
RRAD-FTSE-SO-01	RRAD-FTSE-SO-01-060423	HA	0-2	06/04/2023	0.00056 U	0.00056 U	0.00056 U	0.00056 U	**0.00032 J**	0.00056 U	0.00056 U
RRAD-FTSE-SO-02	RRAD-FTSE-SO-02-060423	HA	0-2	06/04/2024	0.0006 U	0.0006 U	0.0006 U	**0.0005 J**	**0.00096 J**	0.0006 U	0.0006 U
RRAD-FTSE-SO-03	RRAD-FTSE-SO-03-060423	HA	0-2	06/04/2025	0.00056 U	0.00056 U	0.00056 U	0.00056 U	**0.00061 J**	0.00056 U	0.00056 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**600**	**39**	**5.9**	**6**	**4**	**1,800**	**990**
RRAD-345MW57A-GW-02	RRAD-345MW57A-GW-01-060123[a]	PMW	NA	06/01/2023	No analytical data – cooler lost in transit						
	RRAD-345MW57A-GW-02-060823	PMW	NA	06/08/2023	**7.5 J**	4.0 UJ	4.0 UJ	**2.9 J**	4.0 UJ	**5.2 J**	**4.0 J**
RRAD-WIAMW13A-GW-01	RRAD-WIAMW13A-GW-01-060123	PMW	20	06/01/2023	**9.6 J**	4.0 UJ	4.0 UJ	**3.6 J**	**7.7 J**	**15.5 J**	**2.6 J**
RRAD-WIAMW14-GW-01	RRAD-WIAMW14-GW-01-060123	PMW	24	06/01/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	**5.2 J**	**5.1 J**	**3.3 J**
	RRAD-FD-01-GW-060123	PMW	24	06/01/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	**4.9 J**	**5.1 J**	**3.1 J**

[a] The cooler containing this sample was lost. This sample was recollected.
Bolded values denote detected concentrations
HA = hand auger
Highlighted values indicate an exceedance of the Screening Level
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
Mg/kg = milligram per kilogram
ng/L = nanogram per liter
PMW = permanent monitoring well
The Screening Levels are the Residential Scenario Screening Levels calculated using EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
U = The analyte was analyzed for, but not detected above the reported limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was analyzed for but was not detected. The reported limit of detection (LOD) is approximate and may be inaccurate or imprecise.

6.5 CURRENT INDUSTRIAL WASTEWATER TREATMENT PLANT AOPI

6.5.1 AOPI Background

The Current IWTP is identified as an AOPI following records research, personnel interviews, and site reconnaissance. It is in the Western Industrial Area. It was constructed in 1968 and began accepting electroplating waste in 1978. Historical constituents of concern at this AOPI are metals and VOCs in groundwater and soil.

Three former Chromate Sludge Drying Beds, located 100 feet southwest of the Current IWTP, were in use between 1978 and 2005. Located within the Western Industrial Area, these easternmost sludge drying beds (10 drying beds total) were put into service in 1978 to handle chromate industrial wastes associated with the addition of the Current IWTP. In 1986, these chromate beds were converted to a waste pile to house industrial chromate and phosphate sludge. A double-lined leachate collection system is reportedly installed beneath the sludge drying beds with associated groundwater monitoring points. Subsequent RCRA investigations indicated no known release of wastes associated with the sludge drying beds or waste pile. These beds were demolished in 2005. The AOPI was determined to be excess as part of BRAC 1995 and is now operated by RWRD; however, the full property transfer is pending completion of environmental cleanup in the Western Industrial Area and is currently under Army BRAC control.

The former Chromate Equalization Lagoons were in service between 1978 and 1997 at the Current IWTP. There were three lagoons which were located directly north and east of the Current IWTP and used as surface impoundments for electroplating wastewater as it was processed through the Current IWTP. The three lagoons were the Effluent Lagoon, Equalization Lagoon, and Final Holding Lagoon. The Equalization Lagoon was installed in 1978. It was 65 feet wide by 95 feet long and held untreated chromium rinse water prior to treatment at the Current IWTP. The Equalization Lagoon and the soil beneath it were removed in 1989. The Effluent Lagoon (also referred to as the “Intermediate Lagoon”) was installed sometime between 1991 and 1995. It was approximately 70 feet wide by 70 feet long and held treated wastewater from the Current IWTP. The Final Holding Lagoon (also referred to as the “Final Lagoon”) was the third lagoon and was installed sometime between 1978 and 1984. It also held treated wastewater from the Current IWTP and was approximately 200 feet wide and 50 feet long. In 1994, stormwater ditches adjacent to the former lagoons were excavated five feet in depth and replaced with clean fill and concrete. The Effluent Lagoon and Final Holding Lagoons were demolished in 1997. The land was excavated upon closure and remains open. The area of the former Equalization Lagoon is currently used to support the Current IWTP operations. In 2002, metal and VOC-contaminated sludge was stabilized in place, removed, and replaced with clean fill. In 2003, the Response Action Completion Report (RACR) was approved by TCEQ. The selected remedy included the establishment of a PMZ, monitored natural attenuation, and PRB walls. In 2007, a response action was completed with the installation of a PRB. The APAR and RAP for the WIA were approved by TCEQ in November 2008 (Dawson Technical LLC 2017). There is a PMZ for the Western Industrial Area. Long-Term Management including groundwater monitoring, effectiveness reviews of the monitoring, and Five-Year Reviews are performed. Since contaminants related to metal plating activities were detected in at the site, PFAS-containing metal plating waste may have also been released to site media (soil and groundwater).

6.5.2 SI Sampling and Results

Due to land redevelopment at the AOPI, soil samples were not planned for collection. Nine groundwater samples and one QC duplicate sample were collected from existing permanent monitoring wells. These samples collected from locations within one potential release area (RAD-CEL11-GW-01) and downgradient from the release areas (RRAD-DG8A-GW-01, RRAD-FD-02-GW, RRAD-DG13-GW-01, RRAD-DG14-GW-01, RRAD-WWT24-GW-01, RRAD-WWT54B-GW-01, RRAD-BSMW2UA-GW-01, RRAD-SFA2A-GW-01, and RRAD-WIAMW59-GW-01). Monitoring wells were sampled using low-flow methods. Figure 6-5 depicts groundwater sampling locations at the Current IWTP in conjunction with the

Fire Truck Service Extension. Panther Creek laterally bisects this AOPI. Sediment and surface water were not sampled at any AOPI. The Target PFAS analytical results for groundwater samples collected are provided in Table 6-4 and Figure 6-6 and summarized below.

6.5.2.1 Groundwater

PFOS and PFOA were detected in groundwater at concentrations above their respective SLs (4 ng/L and 6 ng/L, respectively). PFOS was detected at estimated concentrations (J flagged) above the SL in four locations: two monitoring wells along Panther Creek (25.5 J ng/L at RRAD-SFA2A-GW-01 and 13.2 J ng/L at RRAD-BSMW2UA-GW-01) and in two monitoring wells downgradient of the sludge drying beds (7.5 J ng/L at RRAD-DG13-GW-01 and 7.4 J ng/L at RRAD-DG14-GW-01). PFOA was detected at estimated concentrations above the SL at four locations: one monitoring well within the former chrome equalization lagoon (241.0 J ng/L at RRAD-CEL11-GW-01), two monitoring wells along Panther Creek (46.7 J ng/L at RRAD-BSMW2UA-GW-01 and 10.2 J ng/L at RRAD-SFA2A-GW-01), and one monitoring well downgradient of the sludge drying beds (43.1 J ng/L at RRAD-DG14-GW-01).

PFBA, PFBS, and PFHxS were detected at estimated concentrations below their respective SLs and were highest at RRAD-SFA2A-GW-02, located by Panther Creek. The highest concentrations were 16.2 J ng/L, 27.3 J ng/L and 12.7 J ng/L, respectively. PFHxA was detected at estimated concentrations below the SL and was highest at RRAD-BSMW2UA-GW-01, also located by Panther Creek. The highest concentration was 33.6 J ng/L.

PFNA was not detected above the LODs in any groundwater samples collected at the Current IWTP.

6.5.3 CSM

The Current IWTP is an approximately 12-acre facility within the Western Industrial Area. The ground surface elevation of the AOPI is approximately 370 feet amsl. Panther Creek runs through the AOPI. Stormwater is conveyed to Panther Creek, as are discharges from the facility.

Similar to other AOPIs in the northern portion of the installation, shallow subsurface geology is generally composed of clays and silty clay shales of the Midway Group. The Midway Group is a marine clay-shale with millimeter scale clay and silty clay horizontal stratification. Vertical migration is limited to occasional small vertical fractures and joints in the weathered portions of the unit. The unit is classified as an aquiclude and has a thickness of approximately 600 feet. Shallow groundwater is approximately between 6 and 16 feet bgs at this AOPI and flows to the north.

This AOPI has not yet been transferred but there is a deed notice of restriction for commercial and industrial activities and restricting groundwater use. These LUCs are unrelated to PFAS. There is also fencing preventing access to Panther Creek (Dawson Technical LLC 2017). The installation obtains its drinking water via a public utility, supplied from Wright Patman Lake and Milwood Lake. Wright Patman Lake is within 5 miles downgradient of the southern installation boundary. Groundwater is not currently used, and historically has never been used, as a drinking water source for the installation. Shallow groundwater at RRAD is classified as Class III.

The primary release mechanism is the potential historical release of PFAS-containing wastewater to unlined IWTP infrastructure (i.e., sludge drying beds, or lagoons) at the Current IWTP. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from shallow soil to deeper subsurface soil and groundwater through infiltration, leaching, and percolation and to surface water and sediment via runoff of precipitation or discharge of groundwater to surface water in Panther Creek.

This AOPI is currently being used as an industrial wastewater treatment plant. Based on the current and historical land use of the AOPI, it is likely to continue being used as a wastewater treatment plant for the foreseeable future and residential development is not a reasonably anticipated future land use. However, Target PFAS-specific LUCs preventing future residential development at this AOPI are not in place. Therefore, all exposure pathways for future onsite residents are potentially complete. The surface soil exposure pathway at the Current IWTP AOPI is potentially complete because site workers may access the AOPI, and presence of Target PFAS in soil is unknown. Surface soil samples were not collected at this AOPI because the land was remediated and/or redeveloped and the extent of the soil re-work is unknown.

Target PFAS were detected in groundwater samples at the AOPI, however there are no potable water wells located at RRAD and groundwater is not and has never been used for drinking water. Although residential development is not a reasonably anticipated future land use at this AOPI, Target PFAS-specific LUCs preventing the withdrawal of groundwater for potable use are not in place. Therefore, the onsite groundwater exposure pathways at the Current IWTP AOPI are potentially complete for future site workers and residents. Groundwater originating in the AOPI could flow offsite and in the absence of LUCs preventing potable use of groundwater offsite, a potentially complete groundwater exposure pathway exists for offsite residents.

Target PFAS in soil or groundwater at the AOPI could migrate and discharge to Panther Creek surface water to sediment. Surface water downgradient of the AOPI is not used for drinking water. Surface water and sediment are not potential exposure media applicable to the off-site residential exposure scenario for this AOPI. Although fencing is in place to prevent onsite access to Panther Creek on-site, to be conservative, surface water and sediment exposure pathways for onsite workers and offsite recreational users are conservatively identified as potentially complete for incidental ingestion and dermal contact. Figure 6-8 presents the CSM for the Current IWTP.

6.5.4 Recommendation

Potentially complete human exposure pathways exist, and concentrations of Target PFAS in groundwater at the Current IWTP exceed the SLs; therefore, further investigation is recommended.

Table 6-4. Target PFAS Analytical Results at the Current Industrial Wastewater Treatment Plant

Location ID	Sample ID	Sample Type	Depth (feet)	Sample Date	PFBS	PFHxS	PFNA	PFOA	PFOS	PFBA	PFHxA
Groundwater				Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
				Screening Levels	600	39	5.9	6	4	1,800	990
RRAD-BSMW2UA-GW-01	RRAD-BSMW2UA-GW-01-060223	PMW	25	6/2/2023	3.8 UJ	**10.9 J**	3.8 UJ	**46.7 J**	**13.2 J**	**7.4 J**	**33.6 J**
RRAD-CEL11-GW-01	RRAD-CEL11-GW-01-060123	PMW	20	6/1/2023	3.8 UJ	3.8 UJ	3.8 UJ	**241.0 J**	3.8 UJ	**9.2 J**	**8.0 J**
RRAD-DG13-GW-01	RRAD-DG13-GW-01-060423	PMW	17	6/4/2023	4.0 UJ	4.0 UJ	4.0 UJ	**2.3 J**	**7.5 J**	8.0 UJ	**2.2 J**
RRAD-DG14-GW-01	RRAD-DG14-GW-01-060223	PMW	17	6/2/2023	4.0 UJ	4.0 UJ	4.0 UJ	**43.1 J**	**7.4 J**	**13.9 J**	**17.6 J**
RRAD-DG8A-GW-01	RRAD-DG8A-GW-01-060223	PMW	18	6/2/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.0 UJ	4.0 UJ
	RRAD-FD-GW-02-060223	PMW	18	6/2/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.0 UJ	4.0 UJ
RRAD-SFA2A-GW-02	RRAD-SFA2A-GW-01-060123[a]	PMW	32	6/1/2023	No analytical data – cooler lost in transit						
	RRAD-SFA2A-GW-02-060823	PMW	32	6/8/2023	**27.3 J**	**12.7 J**	4.0 UJ	**10.2 J**	**25.5 J**	**16.2 J**	**3.1 J**
RRAD-WIAMW59-GW-02	RRAD-WIAMW59-GW-01-060123[a]	PMW	34	6/1/2023	No analytical data – cooler lost in transit						
	RRAD-WIAMW59-GW-02-060723	PMW	34	6/7/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.0 UJ	4.0 UJ
RRAD-WWT24-GW-01	RRAD-WWT24-GW-01-060123	PMW	38	6/1/2023	3.8 UJ	3.8 UJ	3.8 UJ	3.8 UJ	3.8 UJ	7.7 UJ	3.8 UJ
RRAD-WWT54B-GW-01	RRAD-WWT54B-GW-01-060123	PMW	25	6/1/2023	3.8 UJ	3.8 UJ	3.8 UJ	3.8 UJ	3.8 UJ	7.7 UJ	3.8 UJ

[a] The cooler containing these samples was lost. These samples were recollected.
Bolded values denote detected concentrations
Highlighted values indicate an exceedance of the Screening Level
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
ng/L = nanogram per liter
PMW = permanent monitoring well
The Screening Levels are the Residential Scenario Screening Levels calculated using EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
U = The analyte was analyzed for, but not detected above the reported limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was analyzed for but was not detected. The reported limit of detection (LOD) is approximate and may be inaccurate or imprecise.

6.6 OTC LANDFILL AOPI

6.6.1 AOPI Background

The OTC Landfill is identified as an AOPI following records research, personnel interviews, and site reconnaissance indicating the disposal of metal plating wastes. The OTC Landfill is located on the northwest portion of RRAD. The OTC Landfill was excessed as part of a BRAC event but has not been transferred and remains under Army control. The OTC Landfill served many functions from 1942 to 1982. It was a sewage treatment plant, an industrial waste batch treatment plant, a drum storage area, and a landfill. Historical constituents of concern at this AOPI are VOCs in groundwater and soil.

From the 1960s until the early 1970s, it served as a batch sewage treatment plant until the Phase II construction of the Current IWTP was completed. Hexavalent chromium and cadmium-bearing wastewaters were transported by truck from metal plating facility to a sewer settling tank at the industrial waste batch treatment plant. Treated wastewater was discharged into a tributary of Big Creek.

Chromate waste sludge from the Former Hayes Batch Treatment Plant and Current IWTP was containerized and buried at the OTC Landfill until 1982. The waste included solvents, pentachlorophenol, and heavy metals and it was distributed through four burial sites. Spills were reported to occur in the unloading process as well as releases from deteriorated containers. In 1984, a groundwater quality assessment was completed which identified 1,1-dichloroethylene (DCE), 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), and vinyl chloride above Texas residential protective contamination levels (PCLs). A PMZ exists at the site. A RCRA cap was installed over the site in 1985 and fencing was constructed around it. The site subsequently achieved closure. Long-Term Management including cap inspections, groundwater monitoring, and Five-Year Reviews are performed. Since contaminants related to metal plating activities were detected in at the site, PFAS-containing metal plating waste may have also been released to site media (soil and groundwater).

6.6.2 SI Sampling and Results

Due to land redevelopment at the AOPI, soil samples were not planned for collection. Seven groundwater samples and one QC field duplicate sample were collected from existing permanent monitoring wells were collected from locations surrounding the landfill (RRAD-OTC(W)53-GW-01, RRAD-OTC(W)55-GW-01, RRAD-OTC(W)58-GW-01, RRAD-OTC(W)65-GW-01, RRAD-OTC44-GW-01, RRAD-OTC67-GW-01, RRAD-OTC81-GW-01, and RRAD-FD-03-GW). Monitoring wells were sampled using low-flow methods. Sample locations are shown in Figure 6-9. Sediment and surface water are located west of this AOPI. The Target PFAS analytical results for soil and groundwater samples collected at the OTC Landfill AOPI are provided in Table 6-5 and Figure 6-10 and summarized below.

6.6.2.1 Groundwater

PFOA was detected at estimated concentrations above the SL (6 ng/L) in three monitoring wells located southwest of the AOPI. Detections were 59.1 J ng/L at RRAD-OTC(W)53-GW-01,7.6 ng/L at RRAD-OTC(W)58-GW-01, and 6.5 J ng/L at RRAD-OTC81-GW-01. PFBA, PFBS, and PFHxA were detected at estimated concentrations (J flagged) below the respective SLs. Detections of PFBA, PFBS, and PFHxA were highest at RRAD-OTC(W)53-GW-01 (46.6 J ng/L, 10.8 J ng/L, and 110 J ng/L), located southwest of the AOPI.

PFOS, PFNA, and PFHxS were not detected above the LODs in any groundwater samples collected at the OTC Landfill.

6.6.3 CSM

The OTC Landfill AOPI is approximately 9 acres in size and located in the northwestern portion of the former installation. The ground surface elevation of the AOPI is approximately 340 feet amsl. Big Creek is located immediately west of the AOPI. Stormwater conveyances likely follow topography and lead to Big Creek. While active as a wastewater treatment plant, the facility also discharged wastewater into Big Creek.

Similar to the other AOPIs in the northern portion of RRAD, shallow subsurface geology is generally composed of clays and silty clay shales of the Midway Group. The Midway Group is a marine clay-shale with millimeter scale clay and silty clay horizontal stratification. Vertical migration is limited to occasional small vertical fractures and joints in the weathered portions of the unit. The unit is classified as an aquiclude and has a thickness of approximately 600 feet. Shallow groundwater occurs between 14 and 34 feet bgs at this AOPI and flows to the south (Leisnoi Kemron JV 2023).

This AOPI has not yet been transferred but will be deed restricted to commercial and industrial activities. Restrictions against residential use and drinking water well installation are in place at the OTC Landfill, but these restrictions are unrelated to PFAS. Additionally, the OTC Landfill features a cap, signate, a gate, and fencing, preventing access (Dawson Technical LLC 2017). The installation obtains its drinking water via a public utility, supplied from Wright Patman Lake and Milwood Lake. Wright Patman Lake is within 5 miles downgradient of the southern installation boundary. Groundwater is not currently used, and historically has never been used, as a drinking water source for the installation. Shallow groundwater at RRAD is classified as Class III.

The primary release mechanism is the potential release of PFAS-containing materials to soils, or PFAS-containing wastewater to surface water related to historical operations at the OTC Landfill. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from shallow soil to deeper subsurface soil and groundwater through infiltration, leaching, and percolation and to surface water and sediment via runoff of precipitation or discharge of groundwater to surface water in Big Creek tributaries.

This AOPI is currently being used as a landfill and there are LUCs restricting the use of the landfill for residential purposes. Although the restrictions are not specific to Target PFAS, based on the historical and current use of the area, residential development is not a reasonably anticipated future land use for the OTC Landfill. However, because Target PFAS-specific LUCs preventing future residential development at this AOPI are not in place, all exposure pathways for future onsite residents and future site workers are potentially complete. Exposure pathways for current site workers are incomplete because landfill soil is currently covered with a cap that prevents exposure to potential Target PFAS. Exposure pathways for current residents is incomplete because there are no residents at this AOPI.

Target PFAS were detected in groundwater samples at the AOPI. Although there are no potable water wells at RRAD, groundwater is not and has never been used for drinking water at RRAD, and residential development is not a reasonably anticipated future land use at this AOPI, the onsite groundwater exposure pathways are potentially complete for future site workers and residents because there are no Target PFAS-specific LUCs preventing the installation of drinking water wells at this AOPI. Groundwater originating in the AOPI could flow offsite and in the absence of LUCs preventing potable use of groundwater offsite, a potentially complete groundwater exposure pathway exists for offsite residents.

Target PFAS in soil or groundwater at the AOPI could migrate and discharge to the Big Creek tributary west of the AOPI. Big Creek is upstream of Wright Patman Lake, which is the drinking water source for RRAD and the surrounding communities. PFAS impacted surface water could be used as a drinking water source for onsite workers and/or off-site residents; therefore, the surface water (drinking water) exposure pathways are potentially complete. Additionally, surface water and sediment exposure pathways for onsite workers and offsite recreational users are potentially complete via incidental ingestion and dermal contact. Sediment is not a potential exposure medium applicable to the off-site residential exposure scenario for this AOPI. Figure 6-11 presents the CSM for the OTC Landfill.

6.6.4 Recommendation

Potentially complete human exposure pathways exist, and concentrations of Target PFAS in groundwater at the OTC Landfill exceed the SLs; therefore, further investigation is recommended.

Table 6-5. Target PFAS Analytical Results at the OTC Landfill

Location ID	Sample ID	Sample Type	Depth (feet)	Sample Date	PFBS	PFHxS	PFNA	PFOA	PFOS	PFBA	PFHxA
Groundwater				Units	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
				Screening Levels	600	39	5.9	6	4	1,800	990
RRAD-OTC(W)53-GW-01	RRAD-OTC(W)53-GW-01-060623	PMW	21	6/6/2023	**10.8 J**	4.0 UJ	4.0 UJ	**59.1 J**	4.0 UJ	**46.6 J**	**110 J**
RRAD-OTC(W)55-GW-01	RRAD-OTC(W)55-GW-01-060623	PMW	33	6/6/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.0 UJ	4.0 UJ
RRAD-OTC(W)58-GW-01	RRAD-OTC(W)58-GW-01-060623	PMW	22.5	6/6/2023	**2.2 J**	4.2 UJ	4.2 UJ	**7.6 J**	4.2 UJ	**4.7 J**	4.2 UJ
RRAD-OTC(W)65-GW-01	RRAD-OTC(W)65-GW-01-060623	PMW	24	6/6/2023	4.3 UJ	4.0 UJ	4.3 UJ	4.0 UJ	4.0 UJ	8.7 UJ	4.0 UJ
RRAD-OTC44-GW-01	RRAD-OTC44-GW-01-060623	PMW	47	6/6/2023	4.2 UJ	4.2 UJ	4.2 UJ	4.2 UJ	4.2 UJ	**6.5 J**	4.2 UJ
RRAD-OTC67-GW-01	RRAD-OTC67-GW-01-060723	PMW	38	6/6/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.0 UJ	4.0 UJ
RRAD-OTC81-GW-01	RRAD-OTC81-GW-01-060623	PMW	17.5	6/6/2023	4.0 UJ	4.0 UJ	4.0 UJ	**6.5 J**	4.2 UJ	8.0 UJ	4.0 UJ
	RRAD-FD-03-GW-060623	PMW	17.5	6/6/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.0 UJ	4.0 UJ

Bolded values denote detected concentrations
Highlighted values indicate an exceedance of the Screening Level
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
ng/L = nanogram per liter
PMW = permanent monitoring well
The Screening Levels are the Residential Scenario Screening Levels calculated using EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
U = The analyte was analyzed for, but not detected above the reported limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was analyzed for but was not detected. The reported limit of detection (LOD) is approximate and may be inaccurate or imprecise.

6.7 FORMER HAYES BATCH TREATMENT PLANT AOPI

6.7.1 AOPI Background

The Former Hayes Batch Treatment Plant is identified as an AOPI following records review due to the disposal of metal plating wastes here. The former Hayes Batch Treatment plant was an IWTP originally constructed in 1961. It included two Dunbar filter beds, a concrete wet well, a baffled settling basin, above ground steel mixing tanks, and miscellaneous underground piping systems. Located west of the Western Industrial Area, wastewater generated from metal plating was disposed of here from 1961 to 1978. Sludge from this plant would be disposed of in the OTC Landfill. It was as a temporary facility used to treat wastewater generated from metal plating shops until the establishment of the Current IWTP. Dunbar filter beds at this IWTP that received the metal plating waste were removed between 1988 and 1990. This facility, during operation, would discharge into Panther Creek. For what is described in the 1996 RFI as "short time", electroplating wastes were pumped via an underground vitrified clay pipe to a wet well for storage (RRAD 1996). The supernatant from the wet well was pumped into the baffled settling basin and the fed to the Dunbar filter beds. The clay pipe was reportedly in poor condition and demolished at an unknown time. Industrial waste was then hauled by pump trucks to the Hayes Batch Treatment Plant until the Current IWTP was opened. All generated sludges were containerized and buried at the OTC Landfill, and the filtered supernatant was discharged to Panther Creek. The plant ceased operations in 1978, but some infrastructure is still present.

Historical constituents of concern at this AOPI are metals in soil. In 2004, the RAP and APAR were approved by TCEQ. Approximately 280 cubic yards of sludge and soil were removed and approximately 110,000 gallons of water were dewatered from the sludge beds and drainage ditch at the site. Water was discharged to the sewer plant. The beds and drainage ditch were backfilled with clean fill from off-site. In 2003, the RACR was approved by TCEQ. No post-response action care was required because commercial/industrial protective concentration levels were achieved. However, since contaminants related to metal plating activities were detected in at the site, PFAS-containing metal plating waste may have also been released to site media (soil and groundwater). The site is owned by RWRD.

6.7.2 SI Sampling and Results

Three surface soil samples and one QC duplicate were collected from three soil borings distributed within the former drying beds (RRAD-FHTBP-SO-01), former settling basin (RRAD FHTBP-SO-02 and RRAD-FD-FHBTP-SO-02) and adjacent to Panther Creek (RRAD-FHTBP-SO-03). Five groundwater samples were collected using DPT screen point and the development of temporary monitoring wells. Three of these samples were collected from borings co-located with these soil samples (RRAD-FHTBP-GW-01, RRAD-FHTBP-GW-02, and RRAD-FHTBP-GW-03). Two of these groundwater samples were collected from the area downgradient of the former concrete filter beds (RRAD-FHBTP-GW-04) and the former settling basin (RRAD-FHBTP-GW-05). RRAD-FHBTP-GW-01 and RRAD-FHBTP-GW-05 were developed into temporary monitoring wells and sampled via grab methods. RRAD-FHBTP-GW-03 and RRAD-FHBTP-GW-04 were developed into temporary monitoring wells and sampled via low-flow methods. RRAD-FHBTP-GW-02 was sampled using a SP-16 sampler via grab methods. Sample locations are shown in Figure 6-12. The Target PFAS analytical results for soil and groundwater samples collected are provided in Table 6-6 and Figure 6-13 and summarized below.

6.7.2.1 Soil

PFOS, PFOA, PFBA, PFBS, PFNA, PFHxA, and PFHxS were not detected at concentrations above the LODs in any of the soil samples collected.

6.7.2.2 Groundwater

PFOS and PFOA were detected in groundwater at concentrations above their SLs of 4 ng/L and 6 ng/L, respectively.

PFOS was detected at estimated concentrations (J flagged) above the SL (4 ng/L) at three monitoring wells within and downgradient of the AOPI (33.3 J ng/L at RRAD-FHBTP-GW-05, 6.1 J ng/L at RRAD-FHBTP-GW-02, and 5.9 J ng/L at RRAD-FHBTP-GW-01). PFOA was detected at estimated concentrations above the SL (6 ng/L) at one location downgradient of the former settling basin (20.3 J ng/L at RRAD- FHBTP-GW-05) and two locations within and downgradient of the AOPI (10.0 J ng/L at RRAD-FHBTP-GW-02 and 7.9 J ng/L at RRAD-FHBTP-GW-01).

PFBS was detected at an estimated concentration below the SL along Panther Creek (26.4 J ng/L at RRAD-FHBTP-GW-02).

PFBA and PFHxA were detected at estimated concentrations below the respective SLs near the settling basin (29.4 J ng/L and 11.3 ng/L, respectively at RRAD-FHBTP-GW-05).

PFNA and PFHxS were not detected above the LOD in any groundwater samples collected at this AOPI.

6.7.3 CSM

The Former Hayes Batch Treatment Plant AOPI is a former facility approximately 2 acres in size, located immediately east of the Western Industrial Area. The ground surface elevation of the AOPI is approximately 360 feet amsl. Panther Creek is located immediately east of the AOPI. Stormwater conveyances likely follow topography and lead to Panther Creek. While active, the facility discharged wastewater into Panther Creek as well.

Similar to other AOPIs in the northern portion of the installation, shallow subsurface geology is generally composed of clays and silty clay shales of the Midway Group. The Midway Group is a marine clay-shale with millimeter scale clay and silty clay horizontal stratification. Vertical migration is limited to occasional small vertical fractures and joints in the weathered portions of the unit. The unit is classified as an aquiclude and has a thickness of approximately 600 feet. Shallow groundwater is approximately between 14 and 30 feet bgs at this AOPI and flows to the north. Surface water and sediment are not present at the AOPI.

Although the area west of this AOPI has been redeveloped into a mixed-use commercial/industrial park, this specific area has not yet been redeveloped. It is owned by RWRD. All sludge and soil material containing constituents of concern were excavated from the northern and southern sludge beds and the affected on-site drainage ditch for off-site disposal. There is a land use restriction in the form of a deed notice which prevents residential use of this area (Bowie County Deed Book 2005). The LUCs are unrelated to PFAS. The installation obtains its drinking water via a public utility, supplied from Wright Patman Lake and Milwood Lake. Wright Patman Lake is within 5 miles downgradient of the southern installation boundary. Groundwater is not currently used, and historically has never been used, as a drinking water source for the installation. Shallow groundwater at RRAD is classified as Class III.

The primary release mechanism is the potential historical release of PFAS-containing wastewater to unlined WTP infrastructure (i.e., former beds, or basins) at the Former Hayes Batch Treatment Plant. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from surface soil, surface water, and sediment to deeper subsurface soil and groundwater through infiltration, leaching, and percolation and to surface water and sediment via runoff of precipitation or discharge of groundwater to surface water in Panther Creek.

This AOPI was historically used as an industrial wastewater treatment plant. Based on the historical land use of the AOPI, it is likely to continue to be used for commercial and/or industrial purposes for the foreseeable future. Although residential development is not a reasonably anticipated future land use, Target PFAS-specific LUCs preventing future residential development at this AOPI are not in place and have been considered. Target PFAS were also not detected in soil. Therefore, all exposure pathways for onsite residents and site workers are incomplete.

Target PFAS were detected in groundwater samples at the AOPI, however there are no potable water wells located at RRAD and groundwater is not and has never been used for drinking water. Although residential development is not a reasonably anticipated future land use at this AOPI, Target PFAS-specific LUCs preventing the withdrawal of groundwater for potable use are not in place. Therefore, the onsite groundwater exposure pathways are currently potentially complete for future site workers and residents. Groundwater originating in the AOPI could flow offsite and in the absence of LUCs preventing potable use of groundwater offsite, a potentially complete groundwater exposure pathway exists for offsite residents.

Target PFAS in soil or groundwater at the AOPI could migrate and discharge to Panther Creek surface water and sediment. Surface water downgradient of the AOPI is not used for drinking water. Surface water and sediment are not potential exposure media applicable to the off-site residential exposure scenario for this AOPI. Surface water exposure pathways for onsite workers and offsite recreational users are potentially complete for incidental ingestion and dermal contact. Target PFAS in surface water may adsorb to sediment in Panther Creek, therefore sediment exposure pathways for onsite workers and offsite recreational users are also potentially complete for incidental ingestion and dermal contact. Figure 6-14 presents the CSM for the Former Hayes Batch Treatment Plant.

6.7.4 Recommendation

Potentially complete human exposure pathways exist, and concentrations of Target PFAS in groundwater at the Former Hayes Batch Treatment Plant exceed the SLs; therefore, further investigation is recommended.

Table 6-6. Target PFAS Analytical Results at the Former Hayes Batch Treatment Plant

Location ID	Sample ID	Sample Type	Depth (feet)	Sample Date	PFBS	PFHxS	PFNA	PFOA	PFOS	PFBA	PFHxA
Soil				**Units**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
				Screening Levels	**1.9**	**0.13**	**0.019**	**0.019**	**0.013**	**7.8**	**3.2**
RRAD-FHBTP-SO-1	RRAD-FHBTP-SO-01-060723	HA	0-2	06/07/2023	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U	0.00057 U
RRAD-FHBTP-SO-02	RRAD-FHBTP-SO-02-060723	HA	0-2	06/07/2023	0.00061 U	0.00061 U	0.00061 U	0.00061 U	0.00061 U	0.00061 U	0.00061 U
	RRAD-FD-FHBTP-SO-02-060723	HA	0-2	06/07/2023	0.00055 U	0.00055 U	0.00055 U	0.00055 U	0.00055 U	0.00055 U	0.00055 U
RRAD-FHBTP-SO-03	RRAD-FHBTP-SO-03-060723	HA	0-2	06/07/2023	0.00061 U	0.00061 U	0.00061 U	0.00061 U	0.00061 U	0.00061 U	0.00061 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**600**	**39**	**5.9**	**6**	**4**	**1,800**	**990**
RRAD-FHBTP- GW-01	RRAD-FHBTP-GW-01-062023	TMW	23.9	6/20/2023	6.9 UJ	6.9 UJ	6.9 UJ	**7.9 J**	**5.9 J**	**11.1 J**	**4.3 J**
RRAD-FHBTP-GW-02	RRAD-FHBTP-GW-02-061523	DPT SP	15	6/15/2023	**26.4 J**	20.0 UJ	20.0 UJ	**10.0 J**	**33.3 J**	**36.6 J**	20.0 UJ
RRAD-FHBTP-GW-03	RRAD-FHBTP-GW-03-061823	TMW	37	6/18/2023	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	4.0 UJ	8.9 UJ	4.0 UJ
RRAD-FHBTP-GW-04	RRAD-FHBTP-GW-04-062023	TMW	23.8	6/20/2023	4.5 UJ	4.5 UJ	4.5 UJ	4.5 UJ	**3.6 J**	**29.4 J**	4.5 UJ
RRAD-FHBTP-GW-05	RRAD-FHBTP-GW-05-062223	TMW	19	6/22/2023	5.9 UJ	5.9 UJ	5.9 UJ	**20.3 J**	**6.1 J**	8.0 UJ	**11.3 J**

Bolded values denote detected concentrations
DPT SP = direct push technology screen point
HA = hand auger
Highlighted values indicate an exceedance of the Screening Level
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
mg/kg = milligram per kilogram
ng/L = nanogram per liter
The Screening Levels are the Residential Scenario Screening Levels calculated using EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
TMW = temporary monitoring well
U = The analyte was analyzed for, but not detected above the reported limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was analyzed for but was not detected. The reported limit of detection (LOD) is approximate and may be inaccurate or imprecise.

7. CONCLUSIONS AND RECOMMENDATIONS

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 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 (40 CFR 300.420(5)). The SI Report used the findings from the PA in conjunction with soil and groundwater sampling data for each AOPI to determine whether Target PFAS have been released to the environment and whether a release has affected or may affect specific human health targets.

Before the SI sampling, a preliminary CSM was developed in the PA for each AOPI based on an evaluation of existing records, personnel interviews, and site reconnaissance. The preliminary CSMs identified potential human receptors and exposure pathways for groundwater and surface water that is known to be used, or could realistically be used in the future, as a source of drinking water and identified potential soil and sediment exposure pathways. All AOPIs were sampled during the SI at RRAD to further evaluate PFAS-related releases and identify the presence or absence of Target PFAS.

Target PFAS were detected at all six AOPIs. PFOS and PFOA concentrations met or exceeded SLs for groundwater at five of the AOPIs.

The CSMs were updated for each AOPI where Target PFAS were detected. The updated CSMs detailed site geological conditions; determined primary and secondary release mechanisms; identified potential human receptors; and detailed complete, potentially complete, and incomplete exposure pathways for current and reasonably anticipated future exposure scenarios. Table 7-1 summarizes the conclusions and recommendations for each AOPI.

The following table summarizes the results of the SI project and presents recommendations for further investigation at five of the AOPIs and no further investigation at one AOPI.

Table 7-1. Summary of Target PFAS Detected and Recommendations

AOPI	Detection of Target PFAS?		Recommendation and Rationale
	Groundwater	Soil	
Fire Station 1	Detected	Detected	SLs not exceeded; further investigation not recommended at this time
Fire Station 1 Flushing Area	Meets SL[1]	Detected	SL for PFOS met in groundwater; further investigation recommended
Fire Truck Service Extension	Exceeds SL	Detected	SLs exceeded in groundwater; further investigation recommended
Ordnance Training Center Landfill	Exceeds SL	NS	SLs exceeded in groundwater; further investigation recommended
Former Hayes Batch Treatment Plant	Exceeds SL	ND	SLs exceeded in groundwater; further investigation recommended
Current Industrial Wastewater Treatment Plant	Exceeds SL	NS	SLs exceeded in groundwater; further investigation recommended

<u>Notes</u>:
Highlighted cells are recommended for further investigation.
LOD = Limit of Detection
LUC = Land Use Control
ND = Non-Detect
NS = not sampled
PFAS = per- and polyfluoroalkyl substances
SL = Screening Level
Target PFAS = PFOA, PFOS, PFBA, PFBS, PFNA, PFHxA, and/or PFHxS
[1] J flagged groundwater results equal to the SL for PFOS. A J flag indicates that the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

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FIGURES

BRAC Site Inspection
Red River Army Depot, TX

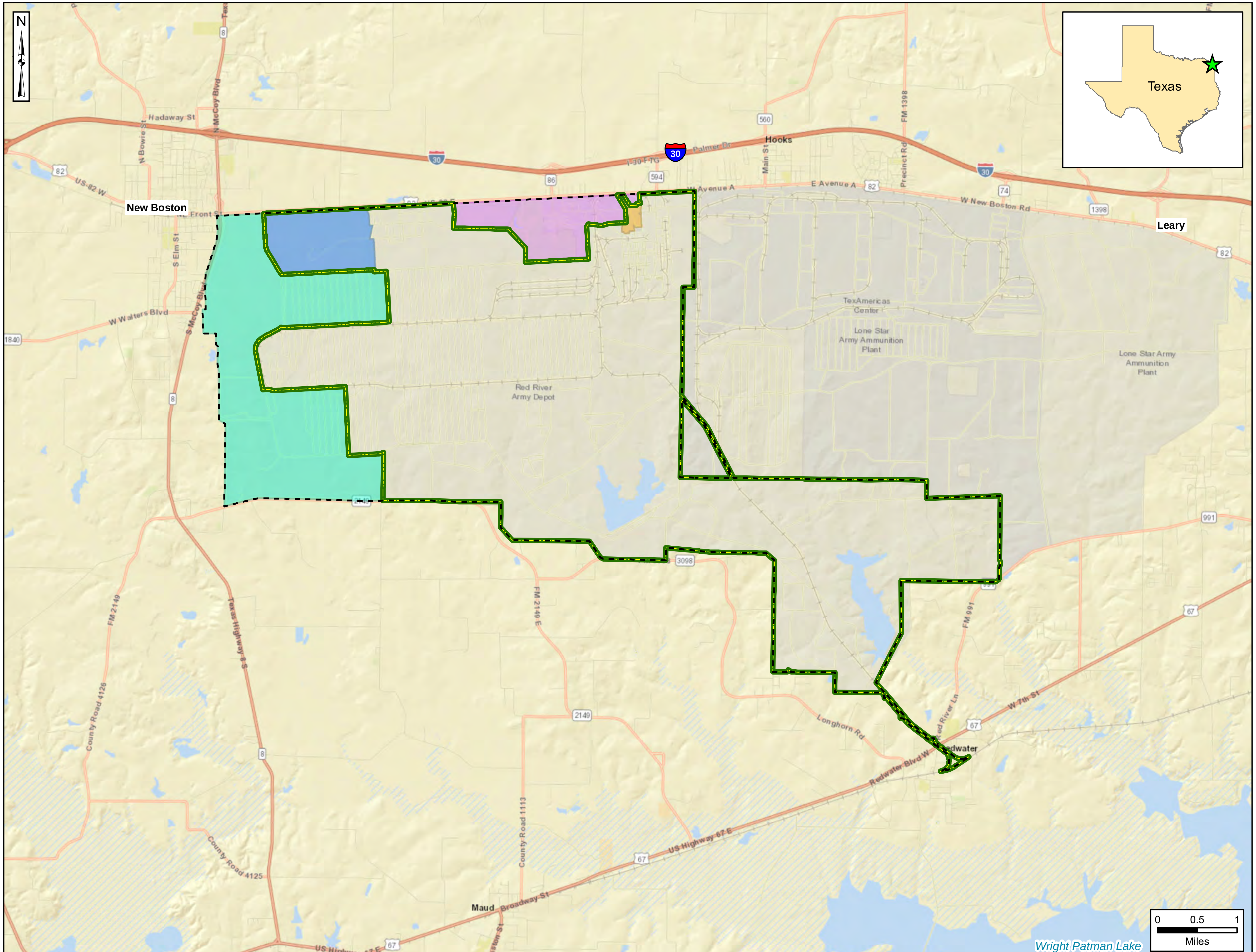


Figure 1-1
Installation Location

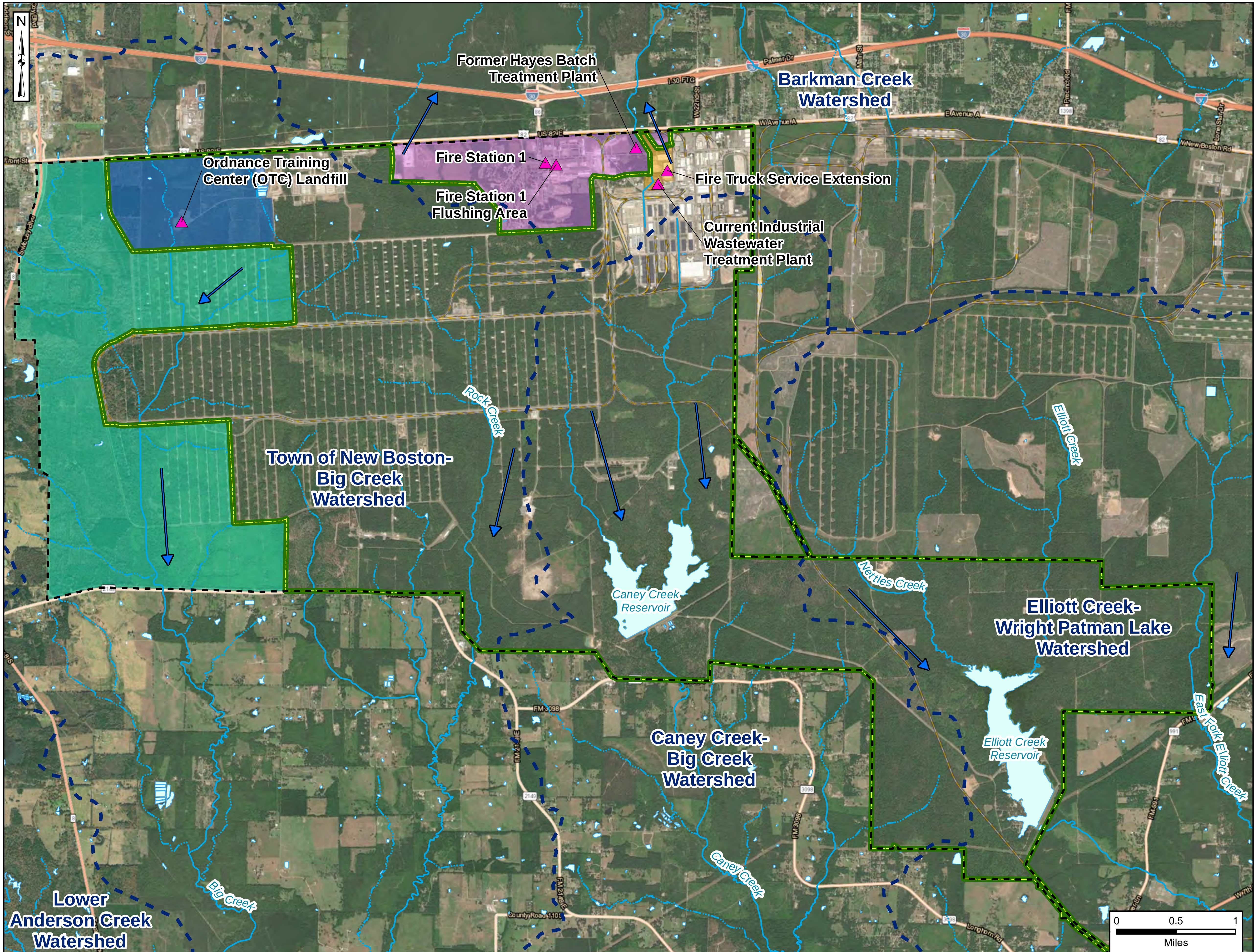
Legend

- Installation Boundary
- Historical RRAD Installation Boundary
- BRAC 1995 – To Be Transferred (Army Retained, BRAC Control)
- BRAC 1995 – Transfer Complete
- BRAC 2005 – To Be Transferred (Army Retained, BRAC Control)
- BRAC 2005 – Transfer Complete

BRAC = Base Realignment and Closure

Data Sources:
Red River Army Depot, GIS Data, 2018
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 15 North



BRAC Site Inspection
Red River Army Depot, TX

Figure 1-2
AOPI Locations

Legend
Installation Boundary
Historical RRAD Installation Boundary
AOPI Location
BRAC 1995 – To Be Transferred (Army Retained, BRAC Control)
BRAC 1995 – Transfer Complete
BRAC 2005 – To Be Transferred (Army Retained, BRAC Control)
BRAC 2005 – Transfer Complete
River/Stream (Perennial)
Stream (Intermittent)
Water Body
Watershed
Surface Water Flow Direction

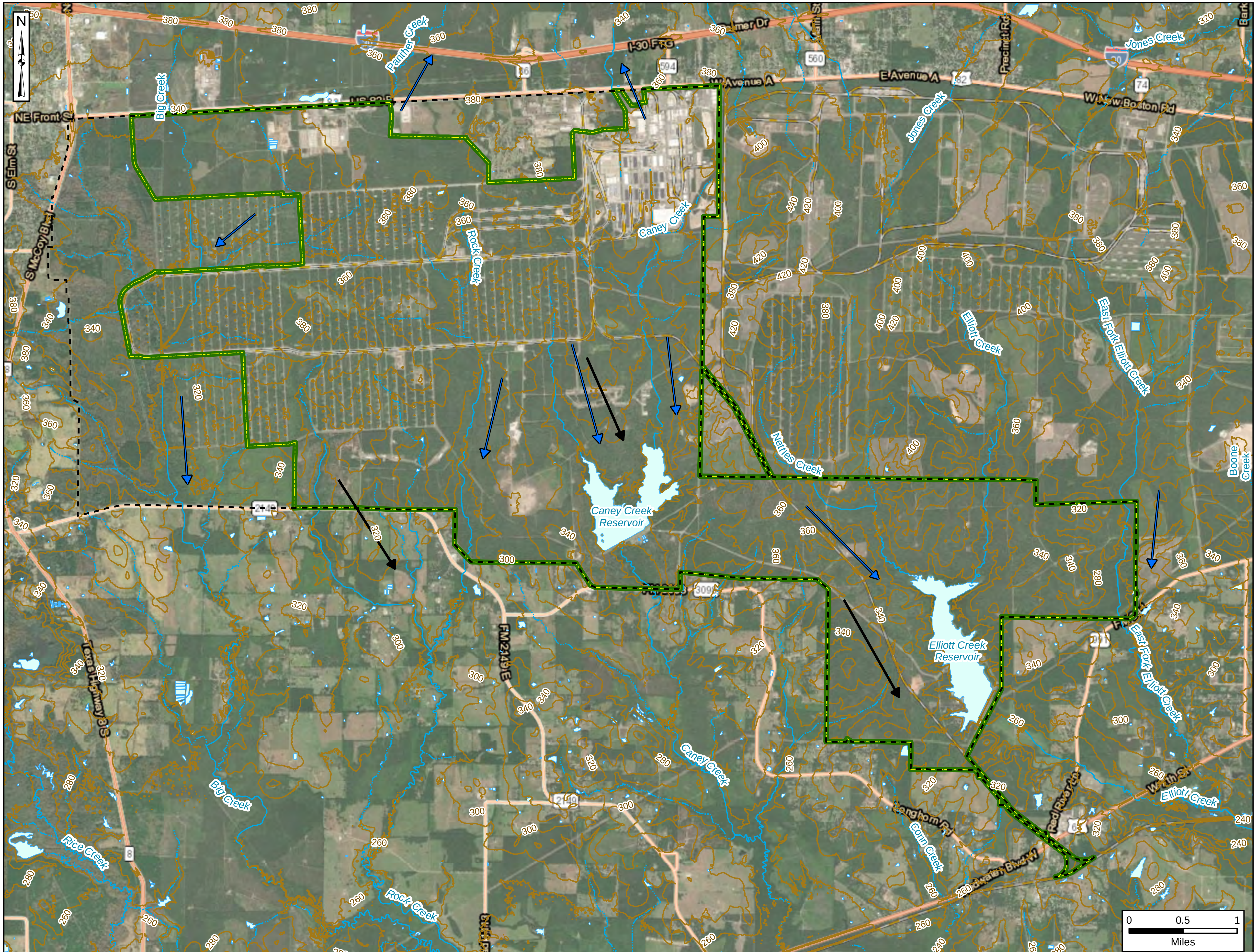
AOPI = area of potential interest
BRAC = Base Realignment and Closure

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

BRAC Site Inspection
Red River Army Depot, TX

Figure 2-1
Site Features



Legend

- Installation Boundary
- Historical RRAD Installation Boundary
- Elevation Contour (feet)
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction
- Approximate Groundwater Flow Direction (Carrizo-Wilcox Aquifer)

Data Sources:
Red River Army Depot, GIS Data, 2018
NHD, Water Bodies, 2019
URS, Environmental Condition of Property Report, Groundwater Flow, 2006
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

BRAC Site Inspection
Red River Army Depot, TX

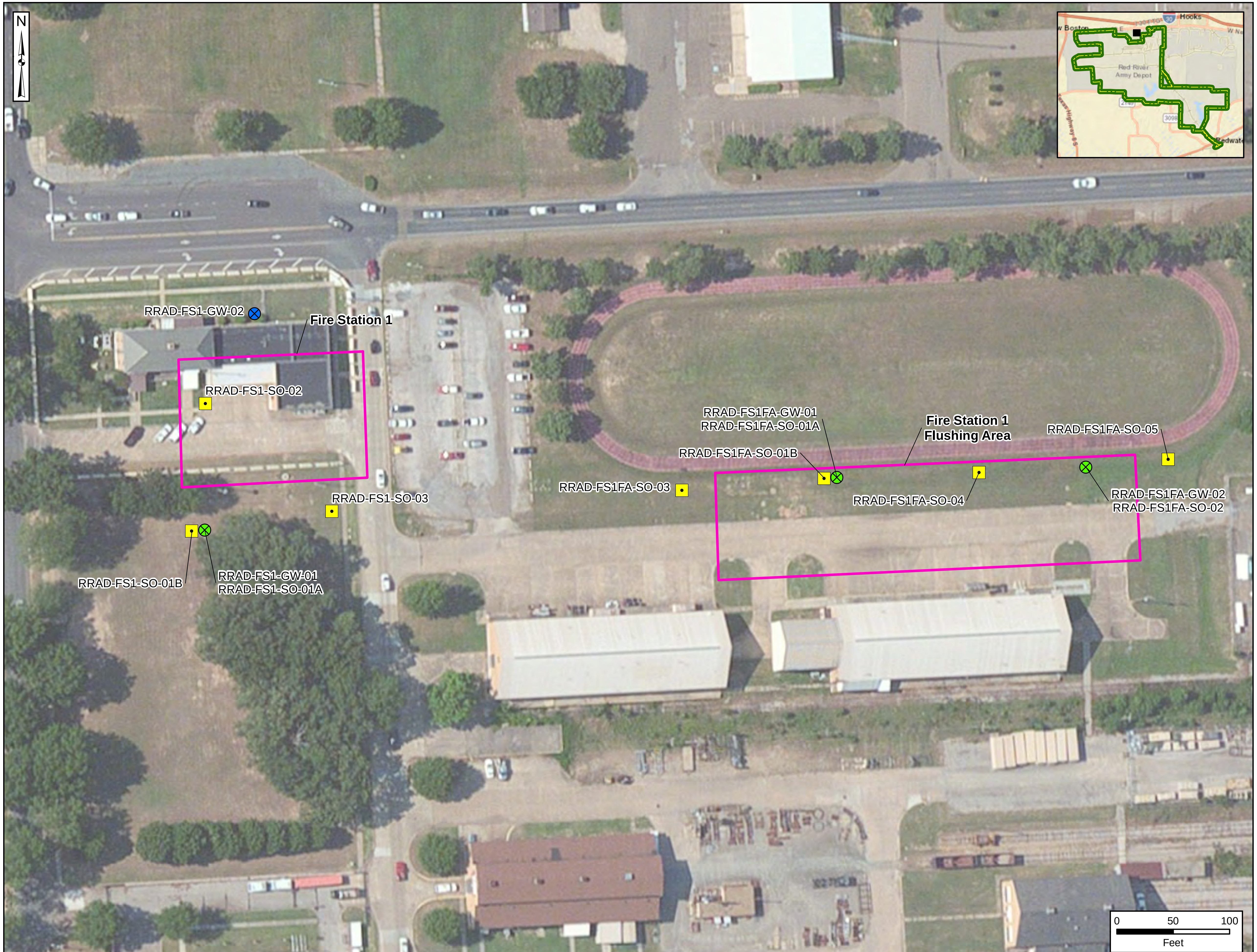


Figure 6-1
Fire Station 1 and Fire Station 1 Flushing Area Sample Locations

Legend

- Installation Boundary
- AOPI

Sampling Locations

- Groundwater (DPT)
- Groundwater / Surface Soil (DPT)
- Surface Soil (Hand Auger)

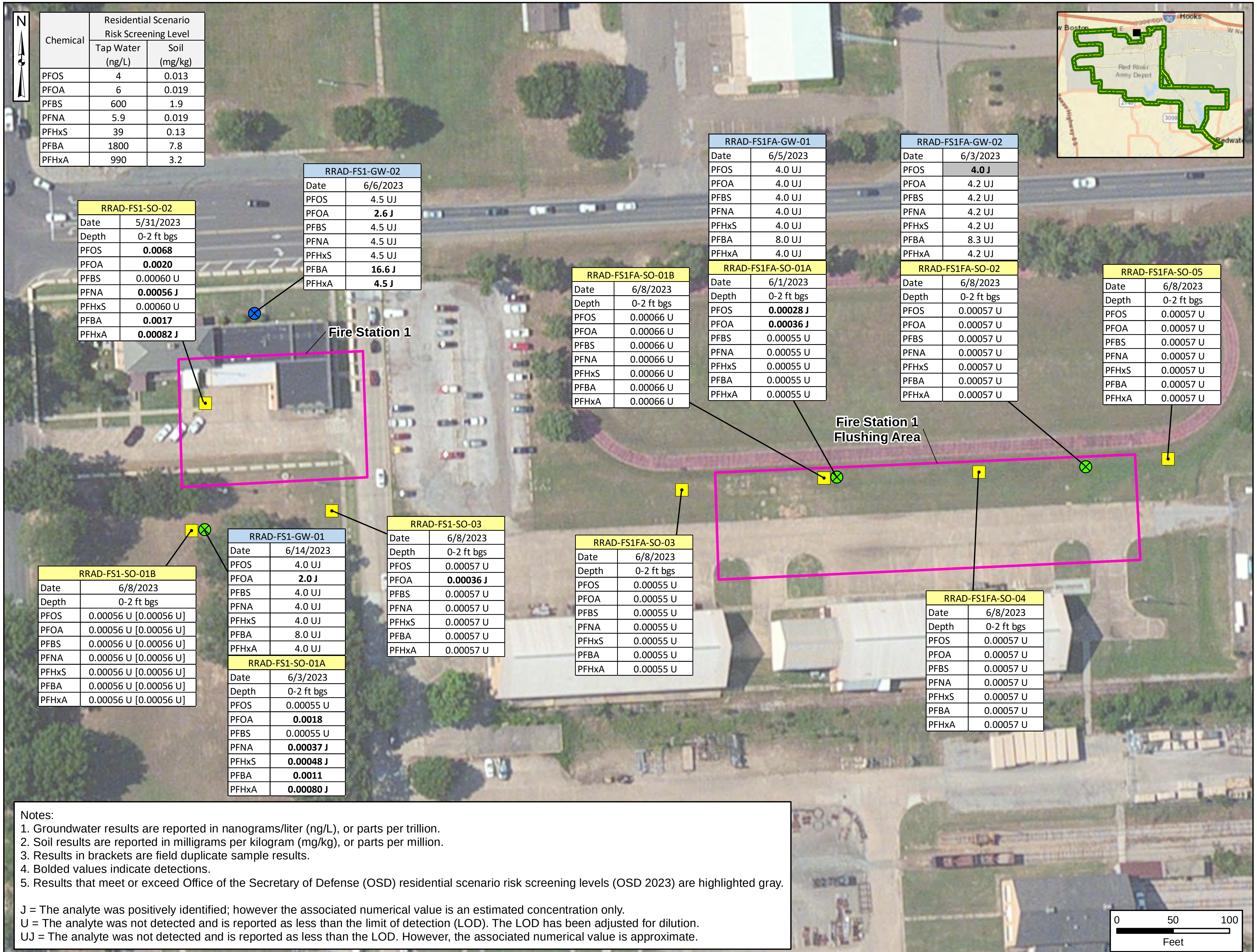
AOPI = area of potential interest
DPT = direct-push technhology

Data Sources:
Red River Army Depot, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

BRAC Site Inspection
Red River Army Depot, TX

Figure 6-2
Fire Station 1 and Fire Station 1 Flushing Area Sample Results



Chemical	Residential Scenario Risk Screening Level	
	Tap Water (ng/L)	Soil (mg/kg)
PFOS	4	0.013
PFOA	6	0.019
PFBS	600	1.9
PFNA	5.9	0.019
PFHxS	39	0.13
PFBA	1800	7.8
PFHxA	990	3.2

RRAD-FS1-SO-02	
Date	5/31/2023
Depth	0-2 ft bgs
PFOS	**0.0068**
PFOA	**0.0020**
PFBS	0.00060 U
PFNA	**0.00056 J**
PFHxS	0.00060 U
PFBA	**0.0017**
PFHxA	**0.00082 J**

RRAD-FS1-GW-02	
Date	6/6/2023
PFOS	4.5 UJ
PFOA	**2.6 J**
PFBS	4.5 UJ
PFNA	4.5 UJ
PFHxS	4.5 UJ
PFBA	**16.6 J**
PFHxA	**4.5 J**

RRAD-FS1FA-GW-01	
Date	6/5/2023
PFOS	4.0 UJ
PFOA	4.0 UJ
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	8.0 UJ
PFHxA	4.0 UJ

RRAD-FS1FA-GW-02	
Date	6/3/2023
PFOS	**4.0 J**
PFOA	4.2 UJ
PFBS	4.2 UJ
PFNA	4.2 UJ
PFHxS	4.2 UJ
PFBA	8.3 UJ
PFHxA	4.2 UJ

RRAD-FS1FA-SO-01B	
Date	6/8/2023
Depth	0-2 ft bgs
PFOS	0.00066 U
PFOA	0.00066 U
PFBS	0.00066 U
PFNA	0.00066 U
PFHxS	0.00066 U
PFBA	0.00066 U
PFHxA	0.00066 U

RRAD-FS1FA-SO-01A	
Date	6/1/2023
Depth	0-2 ft bgs
PFOS	**0.00028 J**
PFOA	**0.00036 J**
PFBS	0.00055 U
PFNA	0.00055 U
PFHxS	0.00055 U
PFBA	0.00055 U
PFHxA	0.00055 U

RRAD-FS1FA-SO-02	
Date	6/8/2023
Depth	0-2 ft bgs
PFOS	0.00057 U
PFOA	0.00057 U
PFBS	0.00057 U
PFNA	0.00057 U
PFHxS	0.00057 U
PFBA	0.00057 U
PFHxA	0.00057 U

RRAD-FS1FA-SO-05	
Date	6/8/2023
Depth	0-2 ft bgs
PFOS	0.00057 U
PFOA	0.00057 U
PFBS	0.00057 U
PFNA	0.00057 U
PFHxS	0.00057 U
PFBA	0.00057 U
PFHxA	0.00057 U

RRAD-FS1-SO-01B	
Date	6/8/2023
Depth	0-2 ft bgs
PFOS	0.00056 U [0.00056 U]
PFOA	0.00056 U [0.00056 U]
PFBS	0.00056 U [0.00056 U]
PFNA	0.00056 U [0.00056 U]
PFHxS	0.00056 U [0.00056 U]
PFBA	0.00056 U [0.00056 U]
PFHxA	0.00056 U [0.00056 U]

RRAD-FS1-GW-01	
Date	6/14/2023
PFOS	4.0 UJ
PFOA	**2.0 J**
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	8.0 UJ
PFHxA	4.0 UJ

RRAD-FS1-SO-01A	
Date	6/3/2023
Depth	0-2 ft bgs
PFOS	0.00055 U
PFOA	**0.0018**
PFBS	0.00055 U
PFNA	**0.00037 J**
PFHxS	**0.00048 J**
PFBA	**0.0011**
PFHxA	**0.00080 J**

RRAD-FS1-SO-03	
Date	6/8/2023
Depth	0-2 ft bgs
PFOS	0.00057 U
PFOA	**0.00036 J**
PFBS	0.00057 U
PFNA	0.00057 U
PFHxS	0.00057 U
PFBA	0.00057 U
PFHxA	0.00057 U

RRAD-FS1FA-SO-03	
Date	6/8/2023
Depth	0-2 ft bgs
PFOS	0.00055 U
PFOA	0.00055 U
PFBS	0.00055 U
PFNA	0.00055 U
PFHxS	0.00055 U
PFBA	0.00055 U
PFHxA	0.00055 U

RRAD-FS1FA-SO-04	
Date	6/8/2023
Depth	0-2 ft bgs
PFOS	0.00057 U
PFOA	0.00057 U
PFBS	0.00057 U
PFNA	0.00057 U
PFHxS	0.00057 U
PFBA	0.00057 U
PFHxA	0.00057 U

Notes:
1. Groundwater results are reported in nanograms/liter (ng/L), or parts per trillion.
2. Soil results are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Results in brackets are field duplicate sample results.
4. Bolded values indicate detections.
5. Results that meet or exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2023) are highlighted gray.

J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
U = The analyte was not detected and is reported as less than the limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was not detected and is reported as less than the LOD. However, the associated numerical value is approximate.

Legend

Installation Boundary
AOPI

Sampling Locations

Groundwater (DPT)
Groundwater / Surface Soil (DPT)
Surface Soil (Hand Auger)

AOPI = area of potential interest
DPT = direct-push technhology
ft bgs = feet below ground surface
PFBA = perfluorobutanoic acid
PFBS = perfluorobutanesulfonic acid
PFHxA = perfluorohexanoic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
Red River Army Depot, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

Source Medium	Release / Transport Mechanisms	Environmental Media	Release / Transport Mechanisms	Exposure Media	Exposure Route	Human Receptors: Onsite [1]: Current/Future Site Worker	Human Receptors: Onsite [1]: Hypothetical Future Resident [2]	Human Receptors: Offsite [1]: Current/ Future Residents	Human Receptors: Offsite [1]: Current/Future Recreational Users
Releases of AFFF to Soil and/or Paved Surfaces	→	→	→	Soil	Ingestion	●	◐	– [3]	– [3]
					Dermal Contact	●	◐	– [3]	– [3]
					Inhalation (dust)	●	◐	– [3]	– [3]
Releases of AFFF to Soil and/or Paved Surfaces	Desorption / Dissolution	Groundwater	→	Groundwater	Ingestion	◐ [4]	◐ [4]	◐	–
					Dermal Contact	◐ [4]	◐ [4]	◐	–

Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

– = Not applicable

Notes:

[1] Onsite refers to the area within the 4,632 acres of BRAC property, and offsite refers to the area outside the boundary of the BRAC property.

[2] There are no current residents at RRAD. Therefore, all exposure pathways for current residents are incomplete.

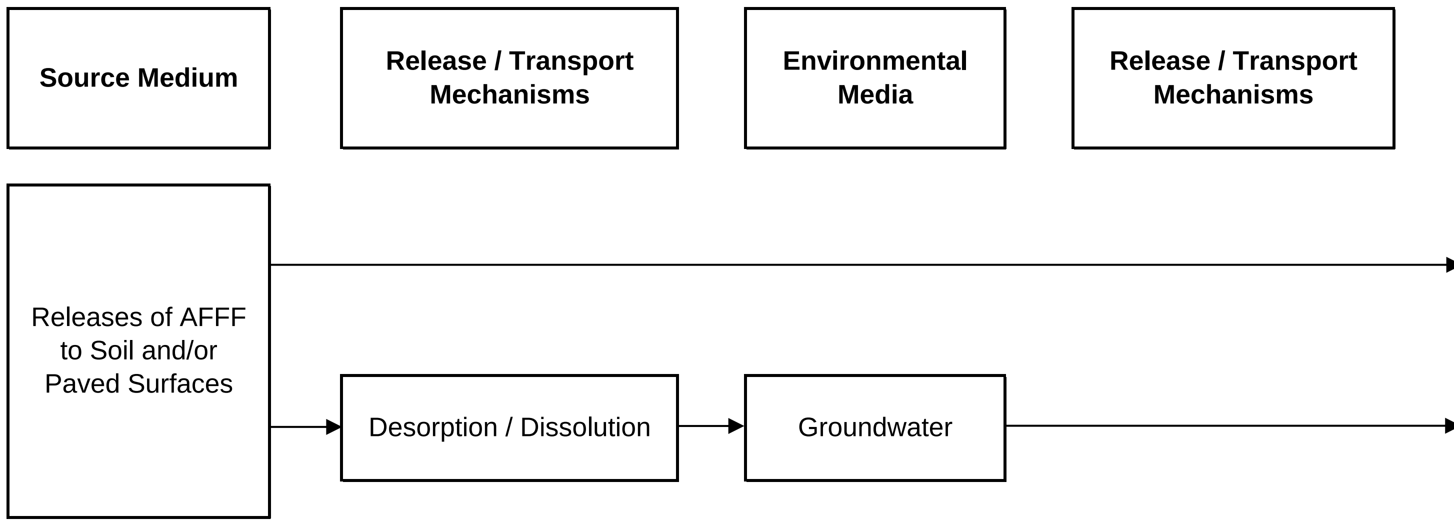
[3] Offsite receptors are not expected to be exposed to soil at the AOPIs.

[4] Shallow groundwater at RRAD is classified as Class III. Class III groundwater is generally not considered suitable for human consumption. Groundwater is not currently used and historically has never been used as a drinking water source for the installation. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use.

AFFF = aqueous film-forming foam
AOPI = area of potential interest
BRAC = Base Realignment and Closure
RRAD = Red River Army Depot

Human Health Conceptual Site Model for Fire Station 1
BRAC Site Inspection for Per- and Polyfluoroalkyl Substances
Red River Army Depot, Texas

Figure 6-3



Exposure Media	Exposure Route	Human Receptors			
		Onsite [1]		Offsite [1]	
		Current/Future Site Worker	Hypothetical Future Resident [2]	Current/ Future Residents	Current/Future Recreational Users
Soil	Ingestion	●	◐	– [3]	– [3]
	Dermal Contact	●	◐	– [3]	– [3]
	Inhalation (dust)	●	◐	– [3]	– [3]
Groundwater	Ingestion	◐ [4]	◐ [4]	◐	–
	Dermal Contact	◐ [4]	◐ [4]	◐	–

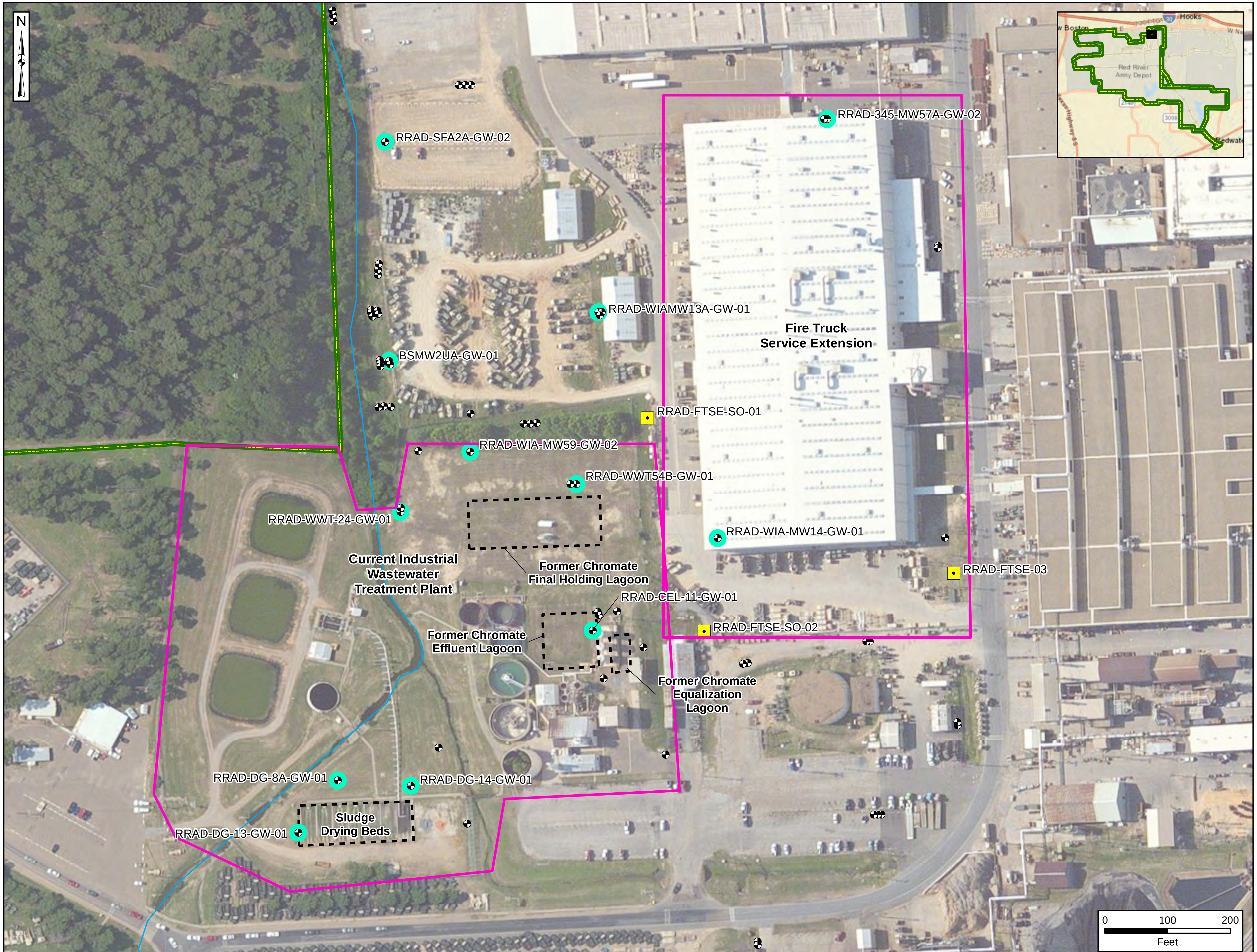
Legend:
- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway
- – = Not applicable

Notes:
[1] Onsite refers to the area within the 4,632 acres of BRAC property, and offsite refers to the area outside the boundary of the BRAC property.
[2] There are no current residents at RRAD. Therefore, all exposure pathways for current residents are incomplete.
[3] Offsite receptors are not expected to be exposed to soil at the AOPIs.
[4] Shallow groundwater at RRAD is classified as Class III. Class III groundwater is generally not considered suitable for human consumption. Groundwater is not currently used and historically has never been used as a drinking water source for the installation. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use.

AFFF = aqueous film-forming foam
AOPI = area of potential interest
BRAC = Base Realignment and Closure
RRAD = Red River Army Depot

Human Conceptual Site Model for Fire Station 1 Flushing Area
BRAC Site Inspection for Per- and Polyfluoroalkyl Substances
Red River Army Depot, Texas

Figure 6-4



BRAC Site Inspection
Red River Army Depot, TX

Figure 6-5
Fire Truck Service Extension and Current Industrial Wastewater Treatment Plant Sample Locations

Legend

- Installation Boundary
- AOPI
- Former Site Feature
- River/Stream (Perennial)
- Monitoring Well

Sampling Locations

- Surface Soil (Hand Auger)
- Groundwater (Existing Well)

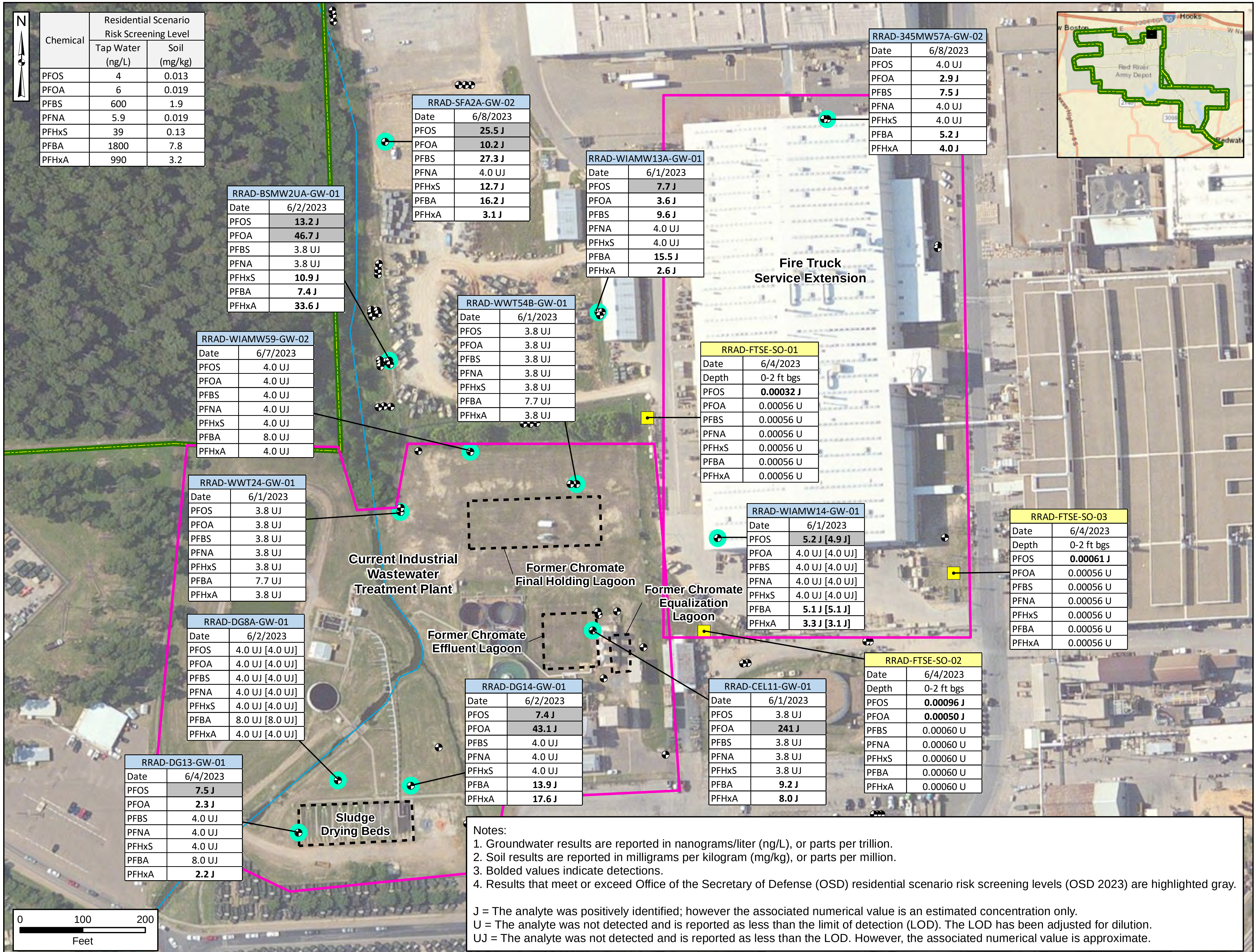
AOPI = area of potential interest

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

BRAC Site Inspection
Red River Army Depot, TX

Figure 6-6
Fire Truck Service Extension and Current Industrial Wastewater Treatment Plant Sample Results



Chemical	Residential Scenario Risk Screening Level	
	Tap Water (ng/L)	Soil (mg/kg)
PFOS	4	0.013
PFOA	6	0.019
PFBS	600	1.9
PFNA	5.9	0.019
PFHxS	39	0.13
PFBA	1800	7.8
PFHxA	990	3.2

RRAD-SFA2A-GW-02	
Date	6/8/2023
PFOS	**25.5 J**
PFOA	**10.2 J**
PFBS	**27.3 J**
PFNA	4.0 UJ
PFHxS	**12.7 J**
PFBA	**16.2 J**
PFHxA	**3.1 J**

RRAD-345MW57A-GW-02	
Date	6/8/2023
PFOS	4.0 UJ
PFOA	**2.9 J**
PFBS	**7.5 J**
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	**5.2 J**
PFHxA	**4.0 J**

RRAD-WIAMW13A-GW-01	
Date	6/1/2023
PFOS	**7.7 J**
PFOA	**3.6 J**
PFBS	**9.6 J**
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	**15.5 J**
PFHxA	**2.6 J**

RRAD-BSMW2UA-GW-01	
Date	6/2/2023
PFOS	**13.2 J**
PFOA	**46.7 J**
PFBS	3.8 UJ
PFNA	3.8 UJ
PFHxS	**10.9 J**
PFBA	**7.4 J**
PFHxA	**33.6 J**

RRAD-WWT54B-GW-01	
Date	6/1/2023
PFOS	3.8 UJ
PFOA	3.8 UJ
PFBS	3.8 UJ
PFNA	3.8 UJ
PFHxS	3.8 UJ
PFBA	7.7 UJ
PFHxA	3.8 UJ

RRAD-WIAMW59-GW-02	
Date	6/7/2023
PFOS	4.0 UJ
PFOA	4.0 UJ
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	8.0 UJ
PFHxA	4.0 UJ

RRAD-FTSE-SO-01	
Date	6/4/2023
Depth	0-2 ft bgs
PFOS	**0.00032 J**
PFOA	0.00056 U
PFBS	0.00056 U
PFNA	0.00056 U
PFHxS	0.00056 U
PFBA	0.00056 U
PFHxA	0.00056 U

RRAD-WWT24-GW-01	
Date	6/1/2023
PFOS	3.8 UJ
PFOA	3.8 UJ
PFBS	3.8 UJ
PFNA	3.8 UJ
PFHxS	3.8 UJ
PFBA	7.7 UJ
PFHxA	3.8 UJ

RRAD-WIAMW14-GW-01	
Date	6/1/2023
PFOS	**5.2 J [4.9 J]**
PFOA	4.0 UJ [4.0 UJ]
PFBS	4.0 UJ [4.0 UJ]
PFNA	4.0 UJ [4.0 UJ]
PFHxS	4.0 UJ [4.0 UJ]
PFBA	**5.1 J [5.1 J]**
PFHxA	**3.3 J [3.1 J]**

RRAD-FTSE-SO-03	
Date	6/4/2023
Depth	0-2 ft bgs
PFOS	**0.00061 J**
PFOA	0.00056 U
PFBS	0.00056 U
PFNA	0.00056 U
PFHxS	0.00056 U
PFBA	0.00056 U
PFHxA	0.00056 U

RRAD-DG8A-GW-01	
Date	6/2/2023
PFOS	4.0 UJ [4.0 UJ]
PFOA	4.0 UJ [4.0 UJ]
PFBS	4.0 UJ [4.0 UJ]
PFNA	4.0 UJ [4.0 UJ]
PFHxS	4.0 UJ [4.0 UJ]
PFBA	8.0 UJ [8.0 UJ]
PFHxA	4.0 UJ [4.0 UJ]

RRAD-FTSE-SO-02	
Date	6/4/2023
Depth	0-2 ft bgs
PFOS	**0.00096 J**
PFOA	**0.00050 J**
PFBS	0.00060 U
PFNA	0.00060 U
PFHxS	0.00060 U
PFBA	0.00060 U
PFHxA	0.00060 U

RRAD-DG14-GW-01	
Date	6/2/2023
PFOS	**7.4 J**
PFOA	**43.1 J**
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	**13.9 J**
PFHxA	**17.6 J**

RRAD-CEL11-GW-01	
Date	6/1/2023
PFOS	3.8 UJ
PFOA	**241 J**
PFBS	3.8 UJ
PFNA	3.8 UJ
PFHxS	3.8 UJ
PFBA	**9.2 J**
PFHxA	**8.0 J**

RRAD-DG13-GW-01	
Date	6/4/2023
PFOS	**7.5 J**
PFOA	**2.3 J**
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	8.0 UJ
PFHxA	**2.2 J**

Notes:
1. Groundwater results are reported in nanograms/liter (ng/L), or parts per trillion.
2. Soil results are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Results that meet or exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2023) are highlighted gray.

J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
U = The analyte was not detected and is reported as less than the limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was not detected and is reported as less than the LOD. However, the associated numerical value is approximate.

Legend

- Installation Boundary
- AOPI
- Former Site Feature
- River/Stream (Perennial)
- Monitoring Well

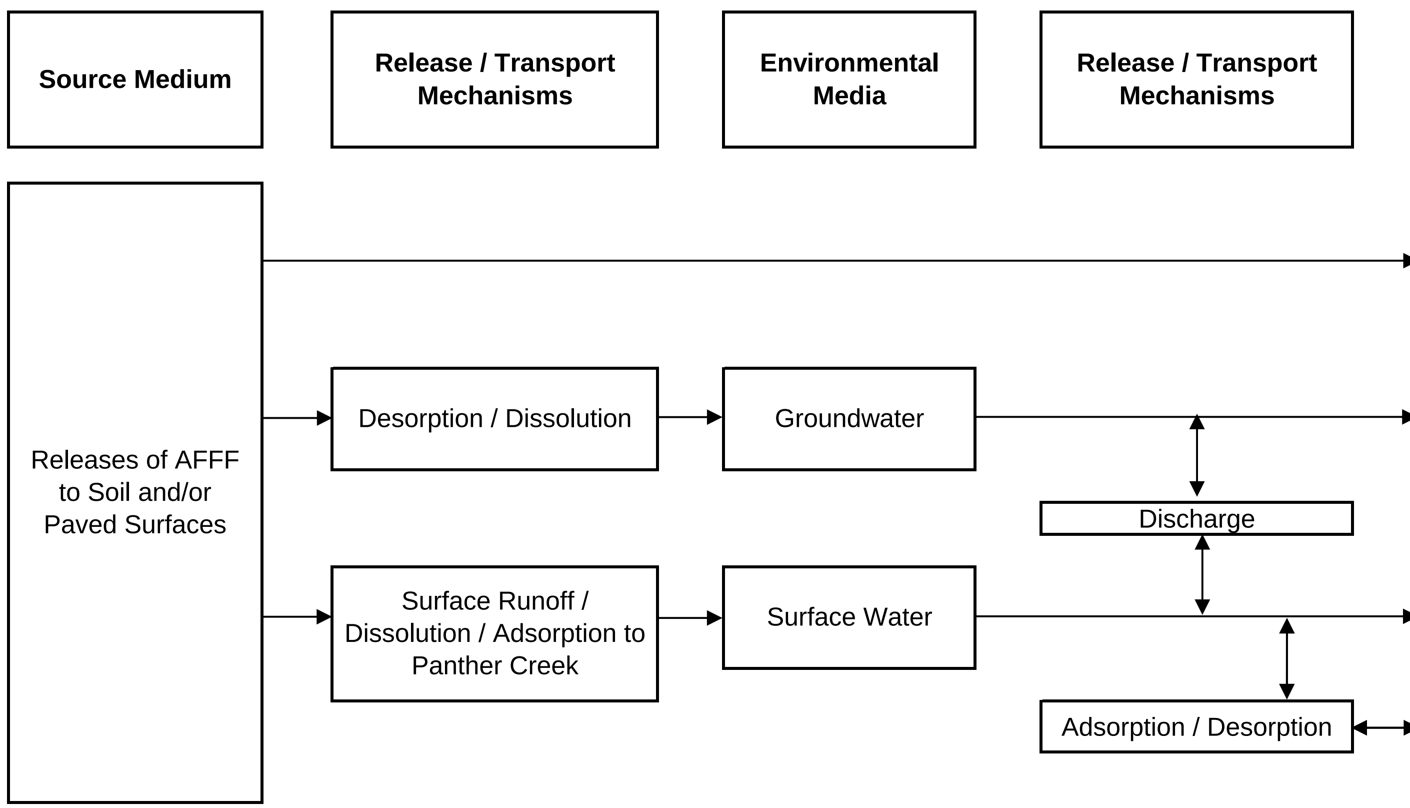
Sampling Locations

- Surface Soil (Hand Auger)
- Groundwater (Existing Well)

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBA = perfluorobutanoic acid
PFBS = perfluorobutanesulfonic acid
PFHxA = perfluorohexanoic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



Exposure Media	Exposure Route	Human Receptors			
		Onsite [1]		Offsite [1]	
		Current/Future Site Worker	Hypothetical Future Resident [2]	Current/ Future Residents	Current/Future Recreational Users
Soil	Ingestion	●	◐	– [3]	– [3]
	Dermal Contact	●	◐	– [3]	– [3]
	Inhalation (dust)	●	◐	– [3]	– [3]
Groundwater	Ingestion	◐ [4]	◐ [4]	◐	–
	Dermal Contact	◐ [4]	◐ [4]	◐	–
Surface Water	Ingestion	◐[5]	○	– [6]	◐[5]
	Dermal Contact	◐[5]	○	– [6]	◐[5]
Sediment	Ingestion	◐[5]	○	– [6]	◐[5]
	Dermal Contact	◐[5]	○	– [6]	◐[5]

Legend:

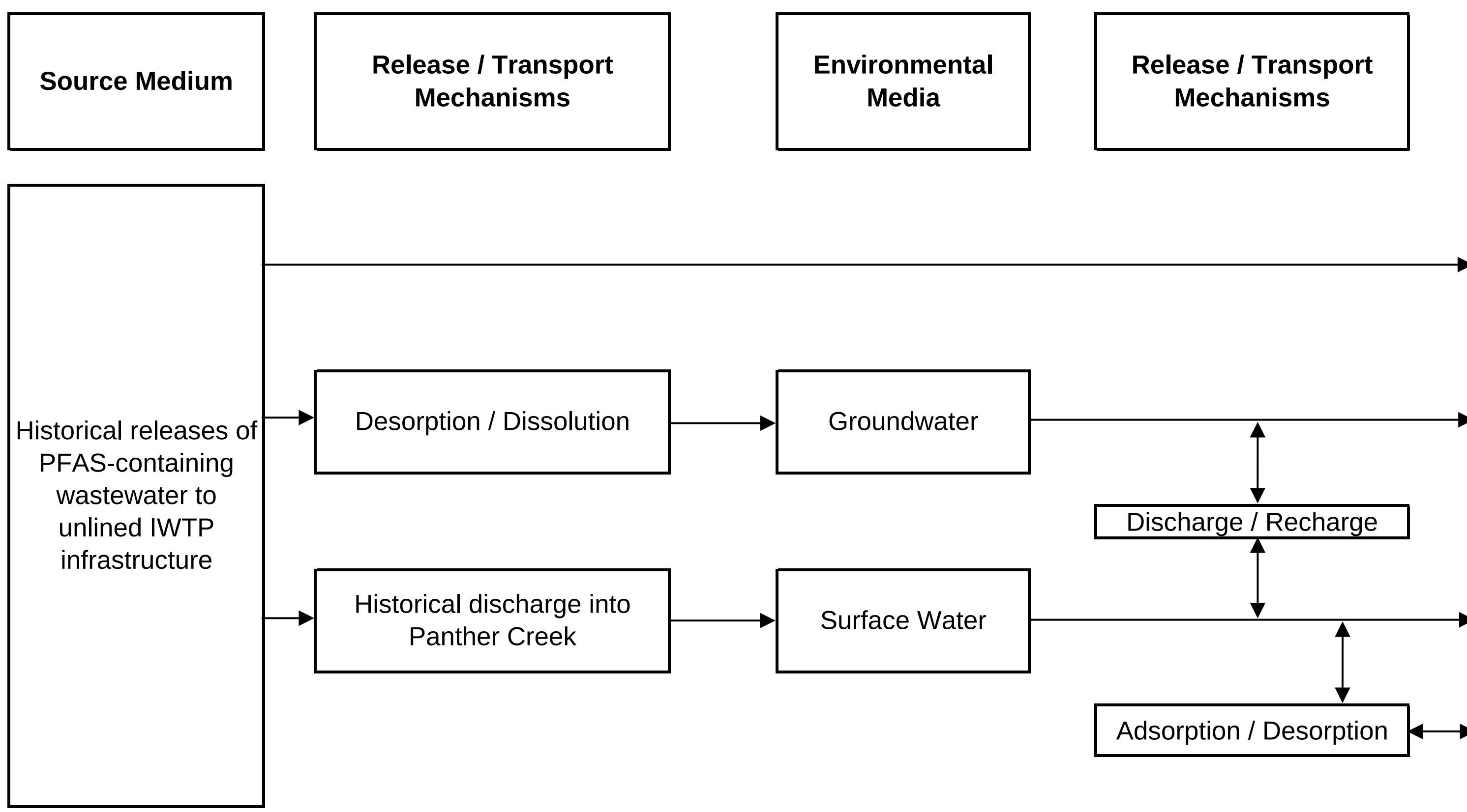
- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway
- – = Not applicable

Notes:
[1] Onsite refers to the area within the 4,632 acres of BRAC property, and offsite refers to the area outside the boundary of the BRAC property.
[2] There are no current residents at RRAD. Therefore, all exposure pathways for current residents are incomplete.
[3] Offsite receptors are not expected to be exposed to soil at the AOPIs.
[4] Shallow groundwater at RRAD is classified as Class III. Class III groundwater is generally not considered suitable for human consumption. Groundwater is not currently used and historically has never been used as a drinking water source for the installation. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use.
[5] Panther Creek and downgradient surface water are not used for drinking water. Surface water exposure pathways for onsite workers and offsite recreational users include incidental ingestion and dermal contact exposures. Fencing is in place to prevent onsite access to Panther Creek, however pathways are conservatively identified as potentially complete.
[6] Surface water and sediment are not potential exposure media applicable to the residential exposure scenario for this AOPI.

AFFF = aqueous film-forming foam
AOPI = area of potential interest
BRAC = Base Realignment and Closure
RRAD = Red River Army Depot

Human Health Conceptual Site Model for Fire Truck Service Extension
BRAC Site Inspection for Per- and Polyfluoroalkyl Substances
Red River Army Depot, Texas

Figure 6-7



Exposure Media	Exposure Route	Human Receptors: Onsite [1]: Current/Future Site Worker	Human Receptors: Onsite [1]: Hypothetical Future Resident [2]	Human Receptors: Offsite [1]: Current/ Future Residents	Human Receptors: Offsite [1]: Current/Future Recreational Users
Sludge/soil associated with historical drying beds and lagoons	Ingestion	◐	◐	– [3]	– [3]
	Dermal Contact	◐	◐	– [3]	– [3]
	Inhalation (dust)	◐	◐	– [3]	– [3]
Groundwater	Ingestion	◐ [4]	◐ [4]	◐	–
	Dermal Contact	◐ [4]	◐ [4]	◐	–
Surface Water	Ingestion	◐[5]	○	– [6]	◐[5]
	Dermal Contact	◐[5]	○	– [6]	◐[5]
Sediment	Ingestion	◐[5]	○	– [6]	◐[5]
	Dermal Contact	◐[5]	○	– [6]	◐[5]

Legend:

● = Complete Exposure Pathway
◐ = Potentially Complete Exposure Pathway
○ = Incomplete Exposure Pathway
– = Not applicable

Notes:
[1] Onsite refers to the area within the 4,632 acres of BRAC property, and offsite refers to the area outside the boundary of the BRAC property.
[2] There are no current residents at RRAD. Therefore, all exposure pathways for current residents are incomplete.
[3] Offsite receptors are not expected to be exposed to soil at the AOPIs.
[4] Shallow groundwater at RRAD is classified as Class III. Class III groundwater is generally not considered suitable for human consumption. Groundwater is not currently used and historically has never been used as a drinking water source for the installation. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use.
[5] Panther Creek and downgradient surface water are not used for drinking water. Surface water exposure pathways for onsite workers and offsite recreational users describe incidental ingestion and dermal contact exposures. Fencing is in place to prevent onsite access to Panther Creek, however pathways are conservatively identified as potentially complete.
[6] Surface water and sediment are not potential exposure media applicable to the residential exposure scenario for this AOPI.

AOPI = area of potential interest
BRAC = Base Realignment and Closure
IWTP = Industrial Wastewater Treatment Plant
PFAS = per- and polyfluoroalkyl substances
RRAD = Red River Army Depot

Human Health Conceptual Site Model for Current IWTP
BRAC Site Inspection for Per- and Polyfluoroalkyl Substances
Red River Army Depot, Texas

Figure 6-8

BRAC Site Inspection
Red River Army Depot, TX

Figure 6-9
Ordnance Training Center (OTC) Landfill
Sample Locations

Legend

- Installation Boundary
- AOPI
- Former Site Feature
- Stream (Intermittent)
- Monitoring Well

Sampling Locations

- Groundwater (Existing Well)

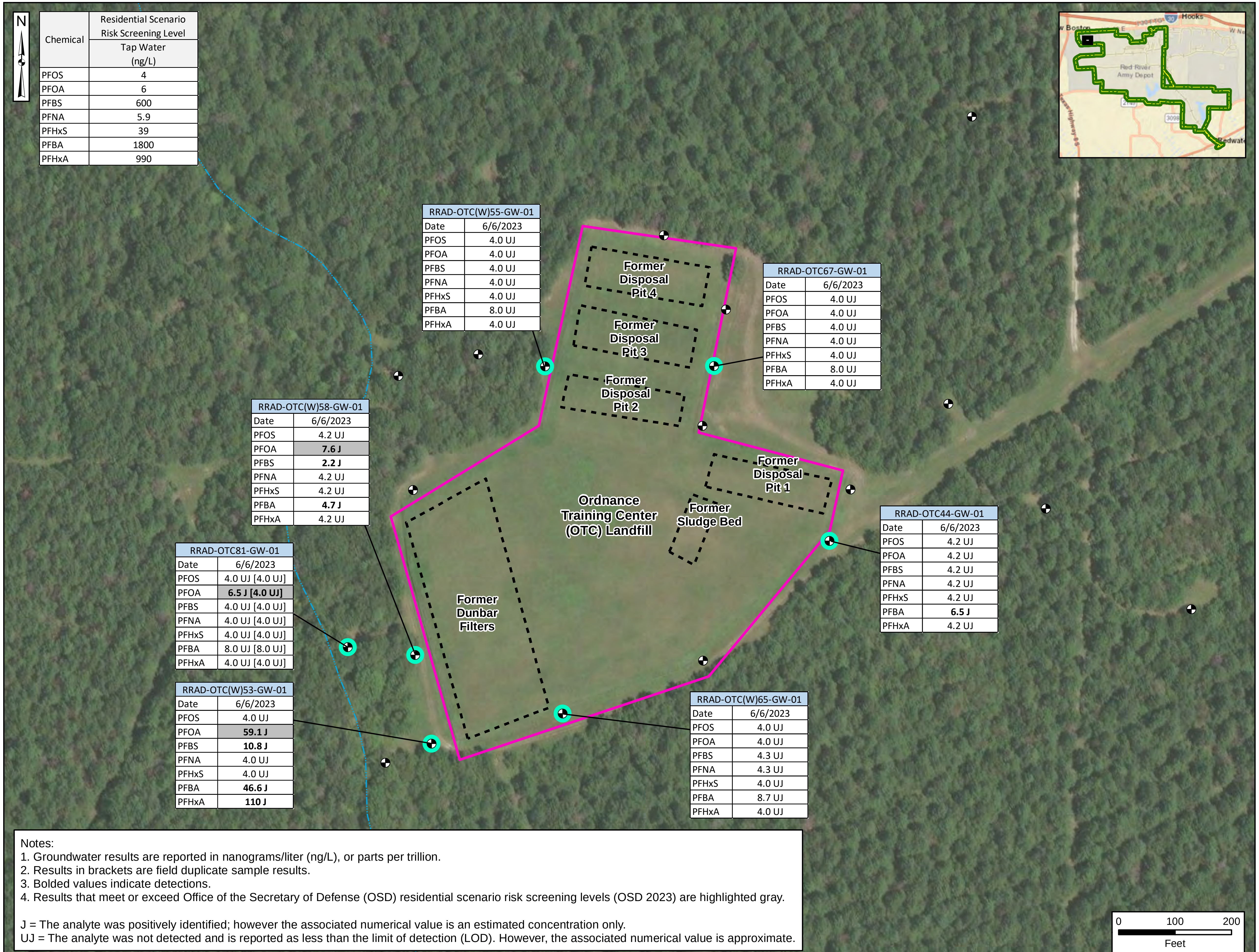
AOPI = area of potential interest

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

BRAC Site Inspection
Red River Army Depot, TX

Figure 6-10
Ordnance Training Center (OTC) Landfill Sample Results



Chemical	Residential Scenario Risk Screening Level Tap Water (ng/L)
PFOS	4
PFOA	6
PFBS	600
PFNA	5.9
PFHxS	39
PFBA	1800
PFHxA	990

RRAD-OTC(W)55-GW-01	
Date	6/6/2023
PFOS	4.0 UJ
PFOA	4.0 UJ
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	8.0 UJ
PFHxA	4.0 UJ

RRAD-OTC67-GW-01	
Date	6/6/2023
PFOS	4.0 UJ
PFOA	4.0 UJ
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	8.0 UJ
PFHxA	4.0 UJ

RRAD-OTC(W)58-GW-01	
Date	6/6/2023
PFOS	4.2 UJ
PFOA	**7.6 J**
PFBS	**2.2 J**
PFNA	4.2 UJ
PFHxS	4.2 UJ
PFBA	**4.7 J**
PFHxA	4.2 UJ

RRAD-OTC44-GW-01	
Date	6/6/2023
PFOS	4.2 UJ
PFOA	4.2 UJ
PFBS	4.2 UJ
PFNA	4.2 UJ
PFHxS	4.2 UJ
PFBA	**6.5 J**
PFHxA	4.2 UJ

RRAD-OTC81-GW-01	
Date	6/6/2023
PFOS	4.0 UJ [4.0 UJ]
PFOA	**6.5 J [4.0 UJ]**
PFBS	4.0 UJ [4.0 UJ]
PFNA	4.0 UJ [4.0 UJ]
PFHxS	4.0 UJ [4.0 UJ]
PFBA	8.0 UJ [8.0 UJ]
PFHxA	4.0 UJ [4.0 UJ]

RRAD-OTC(W)53-GW-01	
Date	6/6/2023
PFOS	4.0 UJ
PFOA	**59.1 J**
PFBS	**10.8 J**
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	**46.6 J**
PFHxA	**110 J**

RRAD-OTC(W)65-GW-01	
Date	6/6/2023
PFOS	4.0 UJ
PFOA	4.0 UJ
PFBS	4.3 UJ
PFNA	4.3 UJ
PFHxS	4.0 UJ
PFBA	8.7 UJ
PFHxA	4.0 UJ

Notes:
1. Groundwater results are reported in nanograms/liter (ng/L), or parts per trillion.
2. Results in brackets are field duplicate sample results.
3. Bolded values indicate detections.
4. Results that meet or exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2023) are highlighted gray.

J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
UJ = The analyte was not detected and is reported as less than the limit of detection (LOD). However, the associated numerical value is approximate.

Legend

- Installation Boundary
- AOPI
- Former Site Feature
- Stream (Intermittent)
- Monitoring Well

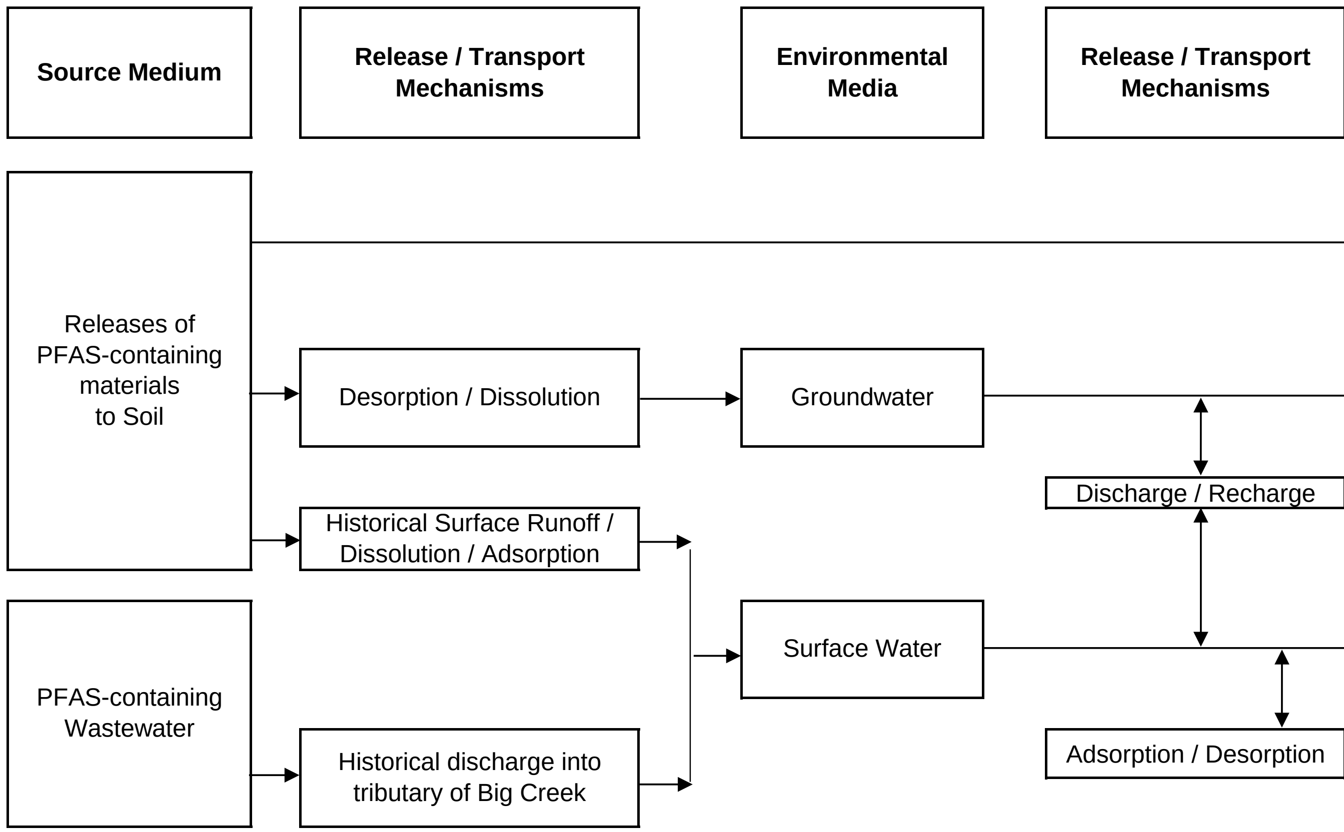
Sampling Locations

- Groundwater (Existing Well)

AOPI = area of potential interest
PFBA = perfluorobutanoic acid
PFBS = perfluorobutanesulfonic acid
PFHxA = perfluorohexanoic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



		Human Receptors			
		Onsite [1]		Offsite [1]	
Exposure Media	Exposure Route	Current/Future Site Worker	Hypothetical Future Resident [2]	Current/Future Residents	Current/Future Recreational Users
Soil	Ingestion	◐	◐	– [3]	– [3]
	Dermal Contact	◐	◐	– [3]	– [3]
	Inhalation (dust)	◐	◐	– [3]	– [3]
Groundwater	Ingestion	◐ [4]	◐ [4]	◐	–
	Dermal Contact	◐ [4]	◐ [4]	◐	–
Surface Water	Ingestion	◐ [5]	○	◐ [6]	◐ [5]
	Dermal Contact	◐ [5]	○	◐ [6]	◐ [5]
Sediment	Ingestion	◐ [5]	○	– [7]	◐ [5]
	Dermal Contact	◐ [5]	○	– [7]	◐ [5]

Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

– = Not applicable

Notes:

[1] Onsite refers to the area within the 4,632 acres of BRAC property, and offsite refers to the area outside the boundary of the BRAC property.
[2] There are no current residents at RRAD. Therefore, all exposure pathways for current residents are incomplete.
[3] Offsite receptors are not expected to be exposed to soil at the AOPIs.
[4] Shallow groundwater at RRAD is classified as Class III. Class III groundwater is generally not considered suitable for human consumption. Groundwater is not currently used and historically has never been used as a drinking water source for the installation. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use.
[5] Surface water exposure pathways for onsite workers and offsite recreational users include incidental ingestion and dermal contact exposures.
[6] Big Creek is upstream of Wright Patman Lake, which is the drinking water source for RRAD and the surrounding communities. Surface water exposure pathways for offsite residents include drinking water ingestion and dermal contact (e.g., washing dishes, showering).
[7] Sediment is not a potential exposure medium applicable to the residential exposure scenario.

AOPI = area of potential interest
BRAC = Base Realignment and Closure
OTC = Ordnance Training Center
PFAS = per- and polyfluoroalkyl substances
RRAD = Red River Army Depot

Human Health Conceptual Site Model for OTC Landfill
BRAC Site Inspection for Per- and Polyfluoroalkyl Substances
Red River Army Depot, Texas

Figure 6-11

BRAC Site Inspection
Red River Army Depot, TX

Figure 6-12
Former Hayes Batch Treatment Plant Sample Locations

Legend

- Installation Boundary
- AOPI
- Former Site Feature
- River/Stream (Perennial)
- Monitoring Well

Sampling Locations

- Groundwater (DPT)
- Groundwater / Surface Soil (DPT)

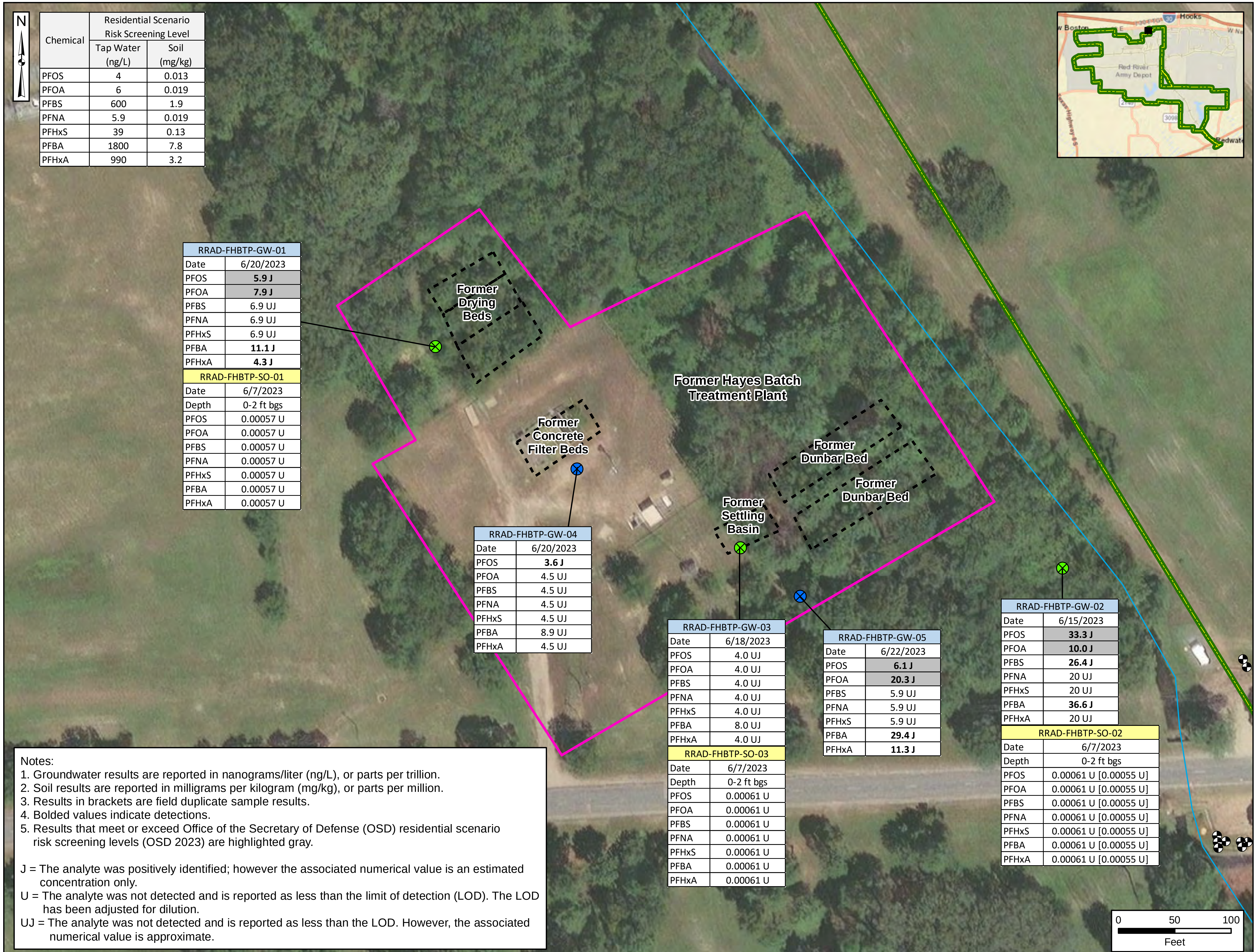
AOPI = area of potential interest
DPT = direct-push technology

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North

BRAC Site Inspection
Red River Army Depot, TX

Figure 6-13
Former Hayes Batch Treatment Plant Sample Results



Chemical	Residential Scenario Risk Screening Level	
	Tap Water (ng/L)	Soil (mg/kg)
PFOS	4	0.013
PFOA	6	0.019
PFBS	600	1.9
PFNA	5.9	0.019
PFHxS	39	0.13
PFBA	1800	7.8
PFHxA	990	3.2

RRAD-FHBTP-GW-01	
Date	6/20/2023
PFOS	**5.9 J**
PFOA	**7.9 J**
PFBS	6.9 UJ
PFNA	6.9 UJ
PFHxS	6.9 UJ
PFBA	**11.1 J**
PFHxA	**4.3 J**

RRAD-FHBTP-SO-01	
Date	6/7/2023
Depth	0-2 ft bgs
PFOS	0.00057 U
PFOA	0.00057 U
PFBS	0.00057 U
PFNA	0.00057 U
PFHxS	0.00057 U
PFBA	0.00057 U
PFHxA	0.00057 U

RRAD-FHBTP-GW-04	
Date	6/20/2023
PFOS	**3.6 J**
PFOA	4.5 UJ
PFBS	4.5 UJ
PFNA	4.5 UJ
PFHxS	4.5 UJ
PFBA	8.9 UJ
PFHxA	4.5 UJ

RRAD-FHBTP-GW-03	
Date	6/18/2023
PFOS	4.0 UJ
PFOA	4.0 UJ
PFBS	4.0 UJ
PFNA	4.0 UJ
PFHxS	4.0 UJ
PFBA	8.0 UJ
PFHxA	4.0 UJ

RRAD-FHBTP-SO-03	
Date	6/7/2023
Depth	0-2 ft bgs
PFOS	0.00061 U
PFOA	0.00061 U
PFBS	0.00061 U
PFNA	0.00061 U
PFHxS	0.00061 U
PFBA	0.00061 U
PFHxA	0.00061 U

RRAD-FHBTP-GW-05	
Date	6/22/2023
PFOS	**6.1 J**
PFOA	**20.3 J**
PFBS	5.9 UJ
PFNA	5.9 UJ
PFHxS	5.9 UJ
PFBA	**29.4 J**
PFHxA	**11.3 J**

RRAD-FHBTP-GW-02	
Date	6/15/2023
PFOS	**33.3 J**
PFOA	**10.0 J**
PFBS	**26.4 J**
PFNA	20 UJ
PFHxS	20 UJ
PFBA	**36.6 J**
PFHxA	20 UJ

RRAD-FHBTP-SO-02	
Date	6/7/2023
Depth	0-2 ft bgs
PFOS	0.00061 U [0.00055 U]
PFOA	0.00061 U [0.00055 U]
PFBS	0.00061 U [0.00055 U]
PFNA	0.00061 U [0.00055 U]
PFHxS	0.00061 U [0.00055 U]
PFBA	0.00061 U [0.00055 U]
PFHxA	0.00061 U [0.00055 U]

Notes:
1. Groundwater results are reported in nanograms/liter (ng/L), or parts per trillion.
2. Soil results are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Results in brackets are field duplicate sample results.
4. Bolded values indicate detections.
5. Results that meet or exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2023) are highlighted gray.

J = The analyte was positively identified; however the associated numerical value is an estimated concentration only.
U = The analyte was not detected and is reported as less than the limit of detection (LOD). The LOD has been adjusted for dilution.
UJ = The analyte was not detected and is reported as less than the LOD. However, the associated numerical value is approximate.

Legend

- Installation Boundary
- AOPI
- Former Site Feature
- River/Stream (Perennial)
- Monitoring Well

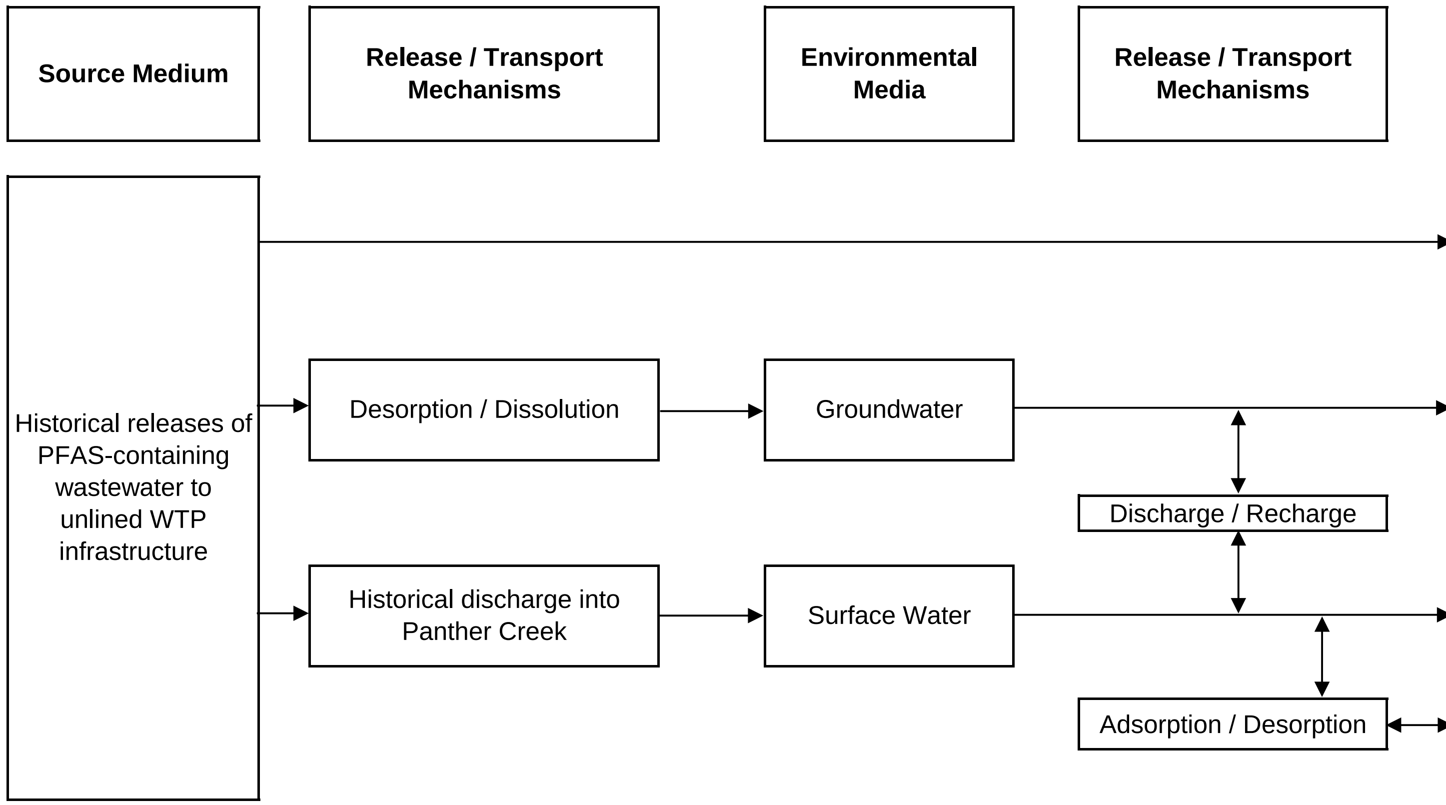
Sampling Locations

- Groundwater (DPT)
- Groundwater / Surface Soil (DPT)

AOPI = area of potential interest
DPT = direct-push technhology
ft bgs = feet below ground surface
PFBA = perfluorobutanoic acid
PFBS = perfluorobutanesulfonic acid
PFHxA = perfluorohexanoic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
Red River Army Depot, GIS Data, 2018
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 15 North



Exposure Media	Exposure Route	Human Receptors: Onsite [1] – Current/Future Site Worker	Human Receptors: Onsite [1] – Hypothetical Future Resident [2]	Human Receptors: Offsite [1] – Current/ Future Residents	Human Receptors: Offsite [1] – Current/Future Recreational Users
Sludge/soil associated with historical drying beds and lagoons	Ingestion	○	○	– [3]	– [3]
	Dermal Contact	○	○	– [3]	– [3]
	Inhalation (dust)	○	○	– [3]	– [3]
Groundwater	Ingestion	◐ [4]	◐ [4]	◐	–
	Dermal Contact	◐ [4]	◐ [4]	◐	–
Surface Water	Ingestion	◐[5]	○	– [6]	◐[5]
	Dermal Contact	◐[5]	○	– [6]	◐[5]
Sediment	Ingestion	◐[5]	○	– [6]	◐[5]
	Dermal Contact	◐[5]	○	– [6]	◐[5]

Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway
- – = Not applicable

Notes:
[1] Onsite refers to the area within the 4,632 acres of BRAC property, and offsite refers to the area outside the boundary of the BRAC property.
[2] There are no current residents at RRAD. Therefore, all exposure pathways for current residents are incomplete.
[3] Offsite receptors are not expected to be exposed to soil at the AOPIs.
[4] Shallow groundwater at RRAD is classified as Class III. Class III groundwater is generally not considered suitable for human consumption. Groundwater is not currently used and historically has never been used as a drinking water source for the installation. However, the onsite groundwater exposure pathway (via drinking water ingestion and dermal contact) is potentially complete because there are no PFAS-specific land use restrictions precluding groundwater use.
[5] Panther Creek and downgradient surface water are not used for drinking water. Surface water exposure pathways for onsite workers and offsite recreational users include incidental ingestion and dermal contact exposures.
[6] Surface water and sediment are not potential exposure media applicable to the residential exposure scenario for this AOPI.

AOPI = area of potential interest
BRAC = Base Realignment and Closure
WTP =Waste Treatment Plant
PFAS = per- and polyfluoroalkyl substances
RRAD = Red River Army Depot

Human Health Conceptual Site Model for Former Hayes Batch Treatment Plant
BRAC Site Inspection for Per- and Polyfluoroalkyl Substances
Red River Army Depot, Texas

Figure 6-14